



# UNMANNED AIRCRAFT SYSTEMS

## FAA Could Better Leverage Test Site Program to Advance Drone Integration

Accessible Version

January 2020

# GAO Highlights

Highlights of [GAO-20-97](#), a report to the Ranking Member, Committee on Transportation and Infrastructure, House of Representatives.

## Why GAO Did This Study

UAS could provide significant economic and social benefits, for example by delivering packages or aiding in search and rescue missions. FAA is conducting a phased approach to incrementally integrate UAS safely into the national airspace. As directed by statute, FAA established UAS test sites to allow industry to assess the safety and feasibility of complex UAS operations, such as flying beyond an operator's line of sight. FAA has stated that this program provides research results and other data needed to reach full integration.

GAO was asked to review FAA's management of the test sites. This report examines, among other things: (1) the research conducted at FAA's designated UAS test sites, and (2) how FAA is leveraging and sharing information from the test site program to advance integration. GAO reviewed relevant statutes and regulations, reports, and FAA guidance; analyzed test sites' efforts, including flight test data submitted to FAA from 2015 through 2018; and interviewed FAA officials, test site representatives from all 7 test sites, and 18 test site users, selected to include a range of perspectives.

## What GAO Recommends

GAO recommends that FAA (1) develop a data analysis plan for test site data and 2) share more information on how this program informs integration, while protecting proprietary data. FAA partially agreed with the first recommendation and agreed with the second. GAO added language to the first recommendation to address the issue that FAA raised, as discussed in this report.

View [GAO-20-97](#). For more information, contact Heather Krause at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov).

January 2020

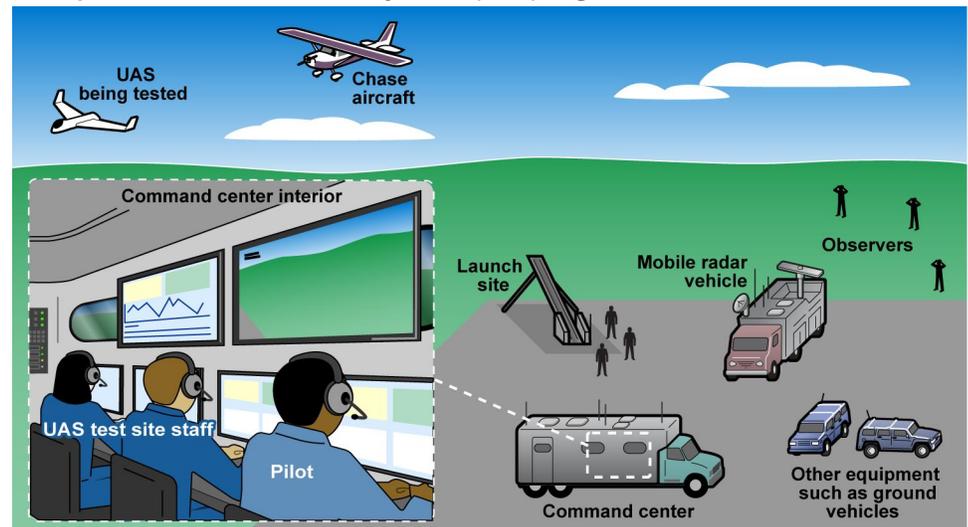
## UNMANNED AIRCRAFT SYSTEMS

### FAA Could Better Leverage Test Site Program to Advance Drone Integration

## What GAO Found

The Federal Aviation Administration's (FAA) seven designated test sites for unmanned aircraft systems (UAS) have facilitated about 15,000 UAS flight tests since 2015 and supported a wide range of research. Both public and private entities have used the test sites to test technologies in preparation for varied UAS activities, from inspecting utilities to carrying passengers. Research conducted at test sites provides data on the performance of various UAS capabilities and technologies; such data could support FAA's integration efforts.

### Example of Unmanned Aircraft Systems (UAS) Flight Test Conducted at a Test Site



Source: GAO. | GAO-20-97

While FAA collects this data from test sites, it has not fully leveraged the data or the program to advance UAS integration. According to FAA's *2018 Roadmap for UAS Integration* a key goal of this program is to provide data to support FAA's decisions on drone integration. FAA officials said the agency intends to use the data to a greater extent in the future to advance integration. Without an analysis plan, however, FAA could miss opportunities to better use the data to inform the overall integration effort, such as to inform UAS operational standards. Also, FAA reports limited public information about how test sites' research relates to the agency's integration plans. Agency officials told GAO they were wary of sharing more information about the test sites, citing concerns about, among other things, protecting test site users' proprietary data. All test site representatives and most users GAO interviewed, however, said that more information on test sites' research would be helpful for UAS stakeholders' research efforts. According to FAA plans, the agency must rely on relationships with stakeholders across government and industry to ensure that integration efforts are harmonized. By sharing more information publicly, FAA could demonstrate to such stakeholders how the agency is fostering and using research to inform and advance integration. Further, with more information, more stakeholders may opt to use a test site to conduct their own research, thus potentially increasing data available to FAA to inform its integration decisions.

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# Contents

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Letter		1
	Background	4
	Test Sites Have Facilitated Thousands of UAS Test Flights for a Wide Range of Research and Activities	13
	FAA Has Improved Collaboration and Taken Other Steps to Address Challenges to Test Sites Conducting UAS Research	22
	FAA Collects Data from the Test Sites but Has Not Fully Leveraged the Data or the Program to Advance UAS Integration	30
	Conclusions	40
	Recommendations for Executive Action	41
	Agency Comments and our Evaluation	41
<hr/>		
Appendix I: List of Unmanned Aircraft Systems (UAS) Test Sites and Stakeholders Whose Representatives GAO Interviewed		43
Appendix II: Comments from the Department of Transportation		45
Appendix III: GAO Contact and Staff Acknowledgments		47
Appendix IV: Accessible Data		48
	Agency Comment Letter	48
<hr/>		
Tables		
	Table 1: Reported Test Flights at Federal Aviation Administration’s (FAA) Designated Unmanned Aircraft Systems Test Sites, from April 9, 2015 to December 31, 2018	14
	Table 2: Examples of Technologies Selected Users Tested at the Federal Aviation Administration’s (FAA) Designated Unmanned Aircraft Systems (UAS) Test Sites	16
	Table 3: Examples of Selected Test Site Users’ Current or Planned Unmanned Aircraft System (UAS) Activities for Use in the National Airspace, as of October 2019	18
	Table 4: Federal Aviation Administration’s (FAA) Steps to Address Challenges GAO Identified at Test Sites in 2015	23

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## Figures

Figure 1: Examples of Fixed-Wing Large Unmanned Aircraft Systems (UAS) and Multi-Rotor Small UAS	6
Figure 2: The Federal Aviation Administration's Incremental Phases for Unmanned Aircraft Systems (UAS) Integration and Examples of Key Capabilities or Topics to Be Researched during Each Phase, as of October 2019	7
Figure 3: Example of Equipment and Infrastructure for a Test Flight of a Small Fixed-Wing Unmanned Aircraft System (UAS)	10
Figure 4: Sample of Existing Test Sites' COA Locations and Allowable Unmanned Aircraft System Operations, as of October 2019	12
Figure 5: Conceptual Rendering of Technologies Involved with Unmanned Aircraft Systems (UAS)	26
Figure 6: Example of the FAA's Websites of Two UAS-Related Research Programs	36

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### Abbreviations

ASSURE	Alliance for System Safety of UAS through Research Excellence
COA	Certificate of Waiver or Authorization
DOT	Department of Transportation
DOT OIG	Department of Transportation's Office of Inspector General
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
ICAO	International Civil Aviation Organization
IPP	Integration Pilot Program
MLS	Mission Logging System
NASA	National Aeronautics and Space Administration
OTA	Other Transaction Agreements
UAS	unmanned aircraft systems
UTM	UAS Traffic Management

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January 9, 2020

The Honorable Sam Graves  
Ranking Member  
Committee on Transportation  
and Infrastructure  
House of Representatives

Dear Mr. Graves:

The emergence of and anticipated growth of unmanned aircraft systems (UAS)—commonly referred to as “drones”—could provide significant social and economic benefits in the United States. UAS operations have the potential to make commercial enterprise more efficient, for example, by delivering packages and monitoring agricultural crops. Additionally, UAS can be used to support public safety by aiding in search and rescue, engaging in aerial surveillance, and inspecting infrastructure, among others.<sup>1</sup> In coordination with government and industry, the Federal Aviation Administration (FAA) is conducting a phased approach to incrementally integrate both existing and planned UAS operations—from package delivery to passenger transport—safely into the national airspace system. Eventually, according to FAA, with industry’s support and based, in part, on the results of research, development, and testing efforts on UAS technologies, the agency will be able to fully integrate UAS operations into the national airspace system, meaning UAS of all sizes operating in the airspace system along with manned aircraft.

FAA’s UAS test site program, which became operational in 2014, is one effort that could help the agency reach full UAS integration. As required by law, FAA established seven UAS test sites to enable both private-sector firms and public entities to safely access the airspace to test complex UAS operations and conduct research on UAS technologies.<sup>2</sup> We reported in 2015 that these test sites provide UAS operational and

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<sup>1</sup>UAS are remotely-piloted vehicles—that is, aircraft without a pilot onboard—and they operate by following commands from pilot-operated ground control stations or pre-programmed routes.

<sup>2</sup>FAA Modernization and Reform Act of 2012 (2012 Act), Pub. L. No. 112-95, § 332(c), 126 Stat. 11 (2012).

safety data to FAA, which the agency could use to support its UAS integration efforts, in part by informing its future decision-making on regulations, policies, and standards.<sup>3</sup> You asked us to examine how FAA is managing the test sites. This report examines:

- what research has been conducted at FAA’s designated UAS test sites;
- what steps FAA has taken to address any test site research challenges; and
- how FAA is leveraging and sharing information from the test site program to advance UAS integration.

To address these objectives, we reviewed relevant statutes and regulations; FAA orders and guidance; and FAA documents related to UAS integration, UAS research and development efforts, and the test site program. We also reviewed test sites’ annual and quarterly reports to FAA, as well as recent relevant reports by the National Aeronautics and Space Administration (NASA), Department of Transportation’s Office of Inspector General (DOT OIG) and GAO. To identify the number of test flights that have occurred through the test sites, we analyzed flight test data collected by the test sites and submitted to FAA via FAA’s Mission Logging System (MLS) from 2015 through 2018. We assessed the reliability of the data provided by FAA from MLS by reviewing them for anomalies, outliers, or missing information, among other things. Based on these steps, we determined them to be sufficiently reliable for capturing the number of qualifying test flights reported as occurring at each test site from 2015 through 2018.<sup>4</sup>

In addition, we interviewed FAA and NASA officials, representatives from all seven test sites, and a selection of seven UAS and aviation industry stakeholders (e.g., UAS industry associations and aviation research organizations) to address these objectives.<sup>5</sup> We identified these stakeholders by reviewing related literature and our prior reports. We also

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<sup>3</sup>GAO, *Unmanned Aerial Systems: FAA Continues Progress toward Integration into the National Airspace*, [GAO-15-610](#) (Washington, D.C.: July 16, 2015).

<sup>4</sup>Qualifying UAS test flights—those that FAA requires test sites to report in MLS—are those that occurred under each test site’s Certificate of Waiver or Authorization (COA) granted by FAA. We will further explain the COA process in a later section of this report.

<sup>5</sup>We conducted a site visit to the Texas test site to interview test site representatives and users in person, and to observe the test site facility and infrastructure.

conducted semi-structured interviews with a non-generalizable sample of 18 current or previous test site clients (whom we will refer to as “users”) (see app. I). Specifically, we conducted interviews with at least two users of each test site. We identified users through recommendations from test site representatives and by reviewing related literature to represent a mix of both public and private entities. We selected users to interview to obtain a range of UAS stakeholder perspectives. Because we selected a non-generalizable sample of users, their responses should not be used to make inferences about a population. To characterize stakeholders’ views throughout the report, we defined modifiers (e.g., “some”) to quantify test site representatives and users as follows:

- **Representatives:** Representatives of “some” test sites refers to representatives from 3 to 4 of the 7 total designated test sites, and representatives of “most” test sites refers to representatives from 5 to 6 test sites.
- **Users:** “Some” users represents from 4 to 8 users of the total 18 interviewed, “many” users represents from 9 to 13 users, and “most” users represents 14 to 17 users.

In addition, we compared FAA efforts identified through documentation review and interviews to FAA’s stated goals, to federal internal control standards related to the use of quality information to achieve objectives and communicating effectively with external parties, and to key practices for reporting on research and development activities.<sup>6</sup>

We conducted this performance audit from July 2018 to January 2020 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.

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<sup>6</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 2014).

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## Background

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### FAA's Efforts to Integrate UAS Operations into the National Airspace System

FAA is responsible for overseeing and authorizing any flight operations in the national airspace system for both manned and unmanned aircraft. FAA's UAS Integration Office, located in the Office of Aviation Safety, seeks to integrate UAS operations into the national airspace system while ensuring the safety of the public and integrity of the airspace.<sup>7</sup> In July 2018, FAA released the *2018 UAS Integration Roadmap*, a second edition of the agency's 5-year plan outlining its most current phased approach for integration, with each step toward full integration allowing UAS operations of increasing complexity.<sup>8</sup> FAA's vision for fully integrating UAS into the national airspace system entails UAS operating safely and routinely—i.e., without requiring prior approval for UAS flights—in the same airspace as manned aircraft. While safety is FAA's paramount concern, the integration of UAS is important because of the potential economic benefits that progress in UAS integration could bring, including more investment in uses such as large passenger operations, as well as the potential safety benefits, such as more effective firefighting and other disaster response efforts.

Currently, FAA only allows certain routine UAS operations under specific conditions while authorizing other UAS operations on a case-by-case basis. For example, since August 2016, operators of small UAS—defined as those UAS weighing less than 55 pounds, including any attachments—who have obtained a remote pilot certificate have generally been allowed to operate without prior FAA approval in certain airspace during the day, under 400 feet, and not over people or beyond an operator's line of sight, among other requirements under FAA's Part 107 rule.<sup>9</sup> Small UAS

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<sup>7</sup>The UAS Integration Office's efforts, in part, include promulgating regulations, researching and testing technology, and ensuring compliance with guidelines and regulations.

<sup>8</sup>FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: Second Edition* (July 2018).

<sup>9</sup>In June 2016, FAA issued the first regulations allowing small UAS operations on a routine basis—meaning, FAA did not have to individually authorize each small UAS flight anymore. These regulations are codified at 14 C.F.R. §§ 107.1-107.205.

operators may seek a waiver of certain FAA operational requirements (referred to as a Part 107 waiver) from the agency on a case-by-case basis, such as a waiver that would allow an operator to fly drones above 400 feet. In contrast, no routine operations—meaning those that can occur without any prior authorization—are currently allowed for large UAS (55 pounds and over) for any purpose (see fig. 1 for examples of small and large UAS). Rather, operators of large UAS must seek authorization from FAA to fly the aircraft on a case-by-case basis, and the processes for accessing the airspace vary.

More specifically, civil large UAS operators must, in most cases, obtain a Certificate of Waiver or Authorization (COA) that demonstrates FAA's approval of airspace access, and may also require approval for the aircraft itself.<sup>10</sup> A COA allows any certificate holder to fly UAS outside of generally allowable operations, such as at certain altitudes, locations, or airspace classes (e.g., near airports). FAA grants this approval to an entity for a specific activity and time period, and sometimes for a specific make and model of UAS. Public entities—which include federal, state and local governments, public academic institutions, and law enforcement agencies—may apply for a COA in order to obtain authorized access to fly in the national airspace for when they are conducting governmental operations, as defined by statute.<sup>11</sup> In such cases, the COA allows for the certificate holder to operate UAS in ways that would otherwise not comply with airspace requirements, such as operating the drone beyond the pilot's line of sight.

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<sup>10</sup>Civil aircraft are defined in 49 U.S.C. § 40102 as “an aircraft except a public aircraft.” Section 40102 also sets forth extensive criteria for who may conduct government aircraft operations. In addition, section 40125 sets forth conditions and purposes that an entity needs to qualify for such operations. Any operation that does not qualify as public is a civil operation. According to FAA officials, civil large UAS operators must obtain an authorization from the Secretary of Transportation based on an analysis of risk that the Secretary conducts under 49 U.S.C. § 44807.

<sup>11</sup>Public entities are defined by statute in 49 U.S.C. § 40102(a)(41). These entities may apply for a COA to conduct public aircraft operations for one of the governmental functions listed in the statute. Governmental functions include activities undertaken by a government, such as intelligence missions, search and rescue, aeronautical research, or geological resource management. 49 U.S.C. § 40125(a)(2). According to FAA officials, guidance on governmental functions is provided in FAA Advisory Circular 00-1.1B and in legal interpretations published on the FAA website.

**Figure 1: Examples of Fixed-Wing Large Unmanned Aircraft Systems (UAS) and Multi-Rotor Small UAS**

Source: National Aeronautics and Space Administration (left) and SZ DJI Technology Co., Ltd. (DJI) (right). | GAO-20-97

In its *2018 UAS Integration Roadmap*, FAA outlined some key topics and operational capabilities to be researched that are associated with specific UAS integration phases (see fig. 2). For example, both government and industry entities have research and testing of technologies underway to provide UAS the capability to detect obstacles in midair, such as other aircraft, and automatically maneuver to avoid collision; this capability is commonly referred to as “detect and avoid.” FAA officials have stated that this key capability is necessary before allowing certain UAS operations on a routine basis, such as flights beyond the operator’s line of sight. According to FAA, the agency plans to use data from several UAS research programs—including the test site program—and from other sources to inform its future decisions regarding UAS integration.

**Figure 2: The Federal Aviation Administration’s Incremental Phases for Unmanned Aircraft Systems (UAS) Integration and Examples of Key Capabilities or Topics to Be Researched during Each Phase, as of October 2019**



Source: GAO review of FAA planning documents. | GAO-20-97

## FAA’s Test Site Program

In 2012, FAA was required by statute to establish a program to integrate UAS into the national airspace system and to establish six UAS test sites in order to develop a process for allowing research to occur at these test sites, among other requirements.<sup>12</sup> In response to Congress’ mandate, in 2013 FAA selected six public entities to be designated as test sites based on a number of factors, including geography, climate, and the respective institutions’ expertise, and added another entity in response to legislation in 2016 for a total of seven designated test sites.<sup>13</sup> According to FAA officials, the test site program was intended to enable industry stakeholders to test complex UAS operations and conduct research on the corresponding technologies. Each test site is a public entity, such as a public academic institution or branch of the state government, which FAA

<sup>12</sup>Pub. L. No. 112-95, § 332(a),(c), 126 Stat. 11 (2012).

<sup>13</sup>Specifically, the seven test sites FAA selected were: North Dakota Department of Commerce, State of Nevada, New Mexico State University, University of Alaska Fairbanks, Texas A&M University at Corpus Christi, Virginia Polytechnic Institute & State University, and Griffiss International Airport (New York). As directed by Public Law 114-190, in 2016, FAA designated New Mexico State University as the seventh test site.

authorizes to conduct various UAS operations through the COA process. UAS stakeholders, including manufacturers or entities seeking to use UAS for various purposes, can pay to work with any of the seven FAA-designated test sites to conduct test flights or receive training on UAS operations and regulations, among other activities, based on the test site staff's expertise. FAA has not directly funded the test sites' general operations, so the sites have had to rely on other funding sources, such as revenues generated from users, state funds, federal research grants, and commercial investment. Congress recently appropriated \$6 million to FAA to provide matching funds to qualified commercial entities seeking to test UAS technologies at FAA designated test sites.<sup>14</sup>

FAA manages the test site program using formal agreements and by providing support to test site staff. The test sites signed individual Other Transaction Agreements (OTA) with FAA that establish their agreement to meet specific requirements aimed to support FAA's UAS integration efforts.<sup>15</sup> For example, these agreements lay out that test sites must follow safety processes and data procedures, as well as provide certain deliverables to FAA. Specifically, the agreements outline that the test sites will provide FAA certain operations and safety-related data for specific test flights, which FAA stores in a database it created specifically for test site data.<sup>16</sup> In addition, once the test sites were operational, FAA designated an official to serve as the test site program manager for all seven sites who, among other duties, facilitates regular meetings with test site representatives to discuss ongoing issues and regularly

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<sup>14</sup>The \$6 million was appropriated through the Consolidated Appropriations Act of 2019. In June 2019, FAA announced the application process for applicants who seek to work on specified technologies in conjunction with a test site, stating that the agency expected to offer awards to qualified applicants through a competitive process. In December 2019, FAA officials told us they planned to complete this process by the second quarter of fiscal year 2020.

<sup>15</sup>Congress has authorized FAA to enter into other transactions. This authority allows FAA to enter into agreements "other than" standard government contracts, grants, or cooperative agreements. Other transactions are generally not subject to federal statutes and regulations applicable to federal procurement contracts or grants, allowing entities, such as public academic institutions, to customize their OTAs to help meet project requirements and mission needs.

<sup>16</sup>As we reported in 2015, FAA officials stated that data obtained from test site users would contribute to the continued development of standards for UAS integration. See GAO, *Unmanned Aerial Systems: Status of Test Sites and International Developments*, [GAO-15-486T](#) (Washington, D.C: Mar. 24, 2015).

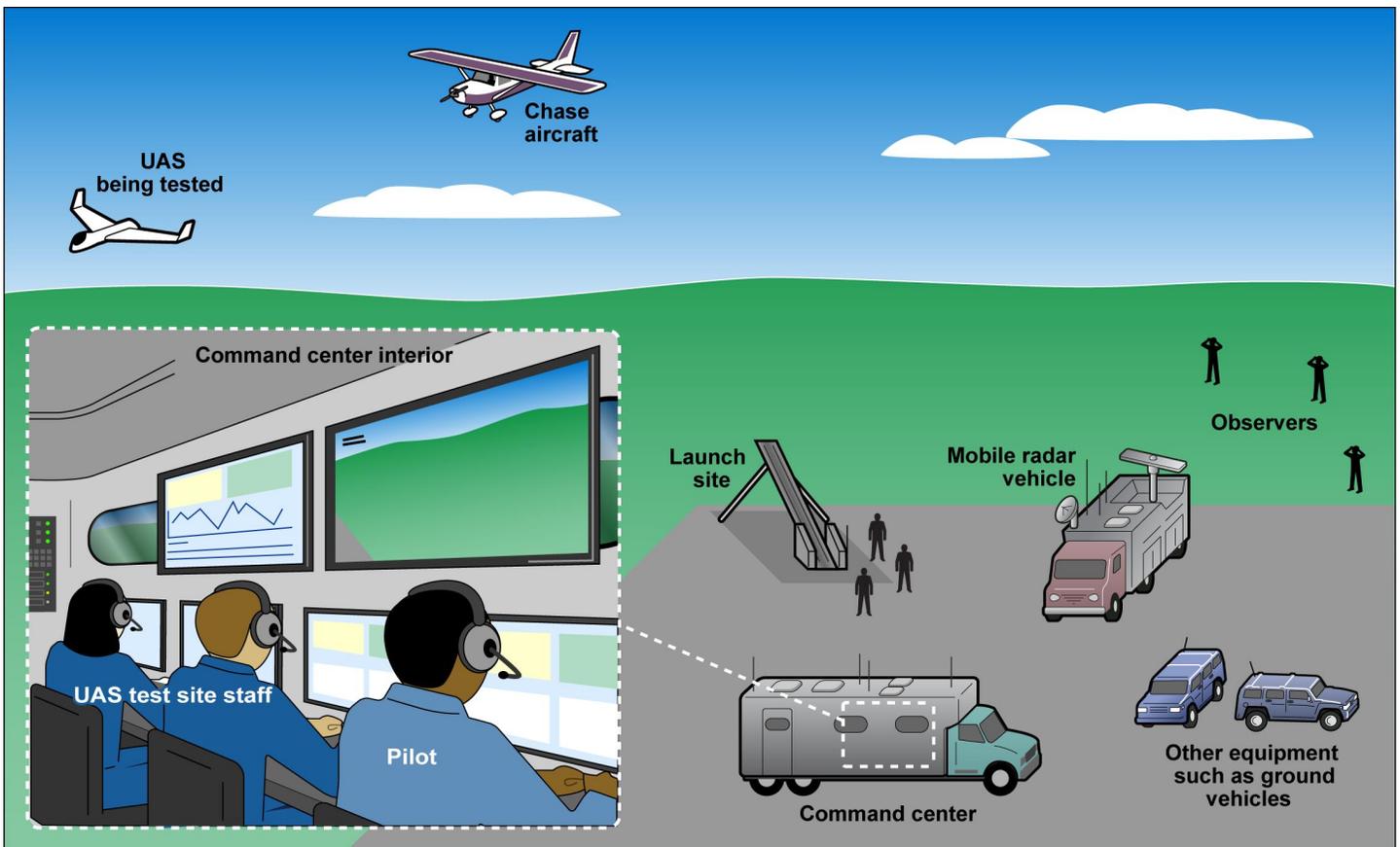
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communicates with other FAA lines of business to keep them informed about key efforts underway at test sites.

## UAS Flight Testing through Test Sites

According to FAA, the designated test sites have the equipment and infrastructure to support UAS flight testing, such as UAS pilots, launch pads, command centers, and, if required, chase aircraft (see fig. 3).<sup>17</sup>

Figure 3: Example of Equipment and Infrastructure for a Test Flight of a Small Fixed-Wing Unmanned Aircraft System (UAS)



Source: GAO. | GAO-20-97

<sup>17</sup>A chase aircraft is typically a small airplane that follows UAS during test operations as the UAS travels through the same airspace used by commercial aircraft.

Test site staff can facilitate UAS flight operations under a test site's COA or by complying with the Part 107 rule.<sup>18</sup> Since 2015, the test sites have held a "blanket" COA that allows them to conduct government functions for small UAS in Class G (uncontrolled) airspace anywhere in the United States except within restricted or prohibited areas.<sup>19</sup> In addition, test sites have applied for and been granted COAs to operate UAS of different sizes in locations (referred to as "test ranges") outside their state, and in a variety of airspaces at various elevations (see fig. 4 for a sample of test site COAs). For example, as of October 2019, the Alaska test site had COAs for test ranges in many states including Alaska, Hawaii, Tennessee, and Oregon—one of which allows operations up to 15,000 feet above mean sea level within three classes of airspace around Pendleton, Oregon.<sup>20</sup> Some test ranges are located at airports, such as Griffiss International Airport in New York, which can help facilitate the testing of UAS that may require runways for take-off and landing, as well as testing of UAS flying in areas with manned aircraft.

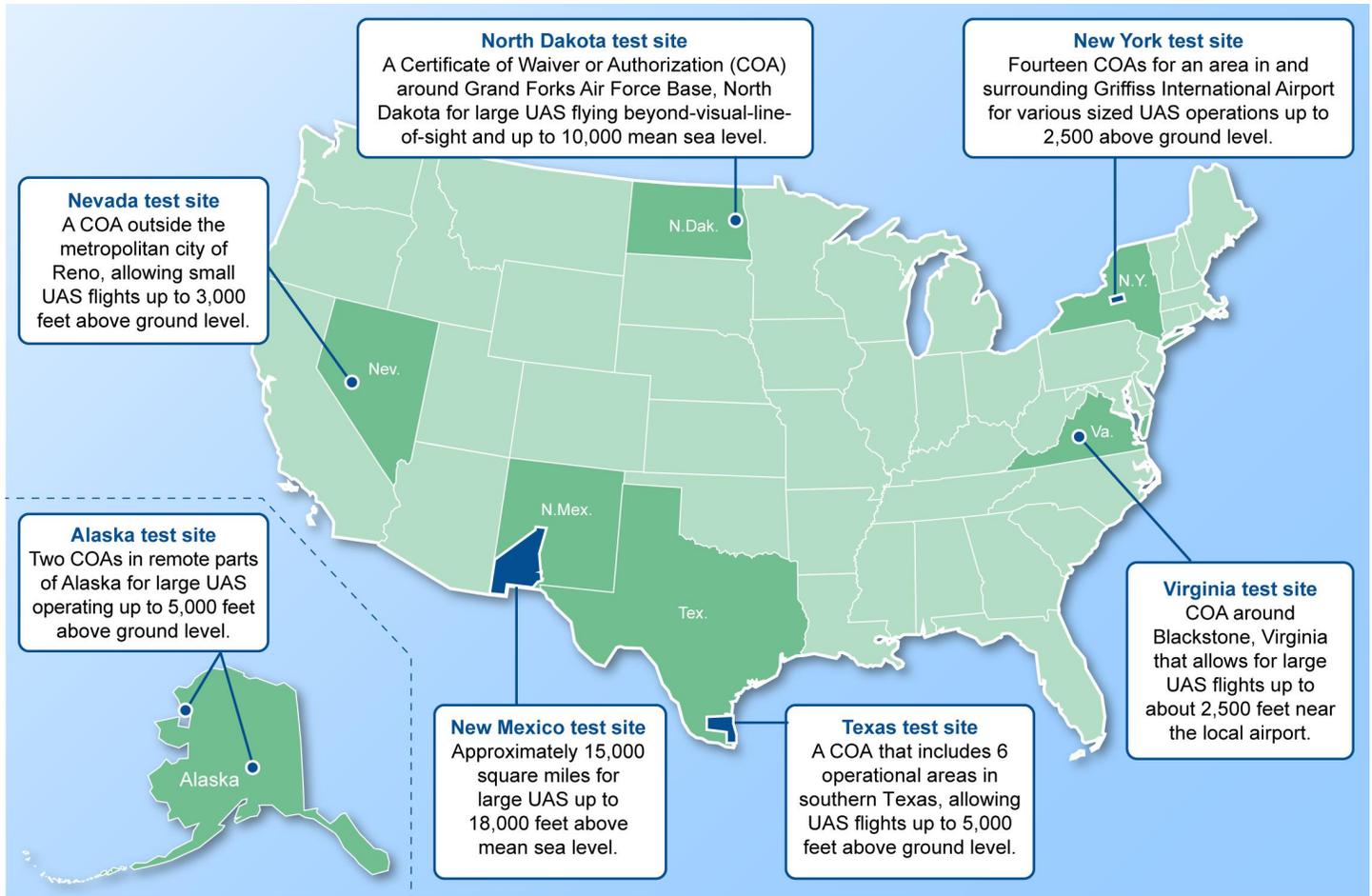
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<sup>18</sup>In order to fly a UAS under the test site's COA, the user leases their UAS to the test site for operation.

<sup>19</sup>Class G airspace refers to uncontrolled airspace and generally extends from the surface to the base of Class E airspace, which in most areas is 1,200 feet above ground level, except for restricted or prohibited areas. Restricted areas include areas near airports and prohibited areas include areas around, for example, the National Mall and White House. FAA first granted the test sites a blanket COA in 2015, allowing them to operate small UAS up to 200 feet generally anywhere in the United States. Other entities can also be granted blanket COAs.

<sup>20</sup>These airspaces are D, E and G classes. Class D refers to areas up to 2,500 mean sea level above airports; Class E refers to controlled airspace not otherwise designated as another controlled airspace class; and, Class G refers to uncontrolled airspace.

**Figure 4: Sample of Existing Test Sites' COA Locations and Allowable Unmanned Aircraft System Operations, as of October 2019**



Sources: Federal Aviation Administration and Map Resources. | GAO-20-97

However, stakeholders, such as UAS manufacturers or companies interested in using UAS for various purposes, are not required to use an FAA-designated test site for UAS flight testing. In addition to seeking authorization directly from FAA to conduct their own flights or flying according to current rules such as Part 107, UAS stakeholders can work with other entities—such as military airports, public academic institutions or other public test sites—to which FAA has granted COAs to conduct complex UAS operations. For many stakeholders, however, working with a designated test site may provide quicker access to testing than seeking their own authorization from the FAA. For example, a UAS manufacturer might work with a test site to test the company’s UAS prototype at a certain elevation under a test site’s existing COA (following all applicable

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COA guidelines, such as performing a government function with the operation) because the test site already had that authorization in place. Additionally, it may be beneficial for a UAS manufacturer or operator to work with a test site because the test site has experience in obtaining authorizations or waivers from FAA for similar types of operations or aircraft.

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## Test Sites Have Facilitated Thousands of UAS Test Flights for a Wide Range of Research and Activities

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### Test Sites Have Facilitated about 15,000 UAS Test Flights

According to FAA's MLS data,<sup>21</sup> the test sites facilitated about 15,000 total UAS test flights occurring under test site COAs from April 2015 through December 2018 (see table 1).<sup>22</sup> However, according to test site representatives, staff at these sites facilitated more UAS flights during this time frame than is reflected in the MLS data, because additional flights were conducted using different allowances than COAs, such as under the Part 107 rule that allows certain routine small UAS operations.

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<sup>21</sup>MLS only contains flight operations data collected from the test sites. While other COA holders must also submit operational data to FAA into FAA's COA Application Processing System per COA requirements, these data are not contained in MLS.

<sup>22</sup>According to FAA, test sites are only required to submit to FAA flight test data from operations occurring under a COA via MLS. As of February 2019, the test sites collectively held 56 COAs. However, officials also told us that they have asked the test sites to also submit data for any flights occurring under the Part 107 rule, so some data within MLS may reflect those flights.

**Table 1: Reported Test Flights at Federal Aviation Administration’s (FAA) Designated Unmanned Aircraft Systems Test Sites, from April 9, 2015 to December 31, 2018**

Test Site	2015	2016	2017	2018	Total
Alaska	63	309	377	410	1,159
Nevada	66	805	495	90	1,456
New Mexico <sup>a</sup>	N/A	3	76	188	267
New York	70	688	633	777	2,168
North Dakota	168	1,595	448	199	2,410
Texas	232	1,432	1,050	364	3,078
Virginia	1,527	1,176	916	760	4,379
<b>Total</b>	<b>2,126</b>	<b>6,008</b>	<b>3,995</b>	<b>2,788</b>	<b>14,917</b>

Source: GAO analysis of data from FAA’s Mission Logging System (MLS). | GAO-20-97

<sup>a</sup>Six of the seven test sites became operational in 2014, but New Mexico did not become an FAA-designated test site until late 2016.

According to FAA officials, the decrease—starting in 2017—in the annual number of reported test flights by the test sites, as reflected in table 1 above, is due in part to a change in regulations. Specifically, when FAA’s Part 107 rule took effect in August 2016, it provided a new avenue for small UAS operators, including test site staff and other airspace users, to test certain small UAS operations without requiring a COA or other authorization, effectively reducing the number of test flights logged into FAA’s MLS. Agency officials also told us that Part 107 changed the type of research users request from the test sites, which may have reduced the number of test flights facilitated through the test sites. While there have been fewer flight tests, according to some test site representatives and users we spoke to, recent testing has been for more complex research. For example, one test site representative stated that now the site’s users have bigger, more extensive research projects involving more tasks than just test flights, such as developing the operational models, performing testing on various technologies, and installing equipment to support complex UAS operations.

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## Test Sites Have Supported UAS Stakeholders in Conducting Research in Preparation for Varied UAS Activities, from Inspecting Utilities to Carrying Passengers

Research conducted at the test sites has provided information to FAA that, according to agency officials, supports its efforts to integrate UAS into the national airspace system. Test site representatives told us that they have supported over 440 public and private users to conduct research and development on UAS to be used for a variety of UAS activities. While FAA officials told us that they cannot direct specific types of research to be conducted at the test sites unless the agency funds that research, we found that users have nevertheless conducted UAS research and development activities that FAA has identified as important for UAS integration. For example, users conducted research on the safety risks of UAS, such as concussion collision studies, and have tested UAS capabilities, such as the ability to carry loads of varying weights. Also, based on our analysis, we found that users have tested UAS technologies at the test sites that align with some of the key capabilities identified by FAA as necessary for the upcoming phases of UAS integration (see table 2).

**Table 2: Examples of Technologies Selected Users Tested at the Federal Aviation Administration’s (FAA) Designated Unmanned Aircraft Systems (UAS) Test Sites**

Category	Technology description	Example of testing of technology
<b>Command and Control Links and Equipment</b>	The command and control link between a UAS and its pilot allows the pilot to maintain control of the UAS during various scenarios, such as avoiding bad weather or nearby air traffic. UAS communications links can be broken by interference from other signals or hacking, causing potentially dangerous situations.	In 2016 a user at the Virginia test site tested new methods of ensuring reliable command and control links for future beyond-visual-line-of-sight inspections of gas pipelines.
<b>UAS-Based Detect and Avoid</b>	Detect and avoid sensors mounted to a UAS will allow the UAS to detect and avoid other aircraft or obstacles, either by alerting the remote pilot to take action or by taking action itself to avoid collision. UAS can detect and avoid through various sensor modes, including radar-based and satellite-based modes, which read signals from the obstacle.	In 2017, a group of users at the Texas test site participated in a test of UAS operations for search and rescue missions. During the search part of the mission, the users tested detect and avoid technology to see if it could detect an “intruder” aircraft flying into the operation and then alert other UAS flying in the mission to take evasive action.
<b>Ground-Based Detect and Avoid</b>	Sensors installed in the ground will allow for remote observations of how the UAS is performing, and could help the UAS detect and avoid other aircraft and obstacles while flying.	One user we met with is developing ground-based sensors deployed along “UAS corridors”—that is, pre-defined UAS traffic routes—that can allow beyond-visual-line-of-sight flights. The user has tested the equipment at the Alaska, Nevada, and North Dakota test sites.
<b>Cybersecurity Software Systems</b>	UAS are cyber physical systems, meaning they are dependent on information technology and remote connectivity to operate. We have previously reported on the risks to information technology systems, and found that rapid developments in new technologies can introduce cybersecurity issues. <sup>a</sup>	A user at the New York test site has been testing technology and solutions designed to protect UAS from cyber threats, such as threats targeting the communication link between the operator and the UAS as well as those targeting the UAS’s own software.
<b>Vertical Take-Off and Landing Capability</b>	This type of technology functions similar to that of a helicopter: the aircraft is able to lift off the ground vertically without requiring any forward movement on a runway, for example. According to one user we spoke to, this technology will likely be important to study for FAA’s final UAS integration phase of allowing routine passenger and large cargo flights.	One user has tested vertical take-off and landing technology for large UAS through the Alaska test site. This user’s ultimate goal is to use the technology to build a large UAS capable of flying passengers remotely as well as autonomously on pre-programmed flights.

Source: GAO review of literature and interviews with selected stakeholders. | GAO-20-97

Note: Technologies described in this table are examples of the types of technologies requiring research to help the FAA advance toward full integration of UAS into the national airspace system.

<sup>a</sup>GAO, High Risk Series: Urgent Actions Are Needed to Address Cybersecurity Challenges Facing the Nation, [GAO-18-622](#) (Washington, D.C.: Sept. 6, 2018).

Test site users also reported benefits from working with test sites. According to the users we interviewed, the test sites have provided them an opportunity to explore and improve UAS technologies, and to learn

more about how they could use UAS for their own purposes in the national airspace.<sup>23</sup> For example, one user of the New York test site had tested communication equipment and detect-and-avoid capabilities on large UAS that they manufacture and sell to other entities for conducting surveillance activities, such as drug interdiction. Many of the test site users (11 of 18) we spoke to stated that using a test site provided a significant benefit for advancing their entity's UAS research and development efforts. In addition, according to 9 of the 18 users we spoke to, test sites provided them with direct and immediate access to tools that helped them test their technologies. For example, users stated that it was beneficial that test sites have specific authorities from FAA for certain types of testing under a COA as well as infrastructure to allow for advanced UAS research.

Some activities the test site users we spoke to plan to conduct with UAS are already regularly occurring—meaning FAA either allows these to occur on a routine basis or has allowed them to occur through additional authorization on a regular basis. Others are not yet occurring on a regular or routine basis due either to legal restrictions, such as restrictions on operating UAS beyond the operator's visual line of sight or needed technological advancements, but FAA expects them to occur routinely in the future (see table 3).

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<sup>23</sup>Not all test site users we spoke to have conducted research for UAS activities to be used in the national airspace. For example, one user we met with is developing a large UAS with surveillance and other capabilities to be used solely for military purposes abroad.

**Table 3: Examples of Selected Test Site Users' Current or Planned Unmanned Aircraft System (UAS) Activities for Use in the National Airspace, as of October 2019**

Current or Expected activities	Type of activity	Description
Regularly occurring	Aerial photography	Many UAS are equipped with cameras, and are actively used for aerial photography, including cinematography for television and movies, photography for real estate purposes, and agricultural monitoring, among other purposes.
Regularly occurring	Utility inspection	Two users we spoke to currently use drones to inspect their utility infrastructure. One user relies on UAS to conduct inspections of power lines, and the other uses them to inspect wind turbines.
Regularly occurring	Insurance claims	According to one user we spoke to, UAS are used to safely and efficiently inspect homes and properties to assess insurance claims.
Regularly occurring	Coastline surveillance	One user has sold their UAS to a local law enforcement entity that uses the UAS to surveil the coastline in their jurisdiction for maritime patrol and drug interdiction.
Regularly occurring	Disaster recovery	UAS have been used after disasters, such as Hurricanes Harvey and Florence in 2017 and 2018, respectively, to conduct search and rescue missions, assess damage, and provide news coverage.
Expected in the future	Routine package delivery	As of September 2019, FAA has authorized four companies to deliver packages for compensation in limited locations, two of which worked with a test site. <sup>a</sup> FAA expects UAS to be used to carry packages for compensation on a routine basis in the future.
Expected in the future	Unmanned air taxis	FAA expects large UAS to carry people for short-range flights in the future after making technological advancements and addressing regulatory challenges. One user we spoke to is developing an electric UAS that is expected to carry up to 2 passengers.
Expected in the future	Emergency response missions over water	One user we spoke to hopes to deploy UAS beyond visual line of sight for emergency response many miles offshore, including assessing damage to ports and facilitating search and rescue missions. Legal restrictions on the routine use of beyond-visual-line-of-sight flights have limited these activities.
Expected in the future	Long-range flights for geographic surveying	Although research on UAS design and technology to allow for long-range flights has occurred, legal restrictions related to UAS operations beyond the line of sight of the operator still limit the routine use of these flights. One user hopes to conduct long-range flights to study the effects of forest fires and inspecting remote archeological sites.

Source: GAO review of literature and analysis of interviews with selected test site users. | GAO-20-97

<sup>a</sup>Because these authorizations were generally limited in scope and only granted to four companies, we determined that this type of activity is not yet regularly occurring.

Some users we spoke to have also worked with a test site to conduct extensive hazard and risk mitigation testing to build safety cases and get approval from FAA to conduct complex UAS operations. FAA generally requires safety cases when a user is seeking approval to deviate significantly from current UAS requirements, such as when seeking to conduct beyond-visual-line-of-sight operations using a small UAS. For example, according to representatives from an insurance company we spoke to, they worked with the Virginia test site for over a year to build a safety case to prove that the company could safely operate its small UAS beyond the operator's line of sight and over people. According to test site representatives, this risk mitigation testing entailed dozens of

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experiments, including how to address the risk of an UAS abruptly losing power. For instance, if a UAS operating over a house for an insurance inspection loses power, it could fall, potentially causing damage to the building as well as injuring someone standing on the ground below. In November 2018, FAA granted approval for the company to fly its fleet of UAS over people and beyond the operator's line of sight in sparsely populated communities nationwide for insurance claim inspections.

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### Test Sites Have Also Participated in Federal UAS Research Projects Intended to Inform UAS Integration

All test sites have competed for and were selected by federal agencies to participate, to varying degrees, in additional UAS research efforts designed to inform aspects of FAA's integration plans. The projects include:

- **The Department of Transportation's (DOT) UAS Integration Pilot Program (IPP):** In May 2018, DOT selected 10 project teams—which included the Alaska, North Dakota, and Virginia test sites—to participate in this program aimed at evaluating different concepts for certain UAS operations in specific communities.<sup>24</sup> According to DOT, the IPP is an opportunity for state, local, and tribal government agencies to partner with private sector entities, such as UAS operators or manufacturers, to, among other things, accelerate the approval of operations that currently require case-by-case authorizations. Two key intended outcomes of the IPP are to assess the respective communities' acceptance of low-altitude UAS operations, and to balance national and local interests in furthering UAS integration. For example, the Alaska test site is a member of the University of Alaska Fairbanks IPP team, with a primary focus of enabling complex UAS technology for pipeline inspections in the area's harsh climatic conditions through testing technologies, such as using detect and avoid technology at night. While project awardees do not receive any federal funding for this program, FAA officials told us they are collecting data from IPP efforts to inform future decision-making.
- **FAA's Center of Excellence for UAS:** In May 2015, FAA selected a team of 15 research institutions, including the Alaska and New Mexico test sites, called the Alliance for System Safety of UAS through Research Excellence (ASSURE), to serve as FAA's Center of Excellence for Unmanned Aircraft Systems and to conduct academic research critical to

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<sup>24</sup>As of October 2019, the UAS IPP included nine project teams.

safe and successful UAS integration. Congress has appropriated funds to ASSURE since fiscal year 2014 to pay for operational expenses and research, and according to FAA officials, ASSURE institutions are eligible to receive grant funding from FAA's Research, Engineering, and Development appropriations. ASSURE institutions receive federal grants to conduct research to assess specific technologies or risks with the intent to inform FAA regulations and policies. For example, ASSURE institutions have received grants from FAA to study UAS noise certification, ground and airborne collision severity and impacts, and UAS detect and avoid technologies.<sup>25</sup> According to FAA, funding from non-federal entities, such as international civil aviation authorities can be applied to ASSURE. Some of ASSURE's research has been peer reviewed and published.<sup>26</sup> According to an ASSURE representative we spoke to, all of the research conducted through ASSURE is in alignment with FAA's plans for UAS integration as outlined in the *2018 UAS Integration Roadmap*.

- **FAA's and NASA's UAS Traffic Management (UTM):** The UTM program is a collaborative effort of FAA and NASA to design a system with a similar concept as FAA's air-traffic-control system for manned aviation that would enable small UAS to operate safely at low altitudes around other aircraft.<sup>27</sup> NASA is leading the research, development, and testing of various technologies that would comprise the system, and plans to transfer the results of the research to FAA to determine next steps. NASA selected six test sites—Alaska, Nevada, New York, North Dakota, Texas, and Virginia—to participate, to varying degrees, in the four different phases of this project. NASA has provided funding to the six test sites through contracts for their participation in testing the system. UTM research is divided into four phases, called technology capability levels, each with specific technical goals. For example, technology capability level three entailed testing technologies that maintain a safe distance between two UAS flying over moderately populated areas. All six sites participated in the first three phases, which according to NASA

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<sup>25</sup>According to an ASSURE representative, other federal agencies that have sought research from ASSURE include NASA, and the Departments of Defense, Energy, Homeland Security, and Interior.

<sup>26</sup>For example, see David M. Arterburn, et al, *Final Report for the FAA UAS Center of Excellence Task A4: UAS Ground Collision Severity Evaluation*, (Washington, D.C.: Apr. 28, 2017).

<sup>27</sup>In 2016, FAA was directed, in coordination with NASA, to develop a research plan for a UAS traffic management system. FAA Extension, Safety, and Security Act of 2016 (FAA Act of 2016), Pub. L. No. 114-190, § 2208, 130 Stat. 633 (2016).

officials brought in about 35 industry partners for this research effort. The Nevada and Texas test sites are currently participating in the fourth and final phase, which—as of October 2019— NASA expected to complete in 2019. In addition, FAA selected the North Dakota, Nevada, and Virginia test sites to participate in its UTM Pilot Program. The program’s goals are to develop, demonstrate, and provide services that will support the implementation of UTM operations.<sup>28</sup>

- **NASA’s UAS Integration in the National Airspace System:** Beginning in 2015, NASA provided funding to the New York and Virginia test sites, among other entities, for this project, which is intended to demonstrate solutions to technical challenges to inform FAA’s development of operational standards for UAS. For example, through this project, NASA intends to test detect and avoid technologies by assessing UAS performance during a variety of scenarios, and then by recommending a minimum set of performance standards to FAA for consideration. According to NASA officials, the agency has completed work at the New York test site related to developing standards for routine operations by large UAS. As of October 2019, NASA had ongoing research at the Virginia test site on command and control communications that officials expected to complete in 2019.
- **FAA’s UAS Detection at Airports:** According to FAA, six test sites— Nevada, New Mexico, New York, North Dakota, Texas, and Virginia— participated in this program alongside various industry partners to evaluate technologies that can be used to safely detect UAS near airports.<sup>29</sup> Funded by FAA, this research project included evaluating the capabilities of various UAS detection technologies by different manufacturers at four U.S. airports in 2016 and 2017. This research was used to inform minimum performance standards for UAS detection systems deployed at airports.

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<sup>28</sup>The FAA Act of 2016 directed the establishment of a UTM System Pilot Program. Pub. L. No. 114-190, § 2208(b).

<sup>29</sup>FAA worked with a UAS industry stakeholder in 2015 to evaluate the company’s UAS detection technology. Since that agreement was signed, Congress passed the FAA Act of 2016, which directed the FAA to continue research into detecting UAS in airport environments.

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## FAA Has Improved Collaboration and Taken Other Steps to Address Challenges to Test Sites Conducting UAS Research

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### As the Program Has Matured, FAA Has Taken Some Steps to Address Management Challenges

All test site representatives stated that FAA has improved both its management of the UAS test sites and collaboration with representatives in recent years as the program has matured. According to test site representatives, initially, as the program began, there was considerable turnover among FAA test site managers, which made it more difficult for the staff at the test sites to collaborate with FAA officials to undertake research efforts. FAA officials acknowledged that because they had not established test sites before, it took time to determine the best approach for managing this program. However, according to most representatives, in the last few years, FAA has begun to better collaborate with the test sites. Specifically, FAA has solicited input from test site representatives on various issues related to UAS integration and helped facilitate information sharing between the test sites and various FAA lines of business. For example, agency officials told us that they invited air traffic specialists from a regional FAA office to participate in a recent UAS Test Site program semi-annual meeting. Through this meeting, these FAA regional staff learned about the test sites' initiatives and about unique aspects of the test sites' COAs, which, as previously noted, they use to conduct flight tests. According to FAA officials, with the better understanding about test sites' operations gained at the meeting, these regional FAA staff will be able to process the test sites' COA requests more efficiently. Most test site representatives also told us that FAA's current UAS test site program manager and other FAA staff are responsive to, for example, questions or requests for guidance on a particular issue.

Further, based on our interviews with test site representatives and our analysis of test sites' reports submitted to FAA, the agency has taken steps to address some challenges from the past. In our March 2015 testimony and July 2015 report on FAA's progress in integrating UAS into the national airspace, we outlined initial challenges that stakeholders

most frequently cited as affecting test sites' ability to attract users and to generate sufficient revenue to remain in operation during their first year.<sup>30</sup> Since 2015, FAA has taken several steps to address these challenges, by providing additional guidance, streamlining the COA process for test sites, and improving the agency's collaboration with and management of the test sites (see table 4).

**Table 4: Federal Aviation Administration's (FAA) Steps to Address Challenges GAO Identified at Test Sites in 2015**

Challenges identified	FAA actions taken since 2015
Lack of FAA guidance on priority research to inform test sites' contribution to the UAS integration effort	<ul style="list-style-type: none"> <li>• Issued guidance such as the Unmanned Aerial Systems (UAS) Integration Plan and the 2018 UAS Integration Roadmap outlining research and other efforts needed for full integration.</li> <li>• Established and held regular meetings between FAA officials and test site staff; these meetings provide an opportunity to discuss issues.</li> <li>• Provided test sites such guidance through various mechanisms, including symposiums, briefings presented by FAA's research division, and other collaborative efforts.</li> </ul>
Complex and lengthy Certificate of Waiver or Authorization (COA) process, which reduces the incentives for industry stakeholders to use the test sites	<ul style="list-style-type: none"> <li>○ Modified test sites' COA process to allow the certificate holders to fly various types of UAS and to fly multiple UAS under a single COA for both public and commercial aircraft operations in the national airspace.</li> <li>○ Updated the test sites' blanket COA to allow certificate holders to operate small UAS in Class G airspace (generally up to 1,200 feet) most places in the national airspace.</li> </ul>
Difficulty generating sufficient revenue to maintain operations in the absence of direct federal funding	<ul style="list-style-type: none"> <li>• Streamlined FAA's processes for approving test sites' COAs and waivers—as described directly above—which has also improved test sites' ability to attract users and generate revenue.</li> <li>• Funded specific research projects conducted at test sites.</li> </ul>

Source: GAO analysis of FAA information and interviews. | GAO-20-97

<sup>30</sup>GAO-15-486T and GAO-15-610.

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However, based on our analysis of interviews conducted for this review with test site representatives and users, these previously identified challenges persist.

- **Lack of FAA guidance on priority research:** Most test site representatives reported that while FAA has improved its management of the program, available FAA guidance still lacks the needed detail about research areas to prioritize in order to promote overall UAS integration efforts. For example, some test site representatives told us that the *2018 UAS Integration Roadmap* should provide more information about the agency's planned timeframes for implementing various steps to achieve full UAS integration, such as how and when FAA plans to integrate large UAS. Without such details, representatives say they cannot fully inform potential users when it might be possible to routinely use some complex UAS operations that are in demand by industry but currently only allowed on a case-by-case basis, such as the ability to fly small UAS beyond the operator's line of sight or over people. Several representatives told us they are concerned that some potential test site users may postpone their research or conduct it abroad because of this lack of detail on when FAA plans to routinely allow such complex UAS operations.

According to FAA officials and as noted in table 4 above, the agency has issued strategic plans and provided briefings to test site representatives and stakeholders on relevant research needed to achieve UAS integration. However, FAA officials told us that there are limitations on how much guidance they can provide the test sites. They said that the Anti-Deficiency Act prevents FAA from directing specific test site activities and obtaining research data, other than the operations and safety data required by the COA, without providing compensation. Officials also noted that until standards and regulations are developed—an effort for which the agency has not set a targeted completion date—a case-by-case approval basis will be needed for allowing complex UAS operations. With regard to the concern that some potential test site users may be conducting research abroad, FAA officials told us that testing abroad will not provide these stakeholders the same experience as testing in the United States, given that the U.S. national airspace system is more complex than those abroad in terms of traffic and congestion.

- **Complex and lengthy COA process:** Most test site representatives and users we interviewed told us that FAA should implement a less complex and time-consuming COA process for the test sites. According to test site representatives, FAA's actions have decreased the time it takes to obtain simple COAs and Part 107 waivers, but for applications to conduct more complex research activities, FAA's process remains lengthy and

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uncertain. This challenge makes it more difficult for test sites to meet users' needs, according to representatives, and can subsequently lead companies to conduct UAS research in other countries. For example, some representatives told us that one test site's request for a waiver to fly UAS beyond visual line of sight had taken 3 years for FAA to approve, and they could not understand why. Representatives also told us that for COA applications involving requests to research complex UAS operations, it was not always clear why FAA denied their requests, leading to uncertainty. According to FAA officials, the waiver that took 3 years to approve was an outlier and the agency's processing of such waivers usually takes 90 days or less. However, in January 2018, DOT's OIG similarly reported that FAA has had difficulty keeping pace with the volume of Part 107 waiver requests received and, in particular, has been slow to approve complex UAS waivers—such as requests to operate beyond the operator's visual line of sight. In this report, the DOT OIG made recommendations related to improving the waiver process, which FAA is working to address.<sup>31</sup>

- **Generating sufficient revenue to maintain test site operations:** Most test site representatives told us that securing sufficient funding to develop future capabilities and infrastructure in order to attract industry users and partners, remains a major challenge that they predict will continue. Some test site representatives told us that their respective contracts with NASA for projects such as UTM have been their largest single revenue source. Another representative mentioned that the U.S. Coast Guard has been a test site user, which has helped the site to generate revenue. Test sites have attempted to generate revenue in other ways, for example by obtaining state and local government funds to build infrastructure to attract users, applying for competitively awarded research contracts, and consulting and conducting research with potential users in different locations. FAA officials acknowledged that the test sites will need to

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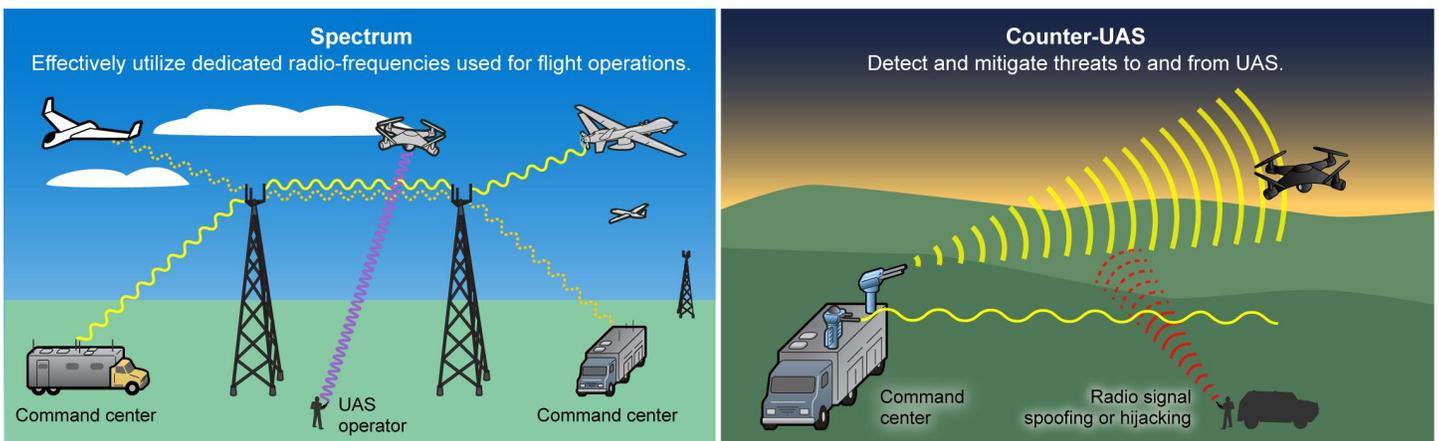
<sup>31</sup>According to the DOT OIG report, complex waivers are taking longer for FAA to review due to insufficient safety information being provided by those requesting waivers, challenges in FAA intra-agency coordination, and lack of guidance available to FAA staff and to stakeholders. The report states that FAA's Flight Standards division—one of the divisions processing waivers—has consistently met its goal to review 80 percent of such applications within 90 days. However, the division has disapproved the majority of applications received, mostly due to insufficient information provided. The DOT OIG made eight recommendations regarding FAA's process for reviewing and granting UAS waivers, including related to such issues as obtaining sufficient information, managing the volume of requests, and explaining reasons for denying requests. As of July 2019, FAA has implemented four of the eight recommendations. See Department of Transportation, Office of Inspector General, *Opportunities Exist for FAA To Strengthen Its Review and Oversight Processes for Unmanned Aircraft System Waivers*, Report No. AV2019005 (Washington, D.C.: Nov. 7, 2018).

continue to generate sufficient revenues to support their operations, but noted that, whenever possible, the agency provides the test sites with opportunities to compete to participate in funded research efforts, such as those related to the UTM program.

### FAA Has Taken Steps to Address Technology-Related Challenges, Which Are Complex

Most test site representatives and users we interviewed also identified technology-related challenges affecting test sites' ability to conduct research as continuing issues. These mostly relate to technology-related capabilities that will be vital for achieving full UAS integration, but which are currently still in development (see fig. 5). As we have previously reported, integrating UAS into the national airspace will require FAA to address key technology-related challenges to enable routine UAS operations with manned aircraft.<sup>32</sup> For example, in our July 2015 report, we identified such challenges affecting test sites, in addition to the management-related challenges discussed above. According to test site representatives and FAA officials, these key technology challenges and concerns could affect broader UAS integration and research efforts, and thus impact the pace of or stop the progress toward full integration into the national airspace system.

**Figure 5: Conceptual Rendering of Technologies Involved with Unmanned Aircraft Systems (UAS)**



Source: GAO. | GAO-20-97

<sup>32</sup>GAO-15-486T and GAO-15-610.

Such key technology-related challenges and related efforts to address them include:

- **Availability of dedicated radio-frequency spectrum:** Radio-frequency spectrum provides communication links between a UAS and its control station or operator. According to FAA, dedicated radio-frequency spectrum is important to ensure UAS safety and security in order to operate in the national airspace. For example, radio-frequency spectrum is needed for command and control, detect and avoid, and beyond visual-line-of-sight capabilities of UAS. Without a dedicated radio-frequency spectrum, the intentional or unintended interference of radio transmissions could sever the UAS means of control because other consumer products also use radio frequencies that could cause interference. FAA officials and test site representatives told us this spectrum-availability problem is the one challenge that has the potential to bring UAS research efforts to a halt if not addressed. Representatives from five of seven test sites indicated that availability of spectrum affects their ability to conduct their research operations and, more broadly, also affects the progress of other efforts contributing to UAS integration. Similarly, some test site users told us that when deciding on a potential test site to contract with for conducting their research, they asked about whether the test site faced any radio frequency interference.

According to FAA officials, the agency is assisting test sites in addressing this challenge by collaborating with the Federal Communications Commission (FCC), which is responsible for allocating spectrum to nonfederal users for various purposes and assigning spectrum licenses.<sup>33</sup> FAA's Spectrum Office is a participant in the regularly occurring meetings between FAA officials and test site representatives. These representatives said they have been communicating with FAA to clarify guidance on the different frequency bands to use at various operating altitudes related to an FCC rule. Nevertheless, according to FAA officials, in the near future, more issues will likely surface related to spectrum because of the industry's interest in conducting flights beyond visual line of sight for both small and large UAS. FAA officials told us spectrum reserved for aviation

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<sup>33</sup>The National Telecommunications Information Administration is responsible for allocating spectrum to federal government users.

safety communications are limited.<sup>34</sup> Therefore, the officials are investigating how to get the maximum UAS capacity in the national airspace by efficient management of the current allocated spectrum. Furthermore, FAA is preparing a report for Congress that covers the use of spectrum allocated for possible UAS activities.<sup>35</sup> FAA officials told us that the report will not delay or prohibit the use of any licensed spectrum for UAS. FAA expects to submit its report to Congress in April 2020.

- **Limitations to conducting counter-UAS detection and research:** Counter-UAS activities involve using technology to help detect, track, and defend against illegal or unauthorized activities.<sup>36</sup> Pursuant to federal law, it is illegal to damage or destroy aircraft,<sup>37</sup> and this statute may apply to UAS.<sup>38</sup> Other provisions of federal law may prohibit the use of certain detection systems and mitigation systems.<sup>39</sup>

FAA does not support the use of counter-UAS systems, which includes interdiction capabilities, by any entities other than the federal agencies with explicit statutory authority to use these technologies, including for the testing and evaluation of such systems. In addition, FAA has limited authority for testing UAS detection and mitigation

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<sup>34</sup>In addition, the International Civil Aviation Organization (ICAO) has determined that critical communication functions, such as command and control must operate over protected aviation spectrum. ICAO is a United Nations specialized agency that promulgates international standards and recommended practices aimed at standardizing international civil aviation operational practices and services. The United States is a member of ICAO and is a signatory to the Convention on International Civil Aviation (Chicago Convention).

<sup>35</sup>The radio frequency spectrum is the part of the natural spectrum of electromagnetic radiation lying between the frequency limits of 3 kilohertz (KHz) and 300 gigahertz (GHz), with the L and C bands allocated for possible UAS use. FAA manages the portions of these bands which are between 960 to 1164 and 5030 to 5091 megahertz. UAS also utilizes other bands for operations, which FAA has worked with FCC to enable.

<sup>36</sup>Counter-UAS systems are defined in 49 U.S.C. § 44801 as systems that are capable of lawfully and safely disabling, disrupting, or seizing control of an unmanned aircraft or unmanned aircraft system.

<sup>37</sup>Aircraft Sabotage Act of 1984, Pub. L. No. 98-473, 98 Stat. 1837 (codified at 18 U.S.C. § 32).

<sup>38</sup>Any individual who willfully damages an aircraft shall be fined or imprisoned not more than twenty years or both. 18 U.S.C. § 32(a)(1).

<sup>39</sup>Such statutes include, for example, the Pen Register Statute and the Trap and Trace Statute, the Wiretap Act, and the Computer Fraud and Abuse Act 18 U.S.C. §§ 3121–3127; Title III of the Omnibus Crime Control and Safe Streets Act of 1968.

systems at airports.<sup>40</sup> Federal agencies with the authority to mitigate risks of UAS under certain circumstances are the Departments of Defense, Energy, Justice, and Homeland Security.<sup>41</sup> According to one test site representative, industry's ability to conduct research on counter-UAS technologies is limited because it requires the participation of one of the four agencies listed above. FAA officials told us that these federal agencies have the authority to conduct counter-UAS operations. These agency officials noted that the test sites could support counter-UAS research activities, for example, by providing the expertise and any infrastructure needed for the test flights, such as a chase aircraft.

Some test site representatives and users we spoke to suggested that it would be helpful if more counter-UAS research were allowed. For example, they said that further research is needed to understand how to address counter-UAS threats—such as someone illegally trying to interfere with the radio frequency of a UAS delivering a package. One test site representative told us that multiple users want to fly swarms of UAS (where one operator flies multiple UAS simultaneously in proximity) to conduct counter-UAS operation research, but it is a challenge to support users' desired research because of current restrictions. However, some stakeholders pointed out that the available technology for conducting such research, such as detect and avoid technology, is not developed enough yet to allow for effective research in this area.

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<sup>40</sup> See 49 U.S.C. § 44810.

<sup>41</sup>The Departments of Defense and Energy were granted authority to take actions—including detecting, tracking, and using reasonable force—that are necessary to mitigate risks UAS poses to the safety or security of a covered facility or asset. 10 U.S.C. § 130i; 50 U.S.C. § 2661; 6 U.S.C. § 124n.

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## FAA Collects Data from the Test Sites but Has Not Fully Leveraged the Data or the Program to Advance UAS Integration

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### FAA Regularly Collects Information and Data from Test Sites, but Has Not Determined How to Use These Data to Advance UAS Integration

FAA regularly gathers information from the test sites in the following ways:

- **Meeting with test site representatives:** In the previously described regular meetings between FAA and test sites—monthly by teleconference and semi-annually in-person—participants share information on experiences conducting research and challenges faced. According to FAA officials, the meetings are helpful in informing the agency about the types of UAS research that users are pursuing, among other things. Representatives of all seven test sites agreed that these meetings are helpful. For example, some representatives noted that such meetings facilitate information sharing about, for example, the status of other FAA-affiliated UAS research efforts—such as UTM and the IPP—and the status of other FAA initiatives underway, such as UAS rulemakings.
- **Collecting data from test sites:** Test sites have provided several types of data to FAA since 2015, including:
  - Entering data on flight tests into the MLS—the system that FAA established for this purpose. MLS data include details about flight tests, such as duration, whether the test involved complex operations such as beyond the operator’s line of sight, and any accidents or incidences that occurred. According to FAA officials, MLS is used for collecting test site data—which will be used to, among other things, inform the final report to Congress that is required by statute.<sup>42</sup>
  - Submitting data into FAA’s aforementioned COA application processing system, which FAA uses to process COAs.

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<sup>42</sup>Pub. L. No. 112-95, § 332(a)(4).

- Submitting quarterly and annual reports to FAA, which summarize activities completed by each test site, including research and development efforts for users, milestones met and the key challenges faced in undertaking activities.

According to FAA officials, their efforts related to the UAS test site program have been primarily focused on meeting requirements such as those related to test sites outlined in the 2012 Act. Among other things, the 2012 Act required FAA to:

- Establish test sites to provide a way to access airspace to conduct research and development.
- Develop standards and requirements for UAS flight operations at test sites.
- At the end of the test site pilot program, submit a final report to Congress with findings and conclusions about projects facilitated through the program.<sup>43</sup>

In response to the 2012 Act's requirements, as previously noted, FAA established the test sites and developed requirements for how test sites should conduct UAS flight testing.

As FAA has been focused on collaborating with the test sites and meeting the 2012 Act's and other requirements, agency officials have not prioritized determining how to use data gathered from the sites to advance UAS integration. To date, FAA has only used data from test sites in a few cases to directly inform the agency's UAS integration efforts. For example, in one case, FAA used data from an ASSURE project conducted at a test site to develop a noise certification standard; these data were not from MLS. In another example, FAA officials told us that—as of February 2019—they were planning to use MLS and other test site data to make a decision about an applicant that had submitted a request to conduct UAS package delivery operations.

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<sup>43</sup>As previously noted, the 2012 Act requires FAA to report on its findings and conclusions about projects in the test site program at the completion of the program. Pub. L. No. 112-95, § 332(a)(4). This final report was initially due in May 2017, following the anticipated completion of this pilot program in 2017, and 5 years after the enactment of the 2012 Act that first authorized this program. However, the test sites' authorization has since been extended two times by the 2016 and 2018 reauthorizations. Unless the authorization is extended again, the final report will be due to Congress no later than 90 days after the current authorization ends on September 30, 2023, or by December 30, 2023.

According to officials, FAA intends to use the data collected from test sites to a greater extent in the future to further integration, such as in the following ways:

- In November 2018, FAA asked ASSURE to review test site data to identify data FAA could use to approve safety cases. As previously noted, FAA generally requires safety cases to be submitted as part of any application to use a UAS operation that is not yet routinely allowed in the national airspace due to risk, such as flights beyond the operator's line of sight. Safety cases include evidence of how the applicant will address any risks that the new complex UAS operation would introduce into the airspace, such as the risks of the UAS abruptly losing power.<sup>44</sup> According to FAA officials, this research was initiated in December 2018 with a plan to complete it by March 2020. According to these officials, the results of this research should help the overall UAS integration effort. Specifically, the results may help FAA officials to more clearly define the information UAS operators should submit to demonstrate how the safety risks associated with their proposed operation will be mitigated.
- Officials indicated that FAA also intends to use MLS and other test site data to continue developing, evaluating, and validating the aforementioned UTM system.

FAA officials told us that while they have not fully leveraged test site data, they are using other information from the test sites—such as information shared in meetings—to support the agency's efforts to integrate UAS into the national airspace. According to FAA officials, the test site program supports UAS integration not only by providing industry stakeholders with an avenue for testing complex UAS operations and concepts, but also by helping FAA officials stay informed about issues related to integration. Specifically, these officials told us that the informal information sharing that occurs in regular meetings between FAA officials and test site representatives has been valuable. Through such informal exchanges, FAA officials keep abreast of the various types of research being requested by industry stakeholders and challenges faced by such stakeholders pursuing such research. For example, as noted previously, test site representatives have used these meetings to discuss challenges—such as related to dedicated spectrum—with FAA officials. In

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<sup>44</sup>According to FAA, safety cases submitted to the FAA must clearly outline the proposed operation (including mitigations), identify hazards associated with the proposed operation, including an explanation of how the applicants' mitigations reduce the safety risk level (limit the hazard's effects) and evidence that the proposed operation addresses any safety risk, such as the risk of the UAS abruptly losing power or signal interference.

addition, based on what FAA officials have observed at test sites, the agency has been able to grant other airspace users more flexible authorizations, for example COAs covering larger geographical areas. Specifically, these agency officials told us that because they observed that the test sites have been able to maintain an acceptable level of safety after being allowed more flexibility in their aforementioned nationwide blanket COAs, the agency felt confident enough to give more flexibility to other airspace users with COAs for using complex UAS operations.<sup>45</sup>

FAA's UAS integration plans specify the importance of not only collecting data but also using the data to inform strategic planning efforts. FAA's publicly available plans state that FAA intended to use information from the test site program to inform its UAS integration efforts. Specifically, according to the *2018 UAS Integration Roadmap*, the test site program plays a critical role in UAS integration as one of the program's goals is to provide information so that FAA can determine technical and operational trends that could support safety-related decision making for integration, and develop policy and standards required to address new and novel aspects of UAS flight operations.<sup>46</sup> In addition, FAA's Unmanned Aircraft Systems Test Site Data Collection and Analysis document issued in 2016, indicates that by September 2016, FAA planned to analyze the data to determine operational trends, communicate them via dashboards, and share the collected and analyzed data with stakeholders.<sup>47</sup> Further, federal internal control standards state that agencies should use quality information to achieve the agency's objectives and support informed decisions.<sup>48</sup> Specifically, agencies should first identify what data are needed to achieve the entity's objectives, then obtain the needed data from internal and external sources in a timely manner, and finally process

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<sup>45</sup>As noted previously, FAA established COAs for test sites that allow them to test anywhere in the U.S. in Class G airspace (generally up to 1,200 feet of elevation) as long as the UAS are outside of restricted airspace, such as at or near airports.

<sup>46</sup>FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: Second Edition* (Washington, D.C.: July 2018).

<sup>47</sup>This document describes, at a high level, the agency's intent to gather and use the test site data. See FAA, *Unmanned Aircraft Systems Test Site Data Collection and Analysis* (Sept. 27, 2016).

<sup>48</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 2014).

and evaluate the obtained data into quality information that supports the entity's objectives.

While FAA has indicated plans to analyze and use test site data in the future, it has not yet developed a data analysis plan to do so. FAA officials told us that having an analysis plan for MLS data could be useful and that—as of September 2019— they were considering creating such a plan but had not taken steps to do so. According to FAA officials and some test site representatives, and based on our review, some currently collected data could be useful in informing integration efforts. Specifically, FAA officials and two test site representatives told us that some MLS data—for example on accidents and lost control links—could be useful. For example, data on accidents and lost communication links could be combined with other MLS data on the respective test flights—such as the time of day, type of UAS being flown, and other factors—to determine whether certain conditions or UAS models are at a greater risk of a crash or other incident. According to FAA officials, this combined data could theoretically help the agency to measure risk and to determine if there are any factors that contribute to lost control links between the UAS and the remote pilot in the flight testing environment. The results of such a data analysis could help inform integration efforts, such as in developing operational standards for UAS.

Without a plan for analyzing the data, FAA could miss opportunities to leverage what was intended to be a cornerstone of the test site program—information to help FAA move UAS further toward full integration into the national airspace. Having such an analysis plan could help FAA articulate how the agency will use test site data more in the future and identify other data that are within the agency's authority to request from test sites that would help inform integration. Representatives from three test sites told us that their staff currently collects other data that FAA is not collecting but which could help to inform the agency's UAS integration efforts. Based on our review of test sites' annual reports to FAA, for instance, all test sites have been involved in facilitating test flights of UAS operations beyond the operator's line of sight. FAA may be able to use data from such flight tests as it develops standards for allowing these types of UAS operations on a routine basis in the national airspace. Further, the National Academy of Sciences reported in 2018 that FAA has underutilized the test sites because it has not determined which test site data could inform the agency's risk assessments for UAS (which FAA conducts before allowing any new complex UAS operation to

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be used on a routine basis) nor collected that specific data from test sites.<sup>49</sup>

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## FAA Is Publicly Sharing Limited Information about How the Test Site Program Informs the Agency's UAS Integration Efforts

FAA provides limited information to the public, including stakeholders and test site users, about how the research being conducted at test sites helps to inform FAA's UAS integration efforts. FAA officials point to two main public efforts related to the test sites program:

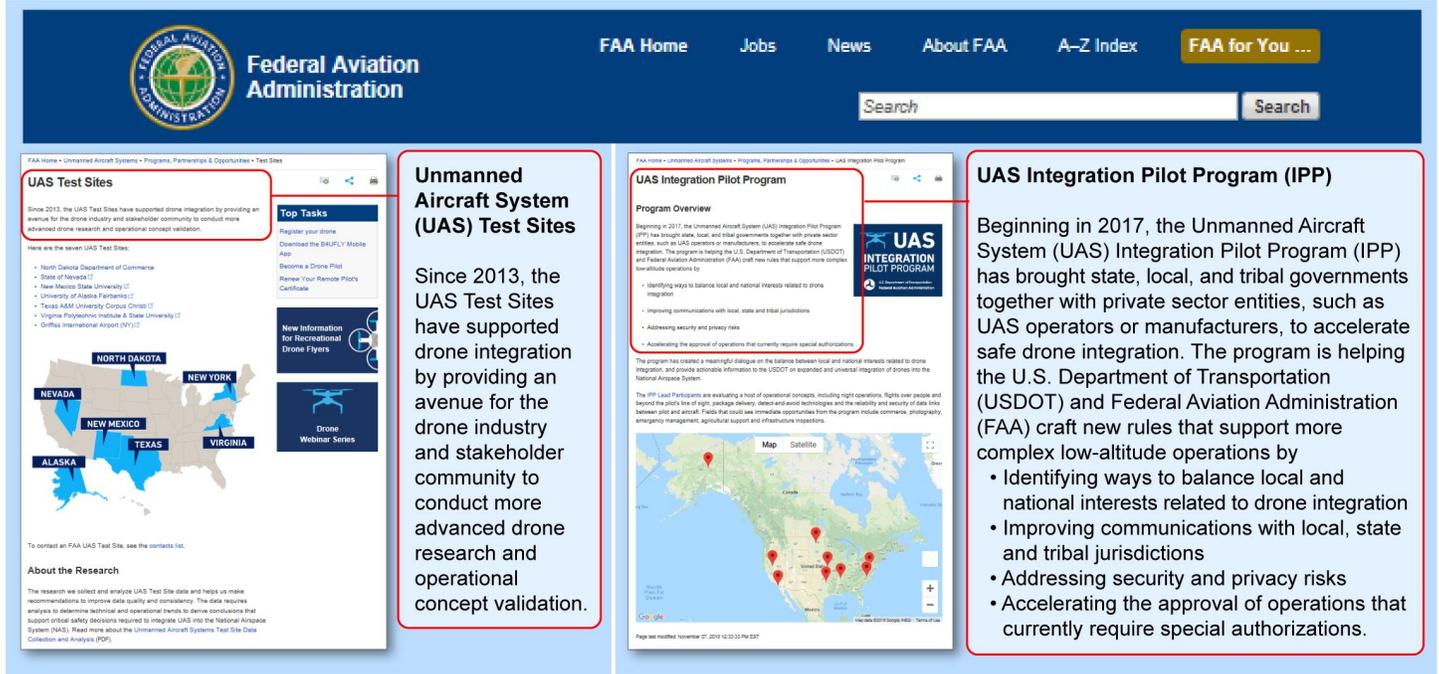
- FAA's *2018 UAS Integration Roadmap*, described earlier, includes a high-level overview of how the test sites program informs the agency's integration efforts. For example, it states that test sites provide information that FAA can use to determine technical and operational trends that could support safety-related decision making. However, it does not provide any information about, for example, how the research at test sites directly relates to FAA's next planned phases of integration.
- FAA's UAS Test Sites website is the agency's main public outreach effort, and provides information such as links to the websites of the test sites.<sup>50</sup> However, in examining the website, we found little description of how this program relates to FAA's broader integration plans and no discussion of desired outcomes from the research under way at test sites. In contrast, the websites for two other UAS research efforts that FAA is involved in—the UTM program and DOT's IPP—have program descriptions that include the purpose of the program, and some intended research outcomes. These two program descriptions make it relatively easy for the reader to understand how those programs fit into FAA's broader UAS integration efforts. See figure 6, which shows the program descriptions on FAA's respective websites for the test site program and the IPP.

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<sup>49</sup>In this report, the National Academy of Sciences recommended that FAA improve the timeliness of responding to authorization requests for UAS operations, among other recommendations. See, National Academy of Sciences, Engineering and Medicine, 2018. *Assessing the Risks of Integrating Unmanned Aircraft Systems into the National Airspace System*, Washington, D.C.: the National Academies Press. According to FAA officials, the aforementioned research that the agency has asked ASSURE to conduct (related to data that would be helpful for safety cases) should also help FAA to address these recommendations from the National Academy of Sciences.

<sup>50</sup>[https://www.faa.gov/uas/programs\\_partnerships/test\\_sites/](https://www.faa.gov/uas/programs_partnerships/test_sites/).

Figure 6: Example of the FAA's Websites of Two UAS-Related Research Programs



Source: www.faa.gov. | GAO-20-97

FAA also compiles some information on test sites that is not publicly available. For example, FAA staff annually compile information about the types of research conducted at test sites and present it in the Test Sites Fact Book, which links the information to key capabilities needed for the incremental integration of UAS into the national airspace. However, this document is only available to FAA staff and, according to officials, contains some data that test site users could deem proprietary. FAA officials told us that they also plan to submit the aforementioned final report to Congress on the test site program, which is currently due in late 2023.<sup>51</sup> According to these officials, however, this report is not intended to be made public.

<sup>51</sup>As noted above, the 2012 Act requires FAA to report on its findings and conclusions about projects in the test site program at the completion of the program. Pub. L. No. 112-95, § 332(a)(4). This final report was initially due in May 2017, but the test sites' authorization has since been extended by the 2016 and 2018 reauthorizations. Unless the authorization is extended again, the final report will be due to Congress no later than 90 days after the current authorization ends on September 30, 2023, or by December 30, 2023.

All test site representatives and many users in our review (13 of 18) reported that publicly available information on research efforts underway at test sites is limited.<sup>52</sup> Many users we spoke to (11 of 18) stated that FAA should include more information about the test sites on its website, and in FAA's planning documents, such as the *2018 UAS Integration Roadmap*.<sup>53</sup> These representatives and users also told us improved FAA communication could increase the UAS stakeholders' awareness of test sites' capabilities, expertise, and services, and their understanding about how the program fits into FAA's broader integration efforts.

According to FAA, collaboration and cooperation across industry and government is important for UAS integration—a complex endeavor involving multiple stakeholders from different sectors. As FAA's *2018 UAS Integration Roadmap* states, given the large scale of the UAS integration effort, FAA must rely on crucial relationships across government and industry to ensure its integration efforts are harmonized and consistent. It further states that all the work needed to resolve collective challenges requires collaboration between partners at local, state, tribal, and national levels as well as with partners across the UAS stakeholder community.<sup>54</sup> In addition, federal internal control standards and leading practices for reporting on research and development activities emphasize the importance of making the status of such activities transparent to stakeholders. Specifically the federal internal control standard for communicating information calls on federal agencies to externally communicate quality information so that external parties can help the entity achieve its respective objectives. Further, this standard suggests that agencies should select appropriate methods to communicate externally, taking into consideration factors such as the intended audience and the availability and ease of access to the information.<sup>55</sup> In addition, as we have reported, leading practices for reporting on research and development efforts include clearly communicating the status of such efforts to the public and stakeholders.

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<sup>52</sup>Of the remaining five test site users, three did not agree with this statement, and another did not respond to the related questions.

<sup>53</sup>FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: Second Edition* (Washington, D.C.: July 2018).

<sup>54</sup>FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: Second Edition* (Washington, D.C.: July 2018).

<sup>55</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 2014).

For example, in a 2017 report about FAA's management of its aviation research and development portfolio—which includes UAS research efforts—we found that FAA could more fully adhere to leading practices if it provided more information for Congress and other stakeholders, such as on the status of various research and development activities. We noted that with more complete and transparent information, Congress and industry and other stakeholders are better able to make informed decisions.<sup>56</sup> In another example, in several reports on FAA's implementation of the Next Generation Air Transportation System—another complex endeavor involving coordination with industry and other stakeholders—we emphasized the importance of sharing information about the status of various projects with stakeholders whose participation will be essential to the progress of the overall effort.<sup>57</sup>

FAA officials told us that they were wary of providing more public information about the test sites, based on concerns about potentially being perceived to be promoting the designated test sites and concerns about sharing data that could be proprietary. For example, officials told us that when potential test site clients approach FAA, they simply direct these potential clients to the FAA's UAS Test Sites website. The officials told us that they do not wish to be seen as promoting or advertising one of the FAA-designated UAS test sites over the others, because such promotion would conflict with FAA's role as a regulator. They also said that FAA wants to avoid suggesting that operators seeking to research complex UAS operations are required to contract with a designated test site. They noted that the decision about whether or not to use a designated test site should be left to the potential client. In addition, FAA officials expressed concerns about sharing any information that the test site users could deem to be proprietary, such as information about their research projects currently underway. For example, the officials noted that some test site users do not want to be identified as such.

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<sup>56</sup>GAO, *Aviation Research and Development: FAA Could Improve How It Develops Its Portfolio and Reports Its Activities*, [GAO-17-372](#) (Washington, D.C.: Apr. 24, 2017).

<sup>57</sup>For example, see GAO, *Next Generation Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, [GAO-10-629](#) (Washington, D.C.: July 27, 2010) and GAO, *Next Generation Air Transportation System: FAA Has Made Some Progress in Midterm Implementation, but Ongoing Challenges Limit Expected Benefits*, [GAO-13-264](#), (Washington, D.C.: Apr. 8, 2013).

In our assessment, however, it would be possible for FAA to share more information publicly about how the test site program fits into the agency's broader UAS integration effort without promoting any particular test site or sharing any proprietary information. For example, some context in the Test Sites Fact Book could be informative because it links research underway at test sites to FAA's integration plans. This book includes a section on current test site research with examples that, if shared, could help increase stakeholders' understanding of how FAA could use the research being conducted at test sites to inform its decisions. This section indicates that test sites are involved in research aimed at, for example:

- *Advancing UAS standardization*, meaning the FAA and all the test sites working together to advance the industry from a systems perspective to develop standardized UAS training, maintenance, and safety risk mitigation. Data from such research could help inform FAA decisions such as, for example, setting standards for drone spacing and mitigating risks.
- *Using UAS for wildfire operations*, including test sites and users—such as emergency response agencies—finding effective ways to use UAS to respond to such situations. Data from such research could help FAA improve, for example, its response time when an emergency COA is requested by such agencies.

Such additional information, if shared, could help FAA to clearly demonstrate to the wider audience of UAS stakeholders that the agency is fostering research through test sites that directly relates to its UAS integration plans. As noted above, the test site users we interviewed told us they were conducting research at test sites related to FAA's upcoming phases of its UAS integration plan, including research on large cargo and passenger operations. Although some UAS stakeholders—such as users of test sites—may currently be aware of the research underway at test sites, the audience for UAS integration is larger and includes others such as those from the information technology and agricultural industries, and local government agencies whose stakeholders may be less familiar with FAA's efforts.

Further, with more accessible information on how research at the test sites relates to FAA's UAS integration efforts, more stakeholders may choose to use a test site to conduct their own research. Given that one of the primary goals of the test site program is to provide information to FAA to help the agency develop the policies and standards required to address new and novel aspects of UAS flight operations, having more test site users could help the agency achieve this goal by making more

data available to FAA. As noted previously, many selected users we interviewed told us that using a test site provided a significant benefit for advancing their entity's UAS research and development efforts. However, some UAS stakeholders who could benefit from a test site's assistance—such as those outside of the aviation industry seeking to submit a safety case to FAA for approval of complex UAS operations—may not currently be aware of the option for conducting research through a test site. For instance, a stakeholder interested in conducting research involving, for example, using UAS for small package delivery, may be unaware that test sites have already helped to facilitate such research for their users. FAA officials told us that stakeholders outside of the aviation industry can particularly benefit from a test site's expertise since they may be less familiar with FAA's processes for approving UAS operations on a case-by-case basis. All test site representatives and some users in our review told us that if FAA communicated more clearly about the role of the test site program in the overall UAS integration effort, more stakeholders would likely leverage the test sites.

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## Conclusions

FAA's designated UAS test sites provide significant benefits to the UAS industry, offering their users a variety of services, with minimal operating investment from FAA. Many users in our review told us that their decision to work with a test site proved invaluable in helping achieve their respective goals. As FAA proceeds with its plans to incrementally integrate UAS into the national airspace—a large effort requiring collaboration with many stakeholders—the agency could benefit from better leveraging all of its available resources. According to FAA, additional research and development work—including data on UAS operations—is needed to inform its decisions as it allows for more complex UAS operations to be routinely used in the national airspace.

UAS stakeholders working with FAA test sites are testing complex UAS operations and various capabilities identified by FAA as needed to inform integration policies and rules moving forward. However, without a plan for analyzing the test site data, FAA could miss opportunities to better use the data to inform the overall UAS integration effort, such as by applying the data to inform UAS operational standards. Having such an analysis plan could help FAA articulate how the agency will use test site data more in the future and identify other data that are within the agency's authority to request from test sites that would help inform integration. In addition, by sharing more information about how the program relates to FAA's

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integration efforts, the broader community of UAS stakeholders may have a greater awareness of the types of research and testing being conducted at test sites and thus be better able to participate in the effort. Further, without more accessible information, such as examples of how research underway at test sites aligns with FAA's planned phases of UAS integration, some UAS stakeholders may not be aware of their options for pursuing research through a test site, thus potentially limiting the usefulness of the test site program for UAS stakeholders and for FAA.

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## Recommendations for Executive Action

We are making the following two recommendations to FAA:

- The Administrator of FAA should develop a plan for analyzing currently-collected UAS test site data to determine how they could be used to advance UAS integration, and whether the collection of any additional test site data, within the agency's authority to request, could be useful for informing integration. (Recommendation 1)
- The Administrator of FAA should publicly share more information on how the test site program informs integration while continuing to protect information deemed proprietary. This information could be shared, for example, on the agency's UAS Test Sites website. (Recommendation 2)

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## Agency Comments and our Evaluation

We provided a draft of this report to DOT and NASA for their review and comment. In its written comments, reproduced in appendix II, DOT partially agreed with the first recommendation and agreed with the second recommendation. FAA also provided technical comments, which we incorporated as appropriate. NASA officials reviewed our draft, but did not have any comments.

FAA partially agreed with the first recommendation to develop a plan for analyzing test site data, noting a concern about using such a plan to determine if the collection of any additional test site data could be useful for informing integration. Specifically, FAA noted that the agency cannot require test sites to share data from their privately contracted users, other than the data required for the test sites' COAs or for their OTAs with FAA. FAA also noted a concern that our draft report incorrectly assumes that the data collected through the test site program are adequate to meet FAA's UAS integration needs when this program is limited in the data that

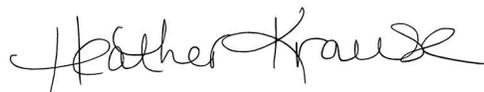
can be collected. However, our report states that the test site program is only one of several sources of data to inform FAA's future decisions regarding UAS integration, and that a data analysis plan could help FAA determine whether any additional data could be useful for informing integration. To address FAA's comments, we added language to our recommendation to clarify that the consideration of potential additional data would be for data that are within the agency's authority to request from test sites, such as through the OTAs. We continue to believe that implementing this recommendation would enable the agency to better leverage test site research and data to inform its decisions related to UAS integration.

FAA agreed with our second recommendation to share more information on how the test site program informs the agency's UAS integration effort. However, FAA stated that the agency's integration plans and Test Site Fact Book cannot be made publicly available due to future rulemaking and proprietary information contained in these documents. We acknowledge in our report that these documents could include information that test site users deem proprietary. We include in our recommendation that FAA should continue to protect any information deemed proprietary while making information about the test site program's contribution to UAS integration publicly available.

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

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

Sincerely yours,



Heather Krause  
Director, Physical Infrastructure Issues

# Appendix I: List of Unmanned Aircraft Systems (UAS) Test Sites and Stakeholders Whose Representatives GAO Interviewed

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Category	Entity
Federal Aviation Administration Designated UAS Test Sites	Griffiss International Airport (New York) - Northeast UAS Airspace Integration Research Alliance New Mexico State University – Physical Science Laboratory North Dakota Department of Commerce – Northern Plains UAS Test Site State of Nevada – Nevada Institute for Autonomous Systems Texas A&M University-Corpus Christi – Lone Star UAS Center of Excellence and Innovation University of Alaska Fairbanks – Alaska Center for UAS Integration Virginia Polytechnic Institute and State University – Mid-Atlantic Aviation Partnership

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**Appendix I: List of Unmanned Aircraft Systems (UAS) Test Sites and Stakeholders Whose Representatives GAO Interviewed**

<b>Category</b>	<b>Entity</b>
UAS Stakeholders	Agricultural Research Service, United States Department of Agriculture Alliance for Drone Innovation Alliance for System Safety of UAS through Research Excellence, Mississippi State University Association for Unmanned Vehicle Systems International Assured Information Services AX Enterprize Booz Allen Hamilton Botlink Cubic Corporation Desert Research Institute Dominion Energy Harris Corporation JHW Unmanned Solutions, LLC Massachusetts Institute of Technology Lincoln Lab National Emergency Response and Recovery Training Center, Texas A&M Engineering Extension Service Navmar Applied Sciences Corporation Port of Corpus Christi Project Vahana, Airbus A3 Project Wing, X State Farm The MITRE Corporation Vanilla Aircraft (now Vanilla Unmanned) Walmart Xcel Energy

Source: GAO | GAO-20-97

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# Appendix II: Comments from the Department of Transportation

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



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

Assistant Secretary  
for Administration

1200 New Jersey Avenue, SE  
Washington, DC 20590

**NOV 26 2019**

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

Dear Ms. Krause:

The Federal Aviation Administration (FAA) established Unmanned Aircraft Systems (UAS) Test Sites to allow industry to assess the safety and feasibility of complex UAS operations, such as flying beyond an operator's line of sight. The FAA has stated that this program provides research results and other data needed to reach full integration of UAS into the National Airspace System. The FAA believes that the Test Site Program has provided and continues to provide significant economic and social benefits by supporting the FAA's expansion of UAS operational capabilities.

The FAA has reviewed the draft report and identified the following GAO findings that do not accurately characterize the FAA's actions regarding the management of the Test Site Program:

- The GAO draft report assumes that the data that the FAA currently receives from Test Sites are adequate to meet FAA's UAS integration needs. This assumption is incorrect because the data collected is limited to specific requirements. These requirements include: (1) Certificate of Waiver or Authorization (COA) reporting requirements, and (2) quarterly and annual reports specified within the Test Site's Other Transaction Agreements (OTAs).
- FAA's integration plans and the Test Sites Fact Book are internal documents and cannot be made publicly available, due to future rulemaking activities and proprietary information contained in these documents.

Upon review of the draft report, the FAA partially concurs with recommendation 1 to develop a plan for analyzing currently collected UAS Test Site data. The FAA data collection requirements for the Test Sites are specified in OTAs and FAA COA Order 7200.23, which is limited to operational data. Because the FAA cannot require the Test Sites to share data from their privately contracted users or share proprietary information, we do not concur with the recommendation to collect additional test site data. We concur with recommendation 2 to publicly share more information on how the test site program informs integration while continuing to protect information deemed proprietary.

The FAA will provide a detailed response to each recommendation within 180 days of the final report's issuance. We appreciate the opportunity to offer additional perspective on the GAO draft report. Please contact Madeline Chulumovich, Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional details about these comments.

Sincerely,

Keith Washington  
Deputy Assistant Secretary for Administration

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# Appendix III: GAO Contact and Staff Acknowledgments

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## GAO Contact

Heather Krause at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov).

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## Staff Acknowledgments

In addition to the individual named above, Vashun Cole (Assistant Director); Jessica Bryant-Bertail (Analyst-in-Charge); Jon Felbinger; Camilo Flores; Richard Hung; Josh Ormond; Amy Rosewarne; Alexandra Rouse; Kelly Rubin; Marc Schwartz; and Larry Thomas made key contributions to this report.

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# Appendix IV: Accessible Data

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## Agency Comment Letter

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### Accessible Text for Appendix II Comments from the Department of Transportation

NOV 26 2019

Heather Krause

Director, Physical Infrastructure Issues

U.S. Government Accountability Office (GAO)

441 G Street NW

Washington, DC 20548

Dear Ms. Krause:

The Federal Aviation Administration (FAA) established Unmanned Aircraft Systems (UAS) Test Sites to allow industry to assess the safety and feasibility of complex UAS operations, such as flying beyond an operator's line of sight. The FAA has stated that this program provides research results and other data needed to reach full integration of UAS into the National Airspace System. The FAA believes that the Test Site Program has provided and continues to provide significant economic and social benefits by supporting the FAA's expansion of UAS operational capabilities.

The FAA has reviewed the draft report and identified the following GAO findings that do not accurately characterize the FAA's actions regarding the management of the Test Site Program:

- The GAO draft report assumes that the data that the FAA currently receives from Test Sites are adequate to meet FAA's UAS integration needs. This assumption is incorrect because the data collected is limited to specific requirements. These

requirements include: (1) Certificate of Waiver or Authorization (COA) reporting requirements, and (2) quarterly and annual reports specified within the Test Site's Other Transaction Agreements (OTAs).

- FAA's integration plans and the Test Sites Fact Book are internal documents and cannot be made publicly available, due to future rulemaking activities and proprietary information contained in these documents.

Upon review of the draft report, the FAA partially concurs with recommendation 1 to develop a plan for analyzing currently collected UAS Test Site data. The FAA data collection requirements for the Test Sites are specified in OTAs and FAA COA Order 7200.23, which is limited to operational data. Because the FAA cannot require the Test Sites to share data from their privately contracted users or share proprietary information, we do not concur with the recommendation to collect additional test site data. We concur with recommendation 2 to publicly share more information on how the test site program informs integration while continuing to protect information deemed proprietary.

The FAA will provide a detailed response to each recommendation within 180 days of the final report's issuance. We appreciate the opportunity to offer additional perspective on the GAO draft report. Please contact Madeline Chulumovich, Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional details about these comments.

Sincerely,

Keith Washington

Deputy Assistant Secretary for Administration

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## Public Affairs

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