



## Testimony

Before the Subcommittee on Aviation,  
Operations, Safety, and Security,  
Committee on Commerce, Science, and  
Transportation, U.S. Senate

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For Release on Delivery  
Expected at 2:30 p.m. ET  
Tuesday, March 24, 2015

# UNMANNED AERIAL SYSTEMS

## Status of Test Sites and International Developments

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

Accessible Version

# GAO Highlights

Highlights of [GAO-15-486T](#), a testimony before the Subcommittee on Aviation, Operations, Safety, and Security, Committee on Commerce, Science, and Transportation, U.S. Senate

## Why GAO Did This Study

UAS—often called drones—are aircraft that do not carry a pilot but instead operate on pre-programmed routes or are manually controlled. Currently, UAS only operate in the United States with FAA approval on a case-by-case basis. However, in the absence of regulations, unauthorized UAS operations have, in some instances, compromised safety.

The FAA Modernization and Reform Act of 2012 emphasized the need to integrate UAS into the national airspace by requiring that FAA establish requirements governing them. In response, FAA has taken a number of steps, most notably,

- issuing an NPRM for small UAS operations, and
- designating six UAS test sites which became operational in 2014 and have begun to conduct test flights.

Other countries have started to integrate UAS as well, and many currently allow commercial operations.

This testimony provides preliminary observations on 1) status of FAA's test sites, 2) how other countries have progressed integrating UAS for commercial purposes, and 3) critical steps for FAA going forward.

This testimony is based on GAO's ongoing study examining issues related to UAS integration into the national airspace system for UAS operations. To conduct this work, GAO reviewed documents and met with officials from test sites, FAA, and industry stakeholders.

View [GAO-15-486T](#). For more information, contact Gerald Dillingham at (202) 512-2834 or [dillingham@gao.gov](mailto:dillingham@gao.gov).

March 24, 2015

## UNMANNED AERIAL SYSTEMS

### Status of Test Sites and International Developments

## What GAO Found

Since becoming operational in 2014, the Federal Aviation Administration's (FAA) unmanned aerial systems (UAS) test sites have conducted over 195 flights across five of the six test sites. These flights provide operations and safety data that FAA can use in support of integrating UAS into the national airspace. FAA has not provided funding to the test sites in support of research and development activities but has provided staff time through, for example bi-weekly meetings to discuss ongoing issues with test site officials. FAA staff said that the sites are a benefit to the integration process and worth this investment.

GAO's preliminary observations found that other countries have progressed toward UAS integration and allow commercial use. GAO studied the UAS regulations in Australia, Canada, France, and the United Kingdom and found these countries have similar rules and restrictions on commercial UAS operations, such as allowing line of sight operations only. In November 2014, Canada issued new rules creating exemptions for UAS operations based on size and relative risk. In addition, as of December 2014, Australia had issued over 180 UAS operating certificates to businesses engaged in aerial surveying, photography, and other lines of business. Under the provisions of FAA's proposed rules, operating restrictions would be similar to regulations in these other four countries. For example, all countries have UAS altitude restrictions of 500 feet or below.

FAA faces some critical steps to keep the UAS integration process moving forward. First, issuing the Notice of Proposed Rulemaking (NPRM) in February 2015 for small UAS operations was an important step, but FAA expects to receive tens of thousands of comments on the proposed rule. FAA's goal is to issue the final rule 16 months after the release of the NPRM. If this goal is met, the final rule would be issued in late 2016 or early 2017, about 2 years after the 2012 Act required. Second, the *Comprehensive Plan* and *UAS Roadmap* provide broad plans for integration; however, an implementation plan would help predict with more certainty when full integration will occur and the resources needed to achieve it safely. Finally, test site operators told GAO that incentives are needed to encourage more UAS operations at the test sites. FAA stated it is working with test sites to make access to the airspace easier. GAO will continue to monitor these issues and plans to report its final results later this year.

#### UAS Conducting Flare Stack Inspections and Powerline Inspections



Flare stack inspection

Source: FAA. | GAO-15-486T



Powerline inspection

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Chairwoman Ayotte, Ranking Member Cantwell, and Members of the Subcommittee:

I appreciate the opportunity to testify on the Federal Aviation Administration's (FAA) efforts to integrate unmanned aerial systems (UAS)<sup>1</sup> into the national airspace system (NAS). Since the early 1990s, unmanned aerial systems have operated on a limited basis in the national airspace system primarily supporting public operations, such as military and border-security operations.<sup>2</sup> The list of potential uses is now rapidly expanding to include a broad range of other activities including assisting in search and rescue operations, inspecting pipelines, photographing real estate, surveying land and crops, disaster assistance, gathering news, and filming movies. The term "unmanned aerial system" is used to recognize that UASs include not only the airframe and power plant, but also associated elements such as a ground control station and the communications links as shown in figure 1. In fact, according to a 2013 report by a UAS industry group, the economic impact of 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. However, without specific UAS regulations in place, authorized UAS access to the national airspace can generally only occur after a case-by-case safety review by the FAA. These approved operations are generally limited to flights within the operator's "line of sight" at a few specified locations.<sup>3</sup> Under the FAA Modernization and Reform Act of 2012, enacted in February 2012 (the 2012 Act), FAA issued a Notice of Proposed Rulemaking (NPRM) for small UAS operations in February 2015.<sup>4</sup> However, FAA has stated that it will take 16 months to address comments and issue a final rule.

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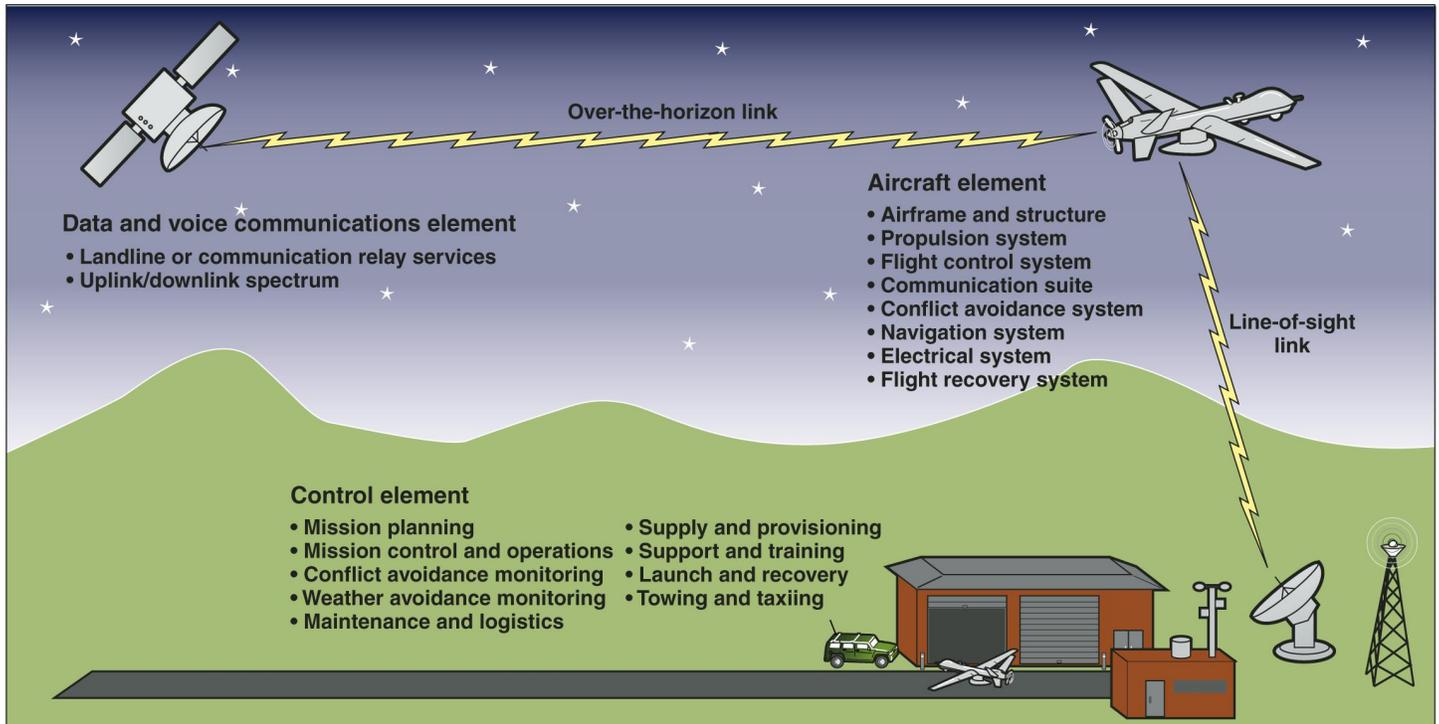
<sup>1</sup>UAS—also known as "unmanned aerial vehicles," "unmanned aircraft systems," "remotely piloted aircraft," "unmanned aircraft," or "drones"—refer to aircraft that operate by following commands from pilot-operated ground control stations and pre-programmed routes.

<sup>2</sup>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).

<sup>3</sup>NASA and the Department of Homeland Security – U.S. Customs and Border Protection operate large UAS beyond visual line-of-sight operations with prior approval from FAA.

<sup>4</sup>FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, §§ 331 – 335, 126 Stat. 11 (2012).

**Figure 1: Conceptual Rendering of Unmanned Aerial System**



Sources: GAO and NASA. | GAO-15-486T

While FAA continues to make incremental progress on integration, questions have been raised about whether the six UAS test sites established by FAA, as required by the 2012 Act, are being used effectively enough to help FAA meet its UAS research needs. FAA requires safety and operations data from UAS operators for continued development of standards supporting the safe and routine integration of UASs. Furthermore, questions have been raised as to whether other countries are making greater progress toward allowing commercial UAS operations, and may outpace efforts made in the United States. Finally, the safety of the national airspace is threatened on nearly a daily basis by UAS operating without approval. The FAA has reported that there have been 25 incidents a month involving unmanned aircraft. These incidents have included UASs operating dangerously close to commercial aircraft, and numerous instances of UASs flying over professional and college football stadiums full of people.

My statement today provides preliminary observations on 1) the status of activity at FAA's designated UAS test sites, 2) how other countries have

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progressed toward UAS integration into their airspace for commercial purposes, and 3) the challenges for FAA going forward.

My statement is based on our ongoing study for this committee and the House Committee on Transportation and Infrastructure and its subcommittee on Aviation on UAS integration into the national airspace system. We expect to issue this report later this year. We conducted the ongoing work from January 2014 through March 2015. For this testimony, we reviewed FAA's *Comprehensive Plan*<sup>5</sup> and *Roadmap* for UAS integration.<sup>6</sup> To identify the status of activity at the UAS test sites, we reviewed documents from each of these six test sites where FAA has recently allowed UAS operations and spoke with officials from all six of the test sites. To identify how other countries have progressed toward UAS integration for civil and commercial purposes, we spoke with the International Civil Aviation Organization (ICAO) and other stakeholders familiar with the UAS activities currently occurring in other countries.<sup>7</sup> We also reviewed relevant empirical literature and media reports to obtain information and perspectives on current developments and future challenges, and spoke with representatives from aviation authorities from Australia, Canada, France, and the United Kingdom, to understand their regulations related to UASs and associated activities. To identify key challenges to UAS integration, we conducted semi-structured interviews with FAA officials and a wide range of stakeholders, including representatives of federal agencies such as Department of Defense, National Aeronautics and Space Administration (NASA), test site officials, research organizations, academics, and industry experts.

The work this statement was based on was performed 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

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<sup>5</sup>JPDO, *Unmanned Aircraft Systems (UAS) Comprehensive Plan: A Report on the Nation's UAS Path Forward* (Washington, D.C.: September 2013).

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

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

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## Background

FAA has authority to authorize all UAS operations in the national airspace—military; public (academic institutions and federal, state, and local governments including law enforcement organizations); and civil (non-government including commercial). Currently, since a final rulemaking is not completed, FAA only allows UAS access to the national airspace on a case-by-case basis. FAA provides access to the airspace through three different means:

- **Certificates of Waiver or Authorization (COA):** Public entities including FAA-designated test sites may apply for COA. A COA is an authorization, generally for up to 2 years, issued by the FAA to a public operator for a specific UAS activity. Between January 1, 2014 and March 19, 2015 FAA had approved 674 public COAs.
- **Special Airworthiness Certificates in the Experimental Category (Experimental Certificate):** Civil entities, including commercial interests, may apply for experimental certificates, which may be used for research and development, training, or demonstrations by manufactures.
- **Section 333 exemptions:** Since September 2014, commercial entities may apply to FAA for issued 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. FAA has granted such exemptions to 48 of 684 total applications (7 percent) from companies or other entities applying under section 333. These companies may apply to fly at their own designated sites or the test sites.<sup>8</sup>

While limited operations continue through these means of FAA approval, FAA has been planning for further integration.

In response to requirements of the 2012 Act, FAA issued the *UAS Comprehensive Plan* and the *UAS Integration Roadmap*, which broadly

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<sup>8</sup>As of March 19, 2014.

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map the responsibilities and plans for the introduction of UAS into the national airspace system. These plans provide a broad framework to guide UAS integration efforts. The *UAS Comprehensive Plan* described the overarching, interagency goals, and approach and identified six high-level strategic goals for integrating UAS into the national airspace.<sup>9</sup> The FAA Roadmap identified a broad three-phase approach to FAA's UAS integration plans—Accommodation, Integration, and Evolution—with associated priorities for each phase that provide additional insight into how FAA plans to integrate UAS into the national airspace system. This phased approach has been supported by both academics and industry. FAA plans to use this approach to facilitate further incremental steps toward its goal of seamlessly integrating UAS flight into the national airspace.

- Accommodation phase: According to the Roadmap, in the accommodation phase, FAA will apply special mitigations and procedures to safely facilitate limited UAS access to the national airspace system in the near-term. Accommodation is to predominate in the near-term with appropriate restrictions and constraints to mitigate any performance shortfalls. UAS operations in the national airspace system are considered on a case-by-case basis. During the near-term, R&D is to continue to identify challenges, validate advanced mitigation strategies, and explore opportunities to progress UAS integration into the national airspace system.
- Integration phase: The primary objective of the integration phase is establishing performance requirements for UAS that would increase access to the NAS. During the mid- to far-term, FAA is to establish new or revised regulations, policies, procedures, guidance material, training, and understanding of systems and operations to support routine NAS operations. FAA plans for the integration phase to begin in the near- to mid-term with the implementation of the small UAS rule and is to expand the phase further over time (mid- and far-term) to consider wider integration of a broader field of UASs.
- Evolution phase: In the evolution phase, FAA is to work to routinely update all required policy, regulations, procedures, guidance material,

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<sup>9</sup>The 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.

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technologies, and training to support UAS operations in the NAS operational environment as it evolves over time. According to the *Roadmap*, it is important that the UAS community maintains the understanding that the NAS environment is not static and that many improvements are planned for the NAS over the next 13—15 years. To avoid obsolescence, UAS developers are to maintain a dual focus: integration into today’s NAS while maintaining cognizance of how the NAS is evolving.

In February 2015, FAA issued a Notice for Proposed Rulemaking for the operations of small UASs—those weighing less than 55 pounds—that could, once finalized, allow greater access to the national airspace.<sup>10</sup> To mitigate risk, the proposed rule would limit small UASs to daylight-only operations, confined areas of operation, and visual-line-of-sight operations. FAAs release of this proposed rule for small UAS operations started the process of addressing additional requirements of the 2012 Act. See table 1 for a summary of the rule’s major provisions.

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<sup>10</sup>80 Fed. Reg. 9544 (Feb. 23, 2015).

**Table 1: Summary of Major Categories and Selected Provisions of Proposed Rule for Small Unmanned Aerial Systems Operations**

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

Source: Notice of Proposed Rulemaking for small UAS. | GAO-15-486T

FAA has also met additional requirements outlined in the 2012 Act pertaining to the creation of UAS test sites. In December 2013, FAA selected six UAS test ranges.<sup>11</sup> 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. 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, there is no funding from FAA to support the test sites. Thus, these sites rely upon revenue generated from entities, such as those in the UAS industry, using the sites for UAS flights.

<sup>11</sup>The 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).

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Foreign countries are also experiencing an increase in UAS use, and some have begun to allow commercial entities to fly UASs under limited circumstances. According to industry stakeholders, easier access to testing in these countries' airspace has drawn the attention of some U.S. companies that wish to test their UASs without needing to adhere to FAA's administrative requirements for flying UASs at one of the domestically located test sites, or obtaining an FAA COA. It has also led at least one test site to partner with a foreign country where, according to the test site operator, UAS test flights can be approved in 10 days.

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## FAA's Six Test Sites Are Operational and Beginning to Conduct UAS Flights

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. From April 2014 through August 2014, as we were conducting our ongoing work, each of the six test sites became operational and signed an Other Transaction Agreement with FAA.<sup>12</sup> All flights at a test site must be authorized under the authority of a COA or under the authority of an experimental certificate approved by FAA. Since becoming operational in 2014 until March 2015, 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 operations and safety data to FAA in support of UAS integration. While there are only a few contracts with industry thus far, according to test site operators these are important if the test sites are to remain operational. Table 2 provides an overview of test-site activity since the sites became operational.

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<sup>12</sup>Other Transaction Agreements (OTA) are administrative vehicles used by the agency that take many forms and are generally not required to comply with federal laws and regulations that apply to contracts, grants, or cooperative agreements. OTAs enable the federal government and others entering into these agreements to freely negotiate provisions that are mutually agreeable.

**Table 2: Overview of Five Designated Test Sites' Activities since Becoming Operational**

Type of test site activity	Overview as of March 2015
Total Unmanned Aerial System (UAS) Flights at FAA designated test sites	<ul style="list-style-type: none"> <li>• Over 195 total UAS flights</li> <li>• One test site has had over 80 UAS flights since becoming operational.</li> </ul>
Number and types of certificate of waiver or authorizations (COA) received	<ul style="list-style-type: none"> <li>• Five test sites hold 48 COAs.</li> <li>• One test sites held 4 broad area COAs allowing flights over nearly the entire state by specific aircraft.</li> <li>• Four other test sites were seeking COAs for large flight ranges that could apply to any aircraft.</li> </ul>
Number of special airworthiness certificate for experimental aircraft	<ul style="list-style-type: none"> <li>• One test site has reviewed and approved an aircraft to operate under an experimental certification.</li> <li>• Three test sites have certified representatives affiliated with the test site to review and approve and aircraft for experimental certification.</li> </ul>
Signed contracts with UAS companies	<ul style="list-style-type: none"> <li>• Five test sites have 22 contracts with industry groups and companies to conduct UAS operations at their respective test site.</li> <li>• These contracts are to allow the test sites to generate revenue.</li> <li>• All test sites have additional negotiations with companies underway.</li> </ul>

Source: FAA designated test site officials. | GAO- 15-486T

Note: FAA designated six test sites but we did not get a response from the Texas A&M University – Corpus Christi test site. We do believe this test site has received COA's and conducted test flights.

FAA officials and some test sites told us that progress has been made in part because of FAA's and sites' efforts to work together. Test site officials meet every two 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, 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.<sup>13</sup>

<sup>13</sup>FAA and several other federal agencies and private sector stakeholders also have research and development efforts under way to develop technologies that are designed to allow safe and routine UAS operations. Furthermore, in support of research and development efforts in the future, FAA solicited for bids for the development of a Center of Excellence. The Center of Excellence is expected to support academic UAS research and development.

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According to FAA, its role is to ensure each test site sets up a safe-testing environment and to provide oversight that guarantees each test site operates under strict safety standards. FAA views the test sites as a location for industry to safely access the airspace. FAA told us it expects to collect data obtained from the users of the test ranges that will contribute to the continued development of standards for the safe and routine integration of UASs. The Other Transaction Agreement between FAA and the test sites defines the purpose of the test sites as research and testing in support of safe UAS integration into the national airspace. FAA and the test sites have worked together to define the role of the test sites and see that both the FAA and the test sites are effectively supporting each other and the goal of the test sites, we will continue to examine this progress and will report our final results late this year.

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## Other Countries Have Progressed with UAS Integration to Allow some Level of Commercial UAS Use

As part of our ongoing work, we identified a number of countries that allow commercial UAS operations and have done so for years. In Canada and Australia, regulations pertaining to UAS have been in place since 1996 and 2002, respectively. According to a MITRE study, the types of commercial operations allowed vary by country.<sup>14</sup> For example, as of December 2014, Australia had issued over 180 UAS operating certificates to businesses engaged in aerial surveying, photography, and other lines of business. In Japan, the agriculture industry has used UASs to apply fertilizer and pesticide for over 10 years.<sup>15</sup> Furthermore, several European countries have granted operating licenses to more than 1,000 operators to use UASs for safety inspections of infrastructure, such as rail tracks, or to support the agriculture industry.<sup>16</sup> The MITRE study reported that the speed of change can vary based on a number of factors, including the complexity and size of the airspace and the supporting infrastructure. In addition, according to FAA, the legal and regulatory structures are different and may allow easier access to the airspace in other countries

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<sup>14</sup>MITRE Corporation, *UAS International Harmonization: A Comparative Policy Assessment of Selected Countries*, Outcome 6, Output 4 (fiscal year 2014).

<sup>15</sup>According to the MITRE study, Japan's regulations also allow UAS operations for agricultural purposes with UASs weighing less than 220 pounds.

<sup>16</sup>In support of developing common standards across Europe, the United States, and other areas of the world, standards-making organizations from around the world have memorandums of understanding supporting their relationships with other standards-making organizations.

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for UAS operations. While UAS commercial operations can occur in some countries, there are restrictions controlling their use.

We studied the UAS regulations of Australia, Canada, France, and the United Kingdom and found 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.<sup>17</sup> 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 of relatively high risk. In addition, each country requires that UAS operators document how they ensure safety during flights and that 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.

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 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 altitudes. Other proposed regulations require that FAA certify UAS pilots prior to commencing operations, while Canada and France do not require pilot certification. Table 3 shows how FAA’s proposed rules compare with the regulations of Australia, Canada, France, and the United Kingdom.

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<sup>17</sup>UASs lighter than 55 lbs. are exempt from Canada’s requirement to obtain a Special Flight Operations Certificate. Those heavier than 55 lbs or otherwise not complying with the exemption requirements must obtain a Special Flight Operations Certificate.

**Table 3: Comparison of Regulatory Requirements for Commercial Unmanned Aerial Systems Operations in Select Countries**

Regulatory requirements for commercial UASs	United States (proposed)	Australia	Canada	France	United Kingdom
Weight classifications (in pounds)	< 55	≤ 0.2 0.2 < ≥ 331 > 331 <sup>a</sup>	<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	Unmanned aerial system (UAS) operator certificate	None; meet specified conditions for < 55 lbs. <sup>b</sup>	Authorization	Permission from Civil Aviation Authority
Pilot training or certification required	Certification <sup>c</sup>	Certification	Training	Operator certifies pilot qualification <sup>d</sup>	Certification <sup>e</sup>
Pilot proficiency check	Biennially	Annually	Upon application	None <sup>f</sup>	None <sup>g</sup>
Airworthiness certification required	No	No, for < 331 lbs.	No, for < 55 lbs.	No < 55 lbs.	Depends upon the weight of the UAS <sup>h</sup>
Beyond line of sight operations allowed by regulation	No	Not specifically addressed in regulation <sup>i</sup>	No	No <sup>j</sup>	No <sup>k</sup>
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 overfly	Limited, based on case-by-case review
Altitude restrictions	500 ft.	Unless specifically authorized, 400 ft.	300 ft. if < 4.4 lbs. 500 ft. if 4.4 lbs <> 55 lbs.	492 ft.	400 ft.

Source: GAO analysis of UAS regulations in foreign countries. | GAO-15-486T

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.

<sup>a</sup>Regulations for large fixed-wing UASs (exceeding 331 lbs.) apply to helicopters or rotary wing UASs heavier than 221 pounds.

<sup>b</sup>Operators must have certain documents available, including the exemption regulation and proof of liability insurance.

<sup>c</sup>Pilot must pass a test at an FAA-approved testing center.

<sup>d</sup>Owner of the UAS must self-certify that the UAS pilots have the required training.

<sup>e</sup>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 lbs. or less being flown within direct unaided line of sight and away from people, property, and congested areas.

<sup>f</sup>Owner of the UAS must self-certify that the UAS pilots have the required training if the pilot has not flown the UAS in proceeding 12 months.

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<sup>9</sup>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.

<sup>10</sup>An airworthiness certification is not required for UAS weighing less than 44 lbs. but is required for UAS weighing more than 44 lbs. Exemptions may be available in specified circumstances.

<sup>11</sup>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

<sup>12</sup>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.

<sup>13</sup>Beyond line of sight operations are allowed with aircraft fitted with a Sense-and-Avoid system or, operated within a Segregated Airspace. The Civil Aviation Authority has noted that it is not aware of any Sense-and-Avoid system with adequate performance and reliability, but has several areas of segregated airspace.

While regulations in these countries require 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 industry have successfully demonstrated detect-and-avoid technology, which is necessary for beyond line-of-sight operations.

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.<sup>18</sup> 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 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

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<sup>18</sup>EASA 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.

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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.<sup>19</sup>

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## Key Critical Steps Remain for UAS Integration

We found during our ongoing work that FAA faces some critical steps to keeping the UAS integration process moving forward, as described below:

*Issue final rule for small UASs:* As we previously discussed, the NPRM for small UAS was issued in February 2015. However, FAA plans to process comments it receives on the NPRM and then issue a final rule for small UAS operations. FAA told us that it is expecting to receive tens of thousands of comments on the NPRM. Responding to these comments could extend the time to issue a final rule. According to FAA, its goal is to issue the final rule 16 months after the NPRM, but it may take longer. If this goal is met, the final rule would be issued in late 2016 or early 2017, about 2 years after the 2012 Act required. 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, the officials 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. According to FAA officials, the challenge of addressing comments could be somewhat mitigated if industry groups consolidated comments, thus reducing the total number of comments that FAA must address.

*Implementation plan:* The *Comprehensive Plan and Roadmap* provide broad plans for integration, but some have pointed out that FAA needs a detailed implementation plan to predict with any certainty when full integration will occur and what resources will be needed. The UAS Aviation Rulemaking Committee developed a detailed implementation plan to help FAA and others focus on the tasks needed to integrate UAS

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<sup>19</sup>RTCA 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, which are specialized in technical fields of aeronautics.

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into the national airspace.<sup>20</sup> The Rulemaking Committee emphasized the need for an implementation plan that would identify the means, necessary resources, and schedule to safely and expeditiously integrate civil UASs into the national airspace. The proposed implementation plan contains several hundred tasks and other activities needed to complete the UAS integration process. FAA stated it used this proposed plan and the associated tasks and activities when developing its *Roadmap*. However, unlike the *Roadmap*, an implementation plan would include specific resources and time frames to meet the near-term goals that FAA has outlined in its *Roadmap*. An internal FAA report from August 2014 discussed the importance for incremental expansion of UAS operations. While this report did not specifically propose an implementation plan, it suggested that for each incremental expansion of operations, FAA identify the tasks necessary, responsibilities, resources, and expected time frames. Thus, the internal report suggested FAA develop plans to account for all the key components of an implementation plan. The Department of Transportation's – Inspector General issued a report in June 2014 that contained a recommendation that FAA develop such a plan.

*Test sites:* Several challenges still exist with the test sites, including identifying the research that test sites should be conducting. According to FAA, it cannot direct the test sites to address specific research and development issues, nor specify what data test operators should provide FAA. Further, FAA officials told us that some laws may prevent the agency from directing specific test-site activities without providing compensation.<sup>21</sup> As a result, according to some of the test-site operators we spoke to, there is uncertainty about what research and development should be conducted to support the integration process. As part of the Other Transaction Agreement between FAA and the test sites, all UAS

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<sup>20</sup>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.

<sup>21</sup>The FAA mentioned concerns regarding the augmentation of appropriations and limitations on accepting voluntary services. As a general proposition, an agency may not augment its appropriations from outside sources without specific statutory authority. The 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.

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operations conducted by the test sites must have a COA.<sup>22</sup> The COA requires the test sites to provide safety and operations data collected for each flight.

Test site operators have told us incentives are needed to encourage greater UAS operations at the test sites. The operators explained that industry has been reluctant to operate at the test sites because under the current COA process, a UAS operator has to lease its UAS to the test site, thus potentially exposing proprietary technology. With a special airworthiness certificate in the experimental category, the UAS operator would not have to lease its UAS to the test site, therefore protecting any proprietary technology. FAA is, however, working on providing additional flexibility to the test sites to encourage greater use by industry. Specifically, FAA is willing to train designated airworthiness representatives for each test site. These individuals could then approve UASs for a special airworthiness certificate in the experimental category for operation at a test site. As previously indicated, three test sites had designated airworthiness representatives aligned with the test site, but only one experimental certificate had been approved. More broadly, we were told that FAA could do more to make the test sites accessible. According to FAA and some test site operators, FAA is working on creating a broad area COA that would allow easier access to the test site's airspace for research and development. Such a COA would allow the test sites to conduct the airworthiness certification, typically performed by FAA, and then allow access to the test site's airspace. As previously stated, one test site received 4 broad area COAs that were aircraft specific. Officials from test sites we spoke with during our ongoing work were seeking broad area COAs that were aircraft "agnostic"—meaning any aircraft could operate under the authority of that COA. According to FAA officials, in an effort to make test sites more accessible, they are working to expand the number of test ranges associated with the test sites, but not increasing the number of test sites. Currently, test sites have ranges in 14 states.

*Public education program:* UAS industry stakeholders and FAA have begun an educational campaign that provides prospective users with information and guidance on flying safely and responsibly. The public

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<sup>22</sup>In order to fly under a COA, the commercial entity leases its UAS to the public entity for operation.

education campaign on allowed and safe UAS operations in the national airspace may ease public concerns about privacy and support a safer national airspace in the future. UASs' operating without FAA approval or model aircraft operating outside of the safety code established by the Academy of Model Aeronautics potentially presents a danger to others operating in the national airspace. To address these safety issues, FAA has teamed up with industry to increase public awareness and inform those wishing to operate UAS how to do so safely. For example, three UAS industry stakeholders and FAA teamed up to launch an informational website for UAS operators.<sup>23</sup> UASs are increasingly available online and on store shelves. Prospective operators—from consumers to businesses—want to fly and fly safely, but many do not realize that, just because you can easily acquire a UAS, that does not mean you can fly it anywhere, or for any purpose. “Know Before You Fly” is an educational campaign that provides prospective users with information and guidance on flying safely and responsibly (see table 4).

**Table 4: Unmanned Aerial Systems Industry Stakeholders and FAA Safety Guidelines for Small UAS Recreational Users**

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Follow community-based safety guidelines, as developed by organizations such as the Academy of Model Aeronautics (AMA).</li> <li>• Fly no higher than 400 feet and remain below any surrounding obstacles when possible.</li> <li>• Keep your small-unmanned aerial system (UAS) in eyesight at all times, and use an observer to assist if needed.</li> <li>• Remain well clear of and do not interfere with manned aircraft operations, and you must see and avoid other aircraft and obstacles at all times.</li> <li>• Do not intentionally fly over unprotected persons or moving vehicles, and remain at least 25 feet away from individuals and vulnerable property.</li> <li>• Contact the airport or control tower before flying within five miles of an airport.</li> </ul> | <ul style="list-style-type: none"> <li>• Do not fly in adverse weather conditions such as in high winds or reduced visibility.</li> <li>• Do not fly under the influence of alcohol or drugs.</li> <li>• Ensure the operating environment is safe and that the operator is competent and proficient in the operation of the small UAS.</li> <li>• Do not fly near or over sensitive infrastructure or property such as power stations, water treatment facilities, correctional facilities, heavily traveled roadways, government facilities, etc.</li> <li>• Check and follow all local laws and ordinances before flying over private property.</li> <li>• Do not conduct surveillance or photograph persons in areas where there is an expectation of privacy without the individual's permission (see AMA's privacy policy).</li> </ul> |
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Source: www.knowbeforeyoufly.org. | GAO-15-486T

<sup>23</sup>Know Before You Fly (www.knowbeforeyoufly.org) was founded by three organizations with a stake in UAS safety: the Association for Unmanned Vehicle Systems International (AUVSI), the Academy of Model Aeronautics (AMA), and the Small UAV Coalition. The Federal Aviation Administration (FAA) is partnering with the founding members to spread the word about safe and responsible flying.

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*UAS and air traffic management:* As FAA and others continue to address the challenges to UAS integration they are confronted with accounting for expected changes to the operations of the national airspace system as a part of the Next Generation Air Transportation System (NextGen)<sup>24</sup> FAA has stated that the safe integration of UAS into the national airspace will be facilitated by new technologies being deployed. However, according to one stakeholder, UASs present a number of challenges that the existing national airspace is not set up to accommodate. For example, unlike manned aircraft, UASs that currently operate under COAs do not typically follow a civil aircraft flight plan where an aircraft takes off, flies to a destination, and then lands. Such flights require special accommodation by air-traffic controllers. Additionally, the air-traffic-control system uses navigational waypoints for manned aircraft, while UASs use Global Positioning System coordinates. Finally, if a UAS loses contact with its ground-control station, the air traffic controller might not know what the UAS will do to recover and how that may affect other aircraft in the vicinity. NextGen technologies, according to FAA, are continually being developed, tested, and deployed at the FAA Technical Center, and the FAA officials are working closely with MITRE to leverage all available technology for UAS integration.

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Chairman Ayotte, Ranking Member Cantwell, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

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<sup>24</sup>NextGen is a new satellite-based air-traffic management system that will replace the current radar-based system for a variety of aircraft types, including UAS. NextGen is expected to enhance the safety and capacity of the air transport system and will provide a number of operational, technical, economic, and environmental opportunities and challenges for all national airspace system users.

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# Appendix I: GAO Contact and Staff Acknowledgments

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## GAO Contact

For further information on this testimony, please contact Gerald L. Dillingham, Ph.D., at (202)512-2834 or [dillinghamg@gao.gov](mailto:dillinghamg@gao.gov). In addition, contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement.

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## Staff Acknowledgments

Individuals making key contributions to this testimony include Brandon Haller, Assistant Director; Daniel Hoy; Eric Hudson; Bonnie Pignatiello Leer; and Amy Rosewarne.

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