



July 2015

UNMANNED AERIAL SYSTEMS

FAA Continues Progress toward Integration into the National Airspace

Accessible Version

GAO Highlights

Highlights of [GAO-15-610](#), a report to congressional committees

Why GAO Did This Study

UASs are aircraft that do not carry a pilot aboard, but instead operate on pre-programmed routes or are manually controlled by following commands from pilot-operated ground control stations. Unauthorized UAS operations have, in some instances, compromised safety. The FAA Modernization and Reform Act of 2012 directed FAA to take actions to safely integrate UASs into the national airspace. In response, FAA developed a phased approach to facilitate integration and established test sites among other things.

GAO was asked to review FAA's progress in integrating UASs. This report addresses (1) the status of FAA's progress toward safe integration of UASs into the national airspace, (2) research and development support from FAA's test sites and other resources, and (3) how other countries have progressed toward UAS integration into their airspace for commercial purposes. GAO reviewed and analyzed FAA's integration-planning documents; interviewed officials from FAA and UAS industry stakeholders; and met with the civil aviation authorities from Australia, Canada, France, and the United Kingdom. These countries were selected based on several factors including whether they have regulatory requirements for commercial UASs, operations beyond the view of the pilot, and whether non-military UAS are allowed to operate in the airspace. In comments on this report, the Department of Transportation noted that GAO did not address environmental considerations of UAS integration; such considerations were outside the scope of this report.

View [GAO-15-610](#). For more information, contact Gerald Dillingham at (202) 512-2834 or dillingham@gao.gov.

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FAA Continues Progress toward Integration into the National Airspace

What GAO Found

The Federal Aviation Administration (FAA) has progressed toward its goal of seamlessly integrating unmanned aerial system (UAS) flights into the national airspace. FAA has issued its *UAS Comprehensive Plan* and *UAS Integration Roadmap*, which provide broad plans for integration. However, according to FAA, it is working with MITRE to develop a foundation for an implementation plan; FAA then expects to enact a plan by December 2015. While FAA still approves all UAS operations on a case-by-case basis, in recent years it has increased approvals for UAS operations. Specifically, the total number of approvals for UAS operations has increased each year since 2010, and over the past year has included approvals for commercial UAS operations for the first time. In addition, FAA has issued a Notice of Proposed Rulemaking that proposes regulations for small UASs (less than 55 pounds).

The FAA's six designated test sites have become operational but have had to address various challenges during the process. The designated test sites became operational in 2014, and as of March 2015, over 195 test flights had taken place. These flights provide operations and safety data to FAA in support of UAS integration. In addition, FAA has provided all test sites with a Certificate of Waiver or Authorization allowing small UAS operations below 200 feet anywhere in the United States. However, during the first year of operations, the test sites faced some challenges. Specifically, the test sites sought additional guidance regarding the type of research they should conduct. According to FAA, it cannot direct the test sites, which receive no federal funding, to conduct specific research. However, FAA did provide a list of potential research areas to the test sites to provide some guidance on areas for research. FAA has conducted other UAS research through agreements with MITRE and some universities, and in May 2015 named the location of the UAS Center of Excellence—a partnership among academia, industry, and government conducting additional UAS research. Unlike FAA's agreements with the test sites, many of these arrangements have language specifically addressing the sharing of research and data.

Around the world, countries have been allowing UAS operations in their airspace for purposes such as agricultural applications and aerial surveying. Unlike in the United States, countries GAO examined—Australia, Canada, France, and the United Kingdom—have well-established UAS regulations. Also, Canada and France currently allow more commercial operations than the United States. While the United States has not finalized UAS regulations, the provisions of FAA's proposed rules are similar to those in the countries GAO examined. However, FAA may not issue a final rule for UASs until late 2016 or early 2017, and rules in some of these countries continue to evolve. Meanwhile, unlike under FAA's proposed rule, Canada has created exemptions for commercial use of small UASs in two categories that allow operations without a government-issued certification, and France and Australia are approving limited beyond line-of-sight operations. Similar to the United States, other countries are facing technology shortfalls, such as the ability to detect and avoid other aircraft and obstacles, as well as unresolved issues involving limited spectrum that limit the progress toward full integration of UASs into the airspace in these countries.

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Abbreviations

ASTM International	formerly known as the American Society for Testing and Materials
COA	Certificates of Waiver or Authorization
DHS	Department of Homeland Security
DOD	Department of Defense
DOT	Department of Transportation
EASA	European Aviation Safety Agency
EUROCAE	European Organization for Civil Aviation Equipment
Experimental Certificate	Special Airworthiness Certificates in the Experimental Category
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
MITRE	MITRE Corporation
MOA	memorandum of agreement
MOU	memorandum of understanding
NASA	National Aeronautics and Space Administration
NPRM	Notice of Proposed Rule Making
RTCA	formerly the Radio Technical Commission for Aeronautics (now RTCA)
the 2012 Act	FAA Modernization and Reform Act of 2012

UAS

unmanned aerial systems or unmanned
aircraft systems

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July 16, 2015

Congressional Committees

Since the early 1990s, unmanned aerial systems (UAS) have operated on a limited basis in the national airspace system, primarily supporting public uses, such as military and border-security operations.¹ The list of potential uses is now rapidly expanding to include a broad range of UAS operations, including assisting in search and rescue operations, inspecting pipelines, photographing real estate, surveying land and crops, disaster assistance, gathering news, and filming movies. According to a 2013 report by a UAS industry group, the economic benefit of fully integrating UASs into the national airspace system will total more than \$13.6 billion in the first 3 years of integration and grow to more than \$82.1 billion from 2015 through 2025.

The Federal Aviation Administration's (FAA) goal is to seamlessly integrate all UAS operations into the national airspace. While FAA is developing regulations to allow routine UAS commercial operations, it currently only allows them in the national airspace after a case-by-case safety review and approval. At the same time, the safety of the national airspace is threatened on a nearly daily basis by UASs' operating without approval. For example, one UAS nearly collided with a New York Police Department helicopter over New York City, another came dangerously close to a US Airways regional jet over the Florida panhandle, and numerous UASs have been spotted flying over professional and college football stadiums full of people. The FAA has stated the number of reported incidents has increased recently, with 97 incidents reported from February through March 2015, compared to just 3 incidents reported

¹See GAO, *Unmanned Aerial Systems: Department of Homeland Security's Review of U.S. Customs and Border Protection's Use and Compliance with Privacy and Civil Liberty Laws and Standards*, [GAO-14-849R](#) (Washington, DC: Sept. 30, 2014). UAS aircrafts do not carry a pilot onboard, but instead operate by following commands from pilot-operated ground control stations or pre-programmed routes. UASs are also referred to as "unmanned aerial vehicles," "unmanned aircraft systems," "remotely piloted aircraft," "unmanned aircraft," or "drones." The term "unmanned aerial system" is used to recognize that UASs include not only the airframe and its power source, such as a battery or combustible engine, but also associated elements such as a ground control station and communications links.

during the same period in 2014. FAA believes the increase is due to more awareness about UASs and the need to report incidents, but the extent these factors contribute to the increase is not clear.

As UAS operations in the national airspace continue to increase, members of Congress have raised questions about the safe and efficient integration of UASs into the national airspace system and asked us to examine the progress of UAS integration. This report examines (1) the status of FAA's progress toward safe integration of UASs into the national airspace, (2) research and development support from FAA's test sites and other resources, and (3) how other countries have progressed toward UAS integration into their airspace for commercial purposes.

To address all the objectives, we reviewed FAA reports and prior GAO work² related to integrating UASs in the national airspace system, reviewing such work as FAA's framework for UAS integration and our prior work on UAS research and development, efforts by FAA to accommodate ongoing research and commercial UAS use, and UASs' technology challenges.³ We also reviewed provisions of the FAA Modernization and Reform Act of 2012⁴ (the 2012 Act), and the Notice of Proposed Rulemaking for small UAS operations.⁵ To determine FAA's progress toward safe integration of UASs into the national airspace, we reviewed and analyzed documents provided by various stakeholders and conducted semi-structured interviews with these stakeholders, including government—FAA, Department of Defense (DOD), National Aeronautics and Space Administration (NASA), and the Department of Homeland Security—academics researching UAS technology, industry trade associations, and others from the UAS industry including a manufacturer and a commercial operator. We selected the private-sector stakeholders,

²GAO, *Unmanned Aircraft Systems: Continued Coordination, Operational Data, and Performance Standards Needed to Guide Research and Development*, [GAO-13-346T](#) (Washington, DC: Feb. 15, 2013); *Unmanned Aircraft Systems: Measuring Progress and Addressing Potential Privacy Concerns Would Facilitate Integration into the National Airspace System*, [GAO-12-981](#) (Washington, DC: Sept. 14, 2012); and *FAA Reauthorization Act: Progress and Challenges Implementing Various Provisions of the 2012 Act*, [GAO-14-285T](#) (Washington, DC: Feb. 5, 2014).

³We did not review the environmental challenges of UAS integration.

⁴Pub. L. No. 112-95, 126 Stat. 11.

⁵80 Fed. Reg. 9544 (Feb. 23, 2015).

such as RTCA and ASTM International, based on their involvement within UAS standards groups.⁶ To identify research and development support from FAA's test sites and other resources, we reviewed and analyzed documents provided by officials at each of FAA's six test sites and conducted semi-structured interviews with officials from each of the six, including the applications submitted by the selected test sites and quarterly reports provided to FAA. We also interviewed FAA officials managing the test site program and those managing other research and development efforts related to UASs. To identify how other countries have progressed toward UAS integration into their airspace for commercial purposes, we obtained the UAS regulations of authorities in France, the United Kingdom, Australia, and Canada and interviewed the civil aviation authorities in them. We selected these countries based on several factors including whether they have regulatory requirements for commercial UASs, operations beyond the view of the pilot, and whether the country allows non-military UAS to operate in the airspace. We also reviewed key documents and interviewed international aviation entities including the International Civil Aviation Organization (ICAO).⁷ More details on our scope and methodology can be found in appendix I.

We conducted this performance audit from January 2014 to July 2015 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

UASs can be categorized by both size and mission, as shown in figure 1.

- For the purposes of this report, in terms of size, we use the broad categories of "small" and "large" UASs. Small UASs typically weigh less than 55 pounds and can be used for a variety of commercial purposes including photography and package delivery. According to

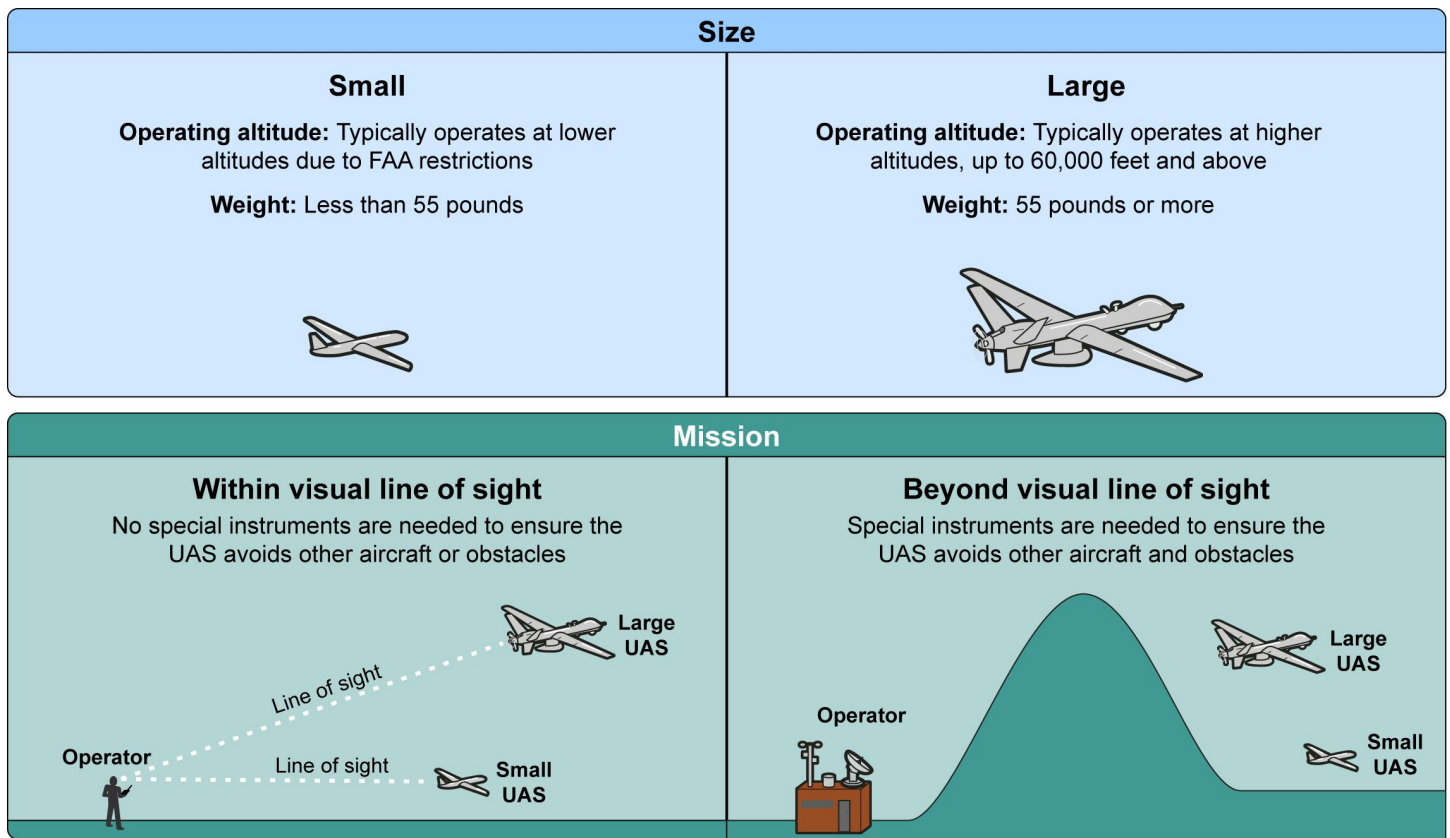
⁶RTCA was formerly known as the Radio Technical Commission for Aeronautics. ASTM International was formerly known as the American Society for Testing and Materials.

⁷ICAO is the international body that, among other things, promulgates international standards and recommended practices in an effort to harmonize global aviation standards.

an industry association, small UASs are expected to comprise the majority of UASs that will operate in the national airspace system. Large UASs, depending on their size and purpose, generally fly at higher altitudes and are used for the purposes of surveillance, data gathering, and communications relay.

- UAS operations are also categorized by how they are being used—their mission—within line of sight of the operator or beyond the line of sight of the operator. For UAS operations within the operator’s line of sight—for example a real estate agent taking photographs of a house—the operator relies only on their vision to avoid colliding with other objects. On the other hand, UAS operations occurring beyond the line of sight of the operator—for example conducting rail or pipeline inspections—requires that FAA segregate the airspace or that the UAS needs instruments to sense other aircraft and obstacles and avoid those obstacles, as well as, other technologies that will keep the aircraft safely operating during its mission.

Figure 1: Unmanned Aerial Systems (UAS) Size and Mission Categories



Source: GAO. | GAO-15-610

The FAA plays two major roles in integrating UASs into the national airspace—a regulator and a service provider. As the regulator, the FAA seeks to ensure the safety of persons and property in the air and on the ground in part by requiring that UAS operators and manufactures follow specific operation and manufacturing standards. As the service provider, the FAA is responsible for providing safe and efficient air-traffic control services in the national airspace system and the other portions of global airspace. In addition to FAA, many federal and private sector entities have roles in the effort to integrate UAS into the national airspace system. See table 1 for UAS stakeholders and their responsibilities.

Table 1: Unmanned Aerial Systems (UAS) Stakeholders and Their Responsibilities

Agency	Responsibility
Federal Aviation Administration (FAA)	FAA's UAS Integration Office is responsible for ensuring that Unmanned Aerial Systems (UAS) operate safely in the national airspace system and for providing safe and efficient air traffic control.
Department of Defense (DOD)	DOD provides FAA with UAS operational and safety data, as well as research and development support.
National Aeronautics and Space Administration (NASA)	NASA provides research and development and testing on UAS integration efforts.
Department of Homeland Security (DHS)	DHS's Customs and Border Protection has provided flight demonstrations to FAA's Next Generation Air Transportation System (NextGen) Office.
UAS Executive Committee [Note A]	The UAS Executive Committee is composed of senior executives from federal agencies including FAA, DOD, NASA, and DHS and is responsible for identifying solutions to the range of technical, procedural, and policy concerns arising from UAS integration.
UAS Aviation Rulemaking Committee	The UAS Aviation Rulemaking Committee was chartered in 2011 to provide a mechanism for industry and academic stakeholders as well as other federal, state, and local government entities to provide recommendations and standards to FAA on issues related to UAS integration. [Note B]
RTCA Special Committee 228	RTCA is a private, not-for-profit organization consisting of industry experts. Special Committee 228 is responsible for developing standards for UASs to avoid objects and other aircraft, and supporting the radio controls of a UAS.
ASTM International Committee F38 [Note C]	ASTM International Committee F38 is a committee consisting of industry experts that are responsible for developing standards and consensus based recommendations for small UAS integration into the national airspace system and worldwide.

Source: GAO. | GAO-15-610

Note A: The UAS Executive Committee was formed as a result of the National Defense Authorization Act for Fiscal Year 2010 (Pub. L. No. 111-84, 123 Stat. 2190 (2009)). Section 935 of the 2010 National Defense Authorization Act states that "The Secretary of Defense and the Secretary of Transportation shall, after consultation with the Secretary of Homeland Security, jointly develop a plan for providing expanded access to the national airspace system for unmanned aircraft systems of the Department of Defense" and requires the Executive Committee members to provide Congress with, among other things, a communications plan, specific milestones for expanded access to the national airspace system, and a report on their efforts.

Note B: FAA extended the Aviation Rulemaking Committee's charter through June 17, 2016, requesting the Committee continue to provide information, advice, and recommendations to the FAA for UAS integration.

Note C: ASTM International, formerly known as the American Society for Testing and Materials, works to deliver the test methods, specifications, guides, and practices that support industries and governments worldwide.

FAA also partners with a range of industry, federal research entities, universities, and international organizations for research and development on UAS issues.

-
- Federally Funded Research and Development Centers⁸ and Cooperative Research and Development Agreements typically require an agency, organization, or company to perform specific research and provide FAA with data in exchange for funding. FAA uses these types of agreements to support research and development in critical technologies needed for UAS integration including “detect and avoid” and “command and control” as well as for the dedicated radio-frequency spectrum and “human factors.”⁹
 - Some other partnerships use Other Transaction Agreements to establish the research and development relationship.¹⁰ However, these take many forms and are subject to requirements that may differ from the federal laws and regulations that apply to contracts, grants, or cooperative agreements, and therefore might not include a requirement to share research results with FAA.

Currently, most UAS operations must remain within visual line of sight of the UAS operator. FAA’s long-term goal is to pursue research and development that will advance technology in these critical areas, such as detect and avoid, and supporting beyond-visual-line-of-sight operations. These types of operations, according to an industry group, have the most potential for commercial purposes.

In response to the 2012 Act, FAA has been planning for UAS integration into the national airspace and has been taking steps toward increasing

⁸FAA’s Federally Funded Research and Development Centers are located at MITRE, MIT’s Lincoln Laboratory, and the Air Force Research Laboratory.

⁹“Detect and avoid” is needed to provide UAS with the capability to operate near other aircrafts and objects, yet avoid collisions. “Command and control” addressed the ability to maintain the integrity of radio signals to ensure that the UAS operates as expected and as intended. Dedicated radio-frequency spectrum is important because spectrum is a key security and safety vulnerability and because intentional or unintentional interruption of radio transmissions can sever the UAS’s only means of control. The study of the “human factors” affecting UAS operators is important because the separation of pilot and aircraft 1) removes sensory cues needed for flight control, and 2) creates difficulties in scanning the visual environment surrounding the unmanned aircraft.

¹⁰Other Transaction Agreements are administrative vehicles used by a federal agency. Other Transaction Agreements generally enable the federal government and others entering into these agreements to freely negotiate provisions that are mutually agreeable. FAA’s Other Transaction Agreement authority, at 49 U.S.C. § 106(l)(6) provides, in part, that the Administrator may enter into other transactions with any federal agency, among others, on such terms and conditions as the Administrator may consider appropriate.

UAS operations.¹¹ The 2012 Act outlined 17 date specific requirements and set deadlines for FAA to achieve safe UAS integration by September 2015. These requirements included developing two planning documents - UAS Comprehensive Plan and the UAS Roadmap. FAA has completed these two requirements in addition to naming six test sites where research and development will occur.¹² However, we found in December 2014 that several other requirements, some key ones, including the publication of a final rule on small UAS operations, had not been completed (see app. II).¹³

As part of its role in supporting UAS integration, FAA authorizes all UAS operations (access to the airspace as well as the aircraft itself) in the national airspace system—military; public (academic institutions and, federal, state, and local governments including law enforcement organizations); and civil (non-government including commercial).¹⁴ Depending on the type of user, public or civil, the process for accessing the airspace may be different (see table 2).

Table 2: Federal Aviation Administration (FAA) Approvals Required for Unmanned Aerial Systems to Access the National Airspace

Type of operations	Airspace approval	Equipment approval
Public (academic institutions and federal, state, and local governments including law enforcement organizations)	Public Certificates of Waiver or Authorization (COA)	Public COA
Civil (non-government, including commercial)	Civil COA	Section 333 exemption, Special Airworthiness Certificates in the Experimental Category

Source: GAO presentation of FAA information. | GAO-15-610

¹¹Pub. L. No. 112-95, §§ 331 – 335, 126 Stat. 11.

¹²The test sites are located at the University of Alaska (includes test ranges in Hawaii, Oregon, and Iceland); State of Nevada; New York’s Griffiss International Airport (includes test range locations in Massachusetts); North Dakota Department of Commerce; Texas A&M University–Corpus Christi; and Virginia Polytechnic Institute and State University (Virginia Tech) (includes test ranges in Maryland, partnered with the University of Maryland, and New Jersey, partnered with Rutgers University).

¹³GAO, *Unmanned Aerial Systems: Efforts Made toward Integration into the National Airspace Continue, but Many Actions Still Required*, [GAO-15-254T](#) (Washington, DC: Dec. 10, 2014).

¹⁴The integration or use of military aircraft was outside the scope of this review.

Currently, since a final rulemaking is not yet completed, FAA only approves UASs access to the national airspace on a case-by-case basis. FAA provides this approval through three different means:

- **Public or Civil Certificates of Waiver or Authorization (COA):** A COA is an authorization, generally for up to 2 years, issued by the FAA to an operator for a specific UAS activity. Public entities, including FAA-designated test sites (described in more detail later), and civil entities may apply for a COA to obtain authorized access to the airspace. FAA has a goal to review and approve all COAs within 60 days of being received.
- **Section 333 exemptions:** Since September 2014, commercial entities have applied to FAA for exemptions under section 333 of the 2012 Act, Special Rules for Certain Unmanned Aircraft Systems. This exemption requires the Secretary of Transportation to determine if certain UASs may operate safely in the national airspace system prior to the completion of UAS rulemakings.
- **Special Airworthiness Certificates in the Experimental Category and the Restricted Category (Experimental Certificate):** Civil entities, including commercial interests, may apply for experimental certificates, which may be used for research and development, commercial operations, training, or demonstrations by manufacturers.

While FAA has proceeded in planning for integration, foreign countries are also experiencing an increase in UAS use and planning for integration, and some have begun to allow commercial entities to fly UASs under limited circumstances. Some countries have already established regulations for flying UASs or formal processes for exemptions, while others have taken steps to completely ban all UAS operations. While some countries have worked independently to integrate UAS operations, some international groups, such as the ICAO, are working to harmonize UAS regulations and standards across borders.

FAA Has Made Progress in the First Phase of UAS Integration

Developing Planning Documents

FAA has taken a number of steps to move toward further safe integration of UAS in the national airspace in response to key requirements of the 2012 Act. FAA has developed the following planning documents:

- In November 2013, FAA issued the *UAS Comprehensive Plan*¹⁵ identifying six high-level strategic goals for integrating UAS into the national airspace, including routine public operation and routine civil operations.¹⁶ The *Comprehensive Plan* provides a phased-in approach for achieving these goals, which will initially focus on public UAS operations, but ultimately will provide a framework for civil UAS operations. According to the plan, each partner agency will work to achieve these national goals and may develop agency-specific plans that are aligned to the national goals and objectives. The DOD's *Unmanned Systems Integrated Roadmap* and FAA's *UAS Integration Roadmap*, described below, are examples of such plans.¹⁷
- In November 2013, FAA also issued the *UAS Integration Roadmap*, which identified a broad three phase approach to UAS integration—accommodation, integration, and evolution—with associated priorities for each phase.¹⁸ These priorities provide insight into FAA's near-, mid-, and far-term goals for UAS integration, as shown in figure 2. FAA intends to use this approach to facilitate further incremental steps toward its goal of seamlessly integrating UAS flight into the national airspace. Under this approach, FAA's initial focus during the accommodation phase will be on safely allowing for the expanded operation of UASs by selectively accommodating some use and demonstrating progress by increasing operations throughout the phase. In the integration phase, FAA plans to develop new operational rules, standards, and guidance, shifting its emphasis

¹⁵Joint Planning and Development Office, *Unmanned Aircraft Systems (UAS) Comprehensive Plan: A Report on the Nation's UAS Path Forward* (Washington, D.C.: Sept., 2013).

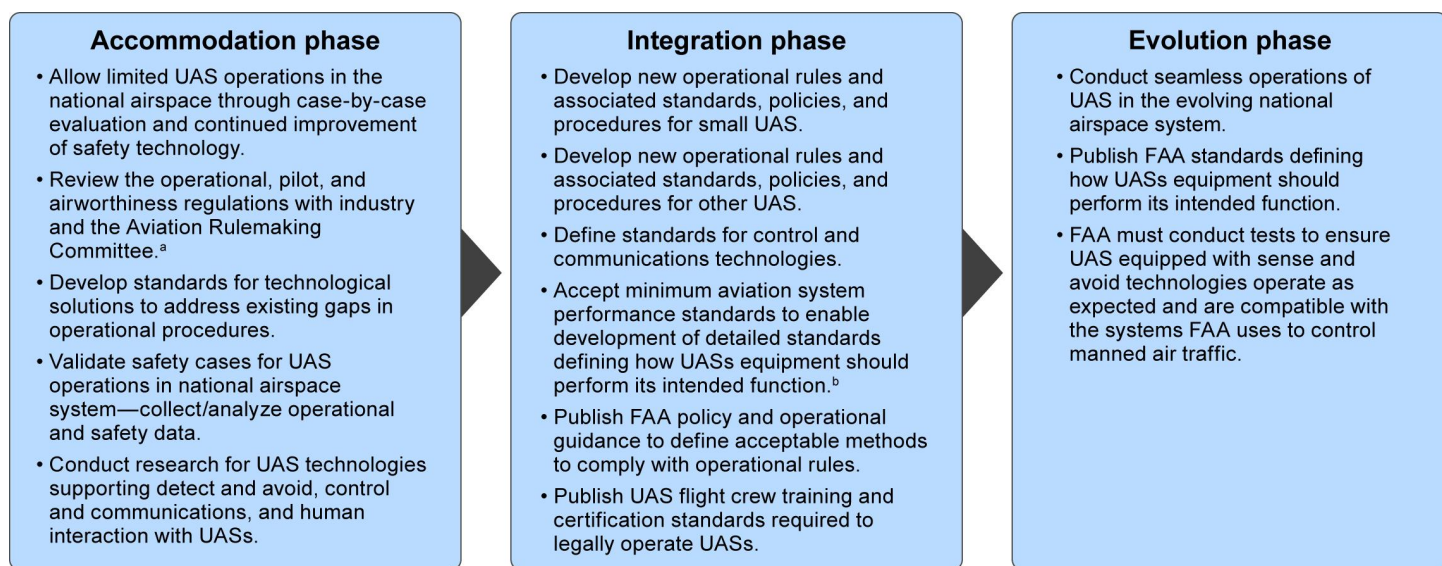
¹⁶The six goals address small UAS (under 55 pounds) operating within visual line-of-sight, larger UASs and operations beyond visual line-of-sight, planning and managing growing automation capabilities through research, and the opportunity for the U.S. to remain world leaders in UAS technology.

¹⁷DOD, *Unmanned Systems Integrated Roadmap FY2013-2038* (Washington, D.C.: 2013).

¹⁸FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: First Edition—2013* (Washington, D.C.: Nov. 2013).

toward moving beyond case-by-case approval for UAS use, once technology can support safe operations. Finally, in the evolution phase, FAA plans to focus on revising its regulations, policy, and standards based on the changing needs of the airspace. This phased approach has been supported by stakeholders across both academia and industry. The 2012 Act requires the Roadmap to be updated annually, but as of May 2015 FAA has only issued one version of the Roadmap. FAA intends to update the *Roadmap* by September 2015 and send it to the Office of Management and Budget for additional review before it is publicly released.

Figure 2: Priorities for Federal Aviation Administration’s (FAA) Three Phases of Unmanned Aircraft Systems (UAS) Integration as Described in the *UAS Integration Roadmap*



Source: Federal Aviation Administration (FAA) UAS Roadmap. | GAO-15-610

Note A: FAA’s aviation policies and regulations focus on overall safety being addressed through three primary areas: equipment (airworthiness), personnel (pilot), and operations. Each of these areas has standards and minimum levels of safety that must be met independent of each other. Since these policies and regulations were not designed with UAS in mind, they must be reviewed and revised to safely accommodate UAS in the national airspace.

Note B: Minimum aviation-system performance standards specify characteristics that are useful to designers, installers, manufacturers, service providers, and users of systems intended for operational use within a defined airspace.

While these planning documents provide a broad framework for integration, FAA is still in process of developing an implementation plan for integrating UASs. FAA’s Comprehensive Plan and Roadmap provide broad plans for integration, but are not detailed implementation plans that predict with any certainty when full integration will occur and what

resources will be needed. The Department of Transportation’s Inspector General issued a report in June 2014 that recommended FAA develop an implementation plan.¹⁹

Two reports—one from the UAS Aviation Rulemaking Committee and a second internal FAA report—have discussed the importance of an implementation plan and information to include as part of such a plan. The UAS Aviation Rulemaking Committee has emphasized that FAA needs an implementation plan that would identify the means, necessary resources, and schedule to safely and expeditiously integrate civil UAS into the national airspace. The proposed implementation plan contains several hundred tasks and other activities needed to complete the UAS integration process, including:

- identifying gaps in current UAS technologies, regulations, standards, policies, or procedures;
- developing new technologies, regulations, standards, policies, and procedures that would support safe UAS operations; and
- identifying necessary activities to advance routine UAS operations in the national airspace, including the development of guidance materials, training, and procedures for certification of aircraft.

An internal FAA report from August 2014 prepared by MITRE Corporation (MITRE) was intended to assist FAA’s development of the key components of an implementation plan.²⁰ This report suggested that among other actions FAA’s implementation plan should:

- identify the tasks necessary, responsibilities, resources, and expected time frames for incremental expansion of UAS operations;
- clarify the priorities for aligning internal resources in support of near-term and long-term integration efforts and provide consistent

¹⁹Department of Transportation Office of Inspector General, *FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems into the National Airspace System*, Report Number AV-2014-061 (Washington, D.C.: June 2014).

²⁰Deborah Kirkman, *Inputs and Recommendations for the Federal Aviation Administration UAS Integration Strategy: 2014–2019*, MITRE Corporation (August 2014).

communication with external stakeholders on the expected progress, cost, and extent of UAS integration during these time periods;

- align resources supporting UAS integration including allocation of FAA personnel and funds used for contracts and to acquire systems and services in support of integration; and
- establish the operational, performance, and safety data needed and also the associated infrastructure for collecting, storing, disseminating, and analyzing data, actions that could be a component of an implementation plan.

According to FAA, it continues to work with MITRE developing the foundation for a detailed implementation plan. FAA expects MITRE to complete this by September 2015 and FAA to enact the plan by December 2015.²¹ According to FAA, the agency used the Aviation Rulemaking Committee's report when writing the *Roadmap* and is applying the report prepared by MITRE to help develop the detailed implementation plan.

Issuing a Final Rule for Small UAS Operations

In February 2015, FAA made progress toward the 2012 Act's requirement to issue a final rule for the operations of small UASs—those weighing less than 55 pounds—by issuing a Notice of Proposed Rulemaking (NPRM) that could, once finalized, allow greater access to the national airspace.²² To mitigate risk, the proposed rule would limit small UASs to daylight-only operations, confined areas of operation, and visual-line-of-sight operations. This proposed rule also addressed other issues pertinent to UAS operations including aircraft registration, operations in the national airspace, and operator certification. See table 3 for a summary of the rule's major provisions. FAA's release of this proposed rule for small UAS operations started the process of addressing remaining requirements of the 2012 Act.

²¹FAA told us they do intend to publicly issue the implementation plan.

²²80 Fed. Reg. 9544 (Feb. 23, 2015).

Table 3: Selected Provisions of Proposed Rule for Small Unmanned Aircraft Systems (UAS) Operations, by Major Category

Category	Summary of proposed requirements
Operational limitations	<ul style="list-style-type: none"> • Must weigh less than 55 lbs. (25 kg). • Must operate within visual line of sight only. • May not operate above any persons not directly involved in the operation. • Must only operate during the day, no nighttime operations. • Maximum airspeed of 100 mph. • Maximum altitude of 500 feet above ground level. • Must not operate carelessly or recklessly. • Establishment of a micro-UAS category (4.4 lbs. or less). • Must yield right-of-way to other aircraft, manned or unmanned.
Operator certification and responsibilities	<ul style="list-style-type: none"> • Must pass a knowledge test initially and every 24 months. • Must be vetted by the Transportation Security Administration. • Must obtain an unmanned-aircraft operator’s certificate with a small UAS rating.
Aircraft requirements	<ul style="list-style-type: none"> • Federal Aviation Administration (FAA) airworthiness certification not required, but operator must inspect the UAS to ensure that it is in a condition for safe operation. • Aircraft markings required; if aircraft is too small to display markings in standard size, then the aircraft simply needs to display markings in the largest practicable manner.
Model aircraft	<ul style="list-style-type: none"> • Would not apply to model aircraft that satisfy all of the criteria specified in section 336 of Public Law 112-95. • Would incorporate a 2012 Act provision that preserves the FAA’s enforcement authority to pursue enforcement against model aircraft operators who endanger the safety of the national airspace system.

Source: Notice of Proposed Rulemaking for small UAS. | GAO-15-610

FAA’s proposed rule also sought comments on a potential micro-UAS classification (4.4 pounds or less) that would apply to very small UAS being used for authorized purposes. This classification would be based on the UAS Aviation Rulemaking Committee’s recommendations, as well as approaches adopted in other countries, that a separate set of regulations for micro-UASs be created. FAA is considering provisions for micro-UASs classification such as limiting operation airspeed to 30 knots, limiting flight to within visual line of sight, and having aircraft made out of materials that break on impact.

The proposed rule would not apply to model aircraft—unmanned aircraft that are flown for hobby or recreational purposes, capable of sustained flight in the atmosphere, and flown within visual line of site of the person

who is operating the aircraft—as specified in the 2012 Act.²³ Whether or not a UAS is considered a model aircraft or a small UAS depends upon its operation. For example, if the operator is flying an unmanned aircraft for recreational purposes the unmanned aircraft is considered a model aircraft. If the exact same type of unmanned aircraft is being operated for an authorized purpose such as a search and rescue mission, it is considered a small UAS.²⁴ The 2012 Act specifically prohibits FAA from promulgating rules regarding model aircraft that meet specific criteria, including model aircraft flown strictly for hobby or recreational use and operated in a manner that does not interfere with and gives way to any manned aircraft.²⁵ However, the proposed rule would incorporate the 2012 Act provisions that preserve FAA’s authority to pursue enforcement against persons operating model aircraft who endanger the safety of the national airspace system.²⁶

According to FAA, it may take 16 months to process the comments it receives on the NPRM and develop and issue the final rule for small UAS operations. If FAA takes 16 months, the final rule would be issued in late 2016 or early 2017, about two years beyond the requirement in the 2012

²³See Pub. L. No. 112-95, §336(c), 126 Stat. 11, 77.

²⁴FAA’s *Advisory Circular 91-57* sets out model aircraft operating standards that encourage voluntary compliance with specified safety standards for model aircraft operators. In June 2014, FAA also clarified this guidance in its Notice of Interpretation of the 2012 Act’s Special Rule for Model Aircraft. 79 Fed. Reg. 36172 (June 25, 2014). The Academy of Model Aeronautics has also published voluntary guidance documents for its members.

²⁵More specifically, section 336(a) of the 2012 Act prohibits the FAA from promulgating rules regarding model aircraft that meet all of the following statutory criteria: The aircraft is flown strictly for hobby or recreational use; The aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization; The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization; The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft; and when flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation.

²⁶Section 336(b) of the 2012 Act provides that “[n]othing in this section shall be construed to limit the authority of the Administrator to pursue enforcement action against persons operating model aircraft who endanger the safety of the national airspace system. The proposed rule provides that it is FAA’s existing authority, under 49 U.S.C. §§ 40103(b) and 44701(a)(5) that provide the FAA with the power to pursue enforcement “against persons operating model aircraft who endanger the safety of the national airspace system.”

Act. However, during the course of our work, FAA told us that the time needed to respond to a large number of comments could further extend the time to issue a final rule. When the comment period closed on April 24, 2015 FAA had received over 4,500 comments. FAA officials told us that it has taken a number of steps to develop a framework to efficiently process the comments it expects to receive. Specifically, they said that FAA has a team of employees assigned to lead the effort with contractor support to track and categorize the comments as soon as they are received.

Creating Test Sites

FAA has also met the requirement from the 2012 Act to create UAS test sites for research and development. Specifically, in December 2013 FAA selected six UAS test site locations, which all became operational between April 2014 and August 2014. According to FAA, these sites were chosen based on a number of factors including geography, climate, airspace use, and a proposed research portfolio that was part of the application. Under FAA policy, all UAS operations at a test site must be authorized by FAA through either the use of a COA or an experimental certificate. In addition, FAA does not provide funding to support the test sites. Thus, these sites rely upon revenue generated from entities, such as those in the UAS industry that are using the sites for UAS flights. The 2012 Act authorized the test sites to operate until February 14, 2017. FAA stated it is too early to assess the test sites' results and effectiveness and thus whether the test sites should be extended. According to FAA officials, FAA does not object to extending the test sites but may need additional resources if that happens.

Accommodating Limited UAS Operations

Although it still relies on case-by-case approvals, FAA has increased UAS operations during the accommodation phase of UAS integration. As we have previously noted, UAS operators can only gain access to the national airspace by obtaining a COA, an experimental certificate, or a section 333 exemption. From 2010 to 2014, the total number of COAs approved for public operations has increased each year, with FAA issuing 403 COAs thus far this year, as shown in table 4. Similarly, from 2011 to 2014, the total number of experimental certificates has increased each year, with FAA issuing 6 thus far this year.

Table 4: Total Number of Federal Aviation Administration-Issued Public Certificates of Waiver or Authorization (COA) and Special Airworthiness Certificates for Experimental Aircraft for Unmanned Aerial Systems

	2010	2011	2012	2013	2014	2015
Public COA	286	309	383	407	609	403 [Note A]
Experimental certificate	15	14	18	26	39	6 [Note B]

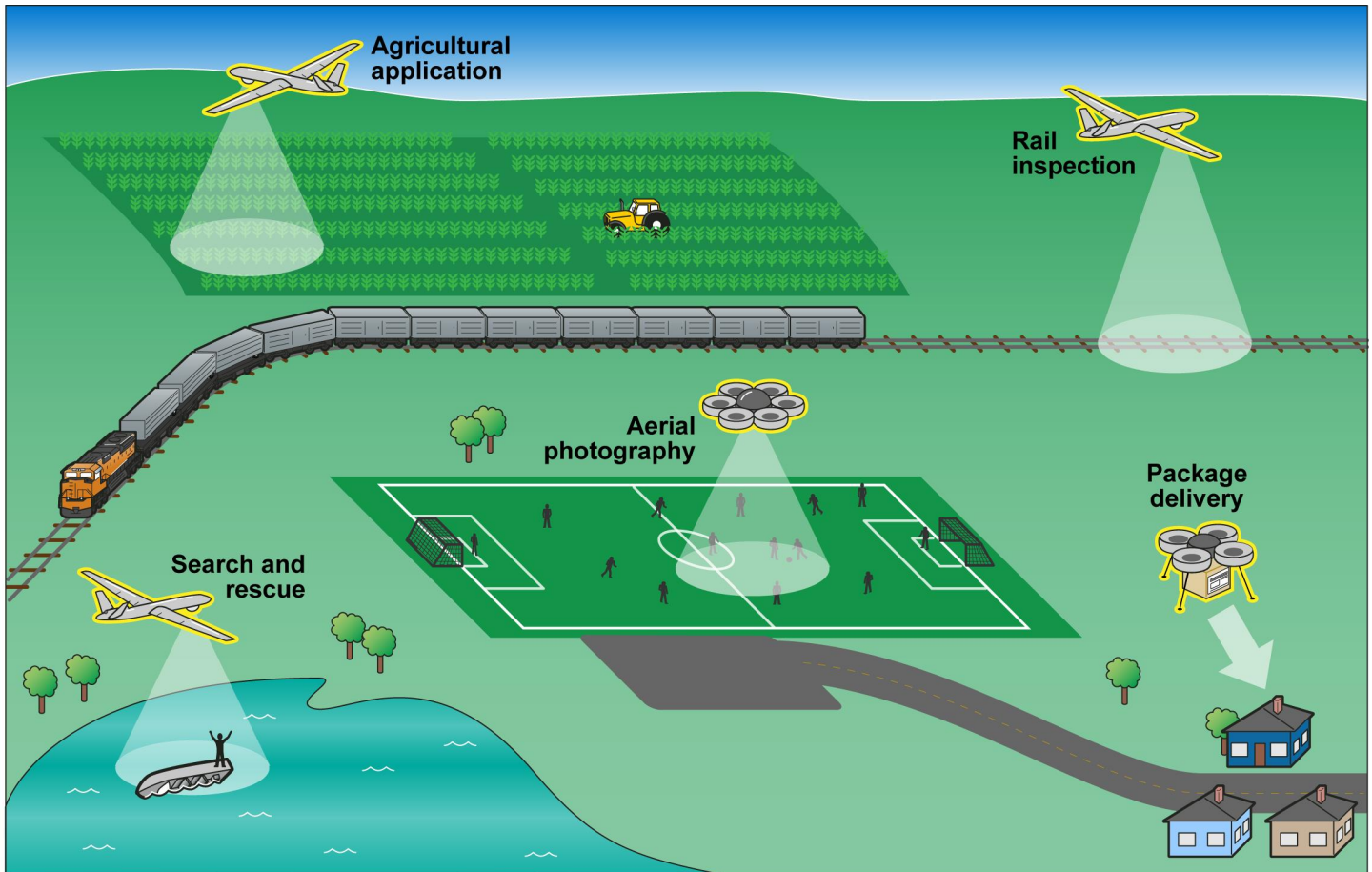
Source: FAA | GAO-15-610

Note A: As of April 30, 2015.

Note B: As of May 1, 2015.

In September 2014, FAA granted the first section 333 exemptions; at that time 6 total exemptions were granted for commercial UAS operations to movie and TV production companies. As of June 9, 2015, FAA had granted 548 section 333 exemptions to companies for a variety of additional commercial operations supporting the real estate, utility, and agriculture industries, among others. See figure 3 for examples of commercial uses, including some approved under section 333 exemptions.

Figure 3: Examples of Potential Commercial Unmanned Aerial Systems Operations



Source: GAO. | GAO-15-610

FAA has taken steps to make access easier for those operating UASs under a section 333 exemption. On March 23, 2015, FAA established an interim policy to speed up authorizations for certain commercial unmanned aircraft operators that request Section 333 exemptions. According to FAA, the new policy helps bridge the gap between the past “case-by-case” approval process, which evaluated every commercial UAS operation individually, and future operations after they publish a final version of the proposed small UAS rule. Under the new policy, the FAA will grant a COA for flights at or below 200 feet to any commercial UAS operator with a Section 333 exemption for aircraft that weigh less than 55 pounds, operate during the daytime, operate within visual line of sight of the pilots, and stay certain distances away from airports or heliports. According to FAA, the “blanket” 200-foot COA allows flights anywhere in

the country except restricted airspace and other areas, such as major cities, where the FAA prohibits commercial UAS operations.²⁷ The agency expects the new policy will allow companies and individuals who want to use UAS within these limitations to start flying much more quickly than before. A company wanting to operate above 200 feet, or outside the other rules set up by FAA, must obtain a separate COA.

FAA took additional steps in May 2015 to work with industry to safely expand UAS operations. FAA announced its Pathfinder Program that will partner FAA with companies to perform research in support of UAS integration. These companies will focus on using UAS for specific applications, such as news gathering and surveying crops. In addition, two will focus on applications for beyond the visual line of sight of the operator. One industry stakeholder stated the next step would be to develop additional mechanisms to allow UAS operations beyond the visual line of sight of the operator once technology supports greater use.

While accommodating UAS access, FAA and industry have taken steps to educate UAS operators on how to safely operate. UAS industry stakeholders and FAA have begun an educational campaign that provides prospective users with information and guidance on flying safely and responsibly. Specifically, they launched an informational website for UAS operators to ease public concerns about privacy and support safer UAS operations in the national airspace.²⁸ In addition, in May 2015, FAA announced plans to develop the “B4UFLY” smartphone application designed to help UAS users, both model aircraft and recreational UAS operators, know where it is safe and legal to fly. The application is designed to let an operator know if it is safe and legal to fly in a specific location.

Potential Commercial Agriculture Use

The University of California-Davis has been conducting a demonstration project using a Yamaha RMAX helicopter to spray pesticides at its vineyard. The purpose of the project is to test the efficiency and safety of aerial spraying of grape crops. According to an official from Yamaha Motor Corporation, USA, initial tests have shown the RMAX can cover up to 12 times as much area in an hour compared with traditional spraying methods.



Source: Yamaha Motor Corporation, USA | GAO-15-610

²⁷Previously, an operator had to apply for and receive a COA for a particular block of airspace, a process that can take 60 days.

²⁸Know Before You Fly (www.knowbeforeyoufly.org) was founded by three organizations with a stake in UAS safety: the Association for Unmanned Vehicle Systems International, the Academy of Model Aeronautics, and the Small UAV Coalition. The FAA is partnering with the founding members to spread the word about safe and responsible flying. FAA also stated that three manufacturers agreed to voluntarily include Know Before You Fly information for model aircraft operators in their packaging.

Collaborating with UAS Stakeholders

FAA has worked with federal and industry stakeholders to coordinate federal activities in support of conducting research and development and creating UAS standards to facilitate UAS integration. As with other large government-wide initiatives, achieving results for the nation increasingly requires that federal agencies and others work together. FAA has worked with the UAS Executive Committee to facilitate federal UAS activities and RTCA Special Committee 228, ASTM International Committee F38, and the UAS Aviation Rulemaking Committee to develop safety, reliability, and performance standards for UAS.

Each collaborative group has defined different long-term goals in support of UAS integration and has made progress toward the achieving these goals.

- The Executive Committee's long-term goals involve working to solve the broad range of technical, procedural, and policy issues affecting UAS integration into the national airspace. In support of this objective, the Executive Committee agencies, other public agencies, and industry have also developed processes and procedures to safely demonstrate small UAS operations in remote areas of the Arctic, including beyond-line-of-site operations. The UAS demonstration occurred in domestic and international airspace on and off the coast of Alaska.
- RTCA Special Committee 228 has set out its own goals across two phases. Currently working toward completion of the first phase, RTCA is developing minimum operational performance standards for detect and avoid and command and control technologies for UASs. RTCA has made progress toward this goal with help from the Executive Committee. Specifically, the Executive Committee's Science and Research Panel developed a definition of "well clear" to help inform RTCA Special Committee 228's work.²⁹
- The UAS Aviation Rulemaking Committee has a goal to develop a report for FAA on its efforts to provide direction for UAS operational criteria, among other tasks, by April 18, 2016.

²⁹The Federal Aviation Regulations generally require that pilots remain "well clear" of other aircraft when flying in the national airspace system. 14 C.F.R. §§ 91.115, 91.181. RTCA will use a definition of well clear provided by the UAS Executive Committee's Science and Research Panel as a baseline for detect and avoid standards.

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- ASTM International F38's long-term goal involves developing and publishing voluntary consensus standards for small and large UASs as FAA requests them. ASTM International Committee F38 has developed standards and recommendations to support FAA's small UAS rulemaking that cover elements such as systems design, construction, and testing.

FAA has applied other interagency collaborative methods in support of UAS integration including memorandums of understanding or agreement (MOU)³⁰ and conferences. FAA entered into MOUs with DOD and NASA to expedite the COA process and ensure the availability of DOD's data.³¹ According to FAA officials, the MOUs eased collaboration with DOD and NASA because the MOUs established roles and responsibilities for each agency as well as procedures for DOD to obtain COAs. In addition, FAA convenes meetings with test site officials and attends conferences where UAS issues are discussed. For example, FAA regularly holds conference calls and convenes technical interchange meetings with test site officials to address test site issues. According to FAA, the technical interchange meetings are opportunities for FAA to provide updates to the test sites and discuss common areas of research interest. The manager of the FAA's UAS Integration Office has presented information about its UAS efforts during industry conferences, such as the Association for Unmanned Vehicle Systems International's annual meeting. These conferences allow FAA to provide guidance and updates directly to the industry and public.

³⁰A memorandum of understanding is a written agreement between more than one federal agency or department that defines the roles, responsibilities, and how each party will act for specific aspects of the relationship between the two participants.

³¹FAA also has UAS related memorandums of agreement or understanding with the U.S. Department of Justice, the U.S. Department of the Interior, the National Oceanic and Atmospheric Administration within the U.S. Department of Commerce, and the Academy of Model Aeronautics.

FAA's Designated Test Sites Have Conducted UAS Test Flights and Addressed Challenges

FAA's Designated Test Sites Are Operating and Conducting UAS Operations

Since being named in December 2013, the six designated test sites have become operational, applying for and receiving authorization from FAA to conduct test flights. Specifically, from April through August 2014, each of the six test sites became operational and signed an Other Transaction Agreement with FAA, establishing their research and development relationship. All flights at a test site must be authorized under the authority of a COA or an experimental certificate approved by FAA.³² Since becoming operational, five of the six test sites received 48 COAs and one experimental certificate in support of UAS operations resulting in over 195 UAS flights across the five test sites. These flights provide the operations and safety data to FAA as required by the COA. While there are only a few contracts with industry thus far, according to test site operators, these will be important if the test sites are to generate sufficient revenue to remain in operation. Table 5 provides an overview of test-site activity since the sites became operational.

³²All test sites are operated by public entities (academic institutions or federal, state, or local governments) and thus all aircraft must be public aircraft—unless they are operating under a special certificate.

Table 5: Overview of Activity at Five of Six Designated Unmanned Aerial Systems (UAS) Test Sites, as of March 2015

Type of test site activity	Overview since becoming operational in 2014
Total unmanned aerial systems (UAS) flights at FAA designated test sites	<ul style="list-style-type: none"> Over 195 total UAS flights. One test site has had over 80 UAS flights.
Number and types of certificates of waiver or authorizations (COA) received	<ul style="list-style-type: none"> Five test sites hold 48 COAs. One test site held 4 broad area COAs allowing flights over nearly the entire state by specific aircraft. Four other test sites were seeking COAs for large flight ranges that could apply to any aircraft.
Number of special airworthiness certificates for experimental aircraft	<ul style="list-style-type: none"> A certified representative reviewed and approved an aircraft to operate under an experimental certification at one test site. Three test sites have representatives affiliated with the test site to review and approve aircraft for experimental certification.
Signed contracts with UAS companies	<ul style="list-style-type: none"> Five test sites have 22 contracts with industry groups and companies to conduct UAS operations at their respective test site thus generating revenue for the test sites. All test sites have additional negotiations with companies under way.

Source: FAA designated test sites. | GAO- 15-610

Note: Of FAA's six designated test sites, one— Texas A&M University-Corpus Christi test site—did not respond to our request for this information.

According to all test sites, FAA approval for access to the airspace can be a lengthy process taking 90 days or even longer. FAA and the test sites have found ways to allow quicker access to the test site airspace and relieve some administrative burden from FAA.

- In February 2015, FAA awarded the Northern Plains Test Site in North Dakota four broad area COAs that were aircraft specific. According to a test site official, these COAs allowed designated aircraft to fly over nearly the entire state of North Dakota and will make it easier to accommodate industry for research. Furthermore, these COAs were a positive step in allowing quicker access to the airspace at test sites. Reducing FAA's role in the process creates more certainty regarding how long it will take an operator to access airspace at the test sites. Specifically, the test site representative indicated FAA's role was reduced because there was a process that allowed aircraft to be added to these existing COAs that was simpler than applying for individual COAs.
- In May 2015, FAA approved a "blanket" COA allowing the test sites to conduct UAS operations at or below 200 feet anywhere in the national airspace, similar to the authority provided to Section 333 exemptions. In particular, these COAs will be for small UAS operations, during the

day, within line of sight of the operator, and the operations cannot occur in restricted airspace and areas close to airports. According to FAA, this will help improve UAS access allowing more operations in support of research that can further the UAS integration process. Previously, all UASs needed their own COA when operating at a test site but this action by FAA will allow any small UASs to operate at the test sites within the COA's requirements.

- The use of designated airworthiness representatives by the test sites to review and approve experimental certificates may be quicker for industry and relieve some of FAA's workload.³³ Industry benefits from not having to lease its aircraft to the test site, as all test sites are operated by public entities (academic institutions or federal, state, or local governments) and thus all aircraft must be public aircraft, unless they are operating under a special certificate.³⁴ In addition, any industry group working with the test site would not have to go through FAA to receive the experimental certificate. The Nevada test site has affiliated itself with a designated airworthiness representative, who has approved an aircraft to operate under an experimental certificate for the Nevada test site. According to FAA, the use of a designated airworthiness representative allows it to better leverage its resources.

FAA officials and some test site officials told us that progress has been made in part because of FAA's and test sites' efforts to work together. Test site officials meet every 2 weeks with FAA officials to discuss current issues, challenges, and progress. According to meeting minutes, these meetings have been used to discuss many issues from training for designated airworthiness representatives to processing of COAs. In addition, the six test sites have developed operational and safety processes that have been reviewed by FAA. Thus, while FAA has no funding directed to the test sites to specifically support research and development activities, FAA dedicates time and resources to supporting the test sites, and FAA staff we spoke to believe test sites are a benefit to the integration process and worth this investment.

³³Designated airworthiness representatives are individuals acting as a representative of FAA trained to examine, inspect, test and issue aircraft certificates.

³⁴For a private company to operate under a public COA at a test site, it must lease the aircraft to the public entity. A concern of some private companies has been the protection of proprietary or sensitive data when they lease the aircraft to the public operator of the test site. The experimental certificate eliminates this concern of protecting proprietary technology.

Test Sites Faced Challenges during Their First Year

Despite the progress made since they began operating, according to test site operators, they faced a number of challenges in the first year of operations:

- **Guidance on research:** According to FAA, because the test sites receive no federal funding, FAA can neither direct specific research to be conducted nor direct the test sites to share specific research data, other than the operations and safety data required by the COA. The Other Transaction Agreement for each test site defines the purpose of the test sites as a place to conduct research and testing under FAA safety oversight to support UAS integration into the national airspace. The Other Transaction Agreement indicates the test sites will provide FAA with UAS research and operational data to support the development of procedures, standards, and regulations. However, FAA officials told us that the Antideficiency Act may prevent the agency from directing specific test site activities without providing compensation.³⁵ In October 2014, FAA provided a list of potential research areas to the test sites to guide the research that each test site may conduct. According to FAA, this document was not to be construed as a directive but more as guidance for possible research areas. However, three test sites told us this document was too broad to be considered guidance for the research test sites should conduct.
- **Incentives for industry to use test sites:** Five test sites told us that the UAS industry gains little advantage to using the test sites for research because they must follow similar processes to access the airspace anywhere. As previously indicated, all flights at a test site must be authorized under the authority of a COA or an experimental certificate, two means the industry can use to access the airspace anywhere, not just at the test sites. All six test sites are seeking to make it easier for companies to access the airspace at a test site rather than working external of the test sites. For example, all test sites told us a COA applicable to any aircraft and covering large flight areas would be beneficial. This would be similar to the two COAs previously discussed, the COA received by the Northern Plains test site and the “blanket” 200-foot COA recently authorized by FAA. However, representatives from two test sites indicated that the “blanket” 200-foot COA meets some of their needs as it is applicable only to public

³⁵The Antideficiency Act prohibits federal officers and employees from, among other things, accepting voluntary services except for emergencies involving the safety of human life or the protection of property. 31 U.S.C. § 1342.

Companies Conducting Beyond-Visual-Line-of-Sight Testing Overseas

Insitu, Inc., a Boeing subsidiary, conducted beyond-visual-line-of-sight testing in Denmark in May, 2015 with a ScanEagle UAS. The flights took place in cooperation with the Danish Transport Authority as part of an agreement signed by Boeing and the airport to develop a UAS Test Center in Denmark, which is used for training, testing, and development. The activity included members of the public and private sector, including the UAS Denmark Consortium, a group of companies, government organizations, and other entities supporting UAS industry development. The testing demonstrated capabilities for a variety of industries, including agriculture and aerial surveying, emergency and natural-disaster response, and defense and Arctic surveillance.



[An Insitu, Inc. ScanEagle UAS launch at sea.]

Source: Insitu, Inc. | GAO-15-610

aircraft, meaning that civil operators still have to lease the aircraft to the test site for operations. But, as one test site representative stated a broad area COA, allowing civil operations at the test site would be even more beneficial. Another test site representative indicated that they will continue to work with FAA to make access easier allowing flights at higher altitude with different aircraft.

- **Maintaining operations:** While all the test sites had some level of initial funding, from either private industry or state legislatures, to become operational, they must attract UAS industry to the test sites to generate enough revenue to maintain operations. However, test site operators reported that test sites have additional requirements as opposed to operating outside the test sites, including leasing the aircraft to the test site to operate under the public COA. While test sites have signed 22 contracts, there is a chance that some test sites will not survive due to the financial burden. Some companies have made a decision to go to other countries to conduct UAS testing because they believe it takes less time to be approved for test flights. For example, Amazon has reported it has testing under way in multiple countries outside the United States, including a site in Canada. In an effort to attract some industry operators, the Pan Pacific Test Site has a location in Iceland where, according to the Director, review and approval for test flights can happen much faster, in as few as 10 days, relative to over 90 days a COA may take in this country. In addition, the UAS industry is conducting tests in this country outside the test sites. For example, CNN worked with Georgia Institute of Technology.

FAA Supports Additional Research and Development Efforts

FAA has used cooperative research and development agreements, federally funded research and development centers, and grants to conduct other UAS research and development. These agreements for research are similar to the Other Transaction Agreement that directs the purpose and goals of the relationship between FAA and the research entities. However, unlike the Other Transaction Agreement in place for the test sites, according to FAA, many of these agreements have language specifically addressing the sharing of research and data. The following are examples of other resources FAA has devoted to UAS integration research and development:

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- Cooperative research and development agreement: New Mexico State University has had a flight test center operating for several years under a cooperative research and development agreement with FAA. The center serves a similar purpose to the designated test sites but has been operating since 2007. The flight test center has conducted research in many areas including nighttime flying and more recently research into long-endurance UAS flights operating between 10,000 and 17,000 feet. According to an official, the New Mexico State University's flight test center has challenges with getting access to the airspace for customers because the process to receive a COA can be lengthy. In addition, this official told us the flight test center would like authority to approve COAs to operate at the test center because the FAA is backlogged and therefore approvals are delayed. Finally, according to the flight test center operators, FAA can get data from the research being conducted at the test site but does not direct them what to provide. While the flight test center has operated under a Cooperative Research and Development Agreement since 2007, in May 2015 the Flight Test Center switched to an Other Transaction Agreement to continue UAS testing.
 - Federally funded research and development center: MITRE manages federal funded research and development centers for multiple federal agencies including FAA and DOD. MITRE has ongoing work supporting FAA's UAS integration effort by supporting UAS standards and rulemaking and supporting research planning and progress, among other efforts. MITRE brings together the federal agencies—FAA, NASA, DOD, DHS, and others—to advance UAS integration. In its role, according to MITRE officials, one of the biggest challenges is how to integrate all the UAS-related work across the federal government, academia, and private sector.
 - Grants: In August 2014, FAA awarded two grants to Georgia Tech Research Corporation and the University of North Dakota to conduct literature reviews of UAS issues. Georgia Tech is collecting information on research being conducted on the effect of UAS collisions on other airborne and ground based objects. The University of North Dakota is looking at the UAS safety criteria and particularly if UASs could be deadly. According to FAA, both studies will support ongoing UAS research and help determine the applicability of past studies.

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- Center of Excellence: In May 2015, FAA selected a team led by Mississippi State University as the Center of Excellence for UAS.³⁶ According to FAA, the goal of the Center of Excellence will be to create a cost-sharing relationship among academia, industry, and government that will focus on the primary research areas needed to support UAS integration. FAA hopes the center could provide both short- and long-term research through testing and analysis. In support of it serving this purpose, the Center of Excellence has an annual \$500,000 budget for the next 10 years.

FAA also has additional resources to support the UAS integration, including facilities working on research and development and management of FAA's other research and development efforts for UAS integration. FAA's William J. Hughes Technical Center houses staff in charge of supporting and managing FAA's designated test sites.³⁷ While the test sites do not have specific funding, FAA has dedicated resources located at Hughes Technical Center to support the set up and ongoing operations of the test sites. For example, COA data are collected and analyzed at the Hughes Technical Center. In addition, FAA has participated in the twice-a-year technical interchange meetings with the test sites. These meetings have brought together the test sites and FAA to address issues in the set-up and operation of the test sites. Furthermore, FAA has staff supporting the test sites through review of test site operation and safety procedures and manuals to support the monthly reporting of the operational and safety data required by each COA.

³⁶In addition to Mississippi State University, the other team members include: Drexel University; Embry Riddle Aeronautical University; Kansas State University; Kansas University; Montana State University; New Mexico State University; North Carolina State University; Oregon State University; University of Alabama, Huntsville; University of Alaska, Fairbanks; University of North Dakota; and Wichita State University.

³⁷The William J. Hughes Technical Center is located in Atlantic City, New Jersey, and contains laboratories supporting aviation research, development, testing, and evaluation of air traffic control and aircraft safety among other aviation areas. It also serves as the primary facility supporting the Next Generation Air Traffic System.

Other Countries Have Established Regulations, and Some Allow More Commercial Operations Than the United States

Numerous Countries Allow UAS Operations

According to numerous studies and stakeholders we interviewed, many countries around the world, have been allowing commercial UAS operations in their airspace for differing purposes. We also identified a number of countries that allow commercial UAS operations and have done so for years. Specifically, Canada and Australia have regulations pertaining to UAS that have been in place since 1996 and 2002, respectively. According to a recent MITRE study, the types of commercial operations allowed vary by country and include aerial surveying, photography, and other lines of business.³⁸ For example, Japan has allowed UAS operations in the agriculture industry since the 1980's to help apply fertilizer and pesticide.³⁹

In March 2015, the European Aviation Safety Agency (EASA) issued a proposal for UAS regulations that creates three categories of UAS operations—open, specific, and certified.⁴⁰ This proposal seeks the safe integration of UAS into national airspace, as well as support for the UAS industry in Europe. Generally, the open category would not require authorization from an aviation authority but would have basic restrictions including altitude and distance from people. The specific category would

³⁸MITRE Corporation, *UAS International Harmonization: A Comparative Policy Assessment of Selected Countries*, Outcome 6, Output 4 (fiscal year 2014).

³⁹According to the MITRE study, Japan's regulations also allow UAS operations for agricultural purposes with UASs weighing less than 220 pounds.

⁴⁰EASA is the European Union Authority in aviation safety. The main activities of the organization include the strategy and safety management, the certification of aviation products and the oversight of approved organizations and EU Member States.

require a risk assessment of the proposed operation and an approval to operate under restrictions specific to the operation. The final proposed category, certified operations, would be required for those higher-risk operations, specifically when the risk rises to a level comparable to manned operations. This category goes beyond FAA's proposed rules by proposing regulations for large UAS operations and operations beyond the pilot's visual line of sight. As other countries work toward integration, standards organizations from Europe and the United States are coordinating to try and ensure harmonized standards. Specifically, RTCA and the European Organization for Civil Aviation Equipment (EUROCAE) have joint committees focused on harmonization of UAS standards.⁴¹

UAS Regulations in Australia, Canada, France, and the United Kingdom Are Similar to Each Other and to Proposed Regulations in This Country

We studied the UAS regulations of Australia, Canada, France, and the United Kingdom and found that these countries impose similar types of requirements and restrictions on commercial UAS operations. For example, all these countries except Canada require government-issued certification documents before UASs can operate commercially.⁴² In addition, each country requires that UAS operators document how they ensure safety during flights and their UAS regulations go into significant detail on subjects such as remote pilot training and licensing requirements. For example, the United Kingdom has established "national qualified entities" that conduct assessments of operators and make recommendations to the Civil Aviation Authority as to whether to approve that operator. Similar regulations in these countries continue to evolve. In November 2014, Canada issued new rules creating exemptions for commercial use of small UASs weighing 4.4 pounds or less and from 4.4 pounds to 55 pounds. UASs in these categories can commercially operate without a government-issued certification but must still follow operational restrictions, such as a height restriction and a requirement to operate within line of sight. Transport Canada officials told us this arrangement allows them to use scarce resources to regulate situations

⁴¹RTCA is a private non-profit organization consisting of industry experts. RTCA provides a venue for public-private collaboration supporting consensus building on aviation modernization issues. EUROCAE is a non-profit organization dedicated to aviation standards. The organization is composed of members, who are specialized in technical fields of aeronautics.

⁴²UASs lighter than 55 pounds are exempt from Canada's requirement to obtain a Special Flight Operations Certificate. Those heavier than 55 pounds or otherwise not complying with the exemption requirements must obtain a Special Flight Operations Certificate.

Firefighting with UASs In Australia

Firefighters in Western Australia have used small UASs during their firefighting operations. The UASs provide intelligence on hot spots and containment lines at night when manned aircraft are not permitted to fly.



[An unmanned Lockheed Martin/Kaman K-MAX helicopter extinguishes several fires, aided by the small unmanned Indago Quad Rotor, also from Lockheed Martin, during a demonstration.]



[The Lockheed Martin Indago Quad Rotor.]

Source: Furnished with permission of Lockheed Martin Corporation. Copyright © 2015 Lockheed Martin Corporation. All rights reserved.

of relatively high risk. Australia, in similar fashion, is considering relieving UASs lighter than 4.4 pounds from its requirement to obtain a UAS Operator's certificate. France's regulation describes 4 weight-based categories of UAS as well as 4 operational scenarios of increasing complexity. The regulations then discuss which UAS categories can operate in each scenario. FAA, by electing to focus on UASs up to 55 pounds in its Small UAS NPRM, has taken a similar risk-based approach.

The United States has not yet finalized regulations specifically addressing its small UAS operations, but if UASs were to begin flying today in the national airspace system under the provisions of FAA's proposed rules, their operating restrictions would be generally similar to regulations in these other four countries. However, there would be some differences in the details. For example, FAA proposes altitude restrictions of below 500 feet, while Australia, Canada, and the United Kingdom restrict operations to similar but slightly lower altitudes. Other proposed regulations require that FAA certify UAS pilots prior to commencing operations, while Canada and France do not require pilot certification in certain low risk scenarios. While FAA continues to finalize the small UAS rule—a process that could take until late 2016 or early 2017—other countries continue to move ahead with UAS integration. Thus, when the rule is finalized the operating restrictions in this country may be well behind what exists in other countries if the final rule reflects the proposed rule. Table 6 shows how FAA's proposed rules compare with the regulations of Australia, Canada, France, and the United Kingdom.

Table 6: Comparison of Regulatory Requirements for Commercial Unmanned Aerial Systems (UAS) Operations in Select Countries

Regulatory requirements for commercial Unmanned Aerial Systems (UAS)	United States (proposed)	Australia	Canada	France	United Kingdom
Weight classifications (in pounds)	< 55	≤ 0.2 0.2 < ≥ 331 > 331 [Note A]	<4.4 4.4 <> 55 >55	<4.4 4.4 ≤> 55 55 ≤ > 331 ≥ 331	≤15 15 < ≥ 44 44 <> 331 ≥ 331
Government-issued documents for airspace access	Unmanned aircraft operator certificate	UAS operator certificate	None; meet specified conditions for < 55 lbs. [Note B]	Authorization	Permission from Civil Aviation Authority
Pilot training or certification required	Certification [Note C]	Certification	Training	Operator certifies pilot qualification [Note D]	Certification [Note E]
Pilot proficiency check	Biennially	Annually	Upon application	None [Note F]	None [Note G]
Airworthiness certification required	No	No, for < 331 lbs.	No, for < 55 lbs.	No < 55 lbs.	Depends upon the weight of the UAS [Note H]
Beyond line of sight operations allowed by regulation	No	Not specifically addressed in regulation [Note I]	No	No [Note J]	No [Note K]
Restrictions from congested or built-up area	May operate over congested area but not over any persons not involved with the operations.	Unless specifically authorized must fly at sufficient height where, if any of its components fail, it would be able to clear the area.	5.75 miles	Do not allow flying over these areas without special permission	Limited, based on case-by-case review
Altitude restrictions	500 ft.	Unless specifically authorized, 400 ft.	300 ft. if < 55 lbs.	492 ft.	400 ft.

Source: GAO analysis of UAS regulations in foreign countries. | GAO-15-610

Note: In certain instances, UASs may operate outside the requirements shown in this table with prior approval from the cognizant authority, e.g., the civil aviation authority or air traffic control. This table shows regulatory requirements for the UAS category used most frequently in each country.

Note A: Regulations for large fixed-wing UASs (exceeding 331 pounds) apply to helicopters or rotary wing UASs heavier than 221 pounds.

Note B: Operators must have certain documents available, including the exemption regulation and proof of liability insurance.

Note C: Pilot must pass a test at an FAA-approved testing center.

Note D: Owner of the UAS must self-certify that the UAS pilots have the required training.

Note E: Pilot qualifications are determined on a case-by-case basis based a number of factors including pilot experience and aircraft weight. Permission is not required for aircraft 44 pounds or less being flown within direct unaided line of sight and away from people, property, and congested areas.

Note F: Owner of the UAS must self-certify that the UAS pilots have the required training if the pilot has not flown the UAS in the preceding 12 months.

Note G: Self-certification accepted using logbook entries unless the pilot changes aircraft type, or the pilot has less than 2-hours experience logged in preceding 3 months on same aircraft type.

Note H: An airworthiness certification is not required for UAS weighing less than 44 pounds but is required for UAS weighing more than 44 pounds Exemptions may be available in specified circumstances.

Note I: An Advisory Circular issued by Australia's Civil Aviation Safety Authority (AC 101-1(0)) provides for beyond line of sight operations under certain circumstances.

Note J: UAS operations beyond line of sight are very limited and allowed only on a case-by-case basis, according to a French civil aviation official.

Note K: Beyond line of sight operations are allowed with aircraft fitted with a detect-and-avoid system or, operated within a segregated airspace. The Civil Aviation Authority has noted that it is not aware of any detect-and-avoid system with adequate performance and reliability, but has several areas of segregated airspace.

While regulations in these countries generally require that UAS operations remain within the pilot's visual line of sight, some countries are moving toward allowing limited operations beyond the pilot's visual line of sight. For example, according to Australian civil aviation officials, they are developing a new UAS regulation that would allow operators to request a certificate allowing beyond-line-of-sight operations. However, use would be very limited and allowed only on a case-by-case basis. Similarly, according to a French civil aviation official, France approves on a case-by-case basis, very limited beyond-line-of-sight operations. Finally, in the United States, there have been beyond-line-of-sight operations in the Arctic, and NASA, FAA and the UAS industry have successfully demonstrated detect-and-avoid technology, which is necessary for beyond line-of-sight operations.

Like the United States, Australia, Canada, France, and the United Kingdom distinguish between recreational model aircraft and commercial UASs and have issued guidelines for safe operation.⁴³ For example, the United Kingdom defines model aircraft as any small unmanned aircraft, weighing less than 44 pounds, or large unmanned aircraft weighing more than 44 pounds, that is used for sporting and recreational purposes.

⁴³As discussed earlier, for the United States, the model aircraft definition is in the 2012 Act. Rules for flying model aircraft are advisory, and compliance is voluntary. However, FAA has enforcement authority over persons operating model aircraft who endanger the safety of the national airspace system.

Australia makes no practicable distinction between a small UAV and a model aircraft except that of use—model aircraft are flown only for the sport of flying them. However, Australia also defines a giant model aircraft as one weighing between 55 pounds and 331 pounds.

Approvals for commercial UAS operations have increased in these four countries and some allow more commercial operations. Since 2011 the number of approvals for commercial operations in France has increased every year. According to a Civil Aviation Authority official, in 2014, there were about 3,600 commercial UAS operators. In Canada, according to a Transport Canada official, there were over 1,600 approvals for commercial and research related UAS operations in 2014. As previously mentioned, certain commercial operations in Canada do not need approval as of November 2014 and there may be even more UAS operations. The United Kingdom's Civil Aviation Authority attributes the growth to UASs in their country to the UASs' becoming less expensive and simpler to operate. In the United Kingdom, as of February 2015, there were 483 commercial UAS operators, and this number has increased every year since 2010. Similar to the United Kingdom, Australia has seen an increase in commercial UAS operators since 2010 with currently over 200 approved commercial operators. Australia's Parliament attributes the growth to improvements in UASs' piloting and control technologies, as well as reductions in UAS prices. With FAA's approvals for commercial exemptions exceeding 500 as of June 9, 2015, the United States has closed the gap with some other countries' level of commercial use.

Other Countries Face Common Challenges to UAS Integration

Other countries face challenges that are common across some countries, including the United States, trying to integrate UAS operations. Specifically, some of the challenges are:

- Technology shortfalls and unresolved spectrum issues. Technology needs and concerns about available spectrum constrain full integration of UASs into airspace with manned aircraft in the United States and in countries around the world. UASs' current inability to detect and avoid other aircraft, the lack of a standard for command and control systems, and no dedicated and secure frequency spectrum are technical challenges preventing full UAS integration into the national airspace. However, organizations around the world are looking to address these technology issues and develop standards to support safe UAS operations. At the worldwide level, the International Civil Aviation Organization is addressing how UAS integration would

affect its existing standards. At the European level, the European UAS Roadmap contains a strategic research and development plan that describes anticipated deliverables along with key milestones, timelines, and resources needed. Separate from the international organizations, researchers in individual countries are also addressing these challenges. For example, in February 2014, Australian researchers achieved what was then believed to be a world-first breakthrough for small UASs by developing an onboard system that has enabled a UAS to detect another aircraft using vision while in flight.

- Safe operations by recreational users. Countries around the world also face challenges in ensuring that UAS purchasers operate them safely. As UASs become more affordable, and increasingly available some individuals are conducting unsafe or illegal UAS operations. In July 2014, Australia's Parliament reported on testimony, from several witnesses, that UASs are being flown by operators who unknowingly break safety rules, thereby posing a safety risk to manned aircraft and persons on the ground. In response to unsafe operations, a few countries have placed outright bans on UAS operations. For example, in India, in response to the surge in interest for commercial and recreational use, the government placed an outright ban on any UAS use until its civil aviation agency issues regulations. Similar to the "Know Before You Fly" education campaign in this country, other countries have sought to educate operators. For example, the United Kingdom has developed and distributed a brochure describing safe flying practices. In Australia, UAS purchasers receive a similar document when they purchase the product. Canada has launched a national safety awareness campaign for UASs, which aims to help Canadians better understand the risks and responsibilities of flying UASs. In addition, Transport Canada has set up a web page that provides safe guidelines for flying UASs and answers frequently asked questions

While countries face some UAS integration challenges that are similar to the United States, other challenges such as airspace complexity and ease of regulatory change, can make integration in this country more difficult. Airspace complexity is one aspect in which the United States differs from other countries. According to FAA, the U.S. airspace is the busiest and most complex in the world, where UASs, after integration, would share with more than 300,000 general aviation aircraft, ranging

from amateur-built aircraft, rotorcraft, and balloons, to highly sophisticated turbojets (executive jets).⁴⁴ Introducing potentially large numbers of UAS by hobbyists, farmers, law enforcement agencies, and others would add to this complexity. In contrast, according to a study by MITRE, other countries have fewer aviation aircraft, a situation that may make integrating UAS easier. For example, the U.K. has about 20,000 registered general aviation aircraft, while Australia has around 8,400. A study conducted by MITRE for FAA indicated this factor as one that can affect the speed of change and adaptation in various aviation environments.

Agency Comments

We provided a draft of this report to Department of Transportation (DOT) for review and comment. In comments, which were provided in an email, DOT stated that the report addresses many of the challenges of UAS integration but does not address any environmental concerns and that the report should state that it did not examine the environmental considerations of UAS integration. DOT further noted that FAA is conducting research to understand the environmental impacts of UAS integration, the role that UASs play in National Environmental Policy Act compliance, and the applicability of noise standards regulations to UASs.⁴⁵ We did not examine the environmental considerations of UAS integration. The discussion of challenges in the report does not mention environmental concerns because it focuses on challenges the test sites faced during their first year of operation, as reported by the test site operators. We did clarify in our scope and methodology description that we did not cover environmental considerations of UAS integration. DOT also provided technical comments on the draft that we incorporated as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Secretary of Transportation and the appropriate congressional committees. In addition,

⁴⁴General aviation includes all civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire.

⁴⁵14 CFR Part 36.

the report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or 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 key contributions to this report are listed in appendix III.

A handwritten signature in black ink that reads "Gerald Dillingham". The signature is written in a cursive style with a large initial "G" and "D".

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

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The Honorable Bill Nelson
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The Honorable Rick Larsen
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Subcommittee on Aviation
Committee on Transportation and Infrastructure
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Appendix I: Objectives, Scope, and Methodology

This report focuses on FAA's efforts to develop procedures to allow UAS use within the national airspace system. Specifically, we reviewed (1) the status of FAA's progress toward safe integration of UAS into the national airspace, (2) research and development support from FAA's test sites and other resources, and (3) how other countries have progressed toward UAS integration into their airspace for commercial purposes.

To address the three objectives, we reviewed and synthesized a range of published reports from GAO¹ and FAA that included general background information on a variety of related issues, such as FAA's framework for UAS integration, efforts to accommodate ongoing research and commercial UAS use, and UAS technology challenges.² We reviewed other relevant background literature on related issues, including results from databases, such as ProQuest® and Nexis®, trade publications, literature from industry stakeholder groups, and information from the Internet. We also reviewed provisions of the FAA Modernization and Reform Act of 2012,³ and the Notice of Proposed Rulemaking for small UAS operations.⁴ In addition, we reviewed more detailed and specific documentation related to the different objectives, as described below.

To determine FAA's progress toward safe integration of UAS into the national airspace, we:

- Reviewed documents provided by officials and conducted semi-structured interviews with officials at federal agencies, including the FAA's Unmanned Aircraft Systems Integration and Research and Development Offices, the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department

¹GAO, *Unmanned Aircraft Systems: Continued Coordination, Operational Data, and Performance Standards Needed to Guide Research and Development*, [GAO-13-346T](#) (Washington, DC: Feb. 15, 2013); *Unmanned Aircraft Systems: Measuring Progress and Addressing Potential Privacy Concerns Would Facilitate Integration into the National Airspace System*, [GAO-12-981](#) (Washington, DC: Sept. 14, 2012); and *FAA Reauthorization Act: Progress and Challenges Implementing Various Provisions of the 2012 Act*, [GAO-14-285T](#) (Washington, DC: Feb. 5, 2014).

²We did not review the environmental challenges of UAS integration.

³Pub. L. No. 112-95, 126 Stat. 11.

⁴80 Fed. Reg. 9544 (Feb. 23, 2015).

of Homeland Security. We reviewed FAA's Comprehensive Plan⁵ and Roadmap for UAS integration.⁶

- Interviewed representatives from FAA's Joint Planning and Development Office, the UAS Aviation Rulemaking Committee, RTCA, and MITRE Corporation as well as voluntary standards development organization ASTM International. We interviewed representatives from the Association for Unmanned Vehicle Systems International, Aircraft Owners and Pilots Association, American Institute of Aeronautics and Astronautics, and the Academy of Model Aeronautics. We also obtained information on the Federal Modernization and Reform Act of 2012 Section 333 exemptions FAA granted from FAA and <http://www.regulations.gov>⁷ from September 2014 to May 2015.
- Reviewed documents provided by and interviewed federal and industry representatives from the collaborative groups—the Executive Committee, RTCA Special Committee 228, UAS Aviation Rulemaking Committee, and ASTM International Committee F38—and industry groups that are involved in FAA's efforts to integrate UAS into the national airspace system

To identify research and development support from FAA's test sites and other resources, we:

- Reviewed and analyzed documents from each of the six test sites where FAA has recently allowed UAS operations including the applications submitted by the selected test sites and quarterly reports provided to FAA.
- Conducted semi-structured interviews with officials from the test sites, including the State of Nevada, the University of Alaska, the North Dakota Department of Commerce, Griffiss International Airport, the Virginia Polytechnic Institute & State University, and Texas A&M

⁵Joint Planning and Development Office, *Unmanned Aircraft Systems Comprehensive Plan: A Report on the Nation's UAS Path Forward* (Washington, D.C.: September 2013).

⁶FAA, *Integration of Civil Unmanned Aircraft Systems in the National Airspace System Roadmap: First Edition—2013* (Washington, D.C.: November 2013).

⁷Regulations.gov is a website that allows the public to access and submit comments on agencies' regulatory documents published in the Federal Register.

University Corpus Christie to determine the issues encountered in an effort to become operational, conduct research, share the research results with FAA, and receive support or guidance from FAA.

- Spoke with representatives from other universities with centers of research on UAS technology and issues, including New Mexico State University, Massachusetts Institute of Technology Lincoln Laboratory, the Humans and Autonomy Lab at Duke University, and the Georgia Institute of Technology to obtain information about the resources FAA has dedicated to conducting other UAS research and development.

To identify how the United States compares to other countries in the progress and development of UAS use for commercial purposes, we:

- Developed case studies for four countries that have made progress in integrating UASs into their national airspace—France (Direction générale de l'aviation civile); the United Kingdom (UK Civil Aviation Authority); Australia (Australia Civil Aviation Safety Authority); and Canada (Transport Canada Civil Aviation). We selected these countries based on several factors including the status of regulatory requirements for commercial UASs, beyond-line-of-site activities, and whether the country allows non-military UAS to operate in the airspace. We obtained the UAS regulations of each country and interviewed civil aviation authorities in each to obtain additional information about the issues encountered with UAS.
- Interviewed other stakeholders familiar with the UAS activities currently occurring in other countries to determine the factors that influenced their country's policies regarding UASs including the International Civil Aviation Organization (ICAO).⁸

We conducted this performance audit from January 2014 to July 2015 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁸ICAO is the international body that, among other things, promulgates international standards and recommended practices in an effort to harmonize global aviation standards.

Appendix II: Selected Requirements and Status for Unmanned Aerial Systems (UAS) Integration under the Federal Aviation Administration (FAA) Modernization and Reform Act of 2012, as of December 2014

Deadline	FAA Modernization and Reform Act of 2012 requirement	Status of action
05/14/2012	Enter into agreements with appropriate government agencies to simplify the process for issuing Certificates of Waiver or Authorization (COA) or waivers for public unmanned aerial systems (UAS).	In process—memorandum of agreement (MOA) with DOD signed Sept. 2013; MOA with Department of Justice signed Mar. 2013; MOA with NASA signed Mar. 2013; MOA with Department of Interior signed Jan. 2014; MOA with the Office of the Director, Operational Test and Evaluation (DOD) signed Mar. 2014; MOA with National Oceanic and Atmospheric Administration still in draft.
05/14/2012	Expedite the issuance of COAs for public safety entities	Completed
08/12/2012	Establish a program to integrate UASs into the national airspace at six test ranges. This program is to terminate 5 years after date of enactment.	Completed
08/12/2012	Develop an Arctic UAS operation plan and initiate a process to work with relevant federal agencies and national and international communities to designate permanent areas in the Arctic where small unmanned aircraft may operate 24 hours per day for research and commercial purposes.	Completed
08/12/2012	Determine whether certain UAS can fly safely in the national airspace before the completion of the Act's requirements for a comprehensive plan and rulemaking to safely accelerate the integration of civil UASs into the national airspace or the Act's requirement for issuance of guidance regarding the operation of public UASs including operating a UAS with a COA or waiver.	Completed
11/10/2012	Develop a comprehensive plan to safely accelerate integration of civil UASs into national airspace.	Completed
11/10/2012	Issue guidance regarding operation of civil UAS to expedite COA process; provide a collaborative process with public agencies to allow an incremental expansion of access into the national airspace as technology matures and the necessary safety analysis and data become available, until standards are completed and technology issues are resolved; facilitate capability of public entities to develop and use test ranges; provide guidance on public entities' responsibility for operation.	Completed
02/12/2013	Make operational at least one project at a test range.	Completed
02/14/2013	Approve and make publically available a 5-year road map for the introduction of civil UAS into national airspace, to be updated annually.	Completed
02/14/2013	Submit to Congress a copy of the comprehensive plan.	Completed
08/14/2014	Publish in the Federal Register the Final Rule on small UAS.	In process

**Appendix II: Selected Requirements and Status
for Unmanned Aerial Systems (UAS)
Integration under the Federal Aviation
Administration (FAA) Modernization and
Reform Act of 2012, as of December 2014**

Deadline	FAA Modernization and Reform Act of 2012 requirement	Status of action
08/14/2014	Publish in the Federal Register a Notice of Proposed Rulemaking to implement recommendations of the comprehensive plan.	None to date
08/14/2014	Publish in the Federal Register an update to the Administration's policy statement on UAS in Docket No. FAA-2006-25714.	None to date
09/30/2015	Achieve safe integration of civil UAS into the national airspace.	In process
12/14/2015	Publish in the Federal Register a Final Rule to implement the recommendations of the comprehensive plan.	None to date
12/31/2015	Develop and implement operational and certification requirements for public UAS in national airspace.	In process
05/14/2017	Report to Congress on the test ranges	None to date

Source: GAO analysis of FAA information. | GAO-15-610

Appendix III: GAO Contacts and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the contact named above, the following individuals made important contributions to this report: Brandon Haller, Assistant Director; Geoffrey Hamilton, Daniel Hoy, Eric Hudson, Bonnie Pignatiello Leer, Ed Menoche, Josh Ormond, Amy Rosewarne, Andrew Stavisky, and Sarah Veale.

Appendix IV: Accessible Data

Accessible Text

Accessible Text for Figure 1: Unmanned Aerial Systems (UAS) Size and Mission Categories

Size:

- **Small:**
 - **Operating altitude:** Typically operates at lower altitudes due to FAA restrictions;
 - **Weight:** Less than 55 pounds;
- **Large:**
 - **Operating altitude:** Typically operates at higher altitudes, up to 60,000 feet and above;
 - **Weight:** 55 pounds or more.

Mission:

- **Within visual line of sight:** No special instruments are needed to ensure the UAS avoids other aircraft or obstacles (“Operator” has “Line(s) of sight” with “Large UAS” and “Small UAS”);
- **Beyond visual line of sight:** Special instruments are needed to ensure the UAS avoids other aircraft and obstacles (Large hill between “Operator” building with satellite dish and “Large UAS” and “Small UAS”).

Source: GAO. | GAO-15-610

Accessible Text for Figure 2: Priorities for Federal Aviation Administration’s (FAA) Three Phases of Unmanned Aircraft Systems (UAS) Integration as Described in the UAS Integration Roadmap

1. Accommodation phase:

- Allow limited UAS operations in the national airspace through case-by-case evaluation and continued improvement of safety technology.
- Review the operational, pilot, and airworthiness regulations with industry and the Aviation Rulemaking Committee. [Note A]
- Develop standards for technological solutions to address existing gaps in operational procedures.
- Validate safety cases for UAS operations in national airspace system—collect/analyze operational and safety data.
- Conduct research for UAS technologies supporting detect and avoid, control and communications, and human interaction with UASs.

2. Integration phase:

- Develop new operational rules and associated standards, policies, and procedures for small UAS.
- Develop new operational rules and associated standards, policies, and procedures for other UAS.
- Define standards for control and communications technologies.

- Accept minimum aviation system performance standards to enable development of detailed standards defining how UASs equipment should perform its intended function. [Note B]
- Publish FAA policy and operational guidance to define acceptable methods to comply with operational rules.
- Publish UAS flight crew training and certification standards required to legally operate UASs.

3. Evolution phase:

- Conduct seamless operations of UAS in the evolving national airspace system.
- Publish FAA standards defining how UASs equipment should perform its intended function.
- FAA must conduct tests to ensure UAS equipped with sense and avoid technologies operate as expected and are compatible with the systems FAA uses to control manned air traffic.

Source: Federal Aviation Administration (FAA) UAS Roadmap. | GAO-15-610

Note A: FAA's aviation policies and regulations focus on overall safety being addressed through three primary areas: equipment (airworthiness), personnel (pilot), and operations. Each of these areas has standards and minimum levels of safety that must be met independent of each other. Since these policies and regulations were not designed with UAS in mind, they must be reviewed and revised to safely accommodate UAS in the national airspace.

Note B: Minimum aviation-system performance standards specify characteristics that are useful to designers, installers, manufacturers, service providers, and users of systems intended for operational use within a defined airspace.

Accessible Text for Figure 3: Examples of Potential Commercial Unmanned Aerial Systems Operations

- **Agricultural application** (UAS flying over and shining a light on a crop field);
- **Rail inspection** (UAS flying over and shining a light on railroad tracks);
- **Search and rescue** (UAS flying over and shining a light on a person atop a capsized boat in a body of water);
- **Aerial photography** (UAS flying over and shining a light on players on a soccer field);
- **Package delivery** (UAS with a box attached to it flying over and directed toward a residential home).

Source: GAO. | GAO-15-610

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