



July 2016

AVIATION SAFETY

FAA's Risk-Based Oversight for Repair Stations Could Benefit from Additional Airline Data and Performance Metrics

Accessible Version

The electronic version of this report was reissued September 2, 2016, to correct errors related to figure 1 on pag 10.

GAO Highlights

Highlights of [GAO-16-679](#), a report to congressional requesters

Why GAO Did This Study

FAA is responsible for overseeing nearly 4,800 FAA-certificated repair stations in the United States and in foreign countries. While U.S. airlines' rely on repair stations for much of their maintenance, some aviation stakeholders have questioned FAA's oversight of foreign repair stations.

GAO was asked to examine maintenance contracting trends and FAA oversight of repair stations. This report assesses: (1) trends and factors influencing airline maintenance contracting from 2010 through 2014, (2) how FAA's oversight of foreign and domestic repair stations differs and associated challenges, and (3) efforts taken by FAA to improve its risk-based oversight. GAO analyzed BTS data on airlines' maintenance spending from 2010 through 2014 for 28 selected U.S. commercial airlines with the largest number of flights, and interviewed representatives for 10 U.S. airlines. GAO visited seven foreign repair stations in three countries, and interviewed industry representatives. GAO also analyzed FAA inspection and enforcement data for repair stations from 2010 through 2014.

What GAO Recommends

FAA should: (1) develop and implement a process for incorporating into SAS volume data for U.S. airlines' maintenance contracted to repair stations and (2) develop a process to evaluate the effectiveness of SAS. FAA disagreed with the first recommendation, noting it considered other volume-related data, and agreed with the second recommendation. GAO continues to believe the recommendation is valid as discussed in this report.

View [GAO-16-679](#). For more information, contact Gerald Dillingham at (202) 512-2834 or dillingham@gao.gov.

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What GAO Found

The extent to which U.S. airlines contract out aircraft maintenance to domestic and foreign repair stations (as opposed to performing maintenance in-house) has remained relatively steady from 2010 through 2014. GAO's analysis of Bureau of Transportation Statistics (BTS) data for that period (the most recent available) showed that 28 selected U.S. airlines' annual contracted maintenance spending ranged from 58 to 64 percent of their total annual maintenance spending. In addition, representatives for all 10 U.S. airlines GAO interviewed said that the type of aircraft maintenance can affect an airline's decision to contract out maintenance. For instance, airlines generally indicated that the majority of light, routine maintenance—i.e., more suited for overnight or quick turnaround—is performed in-house. However, when it is more cost-effective, they contract some, if not all, of the more involved maintenance and repairs that may require specialized skills and equipment. Industry representatives GAO interviewed also identified three key influencing factors that affect airlines' maintenance decisions: (1) service quality available at repair stations, (2) cost considerations, and (3) the use of service contracts with manufacturers of original aircraft parts.

The Federal Aviation Administration's (FAA) regulatory requirements for foreign repair stations differ in several ways from the requirements for domestic repair stations, including certification, renewal, personnel, and drug and alcohol testing requirements. FAA faces challenges in overseeing foreign repair stations related to its inspectors' ability to conduct routine and unannounced inspections of foreign repair stations. FAA also faces challenges with coordinating inspections of repair stations conducted by its oversight offices for airlines and its oversight offices for repair stations, with some stations receiving around 50 visits per year from the airline oversight offices alone. In response, FAA is implementing new strategies aimed at more efficiently using its resources.

In fiscal year 2015, FAA began to deploy its Safety Assurance System (SAS), a risk-based, data-supported oversight system to help standardize how its inspectors identify safety risks in planning and conducting oversight, including of repair stations. Safety assurance is one of the four components of FAA's new Safety Management System oversight approach, and FAA designed SAS to implement that component. GAO found the design of SAS fully meets three of the five principles FAA identified as key for the safety assurance component and partially meets the other two principles, which involve data collection and management review. SAS enables inspectors to collect various data, but does not enable them to consider a repair station's volume of work when determining risk. FAA does not otherwise collect or track this data. FAA officials said they do not consider volume data to be a standalone risk factor, but FAA has previously stated that tracking volume data could help identify high-risk repair stations. GAO and the Department of Transportation's (DOT) Office of Inspector General have reported on the importance of FAA's collection of quality data for providing a comprehensive risk-based oversight system. Also, FAA conducts management reviews, but has not developed a process with goals and performance metrics for determining the effectiveness of SAS. Without the ability to measure progress toward goals, FAA risks not knowing whether its new, risk-based oversight approach is a success or could be improved.

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Abbreviations

A&P	airframe and power plant
ARSA	Aeronautical Repair Station Association
ATOS	Air Transportation Oversight System
BLS	Bureau of Labor Statistics
BTS	Bureau of Transportation Statistics
CAA	civil aviation authority
CAMP	continuous airworthiness-maintenance program
C.F.R.	Code of Federal Regulations
CMO	certificate management office
CRS	Congressional Research Service
DOT	Department of Transportation
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FSDO	flight standards district office
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFO	international field office
IOSA	IATA Operational Safety Audit
MRO	maintenance, repair, and overhaul organization
OEM	original equipment manufacturer
OIG	Office of Inspector General
OMB	Office of Management and Budget

SAS	Safety Assurance System
SMS	Safety Management System
TCCA	Transport Canada Civil Aviation Directorate

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July 28, 2016

The Honorable Peter A. DeFazio
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives

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

The airline industry contributes to the U.S. economy by providing global mobility and connectivity in transporting passengers and cargo, and is critical for supporting a healthy global economic environment. In 2014, there were approximately 24,600 commercial aircraft in the world fleet, and U.S. airlines operated nearly 6,800 aircraft. These aircraft must be maintained, repaired, and overhauled in compliance with operational and safety standards. Aircraft maintenance is a global enterprise, and airlines worldwide spent about \$62 billion on maintenance in 2014, representing around 9 percent of total operational costs.¹ U.S. commercial airlines have traditionally performed much of their aircraft maintenance in-house. Beginning in the late 1990s, they began to “contract out” certain maintenance activities in order to reduce costs, align those activities with their routing structures, and leverage specialized capabilities available in particular locations, either domestically or in other countries.² Ensuring the U.S. airline industry maintains its unprecedented safety record depends, in part, on the roughly 4,800 repair stations located in the United States (domestic) and in foreign countries that are certificated by

¹International Air Transport Association, *Airline Maintenance Cost Executive Commentary, An Exclusive Benchmark Analysis (FY2014 data) by IATA’s Maintenance Cost Task Force (Public)* (December 2015). IATA is the industry trade association that represents airlines worldwide.

²For purposes of this report, contracting refers to any maintenance, preventive maintenance, or alteration activities that U.S. airlines choose not to perform, but rather, contract to external, unrelated, or unaffiliated sources.

the Federal Aviation Administration (FAA).³ The practice of contracting maintenance is not restricted to the United States as other countries' airlines contract some of their aircraft maintenance work to U.S. repair stations (i.e., "insourcing" for purposes of our report) and to other countries. However, questions have been raised in the media and in congressional hearings in recent years over whether U.S. airlines' maintenance contracting practices have adversely affected aviation safety.

The safety of U.S. air travel is a joint responsibility of FAA and the airlines. FAA is responsible for overseeing all repair stations that are certificated under and regulated by Title 14, Code of Federal Regulations (C.F.R.) Part 145.⁴ U.S. airlines are responsible for operating their aircraft safely, and FAA regulations require airlines to ensure that any aircraft maintenance work is performed according to the airline's requirements.⁵ Airlines' use of contracting to repair stations grew from 1990 through 2011 according to the Congressional Research Service (CRS),⁶ and some aviation stakeholders have raised questions about FAA's oversight

³Maintenance, repair, and overhaul organizations—commonly known as MROs—are firms that perform maintenance on aircraft to maintain or to restore them to an airworthy condition since every aircraft must be inspected, maintained, and repaired periodically based on the maintenance manuals to assure airworthiness. For U.S. airlines, FAA regulations require MROs to have an inspection program and a maintenance program. 14 C.F.R. § 121.367. Any maintenance facility that has been approved by FAA to perform aircraft maintenance or repair an aircraft part for U.S. airlines is considered a "repair station."

⁴14 C.F.R. Part 145 prescribes rules for obtaining certification of repair stations, 14 C.F.R. § 145.1. It also contains the rules a certificated repair station must follow related to its performance of maintenance, preventive maintenance, or alterations of an aircraft, airframe, aircraft engine, propeller, appliance, or component part under 14 C.F.R. Part 43 Maintenance, Preventive Maintenance, Rebuilding, and Alteration. 14 C.F.R. § 145.1. It also applies to any person who holds, or is required to hold, a repair station certificate under this part. *Id.*

⁵FAA regulations require that each certificate holder (in this case an airline operator) is primarily responsible for (1) the airworthiness of its aircraft, including airframes, aircraft engines, propellers, appliances, and parts thereof; and (2) the performance of the maintenance, preventive maintenance, and alteration of its aircraft, including airframes, aircraft engines, propellers, appliances, emergency equipment, and parts thereof, in accordance with its manual and the regulations of this chapter. 14 C.F.R. § 121.363(a)(1)-(2). A certificate holder may make arrangements with another person for the performance of any maintenance, preventive maintenance, or alterations. 14 C.F.R. § 121.363(b).

⁶CRS, *Offshoring of Airline Maintenance: Implications for Domestic Jobs and Aviation Safety*, R42876 (Washington, D.C.: Dec. 21, 2012).

of foreign repair stations and whether work performed by them poses potential safety risks. In 2012, FAA began implementing a Safety Management System (SMS) oversight approach and recently deployed its Safety Assurance System (SAS)⁷ to manage the oversight of various certificate holders, including repair stations and airlines.⁸ You asked us to examine airlines' maintenance contracting practices and FAA's oversight of domestic and foreign repair stations. This report assesses: (1) trends in the type and volume of contracted airline maintenance in the United States from 2010 through 2014 and factors influencing these trends; (2) how FAA's oversight of foreign repair stations compares with its oversight of domestic repair stations, and any associated challenges FAA faces in conducting that oversight; and (3) efforts taken by FAA to improve its risk-based oversight of repair stations.

To address these objectives, we reviewed and synthesized available literature and documents related to the topic areas, including relevant FAA regulations, oversight policy and guidance information, government and industry reports on the trends in the type and volume of airline maintenance, and FAA information on its oversight of U.S. airlines' maintenance, including domestic and foreign repair stations. To evaluate the trends in the type and volume of airline maintenance, we reviewed and analyzed financial data for U.S. airlines' maintenance spending that airlines submitted to the Department of Transportation's (DOT) Bureau of Transportation Statistics (BTS) for the years 2010 through 2014.⁹ We analyzed BTS data on yearly maintenance spending for 28 U.S. passenger airlines to determine their contracted maintenance as a

⁷To best target oversight priorities and resources, in the beginning of fiscal year 2015, FAA transitioned to SAS—a risk-based, data-supported system for the surveillance of certificate holders regulated under 14 C.F.R. parts 121 (U.S. commercial airlines), 135 (commuter or on-demand air operations), and 145 (repair stations).

⁸GAO, Aviation Safety: Additional Oversight Planning by FAA Could Enhance Safety Risk Management, [GAO-14-516](#) (Washington, D.C.: June 25, 2014), and Aviation Safety: Additional FAA Efforts Could Enhance Safety Risk Management, [GAO-12-898](#) (Washington, D.C.: Sep. 12, 2012).

⁹U.S. airlines submit financial and operational data to BTS via the Form 41 Financial Schedule, which includes balance sheet, cash flow, employment, income statement, fuel cost and consumption, aircraft-operating expenses, and operating expenses.

percentage of their overall maintenance spending.¹⁰ We reviewed the quality control procedures used by BTS, interviewed BTS officials responsible for data collection efforts, and subsequently determined that the data were sufficiently reliable for our purposes of determining trends for our 28 selected U.S. airlines' spending on contracted maintenance. We also reviewed industry reports, including those published by the Aeronautical Repair Station Association (ARSA)¹¹ and International Air Transport Association (IATA) that provided information on U.S. airlines' maintenance spending, including work performed by airlines' in-house capabilities and by repair stations.

We also interviewed FAA program officials and aviation safety inspectors within the agency's various oversight offices within the Office of Aviation Safety's Flight Standards Service (Flight Standards). In addition, we interviewed and collected information from representatives of various industry stakeholders, including 10 U.S. airlines, trade groups—such as ARSA, IATA, and the Business Travelers Coalition—labor unions for aircraft mechanics, and domestic repair stations to obtain perspectives on issues that influence maintenance contracting decisions. Our 10 selected U.S. airlines included 5 mainline passenger airlines, 2 mainline cargo airlines, and 3 passenger regional airlines.¹² Together, these airlines accounted for about 66 percent of the aircraft in the U.S. airline fleet, as of 2014. We selected the largest mainline passenger and cargo airlines based on their size of operations and overall number of aircraft in their fleets. We initially contacted six regional passenger airlines to interview and three agreed to be interviewed. We selected a non-generalizable sample of four domestic repair stations—visiting two and interviewing representatives from the other two—as based on their geographical

¹⁰We selected 28 U.S. passenger airlines with the largest number of flights in December 2014, which was the most recent data available at the time of our analysis. We selected these airlines to obtain information on the airlines' spending on in-house and contracted maintenance, but our findings cannot be generalizable to all U.S. passenger airlines.

¹¹ARSA is the international trade group that represents certificated repair stations and the global civil aviation maintenance industry.

¹²Mainline airlines provide domestic and international passenger and cargo service on larger aircraft, i.e., American Airlines and Delta Air Lines. Mainline cargo airlines provide domestic and international cargo transportation service, generally using large aircraft, e.g., Federal Express. Regional airlines provide domestic and limited international passenger service, generally using aircraft with fewer than 90 seats, and cargo service to smaller airports.

proximity to a local FAA office, variation in the types of maintenance performed, and size of operation.

To assess the extent to which FAA's oversight of foreign repair stations differs from its oversight of domestic repair stations and FAA's oversight challenges, we compared FAA's regulations and oversight policy guidelines for FAA-certificated domestic and foreign aircraft repair stations. We also analyzed data from FAA's data systems for fiscal years 2010 through 2014 that provided information on inspection and enforcement activities for domestic and foreign repair stations. We tested the reliability of the inspection and enforcement data by electronically testing data elements that we used, and reviewed documentation about the data and the systems that produced them, and interviewed knowledgeable FAA officials in Flight Standards Service. We found the data to be sufficiently reliable for our purposes. We also conducted semi-structured interviews with representatives of the four domestic repair stations mentioned above. In addition, we conducted site visits to a non-generalizable sample of Latin American countries, which included Brazil, El Salvador, and Mexico, to meet with representatives of seven FAA-certificated repair stations in those countries and their respective foreign civil aviation authorities (CAA)—foreign countries' counterpart to FAA. We selected foreign site-visit locations based on factors such as geographical proximity, locations of foreign CAAs, U.S. and foreign airlines' operations, and various types of maintenance performed.¹³

To assess the efforts taken by FAA to improve its risk-based, data-driven oversight of repair stations, we reviewed FAA documentation on its SAS and interviewed FAA officials within the System Approach for Safety Oversight Program Office—responsible for developing, deploying, and maintaining SAS. We also compared the design of SAS with recommended SMS principles from the International Civil Aviation Organization (ICAO) for member States, and FAA's policy documents on

¹³We also selected the region given recent government audit work that had been conducted related to U.S. airlines' maintenance being performed. See CRS, R42876. Also see, DOT OIG, *FAA Has Not Effectively Implemented Repair Station Oversight in the European Union*, Report Number: AV-2015-066 (Washington, D.C.: Jul. 16, 2015); *FAA Continues To Face Challenges In Implementing A Risk-Based Approach For Repair Station Oversight*, AV-2013-073, (Washington, D.C.: May 1, 2013).

its implementation of SMS.¹⁴ We focused on the design of SAS rather than testing the effectiveness of the system's internal controls. Also, we did not conduct a comprehensive audit of the effectiveness of FAA's transition to SAS for conducting oversight of repair stations. See appendix I for a more detailed description of our scope and methodology.

We conducted this performance audit from May 2015 to July 2016 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The U.S. airline industry is vital to the U.S. economy as airlines directly generate billions of dollars in revenues each year and contribute to the economic health of the nation through employment, economic growth, and enhancing people's mobility.¹⁵ Federal regulations require that airlines carrying passengers or cargo for hire or compensation must have an air carrier (airline) operating certificate issued by FAA. The type of certificate required is determined by the type of aircraft being operated and service being provided. Airlines that provide scheduled commercial service in large aircraft are required to operate in accordance with C.F.R. Part 121 and are often grouped into two categories: mainline and regional.¹⁶ FAA regulations also require that a U.S. airline's aircraft maintenance be performed in accordance with the airline's continuous airworthiness maintenance program (CAMP), which is part of an airline's

¹⁴ICAO is the international body that, among other things, promulgates international standards and recommends practices in an effort to harmonize global aviation standards. SMS is an approach recommended by ICAO for collecting and analyzing safety data in order to identify hazards, manage risks, and take corrective action to prevent an accident.

¹⁵FAA, *The Economic Impact of Civil Aviation on the U.S. Economy: Economic Impact of Civil Aviation by State* (January 2015).

¹⁶14 C.F.R. Part 121 prescribes rules governing the domestic, flag, and supplemental operations to hold an air carrier (airline) certificate. 14 C.F.R. § 121.1.

operating certificate under Part 121.¹⁷ Each airline’s CAMP includes the maintenance program and manuals for each aircraft type being operated within its fleet and the procedures for performing the required maintenance.

Three basic types of organizations perform aircraft maintenance for U.S. airlines: (1) airlines’ in-house maintenance facilities; (2) original equipment manufacturers (OEM) that offer maintenance capabilities for the aircraft parts they manufacture; and (3) independent repair stations (i.e., those not owned or affiliated in whole or part by airlines or OEMs). Aircraft maintenance is categorized into four major types of activities—line maintenance, airframe heavy maintenance, engine repair and overhaul, and component maintenance—that vary according to the section of the aircraft involved, required frequency, and required amount of labor, as described in table 1.

Table 1: Types of Scheduled Maintenance for Commercial Aircraft

Line maintenance	Light, regular maintenance checks carried out to ensure that an aircraft is fit for flight. Line maintenance includes troubleshooting, fixing identified defect, and overnight maintenance.		
Activity ^a	Description	General time frame or flight activity between maintenance	Labor required
A-check	Routine and non-routine work included in periodic, short-turnaround checks; emergency and safety equipment checks.	• 110-800 flight hours	64-760 man-hours
B-check	Specific service performed on the aircraft where a detailed series of systems and operational checks are performed.	• Approximately 500-600 flight hours	Approximately 100-300 man-hours
Airframe heavy maintenance	A regularly scheduled inspection, maintenance, preventive maintenance, and alteration that will take the aircraft out of service for a pre-determined time at specified intervals. Heavy maintenance is comparatively labor-intensive and scheduled work scopes are typically based on calendar time or a fixed number of flight hours.		
Activity ^a	Description	General time frame or flight activity between maintenance	Labor required

¹⁷FAA regulations do not require an airline’s CAMP to be approved by FAA. See 14 C.F.R. § 121.374. However, FAA issues airline operations specifications to airlines that authorize them to use a maintenance program and the airline’s maintenance manual that is required by FAA. 14 C.F.R. § 121.374(m).

Activity ^a	Description	General time frame or flight activity between maintenance	Labor required
C-check	Detailed, scheduled inspections, maintenance, preventive maintenance and alteration of the airframe, components and accessories.	<ul style="list-style-type: none"> 12-36 months 2,000-12,000 flight hours 1,000-15,000 flight cycles^b 	1,000-15,000 man-hours (3,800 weighted average)
D-check	Major reconditioning; comprehensive maintenance, preventive maintenance and alteration of the entire aircraft, intending to return it to its original condition (to the extent possible) with interiors and components removed and replaced.	<ul style="list-style-type: none"> 48-144 months 8,000-36,000 flight hours 6,000-24,000 flight cycles 	2,000-70,000 man-hours, 11,600 weighted average
Engine maintenance	Off-wing maintenance, preventive maintenance and alteration that restores the engine to designed operational condition; by regulation the engine must be disassembled, inspected, parts repaired or replaced as necessary, re-assembled and tested.		
Activity ^a	Description	General time frame or flight activity between maintenance	Labor required
Repair and overhaul ^c	Disassemble, inspect, repair, or replace engine parts, reassemble, and test.	<ul style="list-style-type: none"> 3,000-24,000 flight hours 1,500-15,000 flight cycles 	Varies by engine type and required maintenance.
Component maintenance	Repair and overhaul of components that provide the basic functionality for flight, including aircraft control and navigation, communications, cabin air conditioning, electrical power, and braking.		
Activity ^a	Description	General time frame or flight activity between maintenance	Labor required
Repair	Maintenance related to various aircraft components, such as avionics, auxiliary power unit, cabin compartment systems, electrical systems, flight controls, fuel systems, hydraulics, and landing gear.	<ul style="list-style-type: none"> Varies by the condition of the component. 	Varies by the condition of the component.

Source: GAO summary of Aircraft Repair Station Association information. | GAO-16-679

^aWork performed under each maintenance category varies by aircraft type and size, e.g., narrow-body and wide-body aircraft.

^bA flight cycle is one take-off and one landing of an aircraft, a flight hour is one hour of an aircraft flight, and man-hour is one hour of labor.

^cFor airline operators, engine overhaul is performed on an as-needed (on condition) basis, except for the replacement of certain parts which occurs at a fixed time that is established by requirements determined by a country's civil aviation authority for operations in that respective country.

As noted, over the past few decades, it has become common for U.S. airlines to contract some of their maintenance to repair stations, both in the United States and in foreign countries. These, repair stations vary greatly in size, in the scope of work that is authorized by FAA, and specialization.¹⁸ Because repair stations deal with virtually all aircraft components, ensuring that their work is properly done is an important element of aviation safety. FAA regulates both certificated domestic and foreign repair stations under Part 145. To be certificated under Part 145, a repair station must have the appropriate housing, facilities, equipment, knowledgeable personnel, materials, and maintenance data to ensure work can be performed properly. Further, a repair station must develop written operational and quality policies, maintenance procedures and training programs, and manuals that must be either acceptable to or approved by FAA. Additionally, an FAA-certificated repair station must also conduct aircraft maintenance for a U.S. airline in accordance with that airline's CAMP.

As of October 2015, FAA was overseeing 4,030 domestic and 716 foreign FAA-certificated repair stations (see fig. 1). A repair station's certificate specifies the ratings associated with types of maintenance FAA has authorized the repair station to perform. About 2,200 repair stations perform various types of maintenance work on U.S. airlines' aircraft. Some repair stations are authorized in one particular maintenance and repair rating category, while others may conduct work in several categories.¹⁹ Once a repair station obtains an FAA certification, the repair station can request any of the ratings, which are subsequently approved by FAA, based on a demonstration of the capabilities to conduct the type

¹⁸Repair stations may also contract (i.e., subcontract) some of the maintenance tasks they are responsible for to OEMs, other repair stations, and non-certificated repair facilities—as long as certain FAA requirements are met. These facilities may have more specialized capabilities for performing certain work, such as for remanufacturing, repairing, and restoring critical aircraft components and parts.

¹⁹14 C.F.R. §§ 145.59 and 145.61 set forth the types of ratings that FAA issues. FAA classifies maintenance and repair activities into six rating categories: airframes, power plants, propellers, radios, instruments, or accessories. A repair station's certificate and associated ratings specify the maintenance types that it has been approved to perform. In addition to specifying the types of maintenance a repair station can perform, FAA issues limited ratings to limit the scope of a repair station's activities. For example, whenever appropriate, FAA may issue a rating that limits a repair station's work to maintaining or altering only.

of aircraft maintenance associated with the rating, as required by regulations.

Figure 1: The Number of Repair Stations Certificated by the Federal Aviation Administration (FAA) by Regional Locations (as of October 2015)



Sources: Federal Aviation Administration, Map Resources, and GAO. | GAO 16-679

Note: The United States and Canada have a bilateral aviation safety agreement under which FAA and the Transport Canada Civil Aviation Directorate (TCCA) each grant mutual recognition of the other's Part 145 repair station certificates. FAA does not require Canadian repair stations (referred to as Approved Maintenance Organizations) to obtain a FAA-issued repair station certificate to conduct work on U.S. commercial aircraft as long as a repair station maintains a Canadian repair station certificate and is inspected by TCCA. Because of this mutual recognition, there are no FAA-certificated repair stations in Canada.

As a member of ICAO, the United States has agreed to conform to international standards and recommended practices for approved maintenance organizations, i.e. repair stations. Foreign CAAs serve a critical role in the oversight of FAA-certificated foreign repair stations because the authorities perform similar oversight activities as FAA for their countries' respective repair stations. In addition, like FAA, many of these foreign CAAs conduct oversight of repair stations that hold their

repair-station certification in their own countries and in other countries as well (including the United States), and these foreign CAAs have set up their oversight programs to help ensure compliance with their own national standards. FAA-certificated repair stations, both domestic and foreign, are potentially inspected numerous times in a given year from FAA, foreign CAAs, U.S. and foreign airlines, and IATA.²⁰

FAA uses a multilevel approach to overseeing repair stations. Once a repair station has been certificated, surveillance is one of the most important functions of the safety oversight system. According to FAA's *Inspector Handbook*, the term surveillance relates to the continual evaluation of compliance with the federal aviation regulations and safe operating practices.²¹ Inspections are the main component of the surveillance system. In fiscal year 2015, as part of Flight Standards' operating budget of \$851.8 million, FAA utilized slightly more than 2,900 aviation safety inspectors in its 80 flight standards district offices (FSDO), 25 certificate management offices (CMO), and 4 international field offices (IFO) to conduct oversight of repair stations.²² These inspectors perform periodic and unannounced, on-site inspections of repair station operations (see fig. 2).²³ Under reciprocal bilateral aviation safety agreements,²⁴ FAA delegates some of its routine surveillance functions to foreign CAAs for FAA-certificated repair stations in their countries. FAA can review a foreign CAA's audit and inspection findings, and reserves the right to conduct random spot inspections at these foreign repair stations. FAA currently has such agreements with Canada, the European

²⁰IATA initiated the IATA Operational Safety Audit (IOSA) program in 2001 as an evaluation system designed to assess an airline's operational management and control systems. The IOSA includes a review of eight operational areas, including an airline's maintenance activities and any contracted maintenance providers.

²¹FAA, *Inspector Handbook Volume 6: Surveillance, Chapter 1. General Policies and Procedures*. 8400.10 CHG 3 (July 31, 1990).

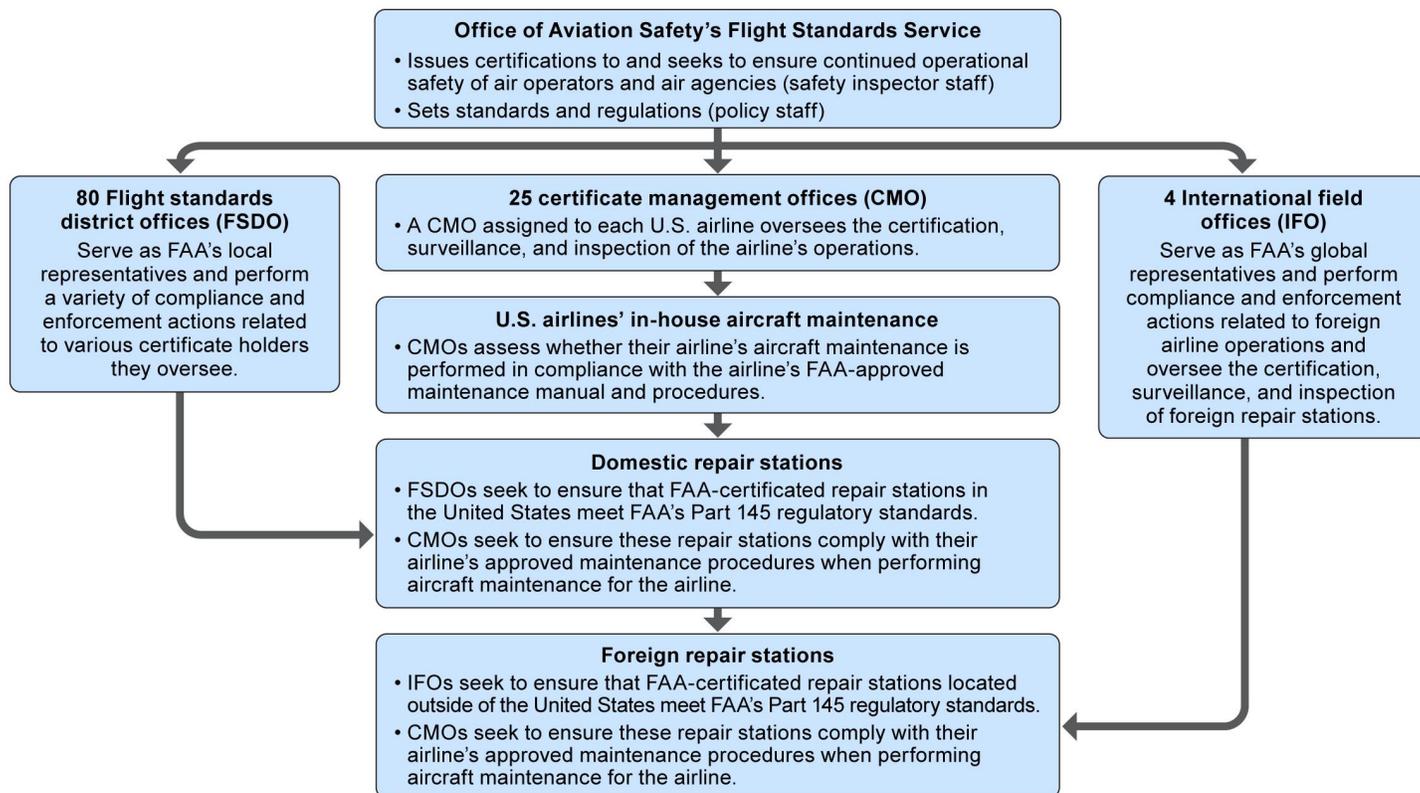
²²The four IFOs are located in the United States and include the Dallas/Fort Worth IFO in Irving, TX; the Los Angeles IFO in Lawndale, CA; the Miami IFO in Miramar, FL; and the New York IFO in Jamaica, NY. Currently, the New York IFO does not perform oversight of foreign repair stations.

²³According to FAA, as of March 29, 2016, the agency employed 1,983 FSDO inspectors, 859 CMO inspectors, and 93 IFO inspectors in the United States. FAA has closed its IFOs outside the United States.

²⁴Bilateral aviation safety agreements provide a framework for delegating aviation oversight functions between the United States and other countries.

Union, Switzerland, and Singapore.²⁵ The agreements also describe FAA's oversight authority for repair stations located in the United States that are also certificated by a foreign CAA.

Figure 2: The Federal Aviation Administration's (FAA) Oversight Structure for U.S. Airlines' Aircraft Maintenance and FAA-Certificated Repair Stations



Source: GAO summary of FAA information. | GAO-16-679

Until recently, FAA used its annual National Program Guidelines, initiated in 1985, as policy guidelines for FSDO and IFO inspectors to determine the nature and amount of oversight to conduct for repair stations. Inspection records and findings were collected in several databases. FAA used its Program Tracking and Reporting Subsystem for scheduling and recording inspection findings for domestic and foreign repair stations, and

²⁵The bilateral aviation safety agreement with the European Union includes 19 countries.

its Enforcement Information System for tracking and reporting information about any enforcement actions the agency takes. In addition, for CMOs, FAA used its Air Transportation Oversight System (ATOS) to schedule and record surveillance activities for airlines and their maintenance providers.

In 2012, to enhance the efficient and effective management of certificate holders' compliance and safety, FAA adopted a proactive, data-driven, risk-based approach to safety oversight referred to as SMS.²⁶ SMS consists of four key components:

- safety policy, a process to define safety objectives and the roles and responsibilities of staff,
- safety risk management, a process to identify hazards and analyze safety risks,
- safety assurance, a process to assure that risk controls achieve their intended objectives and are used to identify hazards, and
- safety promotion, a process to train staff and communicate safety-related information.

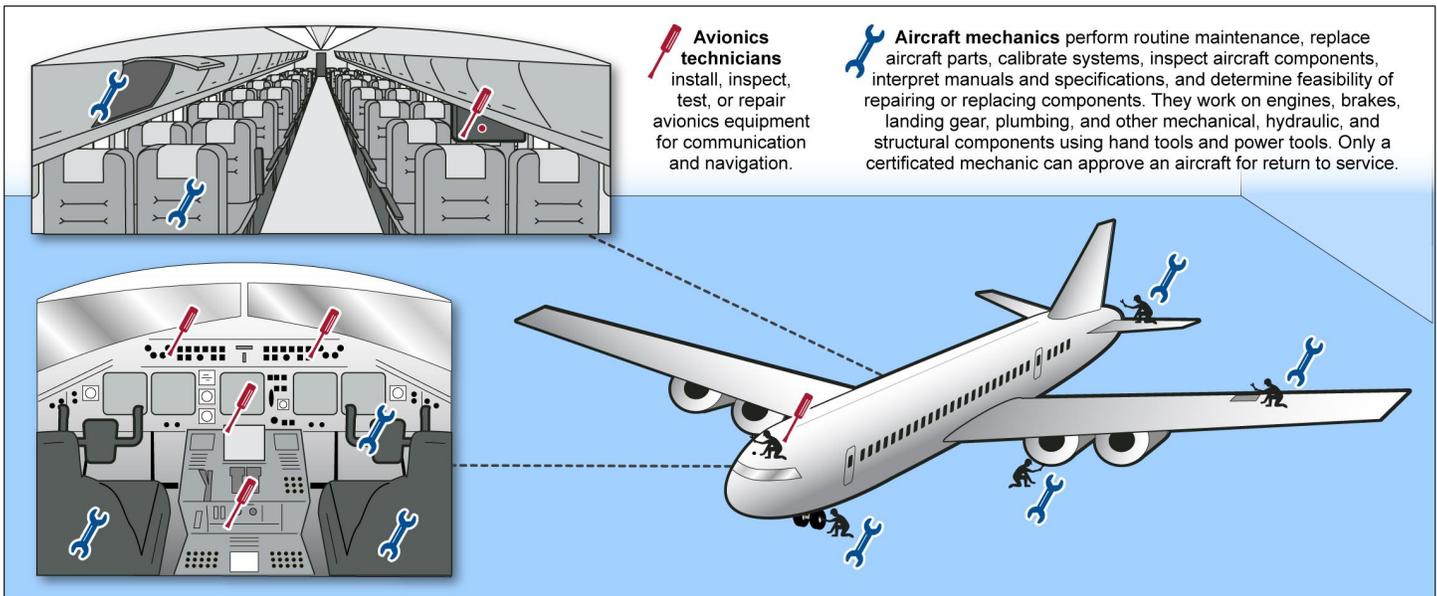
As part of the agency's new safety oversight approach, Flight Standards developed SAS to be the safety assurance component of FAA's SMS. Initial deployment of SAS began in fiscal year 2015 and included oversight of specific certificate holders, including commercial airlines and repair stations. SAS is a comprehensive, risk-based oversight system that according to FAA, was designed to be a more structured, data-driven means to aid FAA inspectors in performing their oversight responsibilities more efficiently and effectively, and allows inspectors to scale oversight to a certificate holder's size, scope, and complexity. For example, FAA inspectors can devote more resources to a larger repair station that performs maintenance for several U.S. airlines than it would for a smaller repair station operation.

The aviation maintenance professionals employed at FAA-certificated repair stations include aircraft mechanics and avionics technicians (see

²⁶FAA began its SMS implementation in 2005, and finalized its agency-wide plan for SMS implementation in April 2012. The plan provided a road map for SMS implementation across the agency and described the activities that FAA business lines and offices would need to complete to integrate SMS into their operations. See [GAO-14-516](#) and [GAO-12-898](#).

fig. 3).²⁷ Aircraft mechanics inspect, service, and repair aircraft bodies (airframe) and engines (power plant). Aircraft mechanics who earn a mechanic certificate from FAA—issued either an airframe (A) rating, power plant (P) rating, or combined airframe and power plant (A&P) ratings—are referred to as certificated mechanics.²⁸ Certification is not necessary to work as an aircraft mechanic; however, without it, an individual must be supervised by a certificated mechanic and cannot approve an aircraft for return to service when work is completed. Avionics technicians test and troubleshoot aircraft instruments and components, install electronic components, and assemble switches or electrical controls. Though some avionics technicians may hold a mechanics certificate, there is no FAA exam or certification specific to avionics technicians.

Figure 3: Examples of Aircraft Maintenance Tasks Performed by Aircraft Mechanics and Avionics Technicians



Source: GAO. | GAO 16-679

²⁷See GAO, *Aviation Workforce: Current and Future Availability of Aviation Engineering and Maintenance Professionals*, [GAO-14-237](#) (Washington, D.C.: Feb. 28, 2014).

²⁸Applicants for a mechanic certificate must pass written and oral exams and demonstrate competence through a practical test.

Some FAA-certificated repair stations employ only a few maintenance professionals and may only repair a limited range of components, such as radios or instruments. Others employ thousands of maintenance professionals who could be involved with a range of work, from routine engine maintenance to rebuilding entire airframes. According to FAA's data on repair stations, as of December 2014, the 4,030 domestic repair stations employed a total of 141,753 maintenance professionals, including 52,970 certificated mechanics and 88,783 non-certificated mechanics. In comparison, according to FAA's data, the 716 foreign repair stations employed a total of 136,520 maintenance professionals, including 6,605 certificated mechanics and 129,915 non-certificated mechanics.

**Contracting of Aircraft
Maintenance
Remained Steady
from 2010 through
2014 and Is
Influenced by a
Variety of Factors, but
Limited Information Is
Available on
Insourcing**

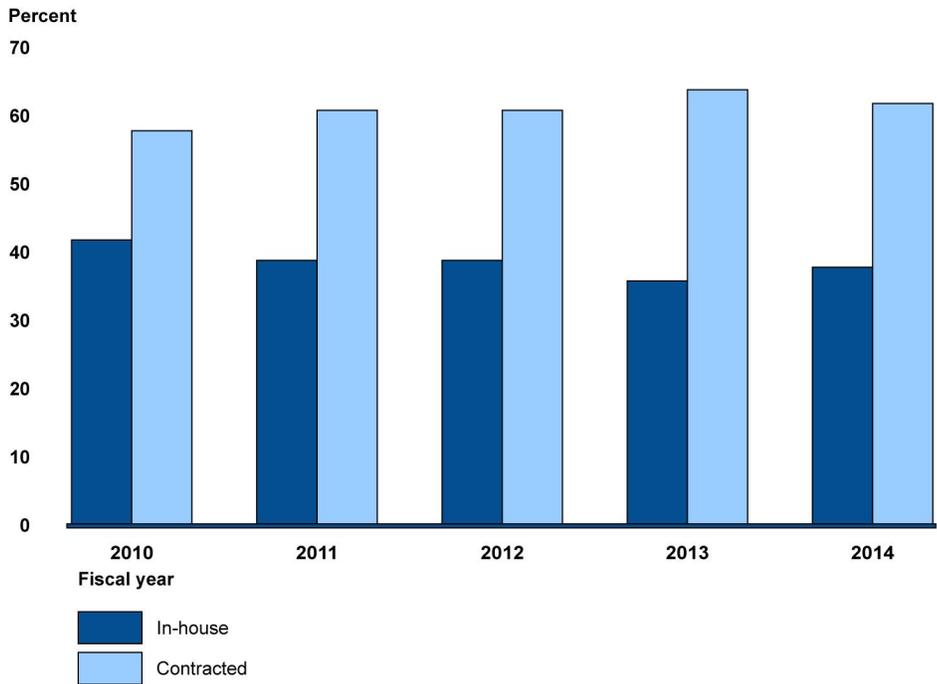
Selected Airlines’ Contracted Maintenance Spending Was Relatively Constant from 2010 through 2014, and Some Types of Maintenance Are More Likely to be Contracted

We found that amongst our 28 selected U.S. airlines, 61 percent of their aircraft maintenance spending in 2014 was contracted to domestic and foreign repair stations, and the overall level of spending for contracted maintenance remained steady from 2010 through 2014 (see fig. 4).²⁹ Specifically, our analysis of BTS data for the selected 28 selected U.S. passenger airlines showed that U.S. airlines’ spending on contracted maintenance as a percentage of their overall maintenance spending ranged from 58 to 64 percent from 2010 through 2014. BTS data does not provide information on the volume of maintenance work that is conducted in-house versus contracted.³⁰

²⁹All U.S. airlines spent nearly \$13.2 billion on aircraft maintenance in 2014, according to BTS.

³⁰While generally not defined, a measure of maintenance volume could be a count of maintenance events such as the number of engine overhauls or a count of various scheduled checks. Representatives for one U.S. airline we spoke to noted that measuring maintenance work by volume rather than by dollars could give a somewhat different picture of the extent of maintenance performed in-house versus contracted because certain maintenance events are more expensive than others even though fewer man hours are required to complete the work.

Figure 4: Selected U.S. Passenger Airlines' In-house and Contracted Maintenance Spending as a Percentage of Total Maintenance Spending from 2010 through 2014



Source: GAO analysis of Bureau of Transportation Statistics data. | GAO-16-679

Note: We selected the 28 largest U.S. commercial airlines based on number of flights in December 2014.

Also, representatives for 9 of the 10 U.S. airlines that we selected for interviews told us their airlines' percentage of contracted maintenance has not changed significantly from 2010 through 2014. Representatives for two of these airlines told us that the airlines' business models have always included contracting aircraft maintenance. However, representatives for one airline told us that maintenance contracting has grown in recent years due to the increased number of repair stations capable of performing needed maintenance services.

Airline representatives told us their airlines tended to conduct certain types of maintenance in-house and are more likely to contract out other types of maintenance. Specifically, representatives for all 10 airlines told us that they conduct the majority of line maintenance in-house. For example, representatives for one airline told us that they have in-house line maintenance capabilities at multiple locations in their network to fulfill this need. A 2014 report on the repair station industry also stated that

airlines predominately conducted line maintenance in-house because it can be done relatively quickly and helps them meet their daily maintenance operational needs.³¹ On the other hand, all 10 airline representatives told us that they contract some, if not all, of their airframe heavy, engine, and component maintenance. The 2014 report also noted that airlines are more likely to contract airframe heavy, engine, and component maintenance.

BTS data does not provide a breakdown of airlines' contracted maintenance to repair stations in the United States versus in foreign countries. Therefore, based on these data, we cannot determine the extent to which contracted maintenance spending by U.S. airlines is going to foreign repair stations. However, representatives for 9 of the 10 airlines we spoke with told us their airline contracted at least some of their maintenance to foreign repair stations. For example, a representative for one airline told us that the airline uses approximately 300 domestic repair stations and 100 foreign repair stations in order to meet its contracted maintenance needs—including engine and airframe heavy maintenance. Another U.S. airline representative said that the airline turned to foreign repair stations for maintenance needs after finding limited capacity for airframe heavy maintenance in the United States. The 2014 industry report also noted that airlines use a mix of domestic and foreign repair stations to meet their maintenance needs.³² The report stated airframe heavy maintenance is mostly contracted to domestic repair stations, but also to repair stations in the Asia Pacific region and Latin America. It further added that contracted engine and component maintenance is mostly conducted in domestic repair stations, and the remainder of that maintenance is typically conducted at repair stations in Western Europe.

³¹ARSA, Global MRO Market Economic Assessment Air Transport (Team SAI Consulting Services, 2014).

³²ARSA, 2014.

Aviation Industry Representatives Reported Several Factors That Influence Decisions for Contracting Maintenance to Domestic and Foreign Repair Stations

Stakeholders we spoke to, including representatives of U.S. airlines, domestic and foreign repair stations, and airline labor unions told us that many factors influence airlines' decisions about contracting and the extent of their use of domestic and foreign repair stations. For example, representatives for the U.S. airlines told us that the decision to conduct work in-house versus through a repair station is a decision that involves the consideration of many factors, including: (1) the quality of services available at repair stations, (2) the cost considerations, and (3) the use of OEMs for certain maintenance needs. On the other hand, representatives from labor unions that represent mechanics who work for these airlines told us that they believe cost considerations have been the driving factor for U.S. airlines to contract maintenance. According to these representatives, repair stations use less experienced and fewer certificated mechanics, and as a result, the quality of maintenance has decreased due to maintenance contracting.

Repair Stations' Quality

Representatives for all 10 of our selected U.S airlines told us the quality of repair stations' maintenance work was a factor in their decision to contract maintenance to domestic or foreign repair stations. Representatives for most of the airlines generally noted that when considering contracting, they looked at repair stations with characteristics such as high-quality workmanship, reputation, and expertise in specific maintenance types and aircraft types. Representatives for one airline told us that the primary factors they consider in selecting a repair station are the quality of the work and the ability to meet their airline's needed turnaround times. The representatives also considered their past experiences with a repair station and the repair station's industry reputation, capability, and resources to do their airline's necessary maintenance work. When selecting and using repair stations, all 10 airline representatives told us their airlines conduct initial and ongoing quality assessments that can include on-site inspections of facilities, training, workforce, and post reliability monitoring of work performed upon return to the airline. A representative for another airline told us that the airline has quality assurance employees on-site to ensure the repair station is following the airline's maintenance program, and that the work meets the airline's quality standards.

Cost Considerations

Cost considerations are one of the major factors that influence U.S airlines' decisions regarding contracting maintenance, according to

stakeholders we interviewed. Specifically, representatives for all 10 airlines told us that it is not cost-effective for them to conduct certain types of maintenance in-house and that contracting is the best way to manage certain elements of their airlines' aircraft maintenance. Representatives of both the airlines and repair stations we spoke with offered a similar view that cost considerations are a key element in airlines' decisions about where to perform aircraft maintenance. Labor cost advantages—particularly for contracting certain maintenance to foreign countries—was a factor noted by many we interviewed. Other cost considerations related more to airlines' decisions regarding the in-house maintenance capacity it was economically feasible for them to build, both in terms of hiring and maintaining a skilled workforce and in maintaining the facility space and equipment needed to perform the maintenance. Airline labor union officials we spoke with also noted that cost considerations are a primary element in contracting decisions.

Labor Costs

Representatives for foreign repair stations in El Salvador and Mexico told us that lower labor costs, relative to U.S. market, are attractive to U.S. airlines when conducting airframe heavy maintenance, as the work is highly labor intensive. For instance, representatives for one foreign repair station related that heavy airframe maintenance had been conducted in Asia for U.S. airlines due to lower labor costs. These officials believe that due, in part, to Asia's rising labor costs, it may be more practical to have this type of work performed in Latin America. Furthermore, we were told that maintenance of older aircraft is even more labor-intensive, and thus, locations with lower labor costs may be particularly attractive for airlines operating older aircraft. For instance, recently, one major U.S. airline established a joint-venture with a foreign airline to operate an FAA-certificated foreign repair station in Mexico to perform airframe heavy maintenance for both airlines. Representatives from that foreign repair station told us the U.S. airline uses the repair station to perform maintenance for a fleet of its older aircraft in part due to lower labor costs.

While cost factors may help explain why some airline maintenance moved off-shore over the years, a recent industry report suggests that some of that work may be returning to the United States—also due to changes in relative costs of labor in the United States compared to other countries. Specifically, according to a 2014 industry report, contracting airframe heavy maintenance from North American airlines to Asia may no longer be considered the best option for airlines because labor wage differences

Cost of Capacity Relative to
Airline Demand for
Maintenance

between the United States and Asia are decreasing, a phenomenon that is reducing the relative cost advantage for airlines to have maintenance performed at repair stations in Asia.³³

One of the considerations that was most consistently identified by representatives from our selected airlines and repair stations related to the cost of maintaining an adequate in-house capacity to support certain maintenance needs. Representatives for all of the U.S. airlines we interviewed told us that for a variety of reasons, it is typically not economical for their in-house capacity to service all of their airlines' maintenance needs. For example, representatives for 7 of the 10 airlines explained that it is can be uneconomical to perform their own airframe heavy maintenance due to a lack of consistent demand or the costs associated with maintaining the capability. Representatives for a domestic and foreign repair station agreed that it is not cost effective for airlines to conduct airframe heavy maintenance in-house due to the lack of demand a single airline generates for such work. Similarly, representatives for another domestic repair station that specializes in component repairs told us that contracting component maintenance is attractive to airlines because specialized repair stations can provide the airline experience in conducting that type of maintenance and large scale capacity for this work, while an individual airline will not generate adequate volume to justify the investments necessary to maintain and conduct the work in-house.

In addition, representatives for two airlines explained that it is most cost efficient to use domestic and foreign repair stations to meet maintenance needs during peak-operating seasons. Specifically, representatives for one airline told us that the airline's peak travel season is summer, so it schedules much of the airframe heavy maintenance during the winter at both domestic and foreign repair stations. These officials also noted the importance of ensuring the needed maintenance capacity during the winter months. Representatives for another U.S. airline told us that repair stations will market themselves based on their capacity to perform work; agreements between airlines and repair stations can include provisions to ensure the facility will have the necessary space availability to meet the airline's maintenance needs.

³³IATA, *Airline Maintenance Cost Executive Commentary: An Exclusive Benchmark Analysis (FY2013 data)* by IATA's Maintenance Cost Task Force (November 2014).

Use of OEMs

Representatives for the selected U.S. airlines reported they now contract to domestic and foreign OEMs maintenance work that had previously been performed in-house or at independent repair stations. OEMs such as Boeing, Airbus, General Electric, Rockwell Collins, and other manufacturers of aircraft and aircraft products offer maintenance services on their products and components. According to the 2014 industry report, manufacturers of engines and complex components offer maintenance service for their respective products—often controlling more than half of the maintenance market.³⁴ Representatives for all 10 airlines said OEMs were used for specific maintenance such as engine, component, and airframe heavy maintenance at the OEMs' domestic and foreign-affiliated repair stations. Representatives for a repair station in Brazil that functions as an OEM-engine service provider stated that about 70 percent of its business is performing engine maintenance for several large U.S. airlines. An airline labor union for aircraft mechanics at one U.S. airline told us this trend of shifting to OEMs is occurring in component maintenance as well, and U.S. airlines contract more work to the OEMs in lieu of maintaining in-house capacity and capabilities.

Global Aircraft Maintenance Market Expected to Grow over the Next Decade and Stakeholders Expressed Concerns Regarding Adequacy of Labor Market

A 2015 aircraft industry report projects the worldwide aircraft-maintenance repair industry to grow substantially over the next decade, with the largest growth occurring in developing countries.³⁵ It is anticipated that airlines in developing countries will fuel this growth by increasing their aircraft fleet. For example, according to the industry report, airlines in China are expected to have a substantial number of new airplane deliveries in the next decade—projected to be about 14 percent of new deliveries worldwide—that will mostly support net growth in its aviation market. Growth in the North America maintenance market, however, is expected to be minimal due to limited anticipated aircraft growth among airlines in this region. Specifically, although North America is projected to have a significant number of airplane deliveries in the next decade—projected to be about 22 percent of new deliveries worldwide—most of these deliveries will replace older and less efficient aircraft rather than supplement existing fleets. Despite the worldwide growth trends, the

³⁴ARSA, 2014.

³⁵ARSA, *Global Fleet and MRO Assessment 2015-2025* (CAVOK, March 2015).

industry report projects that North America will remain the largest single region for total aircraft maintenance by 2025, even as the market share of aircraft maintenance performed in developing countries such as China, India, and countries in Latin America and the Middle East is expected to grow. For example, for engine maintenance, the Asia Pacific region is expected to surpass North America and become the largest market for that type of maintenance by 2025, while North America is expected to remain the largest market for airframe and component maintenance by 2025.

U.S. airlines, domestic repair stations, and aviation industry groups we spoke with expressed concerns about the adequacy of the maintenance workforce available to meet U.S. aviation maintenance needs now and moving forward. Representatives for 7 out of 10 airlines we spoke with expressed concerns about the availability of maintenance professionals in the United States—both now and in the future—with the skills to perform airline maintenance work. Airline mechanics labor unions told us they are concerned that U.S. airlines and repair stations may have difficulty hiring qualified aircraft maintenance professionals in the future because the occupation is viewed as less desirable relative to professions requiring a similar skill set—such as amusement park mechanics, elevator repairers, and mechanics working in the oil and gas industry. Representatives for all four domestic repair stations we interviewed told us that although they have not yet had difficulties being able to hire workers with the necessary skill set to perform aircraft maintenance, they are concerned about the availability in the future.

In 2014, we reported on the aviation mechanics occupation in the United States.³⁶ While many of the employers we spoke to at that time said they were able to hire necessary labor, some employers reported challenges finding workers, especially those with specific skills—such as in welding and upholstery. To further analyze the market for aircraft mechanics for the 2014 report, we collected data from the Bureau of Labor Statistics (BLS) on several aspects of the aircraft mechanic occupation that might indicate whether a labor shortage existed. While no single metric definitively indicated a labor shortage, certain data indicated that a shortage may exist. In particular, we collected information on trends for three such indicators for aircraft mechanics from 2000 to 2012: the

³⁶See GAO, [GAO-14-237](#) for a more detailed discussion of our methodology and analysis.

unemployment rate,³⁷ employment growth,³⁸ and the rate of change of wages in the occupation.³⁹ We found that the unemployment rate among aircraft mechanics averaged only about 3 percent over those 12 years—about half of the economy-wide average rate of unemployment during that time frame—which could be indicative of a shortage of labor available in the profession. However, we also found that both employment and earnings for the aircraft mechanic occupation had stayed about the same over that 12-year period, suggesting that demand for this occupation was not outstripping supply.⁴⁰ Finally, for the current study we examined BLS’s projected growth of the aircraft mechanic occupation, specifically the number of aircraft mechanics BLS projected will be employed by 2024, compared to 2014. According to that projection, the net growth in the aircraft mechanic occupation is expected to be very low.⁴¹ That is, most job openings over that 10-year period are expected to be to fill positions of those leaving the profession rather than to contribute to net job growth. These projections may suggest that filling job openings in the aircraft mechanic occupation in the coming years may be no more challenging than will be the case for other occupations. However, the BLS predictions implicitly assume that the market may need to make adjustments to meet the projected employment level, so that could mean that wages might have to rise to induce adequate entry into the occupation.

³⁷A low unemployment rate would indicate that there are not many idle resources in the labor market available for new jobs.

³⁸More rapid employment growth would be an indication that the demand for workers in this occupation is rising.

³⁹Rising wages may indicate that employers needed to increase pay to draw workers into the occupation.

⁴⁰The 2014 report also noted that the number of aircraft mechanics and avionics technicians separating from the military—another main source of supply—and entering the civilian workforce has stayed relatively constant from fiscal year 2001 through fiscal year 2011. Nevertheless, the Department of Defense officials we spoke to for that report expected separations for aviation maintenance workers to increase in the future given planned workforce reductions.

⁴¹See BLS employment projections for the “aircraft mechanic and service technician” occupation from 2014 through 2024 at http://www.bls.gov/emp/ep_table_102.htm.

U.S. Repair Stations Insource Maintenance Work from Foreign Airlines, but the Extent of Insourcing to the United States is Unknown due to Limited Data

U.S. domestic repair stations also insource maintenance and repair work from foreign airlines—defined as work being contracted to the United States—but the extent of insourcing is unknown due to limited available government and industry published data. However, a 2014 industry report, as well as domestic and foreign repair station representatives we interviewed, provided some perspectives on the type of work that domestic repair stations insource from foreign airlines. According to the 2014 industry report on the global aircraft maintenance market, domestic repair stations performed mostly engine and component work for foreign airlines, but did not conduct significant amounts of airframe heavy maintenance for these airlines.⁴² The report also indicated the pattern of insourced airline-maintenance work could be attributed to the growth of U.S.-based OEMs that are providing maintenance for their aircraft engines and components. For engine work, domestic repair stations insourced maintenance work from regions throughout the world, with a significant portion from Latin America—as well as from the Middle East, Asia Pacific, and Europe. Representatives for a foreign repair station in El Salvador referred to this trend and told us they have been focused on trying to position their repair station to stem the large amount of engine work that is insourced to the United States from Latin America. For component maintenance, the 2014 industry report indicated the United States also insources some work from airlines in the Latin America, Asia Pacific, and Western European regions, as well as from other global regions.

According to FAA as of April 1, 2016, 1,470 domestic repair stations hold certificates from the European Aviation Safety Agency (EASA), which allows repair stations to perform work on EASA-registered airplanes.⁴³ FAA officials told us the agency tracks repair stations' certificates issued by EASA and other countries with which FAA has bilateral aviation safety agreements, but not for other foreign countries. According to ARSA, the country where aircraft is registered controls the maintenance requirements on the aircraft, so FAA-certificated domestic repair stations may need to obtain and hold repair-station certificates from foreign countries in order to insource maintenance from airlines in those

⁴²ARSA, 2014.

⁴³EASA is the European aviation regulatory authority and FAA counterpart. EASA became operational in 2003 and is an independent European Union body under European law accountable to the Member States and the European Union institutions.

countries. Representatives for three of the four domestic repair stations told us their companies held such foreign certificates for the purpose of insourcing. Also, representatives for ARSA told us that domestic repair stations conduct a significant amount of aircraft maintenance for foreign airlines. These representatives noted that due to the stringent nature of FAA's certification and oversight, many countries do not require a certificate from their foreign CAA to allow FAA-certificated repair stations to perform engine and component maintenance. Representatives for a repair station mentioned its specific component capabilities that allowed insourcing of work from Asia, Australia, and New Zealand. Representatives for another repair station told us it predominately conducted airframe heavy maintenance for U.S. regional jets, but it also insourced this maintenance from a Mexican airline.

Differences Exist between FAA's Oversight of Domestic and Foreign Repair Stations, and FAA Is Addressing Challenges with Interoffice Coordination

Differences Exist between FAA's Oversight of Domestic and Foreign Repair Stations and Are due, in Part, to Challenges in Overseeing the Latter

Regulatory Differences for
Domestic and Foreign Repair
Stations

As described previously, aircraft maintenance performed by domestic and foreign FAA-certificated repair stations for U.S. airlines is subject to federal aviation regulations and multiple layers of oversight by FAA. FAA conducts primary oversight, including initial certification and ongoing oversight, of domestic repair stations through 80 FSDOs and for foreign repair stations through three of the four IFOs. In addition, FAA conducts surveillance of the maintenance work that both domestic and foreign repair stations perform for U.S. airlines through each airline's assigned CMO. Regulatory requirements for foreign repair stations differ from those of domestic repair stations, including the certification process, renewal of the repair station certificate, personnel requirements, and drug- and alcohol-testing requirements. A summary of key differences in FAA regulatory requirements for domestic and foreign repair stations is presented in table 2.

Table 2: Differences in Regulatory Requirements between Domestic and Foreign Repair Stations Certificated by the Federal Aviation Administration (FAA)

Type of regulatory requirement	Domestic repair stations	Foreign repair stations
Certification	A certificate or rating is effective from the date of issue until the repair station surrenders the certificate and FAA accepts it for cancellation, or FAA suspends or revokes it.	Initial certification is typically granted for 12 months after the date of issue. Thereafter, FAA may renew the certificate or rating for a 24-month period if the repair station has operated by the requirements of Part 145 regulations within the preceding period.
Certification, renewal, and inspection fees	No fees.	For fiscal year 2016, FAA established a \$189 per-inspector, per-hour fee for certification, approval, authorization, inspection, and renewal actions. ^a
Personnel	Certain personnel, including supervisory personnel and individuals authorized to approve an aircraft's return to service, must be FAA-certificated mechanics.	No certification requirement for personnel. However, supervisors must meet minimum experience requirements and the repair station must have an FAA-approved training program. Foreign countries may have separate certification requirements for mechanics.
Drug and alcohol testing	Required for workers in safety-sensitive positions who perform work on aircraft for U.S. airlines. ^b	Not required. Under development as required by the Federal Modernization and Reform Act of 2012. ^c
English language proficiency	FAA requires demonstrated English proficiency for certificated mechanics. As part of the certification testing, applicants are required to demonstrate they can read, speak, and write, and comprehend spoken English language. All repair stations are required to ensure that persons authorized to approve work for aircraft to return to service, supervisors, and inspection personnel understand, read, and write English.	FAA requires demonstrated English proficiency for certificated mechanics. As part of the certification testing, applicants are required to demonstrate they can read, speak, and write, and comprehend spoken English language. All repair stations are required to ensure that persons authorized to approve work for aircraft to return to service, supervisors, and inspection personnel understand, read, and write English.

Source: GAO summary of selected regulations under 14 Code of Federal Regulations, Part 145 and FAA Orders. | GAO-16-679

^aFAA places the fees collected from foreign repair station oversight and other oversight activities for which it charges fees into a no-year operations fund.

^bThe regulations are covered under 14 C.F.R. Part 120 and 49 C.F.R. Part 40. FAA requires U.S. airlines that contract with domestic repair stations to ensure that the safety-sensitive employees of those facilities are tested before employment, periodically during employment, after accidents, in instances of reasonable suspicion of misuse, and before return to duty. 14 C.F.R. §§ 120.109(a)-(e). For 2016, FAA requires that 25 percent of these employees be tested annually for drug misuse and 10 percent be tested annually for alcohol misuse.

^cThe 2012 Act directed FAA to propose drug and alcohol testing requirements for employees of all FAA-certificated repair stations who perform safety-sensitive maintenance functions on aircraft operated by U.S. airlines, and to be consistent with the applicable laws of the country in which the repair station is located.

FAA's oversight offices hold domestic and foreign repair stations to the same standards, but different FAA offices assess different areas of operations. FSDO and IFO inspectors conduct periodic inspections to assess continued compliance with applicable FAA regulations, approved operations specifications, and the procedures set forth in repair stations' approved manuals. CMO inspectors conduct periodic inspections to assess compliance with the CAMP of the assigned airline and oversee only the maintenance that a repair station conducts for that assigned airline.

One notable regulatory difference between domestic and foreign repair stations is that FAA regulations do not require foreign repair stations to establish and implement drug and alcohol testing programs. Extending the drug and alcohol testing requirements currently in place for domestic repair stations to foreign repair stations presents several challenges for FAA, including practical considerations and privacy and legal concerns—the latter stemming from the recognition of other countries' sovereignty. Many foreign countries, however, impose their own drug and alcohol testing programs at foreign repair stations, but some do not. For instance, the foreign CAAs for the three countries we visited—Brazil, El Salvador, and Mexico—told us they have random drug and alcohol testing requirements in place for their repair stations. Representatives for a foreign repair station in El Salvador told us that their company also conducts prescreening investigations before hiring mechanics, including pre-employment drug and alcohol testing and background checks.

In response to the mandate outlined in the 2012 Act, FAA published an Advanced Notice of Proposed Rulemaking in March 2014 seeking comments and information on countries' laws, regulations, and issues related to drug and alcohol testing of personnel at foreign repair stations. Several countries submitted opposing positions to FAA's consideration for pursuing such drug and alcohol testing requirements. For example, some cited concerns about potential conflicts with national sovereignty and local laws—e.g., a country's prohibition of pre-employment drug testing of workers on human rights grounds—the lack of a stated safety basis for imposing such requirements, and potential violations of existing bilateral aviation safety agreements with the United States. However, FAA plans to issue a Notice of Proposed Rulemaking in May 2017 to require drug and alcohol testing at foreign repair stations. The recently-enacted law for reauthorization of FAA included specific requirements for FAA to issue a

Travel and Scheduling Constraints for Visits to Foreign Repair Stations

final rule within in a shorter time frame.⁴⁴ Additionally, the law also includes specific requirements for FAA to ensure that each employee of domestic and foreign repair stations who performs a safety-sensitive function on a U.S. airline's aircraft has undergone a pre-employment background investigation—i.e., to be consistent with (1) the applicable laws of the country in which the repair station is located, and (2) U.S. obligations under international agreements.

FAA's oversight of foreign repair stations faces challenges related to budget and logistics. FAA inspectors told us that recent budgetary challenges have made it more difficult to travel to foreign repair stations to conduct oversight and that inspectors conduct oversight of foreign repair stations less frequently than for domestic repair stations. For example, inspectors for three of the four CMOs told us that constraints on FAA approval for foreign travel has led to cancellation of some scheduled oversight of foreign repair stations. In addition, CMOs do not charge the \$189 per-inspector-hour fee for conducting inspections of foreign repair stations that IFOs levy for their inspections, and FAA officials told us the fees levied by IFOs do not fully cover the costs to conduct this oversight.

Inspectors from the three IFOs have also encountered travel challenges due to lower staffing levels than their FSDO counterparts and budget cuts for foreign travel. The inspectors told us that foreign trips to conduct oversight are more scrutinized than domestic trips, scrutiny that can make it more difficult to oversee foreign repair stations. However, we could not verify these assertions because FAA could not provide data on traveling expenditures for conducting oversight of domestic and foreign repair stations. FAA officials told us that funds are not appropriated by budget line item for inspector travel and that the process does not include itemizing specific travel expenditures. Officials also told us that inspectors are not restricted from traveling to a foreign repair station when the travel is necessary to mitigate an identified risk. Representatives for airline labor unions told us that foreign repair stations potentially present a higher risk than domestic repair stations due to challenges in overseeing foreign repair stations and the types of critical maintenance and repairs that are

⁴⁴On July 15, 2016, the FAA Extension, Safety, and Security Act of 2016 became law and required FAA to: (1) publish a proposed rulemaking in the Federal Register regarding alcohol and controlled substances testing within 90 days, and (2) finalize the proposed rulemaking within one year of publication. FAA Extension, Safety, and Security Act of 2016, ch. 463, sec. 2112, § 44733(b), Pub. L. No. 114-190 (2016).

performed for U.S. airlines. Thus, the officials said FAA should be conducting more on-site inspections for the foreign repair stations.

Intergovernmental and other restrictions have generally precluded FAA inspectors from conducting unannounced inspections at foreign locations. FAA inspectors told us that logistical challenges make it more difficult to visit foreign repair stations, and some inspectors believe these challenges impacted their ability to conduct unannounced inspections. Some travel by FAA inspectors involves obtaining: (1) official country-entry approvals from the foreign government, (2) facility access approvals from the repair station, and (3) sometimes from the foreign CAA. Inspectors told us that obtaining access can be challenging in certain countries, such as those in areas of Africa and Central America. Travel restrictions, either imposed by the country or the U.S. Department of State, and others can require invitations from the foreign repair station.

FAA inspectors are able to arrive at domestic repair stations unannounced and often do so. Inspectors from 6 of the 11 FAA offices told us unannounced inspections are beneficial to oversight because they provided a more accurate view of a certificate holder's day-to-day operations. The inspectors also said the increased FAA visibility demonstrates the agency's commitment to constant compliance. However, inspectors from 3 of the 11 FAA offices stated their belief that unannounced inspections are no more useful than scheduled inspections. These inspectors told us that if there were regulatory noncompliance problems at a repair station's operations, they would likely be able to find it whether or not the inspection was announced. They explained that the processes and procedures for performing maintenance are too complex to be changed even with advanced knowledge of a FAA visit.

FAA's Delegation of Oversight to Foreign CAAs

As of the end of 2014, FAA had delegated the primary oversight functions for FAA-certificated foreign repair stations to a foreign CAA in 19 countries.⁴⁵ As of that time, 450 repair stations (or 63 percent) of the 716 foreign repair stations were located in these 19 European countries. The United States and those European countries, whose repair stations operate under EASA's regulations, entered into bilateral aviation safety agreements. In addition, FAA also entered into a broader bilateral aviation

⁴⁵As previously stated, because of the full mutual recognition between FAA and TCCA, there are no FAA-certificated repair stations in Canada.

safety agreement with EASA that is multilateral in its scope.⁴⁶ The agreement, and the associated maintenance implementation procedures, enables FAA and EASA to make more efficient use of resources by reducing the amount of duplicative oversight and limiting the travel required by each agency's inspectors.⁴⁷ FAA closed its IFOs in London and Frankfurt and transferred inspectors back to the United States. FAA estimated that closing the IFOs and reducing travel required for oversight of FAA-certificated repair stations in Europe will save it about \$158 million over the next 10 years. FAA officials told us this estimate included savings related to costs for stationing staff in a foreign country and maintaining office space.

FAA conducts annual audits of some of the foreign CAAs to whom it has delegated primary oversight to ensure proper surveillance of foreign repair stations and to verify compliance with the terms of the FAA-EASA bilateral aviation safety agreement. FAA uses a risk-based determination for selecting which foreign CAAs to audit. FAA officials told us the agency conducts on average between three and five foreign CAA audits per year, but may inspect as many foreign CAAs as FAA deems needed. The number may vary depending on risk levels.⁴⁸ During these audits, FAA is expected to review inspection results and findings—and could observe the foreign CAA inspectors conducting oversight at FAA-certificated repair stations, if desired—of the areas where differences exist between the regulations of each country.

A 2015 report from DOT's Office of Inspector General (OIG) found that during FAA audits of foreign CAAs' inspection procedures and data, FAA

⁴⁶On May 1, 2011, the agreements were incorporated into a much broader agreement called The Agreement between the United States of America and the European Community on Cooperation in the Regulation of Civil Aviation Safety. Through the agreement, the United States and the European Union determined that many of their civil aviation standards, rules, and practices were compatible, and the countries allowed FAA and EASA to accept each other's standards, systems, and approvals relating to repair stations located in the United States and Europe.

⁴⁷Maintenance Implementation Procedures define the terms and conditions under which the civil aviation authorities accept each other's repair station inspections.

⁴⁸FAA defines risk levels for each country under the agreement with EASA by analyzing criteria including the number of repair stations in the country, the complexity of the work those repair stations perform, the number of regulatory noncompliance found by EASA's oversight of repair stations in that country, and the number of areas of concern identified during previous sampling inspections of that country.

inspectors were only able to review the areas where differences existed between FAA's and EASA's regulations. Prior to the bilateral aviation safety agreement, FAA inspectors were able to conduct its oversight for a foreign repair station's entire operation.⁴⁹ FAA officials told us that the biggest challenge in conducting CAA audits is logistical; FAA must coordinate with several foreign CAAs and foreign repair-station personnel. While bilateral aviation safety agreements are a potential opportunity for FAA to increase its efficiency in the oversight of foreign repair stations, the 2015 OIG report highlighted several concerns over the implementation of the agreement between FAA and EASA. Particularly, the report pointed to how risk determinations were made; how inspection data and corrective action plans addressed identified areas of noncompliance; and follow-up assessments were shared and coordinated. FAA officials told us that the agency is making changes to address these concerns, including revising the audit questions and time frame for a foreign CAA to respond to corrective actions.

FAA continues to negotiate bilateral aviation safety agreements with other countries. In 2015, FAA began negotiating with Brazil. In February 2016, FAA signed an agreement with Singapore's foreign CAA that would delegate the oversight of FAA-certificated foreign repair stations in that country by 2018. Also, FAA is working jointly with EASA to assess Hungary for inclusion in FAA and EASA's current agreement, and FAA officials told us the agency plans to negotiate additional agreements. The 2015 DOT OIG report concluded that it is imperative that FAA and EASA work to refine processes given that FAA is seeking to use bilateral aviation safety agreements to promote aviation safety and reduce duplicative oversight in other countries.⁵⁰

FAA's transition to delegation of primary oversight of foreign repair stations to foreign CAAs in their respective countries would likely reduce the overall number of inspections for these repair stations. As previously mentioned, many domestic and foreign repair stations hold certifications from a number of countries, such as China, Brazil, Singapore, Mexico, and the European Union member countries. Without a bilateral aviation safety agreement in place, inspectors from each foreign CAA may conduct inspections in accordance with its country's regulations. FAA

⁴⁹DOT OIG, AV-2015-066.

⁵⁰DOT OIG, AV-2015-066.

officials and representatives of ARSA and repair stations told us that a large repair station holding certifications from multiple countries could receive more than 400 total inspections per year, including inspections by the IFOs for the repair station and the CMOs for each airline that utilizes that repair station, and by the other foreign CAAs. According to FAA, the number of potentially duplicative annual inspections that a repair station receives can be reduced by having a foreign CAA in a country where a repair station is located conduct inspections on behalf of other foreign CAAs.

FAA Completed Nearly All Required Inspections for Domestic and Foreign Repair Stations, and Pursued a Similar Rate of Enforcement Actions

Despite the differences in FAA's oversight of domestic and foreign repair stations and challenges in overseeing the latter, our analysis of FAA's inspection data from FAA's Program Tracking Reporting Subsystem database shows that the agency completed at least 98 percent of all required inspections for both domestic and foreign repair stations from fiscal years 2010 through 2014.⁵¹

Our analysis of enforcement actions in FAA's Enforcement Information System from fiscal years 2010 through 2014 found that the agency's rate of enforcement actions pursued against domestic and foreign repair stations did not differ significantly.⁵² Enforcement actions include administrative actions (e.g., warning notices and letters of correction), fines, and suspensions or revocations of a repair station's operating certificate.⁵³ During that 5-year time frame, the number of enforcement actions for domestic repair stations was much higher than the actions

⁵¹This analysis does not include (1) inspections of repair stations located in countries where FAA had delegated primary oversight to the foreign CAA or (2) inspections conducted by FAA's CMO inspectors. Our work did not focus on the effectiveness of FAA's oversight of domestic and foreign repair stations. Rather, the DOT OIG's work resulted in reports on issues with FAA's oversight of domestic and foreign repair stations, identifying deficiencies, communicating findings, and documenting inspection results. See DOT OIG, AV-2013-073; *Air Carriers' Outsourcing of Aircraft Maintenance*, AV-2008-090 (Washington, D.C.: Sept. 30, 2008); *Air Carriers' Use of Non-certificated Repair Facilities*, AV-2006-031 (Washington, D.C.: Dec. 15, 2005); and *Review of Air Carriers' Use of Aircraft Repair Stations*, AV-2003-047 (Washington, D.C.: July 8, 2003).

⁵²These enforcement actions included ones taken against repair stations under Part 145, but did not include actions taken under Part 121, which is specific to airlines.

⁵³Administrative actions refer not only to warning notices and letters of correction, but also informal actions such as oral or written counseling, which can also be used by inspectors to address an apparent violation, provided that certain criteria are satisfied and the apparent violation is a low safety risk.

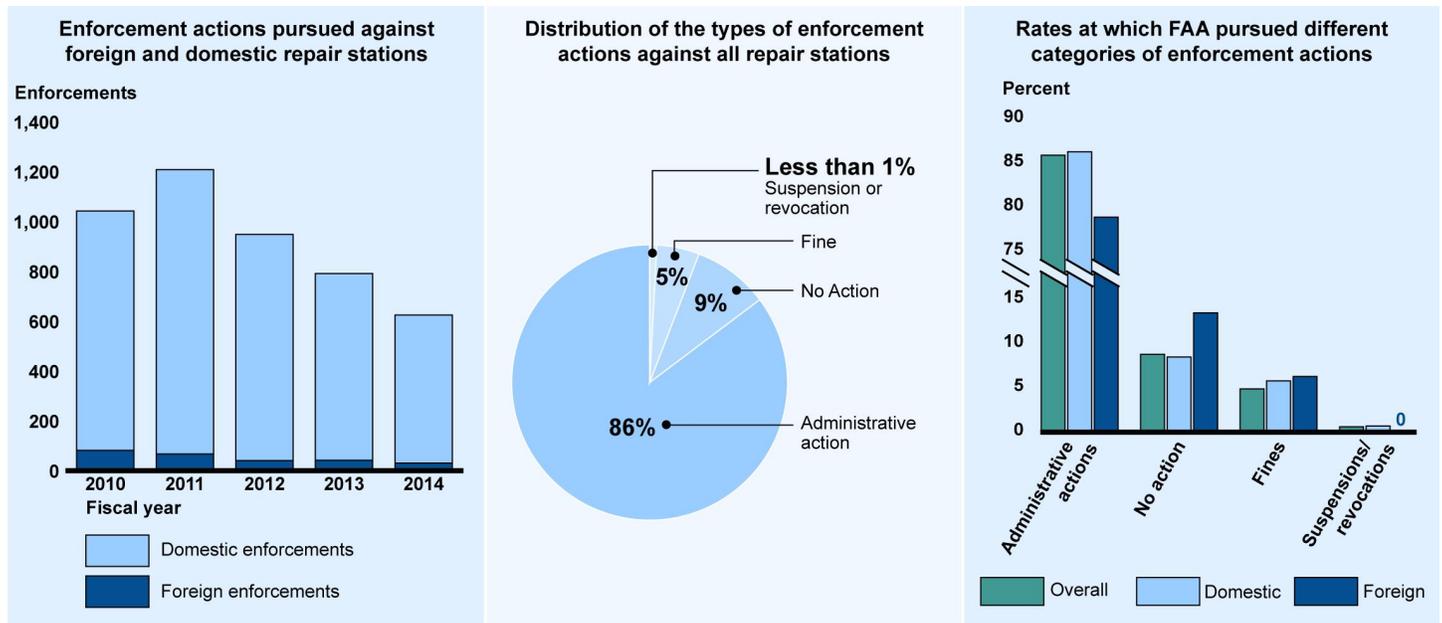
taken against foreign repair stations—to be expected given the large difference in number of domestic repair stations compared to foreign repair stations. However, based on the number of enforcement actions taken compared to the overall numbers of domestic and foreign repair stations, the relative number of enforcement actions was similar.

- *Administrative actions:* Of the three types of enforcement actions, FAA pursued administrative actions most often. Specifically, FAA took such actions in 86 percent of the noncompliance cases against all repair stations (see fig. 5).⁵⁴ FAA imposed administrative actions against domestic repair stations in about 86 percent of noncompliance cases, versus in about 78 percent of noncompliance cases against foreign repair stations.
- *Fines:* FAA imposed fines at a much lower rate, in about 5 percent of the noncompliance cases against all repair stations and in about 5 percent of the cases for both domestic and foreign repair stations.
- *Suspensions and revocations:* FAA imposed the most severe enforcement actions of suspending or revoking a repair station's operating certificate infrequently—in 1 percent of noncompliance cases—and the actions were all against domestic repair stations. Specifically, FAA imposed 5 total suspensions and 18 total revocations against domestic repair stations.

FAA inspectors told us that they consider imposing the most severe penalties when inspection findings indicate that a repair station has deliberately not complied with regulations or has systemic safety-related problems. FAA officials said that while it is possible for them to pursue a suspension or revocation against a foreign repair station, they are more likely to decline to renew a repair station's certificate when serious issues are discovered.

⁵⁴Administrative actions include warning notices and letters of correction, and FAA inspectors utilize this enforcement mechanism when legal action is not required or warranted and the certificate holder has or will take corrective action.

Figure 5: The Federal Aviation Administration’s (FAA) Enforcement Actions Taken Against FAA-Certificated Repair Stations for Fiscal Years 2010 through 2014



Source: GAO analysis of FAA data. | GAO 16-679

FAA changed its enforcement policy for all certificate holders, including repair stations, in June 2015 to emphasize compliance over enforcement. FAA instituted the compliance philosophy as part of its agency-wide, risk-based decision-making initiative to facilitate a more open exchange of information between the agency and its certificate holders.⁵⁵ Some FAA inspectors and representatives for airlines and repair stations told us that this philosophical shift has allowed FAA to collect more comprehensive data. Better communication between FAA and its certificate holders allows for sharing of data without fear of a retribution or enforcement action. FAA can still pursue enforcement actions in the event of intentional or reckless deviation from regulations, but FAA inspectors told us that they now have some degree of discretion for when to pursue such enforcement actions. According to FAA, many inspectors had been using

⁵⁵Until recently, FAA’s regulatory policy focused on legal enforcement action as a first step to address regulatory noncompliance. FAA now allows certificate holders, including repair stations, to take steps to redress a noncompliance finding and demonstrate compliance before initiating an enforcement action, except in certain cases such as an unwillingness or inability to comply.

a similar compliance philosophy before the official change. Our analysis of FAA's enforcement data seems to support this shift; for example, enforcement actions against repair stations declined by about half between fiscal years 2011 and 2014 (see fig. 5 above).

Interoffice Coordination Has Been Ad-Hoc, but FAA Is Taking Steps to Enhance It

FAA inspectors and officials told us that coordination among and between CMOs, FSDOs, and IFOs is currently ad-hoc. FAA's Inspector Handbook contains a requirement for CMOs to notify the local FSDO or IFO when conducting oversight of a repair station used by the assigned airline.⁵⁶ However, some of the FSDO inspectors told us that this requirement is not always followed and that CMO inspections of repair stations are relayed to them by the repair stations themselves. In 2008, the OIG noted that oversight of contract-maintenance repair stations required a multifaceted, risk-based approach and that it is important that each of FAA's oversight offices successfully work together.⁵⁷

According to agency officials, FAA is developing a process to enhance coordination amongst and between its oversight offices. Specifically, FAA is developing guidance that would shift some CMO surveillance activities to FSDOs and IFOs to make better use of and maximize FAA resources; the shift, in turn, would require interoffice coordination. FAA plans to implement this guidance first for FSDOs, and then FAA will look to expand the process to IFOs. This process would require CMOs to plan repair station inspections as they currently do, but FSDO inspectors would perform the actual inspections. The FSDOs and CMOs would be responsible for coordinating activities to ensure that knowledgeable and qualified personnel are conducting the surveillance activities. In addition, the two offices involved would share findings and information from the inspections using functions in the new SAS decision support tool, which is discussed below. FAA originally planned to issue guidance for this new approach in the fourth quarter of 2016, and though FAA still plans to issue it, there is no specific date for doing so.

⁵⁶FAA Order 8900.1, *Flight Standards Information Management System*, May 21, 2015. This guidance contains requirements for FAA inspectors conducting oversight of holders of FAA certificates, including repair stations and airlines.

⁵⁷DOT OIG, AV-2008-090.

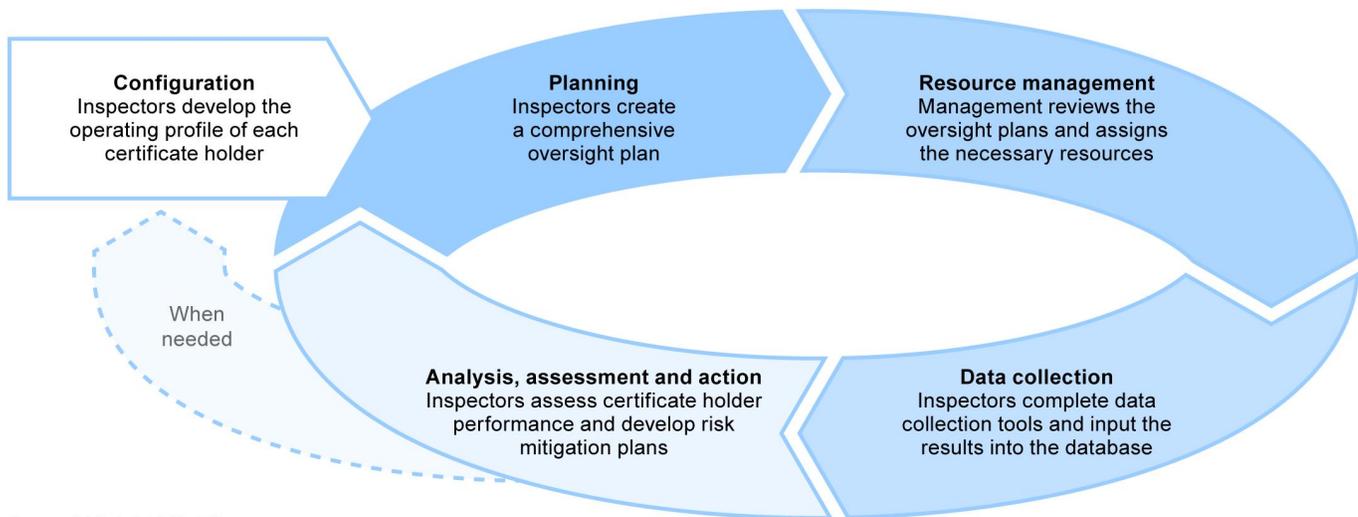
FAA officials and inspectors described a variety of reasons why better coordination among CMOs, FSDOs, and IFOs will be helpful. For example, efficient use of resources based upon good communication exchanges between CMOs, FSDOs, and IFOs could reduce the number of required inspection visits for repair stations. FAA officials told us that this new process will allow reductions in travel by CMO inspectors, and lower the number of inspections that repair stations receive. FAA officials told us that larger repair stations that work for multiple U.S. airlines can receive up to 50 inspections per year from the different CMOs and conducting that much oversight in the absence of significant noncompliance findings is duplicative and a poor use of agency and industry resources. However, some FAA inspectors interviewed had some concerns about the enhanced coordination approach. Inspectors for four CMOs told us that the ability of the agency to ensure that FSDO inspectors possess knowledge of the individual airline's maintenance programs is key to proper oversight. These CMO inspectors noted that because they are assigned to a specific airline, they are much more familiar with the airline's CAMP and manual requirements. FAA management officials responded by stating that FSDO inspectors are required to be familiar with the maintenance practices and requirements of repair stations' customer airlines and the planned CMO-FSDO coordination will help ensure the requisite depth of knowledge.

**FAA's Transition to
SAS May Enhance
Repair Station
Oversight, but
Additional Airline Data
and Performance
Metrics Could Help
Target Inspections**

FAA Has Taken Steps to Enhance Oversight by Implementing SAS

FAA began implementing SAS, a risk-based, data-supported oversight system, for repair stations and airlines in fiscal year 2014, and completed an initial rollout in January 2016. SAS is designed to be the safety assurance component of FAA’s SMS.⁵⁸ As noted, SAS contains requirements to incorporate risk-based decision making, a new approach to collecting data during surveillance activities, and a web-based, decision-support tool to standardize the methodology for oversight of various certificate holders, including repair stations and airlines. FAA inspectors use SAS to perform initial certification and continued operational safety assessments of those certificate holders. The SAS model contains five steps: configuration, planning, resource management, data collection, and analysis, assessment, and action (see fig. 6). According to FAA officials, SAS allows inspectors to make comprehensive assessments of certificate holder operations based on identified risks, which in turn, facilitates effective oversight and a more efficient use of resources.

Figure 6: The Federal Aviation Administration’s (FAA) Oversight Model for the Safety Assurance System



Source: GAO. | GAO 16-679

⁵⁸As previously mentioned, SMS consists of four key components: (1) safety policy, (2) safety risk management, (3) safety assurance, and (4) safety promotion. For more information, see [GAO-14-516](#) and [GAO-12-898](#).

The steps, as shown above, are consistent across areas of FAA oversight and are to be used by inspectors from FSDOs, IFOs, and CMOs. According to FAA guidance, inspectors and FAA management are to complete the following activities in each step:

- **Configuration:** Develop an operating profile for each certificate holder to design data collection tools applicable to the certificate holder's specific operations.⁵⁹ This step is completed after an application for an FAA certificate is received. It is thereafter updated whenever the certificate holder applies for a change in operations, such as adding a rating to a repair station's certificate. The step is expected to identify the initial oversight standards and data to be collected from each particular certificate holder.
- **Planning:** Create a comprehensive oversight plan, which automatically populates with the applicable data-collection tools. Collection tools can be added or modified—or the frequency of data collection can be changed—based on the inspector's assessment of risks posed by a certificate holder's particular areas of operations. This step is expected to assist inspectors prioritize oversight activities based on identified risks.
- **Resource Management:** FAA management reviews the developed profile and oversight plans to determine staff needs and assignments for completing the data collection and for appropriating resources to target agency resources toward the areas of greatest risk. This step is expected to assist field office management in prioritizing oversight resources based on identified risks.
- **Data Collection:** Complete data collection tools and input results into SAS during the initial certificate process and ongoing oversight. Completion is based upon assessing the certificate holder's process design, performance, and adherence to regulations during surveillance or review of information provided. This step is expected to standardize the methods of data collection and provide inspectors with more information on certificate holder operations.

⁵⁹The data collection tools are the lists of questions inspectors answer when conducting an inspection of a certificate holder. A single data collection tool covers one specific area of a certificate holder's operations, such as maintenance manuals, and directs the inspector to collect information related to that area.

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- **Analysis, Assessment, and Action:** Use of collected data to assess the adequacy of the certificate holder's organization and the effectiveness of its performance. If potential safety risks are revealed, such as high employee turnover, they are recorded in SAS along with a description of the likelihood of occurrence and the potential consequences. SAS automatically calculates a risk score for appropriate mitigation. Results of this process can include: identifying corrective actions to be taken by the certificate holder, increased FAA oversight, or enforcement actions. Actions taken by the certificate holder or FAA are entered into SAS database for tracking and review. The result of this step will aid planning for the next round of data collection and keeps the certificate holder's operating profile current. This step is expected to assist inspectors in determining each certificate holder's level of risk for appropriate actions or responses.

FAA officials told us that the design of SAS's web-based decision support tool is a significant improvement from its previous inspection systems. SAS allows inspectors to tailor data collection (amount and frequency) based on the extent to which risks are identified at individual certificate holders. Using data collected and input by inspectors, SAS is designed to assess various risk factors for each certificate holder and classify repair stations as low-, medium-, or high-risk based on a determination of criticality—which refers to the likelihood that a failure in a particular SAS assessment area could lead to an unsafe condition. For instance, an assessment for a repair station with high criticality will have a shorter baseline surveillance interval (every 6 months), while a station with medium or low criticality will have a longer interval (every 12 months and 24 months, respectively). SAS program officials said that inspectors can modify the frequency of inspections targeting each repair station based on the level of risk it presents. Also, SAS's data collection tools are a significant shift from the previous method of covering required inspection items and discretionary planned items during an inspection. FAA officials told us that the new data collection tools offer a more standardized, in-depth approach to collection. While standardized, inspectors can exercise discretion based on their knowledge and experience when assigning corrective actions to mitigate risks. FSDO and CMO inspectors told us that the new method allows a more in-depth review of certificate holder operations and facilitates communication between FAA and the certificate holder.

Several FSDO, IFO, and CMO inspectors we spoke with identified some problems with SAS's initial implementation. Inspectors from one FSDO and two CMOs told us that they were unable to access the results of

inspections conducted by other offices. FAA officials from the SAS program office stated that these problems were related to the database connections between SAS and a previous data system used by FAA inspectors, which are severed with each SAS software update. Officials told us that the connections will continue to be re-established after each software update until a permanent solution is found. Additionally, agency officials told us FAA is currently only able to target risks within the operations of individual certificate holders, such as the repair stations used by a particular airline. However, it is not yet able to compare risk across all certificate holders. Officials said that they are developing this capability and plan to implement it in the future version of SAS.

SAS Design Fully Meets Three SMS Principles, but Partially Meets Data Collection and Performance Metrics Principles

SMS Safety Assurance Principles

ICAO issued the third edition of its Safety Management Manual in 2013 to provide guidance to member states on the development and implementation of a state-level SMS.⁶⁰ As discussed, safety assurance is one of four components of SMS, and the component that SAS is designed to meet. The ICAO document outlines three SMS safety assurance principles, as follows:

- **Safety oversight:** Establish mechanisms to ensure both effective monitoring of critical elements of the safety oversight function and mechanisms to ensure that the identification of hazards and the management of safety risks by service providers follow established regulatory controls.
- **Safety data collection, analysis and exchange:** Establish mechanisms to ensure the capture and storage of data on hazards and safety risks for both individual certificate holders and at an aggregate national level, and to develop safety information from the stored data.

⁶⁰ICAO, *Safety Management Manual* (Third Edition), Doc 9859, 2013.

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- **Safety-data-driven targeting of oversight of areas of greater concern or need:** Establish procedures to prioritize inspections toward those areas of greater safety concern or need, as identified by the analysis of data on hazards, their consequences in operations, and the assessed safety risks.

FAA's SMS order incorporates the three ICAO SMS safety assurance principles into five principles for its SMS safety assurance component.⁶¹ Those five principles, as shown in table 3, include: (1) data acquisition (i.e., collection), (2) data analysis, (3) system assessment, (4) corrective action, and (5) management reviews. According to FAA's published description of SAS, FAA designed its oversight system consistent with these principles.

As shown in table 3, our review of SAS—as it specifically relates to oversight of repair stations—mostly met the five SMS safety assurance principles outlined in FAA's SMS guidance. Specifically, the design of SAS fully met principles related to data analysis, system assessment, and corrective action principles. The system design partially meets the two remaining principles. While FAA collects various data on repair stations, FAA does not collect or track data on the volume of work U.S. airlines send to repair stations. This element is needed to fully meet the data collection principle. Furthermore, FAA conducts management reviews but has not established SAS goals or performance metrics to measure overall system progress, a step necessary to fully meet the management reviews principle.

⁶¹In 2013, FAA incorporated the principles contained within the ICAO's Safety Management Manual in its SMS order, and updated this order in 2016. FAA Order 8000.369A, Safety Management System, May 8, 2013; FAA Order 8000.369B, Safety Management System, March 18, 2016.

Table 3: Comparison of the Federal Aviation Administration’s (FAA) Principles for Implementation of a Safety Management System (SMS) with the Design of Its Safety Assurance System (SAS)

SMS’s safety assurance principle	Assessment
Data collection: Collect, manage, and monitor operational data to assess the segment of the aerospace system for which the organization is responsible, identify new hazards, and measure the effectiveness of, and conformity to, safety risk controls.	<i>Partially Met.</i> SAS contains thousands of data collection tools inspectors use to collect data on certificate holders. Inspectors can customize these tools to match the specific operations of a certificate holder and assess identified risks. However, the system, as designed, does not allow inspectors to track data on the volume of work that individual repair stations conduct for U.S. airlines, and does not allow inspectors to input volume of work as a risk factor.
Data analysis: Analyze data to assess safety performance, identify new hazards, and measure the effectiveness of safety risk controls.	Fully Met. SAS contains a step where inspectors analyze the data collected during inspections. In this step inspectors are able to identify risks based on the data and track a certificate holder’s progress in mitigating identified risks. FAA is also developing the capability for SAS to conduct national-level analysis of data collected from all certificate holders to identify broad safety risks.
System assessment: Conduct assessments of the effectiveness of safety risk controls.	Fully Met. SAS contains steps where FAA inspectors collect data on the overall performance of safety risk and quality controls at certificate holders. As noted above, FAA also plans to be able to conduct national-level analysis of data collected from all certificate holders to identify broad safety risks.
Corrective action: Prioritize and implement corrective actions to mitigate or eliminate problems identified during system assessments.	Fully Met. SAS contains a step requiring inspectors to develop certificate holder’s corrective action plans for each identified risk. The system also allows inspectors to pursue additional data collections and modify inspection intervals based on identified risks.
Management reviews: Conduct regular reviews of SMS effectiveness and assess the need for changes to the SMS, including establishing performance measures and metrics.	Partially Met. FAA’s SAS program office told us that it continually reviews information on the technical performance of SAS and update the SAS software based on that information. However, FAA has not established SAS program goals or performance metrics to measure the performance of the system.

Source: GAO Analysis of FAA orders. | GAO-16-679

Data on Maintenance Volume for Repair Stations

As designed, SAS allows FAA inspectors to collect data on the operations of repair stations, and allows customization of the types of data collected to ensure oversight and tracking of all repair station operation areas. However, the system does not track or use data on the volume of maintenance work that individual repair stations conduct for U.S. airlines as a risk indicator. FAA regulations do not require repair stations or airlines to report this information to it at any level, though as noted below, airlines prior to 2010 could voluntarily provide information to FAA on the volume of maintenance work they contracted. Even if the information were required and available, SAS would not allow input of additional or different data to help target inspections for repair stations. Inspectors and FAA management officials told us they are able to select from a list of identified risk factors, such as personnel changes, financial difficulties, or rapid repair station growth, but cannot input additional or different information. While there is no explicit requirement in the ICAO Safety Management Manual or FAA’s SMS order to capture volume of work,

ICAO recommends capturing data on safety risks at both at an individual certificate holder level and an aggregate state level.

FAA's SMS order requires collection and analysis of operational data to identify safety risks. While maintenance volume data is operational data, FAA management officials told us they did not consider it to be the most important factor when assessing repair stations for risk. Rather, they viewed the types of maintenance performed by repair stations that are considered to be most critical to safe operations of an aircraft to be more important in risk assessment. Prior to 2010, FAA considered the volume of maintenance work performed by repair stations on behalf of airlines as a potential risk factor. FAA collected such data from U.S. airlines on a voluntary basis. In 2003, the DOT OIG recommended that FAA develop a process to identify the repair stations airlines use to perform safety critical maintenance and target oversight resources based on a risk assessment of the data collected.⁶² In 2005, in response to the 2003 OIG report, FAA established a Quarterly Utilization Report for voluntary reporting by airlines of repair stations that perform critical maintenance and those that perform the highest volume of work.⁶³ FAA implemented its Quarterly Utilization Report policy in 2006. In a data-collection justification to the Office of Management and Budget (OMB), FAA stated that the data would help identify repair stations that pose a higher risk due to the volume of work conducted for U.S. airlines and the collection would help ensure that FAA oversight targeted the highest-risk repair stations.

In 2008, the DOT OIG recommended that FAA make its maintenance volume data collection mandatory for all airlines using repair stations to perform critical aircraft maintenance and repairs.⁶⁴ FAA officials told us

⁶²See DOT OIG, AV-2003-047.

⁶³See DOT OIG, AV-2006-031.

⁶⁴DOT OIG, AV-2008-090. According to OIG officials, the recommendation is currently closed. FAA officials told us the recommendation was closed as a result of a recent regulatory change that required each U.S. airline to submit a monthly listing to FAA of that airline's contract maintenance providers, including the type of maintenance performed. FAA plans to use this information to assist in its assessment of the critical maintenance that is being performed by repair stations for airlines. The term "critical maintenance" includes (1) essential maintenance that could result in a failure, malfunction, or defect endangering the safe operation of an aircraft if not performed properly or if improper parts or materials are used; (2) regularly scheduled maintenance; and (3) required inspection items.

that the recommendation was addressed by the new regulations requiring airlines to provide up-to-date information on all contracted maintenance providers. While the 2008 DOT OIG report noted that FAA had taken important steps to move its safety oversight toward a risk-based system, it concluded that the agency still faced challenges in determining where the most critical maintenance occurred and ensuring sufficient oversight. According to that report, the agency needed to improve its system for determining how much and where contracted maintenance is performed. However, in 2010, FAA cancelled its collection of Quarterly Utilization Reports citing a low response rate of approximately 13 percent of airlines participating in the voluntary data collection.

In addition, representatives for airline labor unions and trade groups we spoke to expressed concern about the quality of data, including the lack of volume data, FAA uses to identify safety risks and for conducting its risk-based decision making for targeting oversight. We have also reported on long-standing issues with the quality and usefulness of data used by FAA in its oversight efforts. These continuing issues could negatively affect FAA's ability to evaluate aviation safety and, consequently, affect effective implementation of SMS, including the design and implementation of SAS.⁶⁵ More specifically, and as FAA acknowledged in its 2005 OMB justification, without the ability to analyze maintenance volume data, FAA risks degrading its surveillance of airlines' maintenance programs and delaying the identification of potential high-risk repair stations. By incorporating volume information into targeting the oversight of repair stations, FAA could prioritize oversight on those repair stations providing the highest volume of work for airlines.

FAA Has Not Established Performance Goals and Metrics for SAS

FAA officials told us that the SAS program office continually reviews information on the technical performance of SAS and as a result updates the SAS software. FAA's SAS program office manages the continued development of and improvements to SAS. Officials stated that they also solicit feedback from offices using the system and implement recommended changes. However, FAA management officials stated that here is no formal process, such as establishing and monitoring performance metrics, for determining the effectiveness of SAS, including

⁶⁵See GAO, [GAO-12-898](#); GAO, *Aviation Safety: FAA Is Taking Steps to Improve Data, but Challenges for Managing Safety Risks Remain*, [GAO-12-660T](#) (Washington, D.C.: Apr. 25, 2012) and *Aviation Safety: Enhanced Oversight and Improved Availability of Risk-Based Data Could Further Improve Safety*, [GAO-12-24](#) (Washington, D.C.: Oct. 5, 2011).

its effectiveness in improving oversight of certificate holders, including repair stations. While the agency is considering this element and is at the very beginning phase of this process, to date, FAA has not developed specific performance goals and metrics for SAS, or developed a timeline for doing so. Officials added that SAS provides large amounts of new data, and the agency does not know the entire range of capabilities the system can provide.

FAA's SMS order requires FAA offices to conduct regular management reviews of SMS effectiveness and assess the need for changes through the use of performance measures. According to internal control standards for federal agencies, control activities, such as top-level reviews of performance and the establishment and review of performance measures, should be designed to achieve objectives and respond to risks.⁶⁶ As we have previously reported, SMS-related performance measures could help FAA identify the extent to which SMS, including SAS's safety assessment component, contributes to increased aviation safety—FAA's stated goal for SMS. In 2012, we found that FAA did not have performance measures in place to assess whether the SMS goals of improving safety were being achieved. Our report noted that while FAA had broader safety-related performance measures, SMS-related performance measures could address intermediate safety issues, such as precursors to incidents. Such measures could help FAA track progress toward its broader safety goals. Thus, we recommended that to better evaluate the effectiveness of its SMS, FAA develop a system to assess whether SMS meets its goals and objectives by identifying and collecting related data on performance measures. Without measurements FAA would not be able to gauge the impact of SMS on aviation safety.⁶⁷ As of June 2016, FAA has yet to address this recommendation.

Defining specific performance measurements toward objectives could provide FAA with a view of how well the SMS's safety assurance component is being implemented through SAS. Agencies need to set quantifiable outcome-based performance measures for significant agency activities, such as FAA's SMS, to document their program goals and

⁶⁶GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

⁶⁷GAO, *Aviation Safety: Additional FAA Efforts Could Enhance Safety Risk Management*, [GAO-12-898](#) (Washington, D.C.: September 2012).

measure the extent to which they are achieving them.⁶⁸ Performance measures allow an agency to track its progress in achieving intended results, which can be particularly important in the implementation stage of a new program such as SMS.

Conclusions

FAA plays a critical role in overseeing its roughly 4,800 certificated repair stations worldwide. In its attempt to oversee its certificate holders more effectively, the agency has taken or is taking a number of steps to improve surveillance of repair stations, including implementing a more structured, risk-based oversight system, and improving intra-agency coordination to effectively target risks and maximize resource usage. FAA could further enhance its efforts by collecting and analyzing data from U.S. airlines on the amount of work being contracted to domestic and foreign repair stations. Without incorporating data on the volume of maintenance work performed for U.S. airlines into FAA's repair station oversight process, FAA's ability to administer a comprehensive risk-based oversight system could be limited. This information would help determine trends in airlines' use of contractors and identify the often-used repair stations. FAA is missing an opportunity to better leverage its limited resources by collecting such data as a potential indicator in performing its risk assessments of repair stations.

In addition, FAA has undertaken major changes to its oversight model for repair stations by the transition to SAS, but has yet to develop specific and measurable program goals and measures. We also noted that FAA has yet to develop performance metrics for implementation of SMS overall, as we recommended in 2012. Changes in FAA's oversight model represent significant shifts to the way FAA conducts oversight of certificate holders by changing the planning and execution of repair station surveillance by inspectors and changing the roles and responsibilities of some personnel. Performance information is critical for ensuring the desired results and maximizing the return on federal funds

⁶⁸See GAO, [GAO-12-898](#); *The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans*, [GAO/GGD-10.1.20](#) (Washington, D.C.: April 1998); *VA Health Care: VA Should Better Monitor Implementation and Impact of Capital Asset Alignment Decisions*, [GAO-07-408](#) (Washington, D.C.: Mar. 21, 2007); *NextGen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, But Not of Overall NextGen Implementation or Outcomes*, [GAO-10-629](#) (Washington, D.C. July 27, 2010); and *Motor Carrier Safety: More Assessment and Transparency Could Enhance Benefits of New Oversight Program*, GAO 11-858 (Washington, D.C.; Sept. 29, 2011).

invested. Having a process to continuously improve program performance together with goals and measures would enable FAA to better determine the effectiveness of the agency's oversight processes. Without these steps, it will be difficult to determine whether FAA's efforts have been successful.

Recommendations for Executive Action

To enhance FAA's risk-based approach for oversight of repair stations, we recommend that the Secretary of Transportation direct the Administrator of the Federal Aviation Administration to take the following two actions:

- develop and implement a process in Flight Standards for incorporating into SAS the volume of critical maintenance that each U.S. airline contracts to repair stations, and
- develop and implement an evaluative process with measurable performance goals and measures to determine the effectiveness of SAS as the SMS safety assurance component.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Transportation for review and comment. In written comments, reprinted in appendix II, FAA did not agree with the first recommendation to incorporate volume information as part of the risk-indicator criteria in SAS for identifying higher-risk repair stations. FAA's letter indicated that while the agency does not specifically assess volume of work as a primary factor in determining risk at repair stations, the agency monitors several risk indicators associated with volume of work, such as rapid growth or downsizing of an organization, changes in aircraft complexity/programs, air agency ratings, changes in management, and high workforce turnover. According to its letter, FAA considers such factors and the criticality a specific maintenance function has on the safe operation of an aircraft to be primary risk indicators. Additionally, repair stations are assessed to ensure they have the necessary facilities, equipment, materials, and personnel consistent with their ratings. We recognize that FAA inspectors are able to select from a list of identified risk factors to target oversight of repair stations and that FAA can carry out its risk-based oversight process for repair stations without collecting such volume data from airlines. However, we believe that collecting volume data from each U.S. airline that contracts aircraft maintenance to repair stations would enhance FAA's ability to administer a more comprehensive, risk-based oversight system for prioritizing its surveillance of repair stations involved

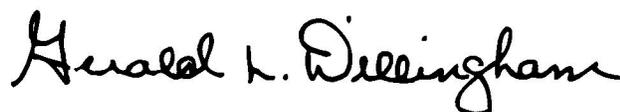
with the highest volume of work for airlines. SAS was designed to be a more structured, data-driven means to aid FAA inspectors in performing their oversight responsibilities more efficiently and effectively. Thus, as stated in the report, this type of volume information from airlines would help FAA to determine trends in airlines' use of contractors and identify repair stations that pose a higher risk due to the volume of work performed on U.S. airlines' commercial aircraft.

FAA agreed with the second recommendation to develop a process to determine the effectiveness of SAS for improving risk-based oversight. FAA's letter noted that since SAS's introduction in 2015, the agency has continued to enhance SAS tools and resources. Also according to FAA's letter, the additional enhancements will include a greater emphasis on risk-based approaches to the oversight of repair stations resulting in better utilization of FAA inspector resources and more effective oversight within the United States and abroad. We are encouraged that FAA plans to take actions that will include developing performance goals and measures to determine the effectiveness of SAS. FAA also provided technical comments that were incorporated, as appropriate.

In addition, to verify information, we provided a draft version of this report to ARSA and Airlines for America for review and comment. Representatives for both organizations provided technical comments that were incorporated, as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Transportation, the FAA Administrator, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or by e-mail at dillinghamg@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 III.



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

Appendix I: Objectives, Scope, and Methodology:

This report examines airlines' contracted maintenance trends and FAA's oversight of domestic and foreign repair stations. Specifically, this report assesses: (1) trends in the type and volume of contracted airline maintenance in the United States from 2010 through 2014 and factors influencing these trends; (2) how FAA's oversight of foreign repair stations compares with the oversight of domestic repair stations, and any associated challenges FAA faces in conducting that oversight; and (3) efforts taken by FAA to improve its risk-based oversight of repair stations.

To address the three objectives, we reviewed and synthesized a range of published reports from GAO, the Department of Transportation (DOT), DOT's Office of the Inspector General (OIG), the Federal Aviation Administration (FAA), industry, and academic sources that included background information on a variety of related issues, such as information on, 14 Code of Federal Regulations (C.F.R.) Part 121 commercial airlines and their maintenance activities, work contracted to domestic and foreign repair stations, and work contracted to domestic repair stations from foreign airlines (insourcing). We also reviewed and summarized FAA's requirements for oversight of FAA-certificated domestic and foreign aircraft repair stations, in accordance with, Title 14, parts 119, 121, and 145.¹ We reviewed and summarized information on the International Civil Aviation Organization's (ICAO) standards, recommended practices, and relevant initiatives.²

To assess trends in the type and volume of airline maintenance contracting in the United States from 2010 through 2014, and what factors influenced these trends, we analyzed airline financial and operational data for selected U.S. airlines, reviewed relevant studies, and

¹14 C.F.R. parts 119 and 121 prescribe rules governing the domestic, flag, and supplemental operations to hold an air carrier (airline) certificate. Scheduled-service airlines are generally issued a Part 121 certificate by FAA and operate turbojet-powered airplanes or airplanes with more than nine passenger seats or airplanes having a payload capacity of more than 7,500 pounds. 14 C.F.R. Part 145 prescribes rules governing certification of repair stations. It also contains the rules a certificated repair station must follow related to its performance of maintenance, preventive maintenance, or alterations of an aircraft, airframe, aircraft engine, propeller, appliance, or component part under 14 C.F.R. Part 43 Maintenance, Preventive Maintenance, Rebuilding, and Alteration. It also applies to any person who holds, or is required to hold, a repair station certificate under this part.

²ICAO is the international body that, among other things, promulgates international standards and recommended practices in an effort to harmonize global aviation standards.

interviewed aviation industry stakeholders. We analyzed data on yearly maintenance spending for 28 selected U.S. passenger airlines that had the largest number of flights in December 2014 to determine their contracted maintenance as a percentage of their overall maintenance spending from DOT Form 41 financial data submitted to DOT by airlines from the years 2010 through 2014, which was the most recent available data at the time of our analysis. The data set is maintained by DOT's Bureau of Transportation Statistics (BTS).³ We obtained these data from Diiio, a private contractor that provides online access to U.S. airline financial, operational, and passenger data with a query-based user interface. To determine the appropriate financial reports to analyze in BTS, we interviewed an official at BTS who is responsible for data collection efforts to obtain information about the maintenance expenses airlines are required to report, how they report maintenance expenses, and the accounts within DOT Form 41 that are relevant to understanding airlines' in-house and contract maintenance expenses. We also reviewed the quality control procedures used by DOT, and subsequently determined that the data were sufficiently reliable for our purposes. As a result of this discussion, we selected DOT Form 41 schedule P-5.2 to determine airlines' maintenance spending for in-house and contract maintenance. Schedule P-5.2 includes six categories with data about airlines' maintenance spending—four that provide data about airlines' in-house maintenance spending and two that provide data about airlines' contracted maintenance spending. We summarized this data to develop information about annual in-house and contracted maintenance spending for 2010 through 2014 for the 28 airlines in our selection. We selected these 28 U.S. passenger airlines to obtain information on these airlines' spending on in-house and contracted maintenance, but our findings cannot be generalizable to all U.S. passenger airlines.

We also reviewed 2014 and 2015 industry reports from the Aeronautical Repair Station Association (ARSA) that provided projections on U.S. airlines' maintenance spending, including work performed by airlines' in-house capabilities and by contracting to repair stations. We interviewed relevant representatives for the company that produced these industry reports for ARSA and determined the reports were sufficiently reliable for our purposes of reporting general trends in where maintenance is

³U.S. airlines submit financial and operational data to DOT via the Form 41 Financial Schedule that includes balance sheet, cash flow, employment, income statement, fuel cost and consumption, aircraft operating expenses, and operating expenses.

conducted. We also interviewed FAA officials within the Office of Aviation Safety's Flight Standards Service and collected data, as well as from various industry stakeholders including representatives of U.S. airlines, industry groups, and domestic repair stations to obtain perspectives on issues that influence maintenance contracting and insourcing decisions. Our selected airline list included 5 passenger mainline airlines, 2 cargo mainline airlines, and 3 passenger regional airlines, which accounted for about 66 percent of the aircraft in the U.S. commercial airline fleet.⁴ We selected the largest mainline passenger and cargo airlines based on their size of operations and overall number of aircraft in their fleets. We initially contacted six regional passenger airlines to interview and three agreed to be interviewed.

To assess the extent to which FAA's oversight of foreign repair stations differ from its oversight of domestic repair stations and any associated challenges FAA faces in conducting that oversight, we reviewed FAA's requirements for oversight of FAA-certificated domestic and foreign aircraft repair stations, including FAA policy and other guidance documents and interviewed FAA officials and aviation industry representatives on the oversight for domestic and foreign repair stations. To review FAA's inspection and enforcement activities related to domestic and foreign repair stations we obtained FAA's inspection and enforcement policies and analyzed raw data from FAA's inspection and enforcement databases. We analyzed data from the Program Tracking Reporting System for inspections that began (had a start date) in fiscal years 2010 through 2014 and data from the Enforcement Information System for enforcement actions with a violation date in those fiscal years. We used these data sets to determine the extent to which FAA had completed all required inspections of domestic and foreign repair stations and the extent to which FAA's enforcement actions differed between domestic and foreign repair stations. To assess the reliability of the inspection and enforcement data that we received from FAA, we obtained and reviewed documentation about the data and the systems that produced them. We found the data to be sufficiently reliable for our

⁴Mainline airlines provide domestic and international passenger and cargo service on larger aircraft, i.e., American Airlines and Delta Air Lines. Regional airlines provide domestic and limited international passenger service, generally using aircraft with fewer than 90 seats, and cargo service to smaller airports. Regional airlines include (1) passenger service providers, such as SkyWest Airlines and ExpressJet, and (2) cargo service providers, such as ABX Air and Kalitta Air, that provide domestic and limited international cargo service on a charter or contract basis.

purposes. For our analysis of data from FAA's Program Tracking Reporting System for repair station inspections, we analyzed data on the number of inspections FAA conducted at each domestic and foreign repair station during each of the fiscal years in our sample, and compared these findings to the requirements set in FAA's National Program Guidelines and a list of repair stations active in each fiscal year. The National Program Guidelines for each fiscal year indicated that an inspection was required for each repair station in each fiscal year (Program Tracking Reporting System activity code 3650 for maintenance operations and 5650 for avionics operations). We also compared our findings to a list of repair stations that were active as of December of each year, including information about the country in which they operated, in order to eliminate from consideration repair stations operating in countries where FAA had delegated primary repair station oversight to a foreign civil aviation authority (CAA)—foreign countries' counterpart to FAA. For our analysis of FAA's Enforcement Information System data on enforcement actions taken against domestic and foreign repair stations, we analyzed the number and type of enforcement actions FAA took against all repair stations, including whether the actions were administrative actions, fines, or suspensions or revocations of repair stations' Part 145 operating certificates. We then compared the results for domestic and foreign repair stations to determine the extent to which FAA pursued similar rates of enforcements against domestic and foreign repair stations. In addition, we reviewed DOT OIG reports about U.S. airlines' maintenance contracting and FAA's oversight of repair stations, and contacted the appropriate OIG officials to discuss their findings. We also interviewed officials from U.S. and international aviation organizations, such as the International Air Transport Association (IATA), and ARSA. We also conducted semi-structured interviews with representatives of four domestic repair stations, which were selected based on types of maintenance performed, size of operation, relationship with U.S. and foreign airlines, and geographical proximity to a local FAA office. In addition, we conducted site visits to a non-generalizable sample of Latin American countries, which included Brazil, El Salvador, and Mexico, to meet with representatives of seven FAA-certificated repair stations in those countries and their respective foreign CAAs. We selected site visit locations based on factors such as U.S. and foreign airlines' operations, geographic location, types of maintenance performed, and locations of foreign civil aviation authorities. We also selected this region given recent work that had been conducted related to U.S. airlines' maintenance being

performed.⁵ The information and perspectives that we obtained from the interviews may not be generalized to all industry stakeholders that have an interest in commercial airline maintenance contracting and insourcing (see table 4).

Table 4: Federal Agencies, Airlines, Industry Groups, and Repair Stations Contacted or Interviewed

U.S. federal agencies
Department of Commerce
Department of Labor, Bureau of Labor Statistics
Department of Transportation, Federal Aviation Administration
Department of Transportation, Office of Inspector General
U.S. mainline passenger airlines
American Airlines
Delta Airlines
JetBlue Airways
Southwest Airlines
United Airlines
U.S. mainline cargo airlines
Federal Express (FedEx)
United Parcel Service (UPS)
U.S. regional passenger airlines
Endeavor Airlines
Mesa Airlines
SkyWest Airlines
Industry groups
Aeronautical Repair Station Association
Airlines for America
International Air Transport Association
Regional Airline Association
Domestic repair stations (in the United States)
AAR
Bombardier

⁵Congressional Research Service, *Offshoring of Airline Maintenance: Implications for Domestic Jobs and Aviation Safety*, R42876 (Washington, D.C.: Dec. 21, 2012).

Appendix I: Objectives, Scope, and Methodology:

Nordam Group

Precision Electronics

Foreign repair stations (outside the United States)

Brazil (GE Celma, TAP Maintenance and Engineering)

El Salvador (Aeroman, Aviatechnology, Avianca Airlines Technical and Training Services)

Mexico (Mexicana MRO Services, Aeromexico)

Consumer groups

Business Travelers Coalition

Consumers Union

Airline labor groups

International Association of Machinists

Professional Aviation Safety Specialists

Teamsters Airline Division

Transportation Trades Department, AFL-CIO

Transportation Workers Union

Source: GAO. | GAO-16-679

To assess efforts taken by FAA to improve its risk-based oversight of repair stations, we compared FAA documentation and interviewed FAA officials within the System Approach for Safety Oversight Program Office on the new risk-based Safety Assurance System (SAS).⁶ We compared the design of SAS with recommended Safety Management System (SMS) principles from ICAO for member states and FAA policy documents for its oversight offices on implementation of SMS.⁷ We focused on the design of SAS rather than testing the effectiveness of the system's internal controls. Also, we did not conduct a comprehensive audit of the effectiveness of FAA's transition to SAS for conducting risk-based oversight of repair stations. To assess the extent to which FAA's new SAS decision support tool aligned with SMS principles, we obtained FAA documentation on the system, conducted interviews with program

⁶To best target oversight priorities and FAA's oversight resources, in the beginning of fiscal year 2015, FAA transitioned to SAS—a new risk-based, data-supported system for the oversight 14 C.F.R. Part 121 (U.S. commercial airlines), Part 135 (commuter or on-demand air operations), and Part 145 (repair stations). SAS is the combination of people, processes, and technology that will be FAA's safety assurance capability under the safety management system components.

⁷SMS is an approach to collect and analyze safety data to identify hazards, manage risks, and take corrective action before an accident occurs.

officials, and analyzed FAA's SMS Order 8000.369A. We first reviewed the extent to which FAA's SMS Order aligned with the principles set forth by ICAO in the 2013 edition Safety Management Manual, the most recent edition published. ICAO's Safety Management Manual and FAA's SMS Order both contain four SMS components: Safety Policy, Safety Risk Management, Safety Assurance, and Safety Promotion, which together comprise an SMS. The Safety Assurance component includes five principles: (1) data acquisition (i.e., collection), (2) data analysis, (3) system assessment, (4) corrective action, and (5) management reviews. To determine the extent to which SAS as designed aligned with FAA's stated SMS principles, we reviewed FAA documentation and interviewed FAA officials from the SAS program office and other relevant FAA offices to compare the design of SAS to each of the five SMS-related safety assurance principles outlined in FAA's SMS Order. We scored the design of SAS against FAA's five SMS safety assurance principles using the following: "fully met" means that the design of SAS completely met the principle, "partially met" means that the design of SAS met about half of the principle, and "did not meet" means that the design of SAS did not demonstrate the principle.

We conducted this performance audit from May 2015 to July 2016 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 evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Department of Transportation



**U.S. Department of
Transportation**

Office of the Secretary
of Transportation

Assistant Secretary
for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

JUL 22 2016

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

Mr. Dillingham:

The Safety Assurance System (SAS) is the data-driven, risk-based safety assurance component of the Safety Management System (SMS), and it provides a comprehensive, standardized approach to the oversight of foreign and domestic Federal Aviation Administration (FAA) certificate holders. Every FAA-certificated repair station, regardless of location, is inspected using this risk-based, data-supported oversight system. The FAA uses SAS tools to validate that a certificate holder has a robust system, thereby ensuring safety is designed into its organization.

FAA concurs with GAO's recommendation to develop a process to determine the effectiveness of SAS for improving risk-based oversight. Since SAS's introduction in 2015, the agency has continued to enhance SAS tools and resources. The additional enhancements will include a greater emphasis on risk-based approaches to the oversight of repair stations resulting in better utilization of FAA inspector resources and more effective oversight within the United States and abroad.

FAA does not concur with GAO's recommendation to incorporate volume information as part of the risk-indicator criteria for identifying higher-risk repair stations and into its risk-based targeting for conducting oversight of repair stations. GAO found that the agency no longer uses data on volume of maintenance work as a risk factor. While the FAA does not specifically assess volume of work as a primary factor in determining risk at repair stations, the agency monitors several risk indicators associated with volume of work, such as rapid growth or downsizing of an organization, changes in aircraft complexity/programs, air agency ratings, changes in management, and high workforce turnover. FAA considers such factors and the criticality a specific maintenance function has on the safe operation of an aircraft to be primary risk indicators. Additionally, repair stations are assessed to ensure they have the necessary facilities, equipment, materials, and personnel consistent with their ratings.

We will provide a detailed response to each recommendation within 60 days of the final report's issuance. We appreciate the opportunity to comment on the GAO draft report. Please contact Madeline Chulumovich, Director, Office of Audit Relations and Program Improvement, at (202) 366-6512 with any questions.

Sincerely,

A handwritten signature in blue ink that reads "Jeff Marootian".

Jeff Marootian
Assistant Secretary for Administration

Appendix III: GAO Contacts and Staff Acknowledgments

GAO Contact

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

Acknowledgements

In addition to the contact named above, the following individuals made important contributions to this report: Vashun Cole, Assistant Director; Amy Abramowitz, Sarah Cantatore, Mya Dinh, Alex Fedell, Camilo Flores, Delwen Jones, Bonnie Pignatiello Leer, Joshua Ormond, Nitin Rao, and Kelly Rubin.

Appendix IV: Accessible Data

Agency Comment Letter

Text of Appendix II:
Comments from the
Department of
Transportation

Page 1

U.S. Department of Transportation

Office of the Secretary of Transportation

Assistant Secretary for Administration

1200 New Jersey Avenue, SE

Washington, DC 20590

JUL 22 2016

Gerald L. Dillingham

Director, Physical Infrastructure Issues

U .S. Government Accountability Office (GAO)

441 G Street NW

Washington, DC 20548

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Sincerely,

Jeff Marootian

Assistant Secretary for Administration

Data Tables/
Accessible Text

Accessible Text for Figure 3: Examples of Aircraft Maintenance Tasks Performed by Aircraft Mechanics and Avionics Technicians

Aircraft mechanics perform routine maintenance, replace aircraft parts, calibrate systems, inspect aircraft components, interpret manuals and specifications, and determine feasibility of repairing or replacing components. They work on engines, brakes, landing gear, plumbing, and other mechanical, hydraulic, and structural components using hand tools and power tools. Only a certificated mechanic can approve an aircraft for return to service.

Avionics technicians install, inspect, test, or repair avionics equipment for communication and navigation.

Data Table for Figure 4: Selected U.S. Passenger Airlines' In-house and Contracted Maintenance Spending as a Percentage of Total Maintenance Spending from 2010 through 2014

	In-house	Outsourced
2010	42	58
2011	39	61
2012	39	61
2013	36	64
2014	38	62

Data Table for Figure 5: The Federal Aviation Administration's (FAA) Enforcement Actions Taken Against FAA-Certificated Repair Stations for fiscal years 2010 through 2014

	Domestic Enforcements	Foreign Enforcements
2010	960	82
2011	1141	67
2012	907	41
2013	749	42
2014	594	31

Suspension or Revocation	Fine	No Action	Administrative Action
1	5	9	86

Category	Overall Percentage	Domestic Percentage	Foreign Percentage
Administrative Actions	85.7	86.1	78.7
No Action	8.6	8.3	13.3
Fines	4.7	5.6	6.1
Suspensions/Revocations	0.4	0.5	0

Accessible Text for Figure 6: The Federal Aviation Administration’s (FAA) Safety Assurance System Oversight Model

Configuration: Inspectors develop the operating profile of each certificate holder

Planning: Inspectors create a comprehensive oversight plan

Resource management: Management reviews the oversight plans and assigns the necessary resources

Data collection: Inspectors complete data collection tools and input the results into the database

Analysis, assessment and action: Inspectors assess certificate holder performance and develop risk mitigation plans

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