U.S. UNMANNED AIRCRAFT SYSTEMS: INTEGRATION, OVERSIGHT, AND COMPETITIVENESS

(113–84)

HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRTEENTH CONGRESS

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December 5, 2014

SUMMARY OF SUBJECT MATTER

TO:	Members, Subcommittee on Aviation
FROM:	Staff, Subcommittee on Aviation
RE:	Subcommittee Hearing on "U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness"

PURPOSE

The Subcommittee on Aviation will meet on Wednesday, December 10, 2014, at 10:00 a.m. in 2167 Rayburn House Office Building to review the state of Unmanned Aircraft Systems (UAS) in the United States. The Subcommittee will specifically hear about the state of the emerging UAS industry including safety of flight, technological issues, the regulatory environment, policy considerations, potential commercial applications and United States' competitiveness. The Subcommittee will receive testimony from representatives of the Federal Aviation Administration (FAA), Government Accountability Office (GAO), Department of Transportation Inspector General (DOT IG), Airware, the Air Line Pilots Association and a Professor of Aeronautics, Astronautics and Computer Science.

BACKGROUND

Overview

UAS have been in existence, in some form, for nearly a century: the U.S. military began research and development of unmanned flight in 1918.[1] Operations of "pilotless aircraft" were addressed in the *Convention on International Civil Aviation* that was signed on December 7, 1944.[2] Today, UAS range in size from small models weighing a few pounds to much larger models with wingspans equal to that of the Boeing 737 airliner. The term "UAS" refers to

[1] John David Blom, *Unmanned Aerial Systems: A Historical Perspective*, Occasional Paper 37, pp 46. Combat Studies Institute Press, US Army Combined Arms Center. Available at: http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/OP37.pdf

[2] See Article 8. Available at: http://www.icao.int/publications/Documents/7300_orig.pdf

unmanned aircraft themselves and also "associated components" such as ground control stations.[3] UAS are either remotely piloted or can fly autonomously (without any direct human control).[4] In the last decade, the American public has become broadly aware of UAS due in significant part to the U.S. military's publicized use in American war efforts and their emerging availability in the general consumer market.

UAS-related Legislation and FAA Actions

In the *FAA Modernization and Reform Act of 2012* (Reform Act), Congress directed the FAA to take certain steps to facilitate safe integration of UAS into the national airspace no later than September 30, 2015.[5] In a report issued in June 2014, the DOT IG reported that the FAA "is behind schedule on most of the act's UAS provisions, and the magnitude of unresolved safety and privacy issues will prevent FAA from meeting Congress' September 2015 deadline for UAS integration."[6]

The DOT IG also noted that the FAA has not developed an "adequate framework for sharing and analyzing UAS safety data" and that the existence of "organizational barriers" is impeding the agency's progress toward the integration and oversight of UAS.[7] In March 2012, the FAA appointed a senior executive position to head a new UAS Integration Office within the FAA Office of Aviation Safety Flight Standards division.[8] However, in June 2014, the DOT IG noted that the office is "not fully staffed –it has lost six people since November 2012 and has identified the need for an additional 20 positions."[9] Further, the DOT IG reported that "questions remain regarding the placement, authority, and structure of the new UAS Integration Office". [10]

Among other things, in the Reform Act Congress directed the Secretary of Transportation to develop a comprehensive plan to safely accelerate the integration of civil UAS into the nation's airspace no later than September 2015.[11] The plan was prepared and submitted to Congress in November 2013.[12] The Reform Act also directed the FAA to issue a final regulation applicable to small UAS (those weighing 55 pounds or less) by approximately August 2014.[13] In its report, the DOT IG observed prolonged and repeated delays in the issuance of this regulation.[14] The FAA has not yet issued a notice of proposed rulemaking (NPRM) which is a threshold step before a final regulation may be issued. According to the DOT IG, given the complexity of the issues and level of interest among the public in UAS, it is unlikely that the

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[3] Pub. L. 112-95, 126 Stat. 11 (Feb. 4, 2012), section 331(9); see also *Unmanned Aircraft Systems (UAS)*, ICAO Circular 328/AN-190 at page x. Available at: http://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf

[4] Remotely piloted versions are sometimes described as Remotely Piloted Aerial Systems (RPAS).

[5] Pub. L. 112-95, 126 Stat. 11 (Feb. 4, 2012), Title III. Subtitle B

[6] *FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems in the National Airspace* System, DOT IG Report: AV-2014-061, Jun. 26, 2014. Pg.13.

[7] *Id.* at 11-12.

[8] *Id.*

[9] *Id.*

[10] *Id*

[11] *Id.* at § 332(a), 126 Stat. 73

[12] See: https://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/UAS_Comprehensive_Plan.pdf

[13] *Id.* at § 332(b), 126 Stat. 74

[14] DOT IG Report: AV-2014-061, *supra*, Pg.15.

FAA can issue a final regulation integrating even small UAS by the September 2015 statutory deadline.[15] The DOT IG also noted that FAA's plans for 2015 "do not represent full, safe integration" and that "it remains unclear when FAA will achieve safe and full integration of UAS in U.S. airspace."[16]

Section 333 of the Reform Act gave FAA to the authority to allow UAS operations meeting certain criteria *in advance of the completion* of the small UAS regulation and other materials required by statute.[17] As of December 2014, nearly 160 applications to operate UAS have been submitted to the FAA under section 333.[18] However, only seven applications have been granted to date, and all of them were granted to firms in the motion picture industry.[19] The seven applications were granted within 120 days of their submission; the majority of the pending applications have been submitted to the agency since September 2014.

The Reform Act directs the FAA to establish a program to integrate UAS at six test ranges chosen by the agency. The purpose of the pilot program is to allow for the development of UAS technical and safety standards.[20] In December 2013, the FAA announced the following entities as test site operators:

1. The University of Alaska;
2. State of Nevada;
3. Griffiss International Airport, New York;
4. North Dakota Department of Commerce;
5. Texas A&M University; and
6. Virginia Polytechnic Institute and State University (includes sites in Virginia and New Jersey).[21]

The DOT IG observed that the FAA "has not developed goals for what it intends to accomplish with the test sites once they are established" and also noted the FAA was 14 months late in having the first test range operational."[22] According to the FAA, all six test ranges are now operational.

Technical and Safety Issues

The United States has the most complex and heavily trafficked airspace in the world. On average, there are over 85,000 flights per day that occur in U.S. airspace.[23] U.S. aircraft operations are also more diverse than those in any other country in the world. This creates unique challenges for the safe integration of UAS into national airspace that do not necessarily exist elsewhere in the world. While many countries around the world have well-developed and

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[15] DOT IG Report: AV-2014-061, *supra*, Pg.3
[16] *Id.* at Pg.15.
[17] Reform Act, *supra*,. at § 333, 126 Stat. 75
[18] FAA supplied chart dated Dec. 1, 2014
[19] See: https://www.faa.gov/uas/legislative_programs/section_333/
[20] Reform Act, *supra* at § 332(c)
[21] See: https://www.faa.gov/news/fact_sheets/news_story.cfm?newsid=15575
[22] DOT IG Report: AV-2014-061, *supra*, Pg.14.
[23] http://www.faa.gov/nextgen/snapshots/nas/

sophisticated air transportation networks, the United States is unique because of its very large and vital general and agriculture aviation communities. Pilots from these communities generally operate smaller aircraft at lower altitudes (than airliners) for pilot training, recreation, crop dusting and numerous other purposes. These are a few of the key factors that the FAA will very likely consider as it works to safely integrate UAS into the national airspace.

UAS differ from traditional, manned aircraft in key respects and thus pose unique challenges to regulators and pilots. For example, a fundamental precept of aviation safety is that pilots must "see and avoid" all other aircraft. The see-and-avoid principle, which is codified in FAA regulation, is predicated on the presence of pilots in cockpits with a relatively unobstructed view of all other aircraft.[24] Existing UAS, even those equipped with cameras, cannot currently comply with the requirements of the regulation. As a result of this difference, efforts are underway to develop robust "sense-and-avoid" technology to enable UAS to detect potential collisions and take evasive action.[25] In addition, the risks associated with UAS mechanical failures, such as disrupted radio control links, are different from those of manned aircraft.

In recent weeks, media outlets have reported a large rise in the number of UAS sightings by airline and other aircraft pilots. According to the *Washington Post*, the FAA is receiving approximately 25 reports per month of such sightings, including possible "near-collisions."[26] These sightings have occurred at a variety of altitudes throughout the country including near major airports.

In his report, the DOT IG indicated that while the FAA has begun to authorize certain UAS operations, the FAA "has not developed the procedures, training, and tools for controllers to effectively manage UAS in the same airspace as other aircraft."[27] The DOT IG reported that controllers expressed uncertainty on how to manage certain situations involving UAS operations, including "lost link" events.[28]

Civil UAS Operations in the United States and the *Pirker* Case

The FAA first authorized civil UAS operations within the United States in 1990.[29] Since that time, the FAA's authorizations of civil UAS flights have been largely limited to public interest operations such as law enforcement, firefighting, border surveillance, military training and disaster relief missions performed by public entities such as local government agencies. The FAA authorizes these operations through the issuance of certificates of waiver or authorization (COA) to public entities. A COA specifies conditions on a UAS operation such as limiting flights to certain airspace, requiring coordination with air traffic control facilities or limiting

[24] 14 C.F.R. § 91.113

[25] http://gcn.com/articles/2013/07/12/drone-uav-sense-and-avoid-technologies-civilian-airspace.aspx

[26] Craig Whitlock. *Near-collisions between drones, airliners surge, new FAA reports show*, Wash. Post, Nov.26, 2014. http://www.washingtonpost.com/world/national-security/near-collisions-between-drones-airliners-surge-new-faa-reports-show/2014/11/26/9a8c1716-758c-11e4-bd1b-03009bd3e984_story.html

[27] DOT IG Report: AV-2014-061, *supra*, Pg.9.

[28] *Id.*

[29] https://www.faa.gov/uas/

flight to daytime hours.[30] Before enactment of section 333 of the Reform Act, described above, private individuals and companies had to obtain "experimental" or "restricted" certifications from the FAA to operate UAS. As of June 2014, the DOT IG noted that there were approximately 300 FAA-issued public-use authorizations and 20 experimental or restricted certificates in existence.[31]

Hobbyists operating model aircraft have been able to do so as long as they comply with certain requirements; for example, they must operate model aircraft below 400 feet, at a minimum distance from airports, and within line of sight; must not interfere with operations of manned aircraft; and must not operate the model aircraft for purposes other than hobby or recreational purposes.[32] The Reform Act further clarified the rule for model aircraft. Specifically, the Reform Act prohibits the FAA from promulgating any regulation regarding a model aircraft if the aircraft—is flown strictly for hobby or recreational use; is operated in accordance with a community-based set of safety guidelines; is limited to not more than 55 pounds unless otherwise certified; is operated in a manner that does not interfere with and gives way to any manned aircraft; and, when flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower) with prior notice of the operation.[33]

As UAS technology has evolved, the distinction between model aircraft and UAS has become less clear in some cases, particularly for smaller devices where the operator is compensated for the operation. This lack of clarity led to a high-profile legal dispute between the FAA and an Austrian national named Raphael Pirker. This was the first case that addressed whether the FAA had the legal authority to regulate UAS.

In October 2011, Pirker operated a five-pound Styrofoam powered glider on the campus of the University of Virginia in Charlottesville to take photographs for which he was paid. In June 2013, the FAA assessed a $10,000 civil penalty based on findings that he operated an "aircraft in a careless and reckless manner."[34] Among other things, the agency stated that Pirker also flew within approximately 100 feet of an active heliport and within 50 feet of people. Mr. Pirker appealed the decision and initially prevailed before an administrative law judge of the National Transportation Safety Board (NTSB). However, the NTSB ultimately reversed that decision, concluding that FAA's authority to restrict unsafe flight activity includes unmanned aircraft; the case is pending. [35]

Commercial Potential of UAS Technology

According to a range of stakeholders, UAS technology represents a substantial economic opportunity. According to an Association of Unmanned Vehicle Systems International (AUVSI) report, UAS will create more than 70,000 jobs in the United States and generate economic

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[30] *Id.*
[31] DOT IG Report: AV-2014-061, *supra*, Pg. 3.
[32] FAA Advisory Circular 91-57, Jun. 9, 1981.
[33] Reform Act, *supra* at § 336, 126 Stat. 75.
[34] 14 C.F.R. § 91.13
[35] *Huerta v. Pirker*, NTSB Order No. EA-5730 (Nov. 18, 2014)

impact of more than $13.6 billion within the first three years of integration and will grow to 100,000 jobs and $82 billion in economic impact by 2025.[36] The FAA estimates that $89 billion will be invested in UAS worldwide over the next 10 years.[37] There are numerous commercial applications of UAS under discussion including monitoring infrastructure such as pipelines, land surveying, crop-dusting, and filmmaking, to name a few.

U.S. Competitiveness

The United States has long been the global leader in civil aviation. U.S. aerospace firms, airlines, flight schools, regulatory agencies and universities have been at the forefront of global innovation in this industry. Leading U.S. companies, such as Amazon.com and Google, have invested in UAS technology. However, media reports indicate that many of these companies chose to conduct their outdoor UAS testing activities in Canada or Australia rather than in the United States.[38]

There has been substantial UAS activity outside of the United States. For example, SZ DJI Technology Co. (DJI) of Shenzhen, China, is the world's largest manufacturer of consumer-oriented camera-equipped UAS. DJI sells its UAS for approximately $1,000 around the world.[39] Technology firm Parrot of Paris, France, is also considered a prominent manufacturer of consumer-oriented UAS.[40] Australia is now home to at least 100 UAS operators, most of which are small businesses.[41]

Regulators in Germany, the United Kingdom, Canada, France and other countries have recently made substantial progress in authorizing greater UAS operations. For example, the *Wall Street Journal* reported that a $50,000 UAS has enabled a German road engineering company to create three-dimensional maps of a flood-prone road intersection with very high accuracy after 30 minutes of UAS flights.[42] Before acquiring the UAS, the company's workers spent two days taking ground measurements to produce a less detailed two-dimensional map with much lower accuracy.

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[36] The Economic Impact of Unmanned Aircraft Systems in the United States, AUVSI, Mar. 2013. See: http://www.auvsi.org/resourcesold/economicreport

[37] *FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems in the National Airspace* System, DOT IG Report: AV-2014-061, Jun. 26, 2014

[38] Jack Nicas. *Regulation Clips Wings of U.S. Drone Makers: FAA Ban, Export Controls Weigh Down American Entrepreneurs, Even as Foreign Rivals Fly High*, Wall St. J., (Oct. 6, 2014)

[39] Jack Nicas and Colum Murphy. *Who Builds the World's Most Popular Drones*, Wall St. J., Nov. 10, 2014

[40] See: http://spectrum.ieee.org/automaton/robotics/aerial-robots/parrot-bebop-drone and http://store.apple.com/us/product/HE291ZM/A/parrot-ardrone-20-power-edition-quadricopter

[41] *Certified UAS Operators in Australia hits 100*, Australian Aviation, May 19, 2014, Available at: http://australianaviation.com.au/2014/05/certified-uas-operators-in-australia-hits-100/

[42] Jack Nicas, *supra*.

WITNESS LIST

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U.S. UNMANNED AIRCRAFT SYSTEMS: INTEGRATION, OVERSIGHT, AND COMPETITIVENESS

WEDNESDAY, DECEMBER 10, 2014

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON AVIATION,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
Washington, DC.

The subcommittee met, pursuant to call, at 10:01 a.m., in Room 2167, Rayburn House Office Building, Hon. Frank A. LoBiondo (Chairman of the subcommittee) presiding.

Mr. LOBIONDO. Good morning. The committee will come to order. I would like to ask unanimous consent that members not on the committee, in addition to members not on the subcommittee, be permitted to sit with the subcommittee at today's hearing—there is a great deal of interest—and offer testimony and ask questions. Without objection, so ordered.

I would like to thank all of you for being here. The United States has been the global leader in aviation. We are all very proud of that. And American leadership in aerospace, manufacturing, air transportation, flight safety and technological innovation is tremendous. The aviation industry contributes billions of dollars to our economy, supports millions of jobs throughout our country, and is a source of pride for all Americans.

Unmanned aerial systems, or UAS, have been increasingly in the news, but they're not truly new. It has been almost 100 years since the U.S. military began developing the first UAS. Like other new technologies, UAS offers both exciting opportunities and daunting challenges.

The previous FAA reauthorization law contained provisions directing the FAA to take steps towards safely integrating UAS into our Nation's airspace by September 2015. Among other things, we directed the FAA to create test sites and regulations for UAS. The results so far appear to be mixed, and I look forward to hearing from our witnesses today on the FAA's efforts.

There are many issues surrounding UAS we need to consider; first and foremost, and has always been, safety. Our Nation's safety record is the result of decades of hard work by thousands and also some hard lessons learned. Safety is the cornerstone of the U.S. aviation industry, and without it, the UAS industry cannot succeed, period. Thus, I am very concerned when I read in the Washington Post that the FAA is receiving about 25 reports each month from pilots about UAS flying too close to their aircraft, sometimes even near major airports.

Protecting privacy is equally important as we further integrate and deploy UAS, whether by individual hobbyists or in commercial applications. I know the FAA and aviation industry are taking the issue very seriously, and Congress will continue to be actively engaged.

We can all agree that UAS represents a tremendous economic opportunity. The FAA estimates that $89 billion to $90 billion will be invested globally in UAS over the next 10 years and major U.S. companies have begun investing in UAS technology in a major way. There are many valuable applications in real estate, agriculture, medical transport, and infrastructure maintenance, with many more on the horizon.

It is not hard to imagine UAS making existing industries more efficient and giving rise to entirely new ones. All of this could mean new jobs and vast economic opportunities for the American people if we do this right. So it also concerns me when I read in The Wall Street Journal about major U.S. companies taking their UAS research and development activities to foreign countries, such as Canada and Australia, because FAA regulations are too burdensome and too slow.

It also concerns me that the road builders in Germany and farmers in France today are enjoying economic benefits from UAS because safety regulators there have found ways to permit such flights.

I can't help but wonder that if the Germans, the French and the Canadians do some of these things today, then why can't we also be doing them? Are they smarter than us? I don't think so. Are they better than us? I don't think so. So we really need these questions answered. I hope to get a better understanding of this issue during today's hearing.

As I said earlier, safety is paramount and the challenges are difficult, but if there is a country that is up to the challenge of safe UAS integration, it is certainly the United States of America. We have the very best engineers, the smartest inventors, the most creative minds, and the knowledgeable regulators to ensure American leadership in aviation in the decades ahead. I know this, because many of our best and brightest minds in aviation work at the FAA's Technical Center flagship, which is in my district. The FAA Tech Center is a one-stop shop for the best and brightest to research, develop, demonstrate, and validate new aviation technologies and data sources. It has had a role in many advances in flight safety, including air traffic control, which is key to safe UAS integration. It is a place where new ideas are developed and old ones are improved. Work on UAS is underway there already, and I fully expect their contributions will continue and they will be invaluable.

I am interested in hearing today where we are in terms of the UAS industry and what lies ahead, what progress the Government has or hasn't made, and what industry and FAA need, and how we in Congress can help as we consider the next FAA reauthorization bill.

And I talked with Mr. Larsen and members of the committee and Chairman Shuster, we are really looking at this very closely, because as we prepare the next FAA authorization bill, we are going to be looking for substantial improvements and advancements in this particular area, and we will be looking at specific language, if necessary, if we don't see these advances in a timely way.

I look forward to hearing from our witnesses on these topics and thank them for joining us today.

Before I recognize my colleague, Mr. Larsen, for his comments, I would like to ask unanimous consent that all Members have 5 legislative days to revise and extend their remarks and include extraneous material for the record for this hearing. Without objection, so ordered.

I would now like to yield to Mr. Larsen for his opening remarks.

Mr. LARSEN. Thank you, Chairman LoBiondo, for calling today's hearing on the U.S. unmanned aircraft systems integration oversight and competitiveness. I appreciate you holding this hearing at my request. And safety is and must be the FAA's number one priority, certainly is mine, I know it is yours as well.

We have looked at unmanned aircraft systems, or UAS, twice earlier this year, but last week's report of numerous near collisions between UAS and manned aircraft are a stark reminder that the FAA must be prepared to ensure UAS operations are safe, both for those in the air and people on the ground, so this hearing is timely.

The UAS industry has great potential to drive economic growth and create jobs, including in Washington State, where I am from, and which is an epicenter of aviation R&D; however, there is no doubt there are some near-term challenges. For example, the FAA says it receives about 25 reports each month from pilots who've seen unmanned aircraft or model aircraft operating near their aircraft, including some near collisions.

But we rise to challenges; we do not shrink from them. And I want you to consider these headlines with cautionary tales. "Planes crash in air, man killed." That is from the Wyoming State Tribune. "Two killed in a crash in air," Trenton Evening Times. "Crash in air kills two." "Pilots die when two machines collide in practice flight." That is the Oregonian. All these headlines are from 1917, 1917 and 1920. I found more than 80 stories of this kind alone all written before 1921.

These reports could have caused the American public to give up on developing things that fly, what they used to call machines, now we call airplanes, but we didn't. Had we given up on commercial air travel then, we would not have the safe and efficient passenger airline system that we have today. So while near collision headlines reflect undeniable challenges that must be addressed, we have to keep moving forward to ensure progress and competitiveness, but let's be clear: integration of UAS must never come at the expense of safety. So to help guide this effort, the last authorization set forth specific requirements and milestones for the FAA to safely integrate UAS into the national airspace. We have heard a number of concerns from industry that FAA's not moving quickly enough.

The Department of Transportation inspector general reported in June that FAA had completed work toward nine of the milestones in the act, but that agency was—but that the agency was behind schedule on remaining milestones. The bill required the FAA to publish a rule on small UAS by August, August 14th of this year. We expect that rule soon. The bill also required the FAA to establish six test ranges for UAS research; however, while these test ranges are up and running, we continue to hear from stakeholders that those test ranges are not being utilized as much as they can be.

However, given the magnitude of the safety implications of incorporating this technology into our sophisticated and crowded airspace, we have to give credit where credit is due, and the FAA is proceeding with caution and is making some progress. For example, section 333 of the act gave the FAA authority to authorize certain UAS operations on an interim basis in advance of the final rule on small UAS. The FAA is just beginning using this authority and has granted several exemptions, including some this morning. We must ensure, though, that the agency allows prudent testing and operations to begin safely, even if on a limited basis.

We have also heard concerns from other countries—that other countries afford more flexible environments to test and operate UAS. So while we must hold safety paramount, we do not want to fall needlessly behind.

Privacy is another major concern that must be addressed, and I share the public's concern about implications of aerial surveillance from UAS operators, and work to ensure these concerns are addressed through the proper channels.

Within the past 2 years, we have seen the FAA make progress on implementing NextGen capabilities, with the strong bipartisan support of this subcommittee and the leadership of Chairman LoBiondo. Our work on NextGen shows us the absolute necessity of FAA's collaboration with stakeholders, especially pilots and air traffic controllers, who will be directly affected by new technologies.

Our goal with regard to UAS integration should be to keep safe integration on track so that we are not here in 2024 talking about a plan to integrate UAS into the airspace.

Finally, Mr. Chairman, I would just like to ask unanimous consent to enter the written remarks from MITRE into the record. MITRE is engaged in research and development for the FAA, and its input is critical as we look towards reauthorization.

Mr. LoBiondo. Without objection, so ordered.

[The information follows:]

STATEMENT OF LILLIAN Z. RYALS

COMMITTEE ON TRANSPORTATION AND

INFRASTRUCTURE, SUBCOMMITTEE ON AVIATION

U.S. HOUSE OF PREPRESENTATIVES

U.S. UNMANNED AIRCRAFT SYSTEMS, INTEGRATION, OVERSIGHT, AND COMPETITIVENESS

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I appreciate the opportunity to submit a statement in support of today's hearing on U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness. My name is Lillian Ryals and I am a Senior Vice President at The MITRE Corporation. I am also the General Manager of MITRE's Center for Advanced Aviation System Development (CAASD), which is the Federal Aviation Administration's (FAA's) Federally Funded Research and Development Center (FFRDC).

My statement addresses Unmanned Aircraft Systems (UAS) and the technical and operational challenges for safely operating UAS in the National Airspace System (NAS). It focuses on the following points:

- The vision for UAS operations is to integrate unmanned aircraft into civil airspace without adversely affecting the overall safety and efficiency of the NAS. This goal will be achieved through incremental steps as technology, policies, operational procedures, and automation systems evolve for both UAS operators and for air traffic controllers. Routine access will depend on factors such as aircraft size, the overall airspace environment, and the population density below the flight path.
- The focus for the next 3-5 years should be on enabling commercial use of small UAS (sUAS) for low altitude operations. To date, the majority of UAS operations have been associated with meeting military UAS operational requirements. More recently, the affordability of sUAS, combined with low-cost digital imaging technology, has resulted in rapid growth in the sales and operations of these aircraft. There are many commercial uses for these sUAS, and new applications are being developed on a regular basis. These UAS are not being purchased as "model aircraft" or toys; instead they are tools for photography, for agriculture monitoring, and to support other business and hobbyist needs.

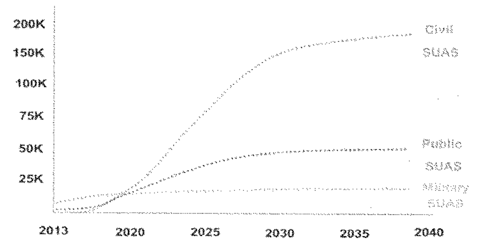

FIGURE 1. SMALL UAS OPERATIONS, BOTH PUBLIC AND CIVIL, WILL GROW SIGNIFICANTLY AND WILL REQUIRE A DIFFERENT APPROACH FOR NAS INTEGRATION THAN FOR LARGER UAS

- The MITRE Corporation believes that the efforts needed to integrate sUAS are significantly different than those needed for larger UAS. Small UAS tend to be operated at very low altitudes in locations where most traditional (manned) aircraft tend not to fly. Because of their low weight, slower speed, and differences in propulsion systems, the safety risks to people and property on the ground from individual UAS are much lower than traditional aircraft, although the number of flights flown near people and property

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may be much higher. Further, these sUAS are not being designed, manufactured, or operated by the traditional aviation community. They are emerging from the information technology and consumer electronics communities that are not familiar with, or appreciative of, traditional aviation safety culture.

- The routine integration of sUAS beyond visual range and the longer term integration of larger UAS have common challenges, but may involve different resolutions due to the differences in inherent risk and operating environments. Key challenges include 1. ensuring the ability to detect and avoid other aircraft and obstacles; 2. ensuring a robust, resilient, and efficient command and control (C2) link; and 3. ensuring that automated functions in UAS can be relied upon.
- In parallel to addressing near-term emergent needs of sUAS, longer-term work is needed to enable increased numbers of large UAS operating in busy airspace and at major airports. Long-term, routine access in busy airspace will also require changes to air traffic control (ATC) systems, NAS infrastructure, policies, airspace, and operational procedures. A significant systems-engineering effort is needed to identify NAS systems requirements, address system tradeoffs, develop the appropriate costing and benefit analyses to allocate requirements, and to execute changes to airspace, procedures, or in acquisitions.

1 INTRODUCTION

The NAS and the aircraft that operate in the NAS, are constantly changing and evolving. New entrants to the NAS, such as UAS and commercial space vehicles are significant drivers for the FAA's NextGen efforts. The overall goal for UAS operations in the NAS can be stated simply: *Routine access of unmanned aircraft into civil airspace without adversely affecting the safety and efficiency of the NAS.*

Expanding routine UAS access will be achieved through incremental steps as technology, policies, operational procedures, and automation systems evolve for both UAS operators and for air traffic controllers.

Currently, most authorized UAS operations are accommodated in the NAS on a limited case-by-case basis through issuance of a Certificate of Waiver or Authorization (COA). The majority of COAs issued have been in support of DOD needs, especially for large UAS transitioning into controlled airspace. There has been a significant level of collaboration between the FAA and the DOD to address these needs, and progress has been made in improving COA processes, in creating streamlined operational procedures, and in putting a ground-based sense and avoid (GBSAA) capability in operation at several DOD locations.

The next major step in expanding access will be the FAA's publication of the first sUAS rule (aimed at vehicles weighing less than 55 pounds). The sUAS rule will dramatically increase the

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ability for commercial and other non-hobbyist operators to operate UAS within line-of-sight, under specified constraints, without a prior approval process.

In the long term, access to busy, more complex airspace will require technologies to compensate for the lack of a pilot's ability to see and avoid manned aircraft, other UAS, people, and property on the ground. Longer-term integration of UAS may also require changes to the NAS such as airspace redesign, new policies, adapted operational procedures, changes to air traffic management (ATM) automation and decision support systems, and changes to NAS infrastructure. A significant difference between the NAS and airspace in other parts of the world is the mix of aircraft operating under visual flight rules as well as those actively managed by the ATC system under instrument flight rules.

In addressing the need for expanded access, the FAA needs to work with a diverse community. Those needing access to the NAS include traditional hobbyists, DOD and other government users using both small and large UAS to meet mission needs, and new entrants who intend to use UAS for communications services, imaging, and other innovative business objectives.

Overall, one can look at the UAS community in four different categories:

1. **Authorized Operators** have used the regulatory processes to receive formal FAA approval. Currently, authorized UAS operations are accommodated on a case-by-case basis. These operators have received FAA approval via a Certificate of Authorization, Special Airworthiness Certificate – Experimental, or an Exemption against a specific regulation. They are mostly public agencies (military, law enforcement, state universities, test sites); mainly operating larger aircraft under significant scrutiny; a commercial operator in Alaska has also received authorization. More recently, civil users are working with the FAA to receive a modified COA partnered with an approval gained through the process, established in the 2012 FAA Modernization and Reform Act (FMRA, Section 333). Much has been learned through the accommodation of public unmanned aircraft operating in the NAS, and UAS operations at the FAA's test sites will increase our overall experience with UAS.
2. There is also a historic community composed of **Traditional Modelers,** who generally operate smaller aircraft (in comparison with authorized users) without direct FAA oversight based on the hobby status of their operations. Typically flying for the fun of flight, this group tends to operate at designated flying fields. Members of this community are often part of aeromodeler clubs and have significant "sweat equity" in their operations.
3. With the emergence of relatively low cost, high performance and very small "drones", there are now **New Recreational Users**, who also operate without direct FAA oversight. They have typically purchased ready-to-fly or near-ready-to-fly aircraft, and are mostly flying aircraft with automated flight stabilization. Unlike the traditional hobbyists, they are flying aircraft to augment other interests such as photography.

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4. There is also ample evidence of **Unauthorized Commercial Operations**. These operators are receiving some form of compensation for flight and tend to use hobby-grade equipment similar to the equipment used by the new recreational users.

MITRE is working with the government and the aviation community to assist with increased UAS access, and leveraging our expertise and research across our sponsors, to include the FAA. We are looking across applicable domains, providing awareness of UAS integration challenges, supporting implementations, building relationships where critical issues require multiple stakeholder engagements, and facilitating consideration of UAS integration needs in future research. MITRE's work in the UAS area includes novel surveillance methods to assist in UAS Detect and Avoid, ATC requirements, UAS standards, and in enabling public UAS access. MITRE has also invested internal research dollars to investigate cooperative airspace, new surveillance technologies, and how to address software of unknown pedigree in unmanned aircraft systems. At the enterprise level, MITRE is providing engineering and technical contributions toward development of the FAA's overall UAS integration strategy.

2 Near-Term Expansion of Civil Small UAS Access

Over the past few years, the affordability of sUAS, combined with digital imaging technology, has resulted in rapidly expanding ownership of these aircraft, often referred to in the public domain as "drones." We are seeing rapid growth in the number of new users with manufacturers shipping tens of thousands of such consumer-grade aircraft a month. There are a number of commercial uses envisioned for these sUAS, and new applications are being invented on a regular basis. Many commercial users are eager to operate under a legal framework, as evidenced

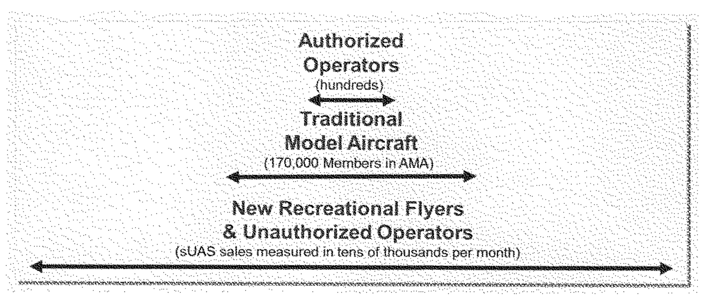

FIGURE 2. SUAS SALES ARE RAPIDLY EXPANDING THE NUMBERS OF UAS OPERATORS IN THE NAS

by the recent increase in Section 333 exemption requests.

Examples of commercial uses for sUAS based on recent submissions to FAA for Section 333 approvals, provide some insights into the expected characteristics for sUAS operations. Of these applications, 98% of the proposed Section 333 operations are below 500 feet above ground level. Some of the applicants have indicated their primary purpose is for research. Many capabilities are likely to be allowed under the sUAS rule, and we expect many others will require additional capabilities and regulation to allow them on a routine basis. While a sUAS rule will address many civil uses, there will be demand for other applications that are not enabled by the rule. Emergent applications that will likely not be authorized under the sUAS Rule include:

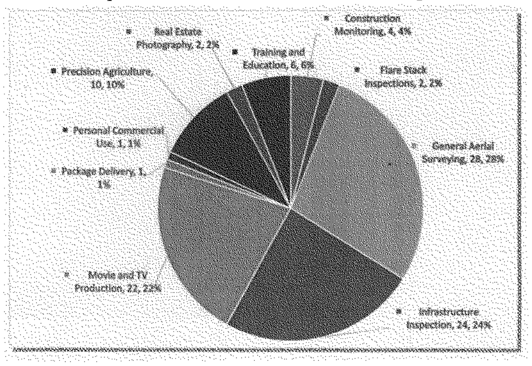

FIGURE 3. RECENT SECTION 333 PROPOSED APPLICATIONS

- **Agricultural Monitoring:** UAS used to monitor crop health will generally take place in areas with low population and with a property owner's approval. UAS on large farms will require operations beyond the operator's ability to see the unmanned aircraft. Agricultural imagery from unmanned aircraft can be used by farmers to target hydration, fertilizer, and pesticides to specific areas of their crops, thus reducing their costs as well as environmental impacts. Challenges include the ability to detect and avoid other low-altitude aircraft such as crop-dusters and helicopters, as well as the ability to avoid obstacles such as power lines, guide wires, and towers.
- **Public Safety:** UAS first responder applications may take place in a variety of environments and conditions, including urban, rural, and remote. There could be potentially hazardous conditions, such as other aircraft in the vicinity and people on the ground. These aircraft may be operating within an operator's visual range, or may require pre-programmed operation well beyond the operators' visual range. Capabilities to ensure safe operation over populated areas are critical.
- **Inspection of Infrastructure:** Small UAS are valuable for inspecting infrastructure at close range (e.g., bridges, towers), in both urban and rural environments. Use of long-endurance UAS to inspect pipelines, railroads, and power lines may require pre-programmed operation well beyond the operators' visual range. This will necessitate overcoming challenges such as detecting and avoiding other aircraft like helicopters, and ensuring that the UAS

98% of the proposed Section 333 operations are below 500 feet above ground level.

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is aware of the surrounding environment so that it can avoid obstacles in its way while ensuring the safety of property or people in the vicinity of the infrastructure. Availability of a robust command and control link for beyond line-of-sight operations, and efficient use of spectrum, is another key challenge for this application.

- **Small Package Delivery:** Notwithstanding the excitement this application evokes, significant challenges remain. For small package deliveries to become routine, challenges that must be overcome include ensuring a UAS can detect and avoid people, buildings, and other structures. Package drop-off and UAS launch and return methods are needed, and in urban environments, some level of pre-programmed operation or automation will also be likely.
- **High-altitude Operations / Stationary Systems:** UAS may operate for long periods of time at very high altitudes to provide communications and internet service, atmospheric monitoring, and high altitude imagery and mapping. This may require them to fly at relatively slow speeds through airspace with commercial air traffic, which could affect air traffic flows. At very high altitudes, there is also the possibility of visual flight rules (VFR) traffic, again requiring detect-and-avoid (DAA) functionality.

A major step in enabling the benefits of civil sUAS and for enabling a regulatory framework will be the issuance of a rule for sUAS. In our NextGen Independent Assessment,[1] we recommended that the FAA fast-track sUAS rulemaking, including ensuring that all needed resources are available and applied to expedite the operational use of the new rule. Such an effort would expand the number of authorized operations and provide further guidance to the community on safe operating practices. In addition, early experience and monitoring of these operations will provide guidance on further expansion of access and will increase overall confidence in the FAA's ability to implement sound and useful regulations.

We also recommended that the FAA execute a cross-organizational plan to incrementally expand commercial UAS access (beyond the sUAS rule) into the NAS by adapting existing policies, regulations, and procedures. The FAA is actively developing this plan and MITRE is working with the FAA to develop early "pockets of implementation" that can partially address this demand while providing additional insights that can inform future rulemaking and investment decisions. We believe that these efforts will be helpful in maturing operational enablers, as well as informing future rule-making efforts and investments associated with integration planning and evolution.

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[1] See Recommendation C1 and C2. Other recommendations from MITRE's Independent Assessment associated with UAS are: A3, on voice services, B7, on trajectory modeling and flight planning, E5, on airspace and ATM modifications. The document is on the FAA's website at: http://www.faa.gov/nextgen/media/MITRE_NextGen_Independent_Assessment_and_Recommendations.pdf

The efforts needed to integrate sUAS are significantly different from those associated with large UAS. Small UAS tend to be operated at low altitudes in locations where most traditional aircraft do not fly. Because of their lower weight, speed, and size, the risks to people and property on the ground are much different in comparison to traditional aircraft. Small UAS might be able to safely operate significantly closer to structures and obstacles than traditional aircraft. In fact, operating close to structures might help to reduce potential encounters with traditional aircraft which must be remain a significant distance away.

Even with a sUAS rule in place, there are challenges to address before expansion of access can be achieved. A significant difference between the NAS and airspace in other parts of the world is the mix of aircraft operating under visual flight rules as well as those actively managed by the ATC system under instrument flight rules. Many General Aviation (GA) operations (such as crop dusting) and helicopter operations fly at low altitudes and operate under visual flight rules and may not be visible to air traffic controllers. As part of the FAA's mission to provide a safe and efficient NAS, FAA needs to address how this low altitude airspace is shared between GA operators and UAS entrants.

Further, these small, consumer-grade UAS are not being designed, manufactured, or operated by the traditional aviation community. They are emerging from the information technology and consumer electronics communities which are not familiar with, or appreciative of, the traditional aviation safety culture. The relatively recent widespread availability of consumer-grade sUAS, which are selling tens of thousands a month has resulted in a clear contrast of two cultures: the Information technology (IT) community's culture of innovation, which stresses continuous and rapid product evolution and speed to market, and the aviation safety culture, which stresses safety and minimizes risk.

3 KEY CHALLENGES FOR UAS INTEGRATION

The distributed architecture for UAS and the lack of an on-board pilot present challenges different from traditional, piloted aircraft operations. To support routine access in busy airspace, there are three major challenges that have to be addressed: establishing Detect and Avoid capabilities; ensuring a robust and reliable command and control link; and ensuring airworthiness of UAS, especially as these systems become more automated. To integrate these new entrants more routinely, integration into existing Air Traffic

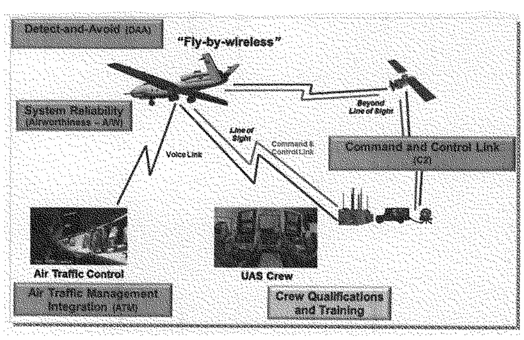

FIGURE 4. KEY ELEMENTS FOR ROUTINE UAS OPERATIONS

Management systems along with qualifications and training of UAS crews must be developed and put in place along with the regulatory guidance on their use.

Detect and Avoid Challenges

As noted earlier, much of the regulations that are applicable to airspace in the NAS assume that a pilot is on-board who can "see and avoid" other aircraft and obstacles. For a UAS flying beyond the visual line of sight (BVLOS), the pilot is not able to directly see other aircraft and obstacles. The ability to electronically mitigate this difference is referred to as either "Sense and Avoid" (SAA) or "Detect and Avoid" (DAA). DAA systems may either be based on surveillance capabilities on the ground (ground based SAA, or GBSAA), or on the UAS itself (aircraft-based SAA, or ABSAA). For UAS operating at very low altitudes, there are additional challenges of being able to avoid uncharted obstacles (e.g., trees, low buildings, or temporary structures) and people.

MITRE is actively involved in research on both GBSAA and ABSAA. Innovations for GBSAA capabilities have been implemented for the DOD, addressing DOD operational needs while also addressing FAA requirements for ensuring overall safety of the NAS and to protect manned aircraft from these public UAS. In addition to the Marine Corps Air Station (MCAS) GBSAA system implementation at Cherry Point, NC, the USAF has successfully implemented a GBSAA system at Cannon Air Force Base, New Mexico. The U.S. Army is also working toward deploying a GBSAA system to support Grey Eagle UAS operations at five Army posts (Fort Hood, TX; Fort Drum, NY; Fort Campbell, KY; Fort Riley, KS; and Fort Stewart, GA). Other DOD locations are in various stages of acquiring a GBSAA system including Syracuse, NY; Grand Forks, ND; Palmdale, CA; and Wilmington Park, OH.

Command and Control (C2) Challenges

The Command and Control (C2) link is the mechanism for the UAS pilot to provide flight instructions to the unmanned aircraft. Unlike piloted aircraft, where the pilot is manipulating controls in the aircraft cockpit, a UAS pilot has to rely on a wireless signal to convey instructions. UAS operating within visual line of sight are often controlled over unprotected spectrum. For a UAS to routinely operate in busy airspace, the following is required: mitigation of link vulnerabilities, coping mechanisms for vulnerabilities, and the mechanism for managing spectrum and any potential required C2 link communications infrastructure. Protected spectrum will be needed to assure the safety of flight.

DOD aircraft use DOD-operated C2 systems and DOD-controlled spectrum for beyond line-of-sight operations. Such solutions are not in place for civil operations. While there may be C2 solutions that are individually implemented for a specific user operating a UAS within visual line of sight, there are no mature standards that would enable broad use of a common C2 radio design. Initial draft standards for a C2 radio signal are in progress in RTCA. However, significant work is needed to lay out the systems engineering and legal mechanisms needed.

There is also a need to manage spectrum and to outline how a capability is acquired and/or deployed. Finally, work is needed to understand the evolution from individual assignments to a more efficient use of spectrum that is shared among the wide range of users anticipated to need his resource.

Airworthiness and Automated Function Challenges

Small UAS operators may not have the same training required of today's pilots. This implies a heavy reliance on automation for everything from maintaining flight stability, automatic landings, and predefined search/imagining patterns. This increased emphasis on automation raises new issues as we need to ensure that these software-intensive systems function as intended.

Software assurance is an increasingly important area, yet many UAS software systems were not designed to comply with aviation software assurance guidelines and processes. For sUAS, such processes would have a large impact on manufacturing costs. New methods that better match the agile development approach by manufacturers of sUAS and that reduce the cost of software assurance may be required to evaluate the dependability of software for certification. MITRE and other organizations are researching ways to address software of unknown pedigree with the goal of creating innovative ways to evaluate software certification.

Many UAS software systems were not designed to comply with aviation software assurance guidelines and processes...MITRE, as well as other organizations, is researching ways to address software of unknown pedigree in the goal of creating innovative ways to evaluate software certification.

UAS provide other challenges for establishing airworthiness. Because UAS do not carry people, requirements for survivability may not be as strict. However, there is a need to ensure that UAS airworthiness addresses potential harm to other aircraft, or to the uninvolved public or to infrastructure. Civil airworthiness criteria including the tailoring of existing airworthiness criteria and the creation of new criteria associated with detect and avoid, a command and control link, pilot interfaces, ATM interfaces, unique launch/recovery systems, navigation and automated contingency management.

Other Challenges

There are other challenges to address in achieving routine UAS access to the NAS. Changes to the NAS are needed, as noted in Section 4. While the risks posed by small or very small UAS are fewer, the rate at which incidents may occur may be higher due to the high numbers of UAS now in the marketplace and the level of training, especially for recreational users. There is also a need to consider increased security threats. With sUAS that are difficult to detect and the reduced response time available to counteract such threats, there is a need to develop appropriate strategies to anticipate and mitigate this new class of security threat.

4 LONGER TERM STEPS: UAS ACCESS INTO BUSY AIRSPACE

The solutions being considered for expansion of sUAS operations and utilization of GBSAA for DOD needs are important steps to achieving near-term access. There are also efforts in place to address longer-term needs. For some UAS operations, the mission profile will include transit through busy airspace.

The ultimate goal for many of these UAS mission profiles is to enable routine operations in which procedures for operating UAS in the NAS are similar to those for manned aircraft. In addition to enabling increased access by public unmanned aircraft, solutions to those key challenges will enable further innovations in aviation. In particular, ABSAA and the use of certified UAS automation is a key part of this path. For sUAS, this is especially challenging due to cost, size, weight, and power limitations. While FAA is able to accommodate a limited number of UAS operations in busy airspace today, achieving efficient operations is predicated on the ability for UAS to overcome the challenges previously described as well as evolving the NAS.

Routine integration of UAS into busy airspace will also require changes to ATC systems, NAS infrastructure, policies, and airspace. For example, ATC voice communications systems may need to be adapted to enable seamless communications with remotely piloted aircraft. Controllers may need additional tools to monitor and provide services to UAS. The systems that manage traffic will need to recognize the characteristics of this new entrant into the NAS. Such changes have the potential of affecting automation and infrastructure in airports, terminal facilities, and en route facilities.

Changes to the NAS will be driven by some of the unique characteristics of UAS, such as the following:

- Tactical control of the UAS is performed via the command and control link with the UAS operator, introducing communications and control latencies, resulting in longer times before a UAS can execute a command in comparison with manned aircraft. The command and control link also introduces the risk of a lost link, during which time the UAS crew is unable to control the UAS.
- UAS used for long-endurance missions have much longer flight times than have been allocated for automation systems in traditional aircraft.
- UAS have dramatically different performance characteristics, often flying at slower speeds and with slower climb performance in comparison with traditional aircraft. Further, UAS flights often do not follow a simple origin-destination path and may include loitering and other unusual paths.

Significant work in developing technology and requirements for UAS is also in progress. In particular, ABSAA and the use of certified UAS automation is a key part of this path. ABSAA capabilities are many years away; research is in progress for new radar capabilities, automation, and algorithms. While there is a possibility of an ABSAA capability for larger UAS operating at higher altitudes, challenges in size, weight, and power make it difficult to anticipate use on a sUAS, given limitations in payload and flight duration, as well as cost constraints. The use of Automatic Dependent Surveillance-Broadcast (ADS-B) has also been considered to improve safety. An ADS-B "Out" capability on all UAS would enable manned aircraft and ATC authorities equipped with ADS-B "In" capability to detect those UAS. Such a capability could also enhance the identification of, and response to, security threats. However, sUAS are expected to operate mostly at low altitudes away from airports, a domain where there is no requirement for ADS-B equipage. Even if all aircraft (both manned and unmanned) were equipped with ADS-B Out, there would still be a gap in the ability for UAS to sense and avoid people and property.

Routine integration of UAS into busy airspace will also require changes to ATC systems, NAS infrastructure, policies, and airspace.

5 COMMUNITY EFFORTS TO ADDRESS UAS CHALLENGES

There are a number of fora where UAS challenges are being actively addressed, such as the UAS Executive Committee (UAS EXCOM), enabling coordination across government agencies and with manufacturers and operators. As noted earlier, the FAA and the DOD are also working with industry standards bodies, such as RTCA, to develop the technical requirements for DAA, C2 links, and other elements of a UAS. Key venues include:

- **The Sense and Avoid (SAA) Science and Research Panel (SARP)**, co-chaired by MITRE and the NMSU, operates under the guidance of the UAS EXCOM, which has membership from DOD, FAA, NASA, and DHS
- The **UAS Aviation Rulemaking Committee (UAS ARC)** is a cross-industry advisory committee to the FAA and is providing industry guidance on regulations and rules concerning UAS operations.
- **RTCA Special Committee 228** on UAS is developing standards related to Sense and Avoid capabilities and for the Command and Control (C2) link between the UAS control station and the aircraft.
- **ASTM International's F38 Committee** is developing standards related to design, performance, quality acceptance tests, and safety monitoring for sUAS. FAA intends for these standards to apply to sUAS operating under the sUAS Rule.

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Many challenges are also being addressed by the FAA's UAS Test Sites, and per the FMRA, a new UAS Center of Excellence will provide a venue for targeted research. There is other key research funded by government and other entities being conducted by researchers at number of organizations and leading academic institutions.

6 SUMMARY

The overall goal for UAS operations is to enable routine access into airspace without adversely affecting the overall safety and efficiency of the National Airspace System. UAS span in size from systems that are hand-held to large vehicles with extended flight durations. While current DOD needs are being accommodated by the FAA, there is a growing set of users that are operating with little knowledge of aviation safety practices. The emergence of affordable, sUAS systems is resulting in a growing demand for operations in low altitudes and in locations where traditional aircraft rarely operate.

In the near term, the focus for enabling access needs to be for civil uses of sUAS. The efforts to enable sUAS access are significantly different from those associated with large UAS, due to their low weight, lower speeds, and the locations where they are likely to be operated. These smaller aircraft are difficult to detect and while enabling innovations and improvements, there is also a need to develop appropriate safety and security measures that can respond to risks associated with these aircraft.

While the sUAS rule is anticipated to address a significant portion of this demand, we are working with the FAA and our other government sponsors to develop incremental steps to expand sUAS access and to gain further knowledge on the performance of these systems. Longer-term efforts are also underway to address key challenge areas, and as they mature, we expect further innovations to emerge.

Thank you for the opportunity to provide a statement. I would be happy to answer any questions the Committee may have; my contact information is included on the cover page.

Mr. LARSEN. Thank you, Mr. Chairman. I look forward to hearing from all our panelists about why we are here today, what we can do to keep the integration of UAS on track and to ensure safety. Thank you.

Mr. LOBIONDO. Very pleased to welcome the chairman of the full committee, Mr. Bill Shuster, and thank him for his tremendous interest and involvement in this issue and the FAA authorization bill. Mr. Chairman.

Mr. SHUSTER. Thank you, Mr. Chairman. And I am going to start off by saying welcome to our panelists here today. We are interested in hearing your testimony and your views on this issue, but I share Mr. Lobiondo's views on safety. Safety in our skies is simply paramount. That has to be first and foremost to us. So we in Congress are very interested in UAS.

In the last FAA bill, we directed the FAA to safely integrate that into our airspace by September 2015, but the UAS industry cannot develop unless it is proven safe. And based on the opening statements by the chairman and the ranking member, Republicans and Democrats are united in our views about the priority and importance of safety.

We also understand that UAS are an exciting technology with the potential to transform parts of our economy. I am intrigued by how UAS might improve our modes of transportation. For example, the UAS might be used for certain kinds of bridge inspections without closing lanes, for traffic stopping, or requiring workers to have to climb up to high places to do inspection. And the UAS, I am told, can survey 180 acres of land in less than an hour during construction projects.

UAS can safely help us get more bang out of the taxpayers' buck on infrastructure projects, and with that in mind, it is our responsibility to look at this and take a close look at this technology.

I know there are some challenges to getting this right. I am confident that the American inventors, engineers and entrepreneurs are up to the challenge to ensure the United States retains its lead in aviation technology. As we work towards safe integration of UAS, we cannot let a few irresponsible individuals jeopardize the safety of the many and set back a potentially promising technology.

So I am glad you are all here today. And thank you for holding this hearing, Mr. Chairman, and I yield back.

Mr. LOBIONDO. OK. Thank you, Mr. Shuster.

I want to thank our distinguished panel of witnesses today. Our first panel will include Ms. Peggy Gilligan, Associate Administrator for Aviation Safety to the Federal Aviation Administration, essentially all things UAS; Mr. Matthew Hampton, assistant inspector general for aviation for the U.S. Department of Transportation, Office of the Inspector General; Dr. Gerald Dillingham, Director of Physical Infrastructure Issues for the U.S. Government Accountability Office; Captain Lee Moak, who is president of Air Line Pilots Association, International; Mr. Jesse Kallman, head of business development and regulatory affairs for Airware; and Dr. Nicholas Roy, associate professor of aeronautics and astronautics at the Massachusetts Institute of Technology.

And, Ms. Gilligan, you are recognized. We welcome your remarks.

TESTIMONY OF MARGARET GILLIGAN, ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY, FEDERAL AVIATION ADMINISTRATION; MATTHEW E. HAMPTON, ASSISTANT INSPECTOR GENERAL FOR AVIATION, U.S. DEPARTMENT OF TRANSPORTATION; GERALD L. DILLINGHAM, PH.D., DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, U.S. GOVERNMENT ACCOUNTABILITY OFFICE; CAPTAIN LEE MOAK, PRESIDENT, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL; JESSE KALLMAN, HEAD OF BUSINESS DEVELOPMENT AND REGULATORY AFFAIRS, AIRWARE; AND NICHOLAS ROY, PH.D., ASSOCIATE PROFESSOR OF AERONAUTICS AND ASTRONAUTICS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Ms. GILLIGAN. Thank you, Chairman LoBiondo, Congressman Larsen, and Chairman Shuster for the opportunity to appear before the subcommittee to discuss unmanned aircraft systems, or what we know as UAS.

In the FAA Modernization and Reform Act of 2012, Congress mandated the safe and efficient integration of UAS into the National Airspace System. Administrator Huerta, in announcing his strategic initiatives, identified integration of UAS and commercial space operations into the NAS one of his top priorities, and we are working hard to meet those mandates.

In the act, Congress mandated that the Secretary of Transportation consult with Government partners and industry stakeholders to develop a comprehensive plan and 5-year roadmap for UAS integration. Both documents have been published, and outline the path ahead for UAS.

As called for in the statute, these documents set out a phased approach that must be carried out thoughtfully to ensure safety is not compromised.

Consistent with congressional direction, we announced six UAS sites to aid in UAS integration. As required, we set out to have one test site operational within 6 months of selection. We surpassed that goal, with the first test site operational within 4 months and three more sites operational within 6 months of their selection. Now all six UAS sites are fully operational and have established their research agendas. The data and information from the test sites will help answer key questions about how unmanned aircraft systems interface in the airspace as well as with air traffic control.

The FAA Technical Center in Atlantic City is playing a key role in data collection and analysis, and will continue to make significant contributions to UAS integration as we work closely with the test sites to identify the data that will be the most useful to the FAA.

We are moving forward with UAS integration through rulemaking. As mandated by the act, the FAA initiated rulemaking to permit civil operation of small UAS in the airspace. We all agree that that project is taking too long, but I am pleased to say that we believe we now have a balanced proposal that is currently under executive review.

In the meantime, and consistent with the act, we are looking at activities that do not pose a risk to others who operate in the airspace, to the general public, or to national security, and that can be operated safely without an airworthiness certificate. Once the

Secretary of Transportation is able to make that determination, FAA then grants relief from other FAA operating regulations. We have authorized 11 operators, including five exemptions that we have issued today, to conduct commercial UAS activity in the national airspace, covering activities such as surveying, inspection and movie making.

We continue to facilitate the use of UAS by public entities. For more than two decades, FAA has authorized the use of unmanned aircraft for important safety missions such as firefighting and border security. Working closely with the Departments of Defense and Homeland Security and other agencies, we are taking advantage of the extensive Federal investment that has been made in these systems.

In addition, more than 35 law enforcement agencies now operate unmanned aircraft under certificates of authorization, and we are also working with law enforcement agencies to address the unauthorized use of UAS, for they are often in the best position to help us deter, detect, and investigate such activities.

We are working hard to educate the public about the requirements for operating UAS in the national airspace, and we believe opportunities like this will help us in that endeavor, but that has proven to be a challenge. Unlike traditional manned aircraft, unmanned aircraft are widely available for purchase by individuals who may not realize that they are entering the National Airspace System or that they must comply with FAA regulations. They may not appreciate the significant safety risk that is presented by unauthorized or unsafe UAS operations in the national airspace.

Just as you directed in the 2012 Act, FAA can and will take enforcement action against anyone who operates a UAS in a way that endangers the safety of the national airspace, but we continue to lead with education, because we believe the vast majority of UAS operators want to comply with FAA regulation.

We remain committed to serve as world leaders in this segment of the aviation industry. The United States is proud to lead the Remotely Piloted Aircraft Systems Panel recently formed by the International Civil Aviation Organization. The U.S. will be leading the way to establish standards and recommended practices, procedures, and guidance materials to facilitate the safe integration of remotely piloted aircraft systems around the world. Together with our international partners, we will facilitate integration at the international level while continuing to lead the world in aviation safety.

Mr. Chairman, this concludes my testimony. I look forward to answering your questions.

Mr. LoBiondo. OK. Thank you very much.

Mr. Hampton.

Mr. Hampton. Chairman Shuster, Chairman LoBiondo, Ranking Member Larsen, and members of the subcommittee, thank you for inviting me to testify today on FAA efforts to integrate unmanned aircraft systems, or UAS, into the National Airspace System.

The increasing demand for UAS systems has enormous economic and competitive implications for our Nation. As you know, the FAA Modernization and Reform Act was a catalyst for UAS technology. The act directed FAA to take steps to advance UAS integration, with the goal of safely integrating UAS technology by 2015.

In June, we reported on FAA efforts and made 11 recommendations specifically aimed at helping FAA to more effectively meet the act's goals.

My testimony today will focus on FAA's progress in implementing the act's provisions and the challenges the agency faces in safely integrating UAS technology.

To date, FAA has completed more than half of the 17 UAS requirements in the act. This includes selecting the test sites as well as publishing a roadmap outlining agency plans. In addition, using the authority granted in the act, FAA recently authorized 11 companies to operate UAS in commercial operations. However, FAA is behind schedule on the act's remaining requirements, many of which are key to advancing UAS integration. For example, FAA missed the act's August 2014 deadline for issuing a final rule on small UAS systems. These are systems weighing less than 55 pounds.

While FAA expects to issue a proposed rule soon, it will likely generate a significant amount of public comment that the agency will need to consider before issuing a final rule. As an result, it is uncertain when a final rule will be published. Ultimately, FAA will not meet the act's overarching goal to safely integrate UAS technology by September 2015.

As FAA works to implement the act's provisions, the agency also faces significant technological, regulatory, and management challenges. On the technological front, the evolution of detect and avoid technology is paramount. Also, the risk of loss link scenarios, when an operator loses connectivity with an unmanned aircraft, remains high. Furthermore, establishing secure radio frequency spectrum to support UAS communications has also proven difficult to address.

FAA, DOD and NASA have several important research projects underway, but it remains unclear when the technology will be robust enough to support safe UAS operations.

Regulatory challenges have also affected progress to date. Also FAA has authorized limited UAS operations on a case-by-case basis, it is not yet positioned to certify civil UAS operations on a large scale.

FAA has worked with a special advisory committee for more than 9 years, but has not yet reached consensus with stakeholders on minimum performance and design standards for UAS technology. Much work remains to set requirements for pilot and crew qualifications, ground control stations, and communication links for UAS systems.

Finally, I would like to turn to challenges in areas that need significant management attention. FAA lacks the training, tools and procedures air traffic controllers need to manage UAS operations. FAA also lacks standard databases to collect and analyze safety data from current UAS operators and a severity-based classification system for incident reporting. Data from FAA's UAS test sites will provide critical information related to certification, air traffic control, and detect-avoid technologies I discussed earlier. All of these can inform FAA's decisions and advance progress.

Other important and much needed steps include publication of the small UAS rule and developing an integrated budget document that clearly identifies funding requirements in the near and mid term.

In conclusion, UAS will be and remain a front and center issue that requires significant management attention. It remains uncertain when and at what pace UAS technology can be fully and safely integrated into our airspace. Now is the time for FAA to build on the knowledge base to make informed decisions, set priorities, identify critical path issues, and develop the basic regulatory framework for integrating UAS technology into the National Airspace System. We will continue to monitor FAA's progress on these issues and keep the subcommittee apprised of our efforts.

Mr. Chairman, this concludes my prepared statement. I will be happy to answer any questions you or other members of this subcommittee may have.

Mr. LOBIONDO. Thank you, Mr. Hampton. That is—wow. OK. We will leave it at that for right now.

Dr. Dillingham.

Dr. DILLINGHAM. Thank you, Mr. Chairman, Ranking Member Larsen, Chairman Shuster, members of the subcommittee.

My statement this morning is based on our ongoing work for this subcommittee and focuses on three areas: First, FAA's progress towards meeting the unmanned aerial systems provisions of the 2012 FAA Reauthorization Act; second, key research and development activities needed to support unmanned systems integration; and third, how other countries have progressed towards integrating unmanned systems into their airspace.

Regarding the provisions of the 2012 Act, the act included 17 specific provisions for FAA to achieve safe unmanned systems integration by September 2015. While FAA has completed most of these provisions, key ones remain and additional actions are needed to effectively leverage the completed provisions for the integration effort. For example, a critical step for allowing commercial operations is the publication of a final rule. To develop the rule, FAA must publish a notice of proposed rulemaking; however, as you have heard, the NPRM has been significantly delayed. Given the time that is generally required for rulemaking and the tens of thousands of comments expected on this NPRM, the consensus of opinion is that the integration of unmanned system will likely slip from the mandated deadline of September 2015 until 2017 or even later.

The delay in the final rule, which will establish operational and certification requirements, could contribute to unmanned systems continuing to operate unsafely and illegally, and lead to additional enforcement activities for FAA's scarce resources. Additionally, without a small unmanned systems rule, U.S. businesses may continue to take their testing and research and development activities outside of the U.S.

Regarding research and development activities, the key technology issues remain essentially the same as they have been since the beginning of the unmanned systems era, including detect and avoid, command and control, air worthiness, and spectrum issues. There are a wide range of stakeholders involved in addressing these issues and there has been some notable progress, including the establishment of the test sites; however, in spite of the progress in research and development, the role of the six test sites remains unclear.

The designation and operational startup of the six test sites, viewed by many as a major step forward in acquiring the necessary data to address the technological and operational challenges associated with integration. Our preliminary work suggests that this development has not lived up to its promise. The test site operators told us that they were significantly underutilized by FAA and the private sector and that they were unclear as to what research and development and operational data was needed by FAA to support the integration initiatives.

However, our preliminary work suggests that FAA has provided some guidance to the test sites regarding the needed research and development and data needs. FAA officials said that Federal law prevents them from asking the test sites for specific data. According to FAA, the law does not allow the agency to give directions to the site or accept voluntary services without payment. As we continue our study, we will be trying to better understand the relationship between the test sites, FAA, and the needed research and development and how the test sites can achieve their highest and best use.

Regarding developments in foreign countries, as is the case in the U.S., many countries around the world allow commercial operations under some restrictions. Also similar to the U.S., foreign countries are experiencing problems with illegal and unsafe unmanned systems operations; however, a 2014 MITRE study and our preliminary observations have revealed that several countries, including Japan, Australia, the United Kingdom and Canada have progressed farther than the United States with regulations supporting commercial operations for small unmanned vehicles, but the regulations governing unmanned systems are not consistent worldwide. Some countries, such as Canada, are easing operating restrictions through a risk management approach, while other countries, such as India, are increasing unmanned systems restrictions. Our ongoing study for this subcommittee will look further at the experiences of other countries for potential lessons learned for the United States.

Mr. Chairman, Ranking Member Larsen, and members of the subcommittee, thank you for the opportunity to speak with you today.

Mr. LOBIONDO. Thank you, Dr. Dillingham.

Captain Moak.

Mr. MOAK. Thank you, Chairman LoBiondo, Ranking Member Larsen, and members of the subcommittee for the opportunity to provide our perspectives on the critical importance of safely integrating unmanned aircraft systems into the National Airspace System.

Our country's national airspace is the most dynamic and diverse on the planet, and also I want to underscore this, the safest. We need to protect it and maintain it to deliver the safest, most efficient air transportation possible.

UAS and remotely piloted aircraft systems include aircraft ranging in the size from a small bird to as large as an airliner. Some UAS aircraft are operating completely autonomously. Their flight route is computer-programmed and the device operates without a pilot. Other UAS aircraft are flown remotely by pilots from an operational center or control stations that can be located at the launch and recovery site or perhaps thousands of miles away.

ALPA supports the safe use of unmanned aircraft systems. We recognize the potential benefit to our Nation's economic competitiveness, but we also recognize the potential for a safety risk if we don't treat them as what they are: airplanes in airspace.

We have all seen photos of the damage that can be caused to an airplane by a bird strike in flight. Unmanned aircraft can be much smaller or much larger than birds, but they harbor added risk in that they carry batteries, motors and other hard metal components.

This was a bird strike, please take a look at this, on a commercial airplane, and this next photo of a military airplane's encounter with an unmanned aerial vehicle. Hit it in the wing root there.

We must not allow pressure to rapidly integrate UAS in into the NAS to rush a process that must be solely focused on safety. Standards and technologies must be in place to ensure the same high level of safety as is currently present in the NAS before a UAS RPA can be authorized to occupy the same airspace as airliners are operating in areas where it might inadvertently stray into airspace used by commercial flights.

We also need to make certain that UAS pilots are properly trained and understand the consequences of possible malfunctions.

Now, I knew I would be speaking before you today, so I went online last Thursday and purchased this quadcopter for the committee for just a few hundred dollars. I received it 2 days later, and as the marketing promised, it was ready to fly in a few minutes and I was flying it in my office.

Now, this UAS can carry a camera, it has a GPS, which with the purchase of additional software can be used to pre-program a flight plan. It has the capability, this one, to fly as high as 6,600 feet for 15 minutes, and that means it could easily end up in the same airspace I occupy when I am on approach to land at Newark or at Seattle or at any other airport.

Now, if we took this aircraft out in the courtyard building, it has the capability to fly from this courtyard to the final approach path at Reagan National Airport, and from the park at the end of the runway. That is Reagan Airport, that is that Gravelly Point Park. You can see it would be even easier to fly right into the aircraft zone.

Now, a well trained and experienced flight crew is the most important safety component of the commercial air transportation system. A pilot in the cockpit of an aircraft can see, he can feel, he can smell, and he can hear indications of a problem and begin to formulate a course of action long before even the most sophisticated indicators verify trouble. Without a pilot onboard, we lose this advantage, and as a result, it is essential that UAS pilots are highly trained, qualified and monitored to meet the equivalent standards of pilots who operate manned aircraft.

We also need to make certain that UAS aircraft can't stray into areas where it poses a hazard if the operator loses control, that it behaves like it is supposed to, and if there is a failure, the aircraft doesn't endanger other aircraft or people on the ground.

If UAS is intended to be operated in civil airspace or could unintentionally be flown into our airspace, airline pilots need to be able to see them on our cockpit displays, and controllers need the ability to see them on their radarscopes. UAS aircraft also need to be equipped with collision avoidance capability.

And, finally, the FAA resources are limited, and the agency must have a long-term sustained source of funding as well as realistic timelines and a systematic approach that builds the path of UAS integration based on safety.

We appreciate the opportunity to testify today. We look forward to working with Congress to ensure that safety is held paramount in bringing UAS into the national airspace.

Mr. LOBIONDO. Thank you, Captain Moak.

Mr. Kallman.

Mr. KALLMAN. Chairman LoBiondo, Ranking Member Larsen, and members of the subcommittee, thank you for inviting me to testify here today.

I am the head of business development and regulatory affairs for Airware, a San Francisco-based company developing flight control systems for commercial unmanned aircraft, enabling companies to use commercial UAVs to collect, analyze and disseminate data for a growing number of commercial applications around the world.

Airware has raised over $40 million from several of the world's leading venture capital firms and our team has more than doubled over the last year.

I also serve on the board of the Small UAV Coalition, which was formed earlier this year to promote safe commercial operations of small UAVs here in the United States.

This is a critical time for the UAV industry and Airware. The Small UAV Coalition and others in the community would like to ensure that the United States becomes the global leader for commercial UAV technology development and operations while maintaining the safest airspace in the world.

Today I will focus on three key issues for this subcommittee: one, the current state of UAV technology and potential implications in a variety of industries; two, the need for a risk-based approach to UAV regulations; third, the effective current and expected regulations on U.S. businesses.

First, the UAV industry is one the fastest growing markets here in the United States. Many here today may be familiar with the small consumer UAVs used for personal enjoyment or photography, but I would like to focus on the commercial-grade UAVs which are tackling some of the biggest problems across a variety of industries.

Commercial UAVs are being used for disaster management, oil and gas exploration, search and rescue, inspection of wind turbines, and surveying of crops. These UAVs are equipped with many technological features to ensure safety and reliability of operations, such as geo-fencing systems, which keep a UAV within certain altitude and distance limits as well as away from sensitive areas. Also, contingency management systems, which in the case of an issue onboard the aircraft, enable the UAV to automatically return to a safe landing location.

These types of technologies are developing at an increasingly rapid rate and are enabling safe operations around the world today. In addition, NASA's also working to develop a UAS traffic management system to provide a means for safely managing a lot of these small systems.

Through my past experience working at the FAA, I understand the challenge in regulating this new and revolutionary technology in the United States, but there are steps we can be taking to begin to open up operational environments now. Most commercial UAV operations will take place below 400 feet, 100 feet below the typical minimum safe altitude of 500 feet for manned aviation.

This brings me to my second point. We must take a new, risk-based approach to regulating UAVs. For example, a very small aircraft operating over a remote farm field at 300 feet would be subject to minimal regulatory requirements, whereas a larger aircraft operating over populated areas would require highly reliable avionics, additional training, geo-fence technology, and fail-safe mechanisms, like a parachute. These are the types of risk models being used to allow commercial operations in Europe today, including France.

I am pleased that the FAA recently stated its intentions to shift to this type of model, I applaud them for this, but the critical question is how quickly can it be implemented?

Finally, I would like to discuss the effect of delayed regulations on U.S. businesses. As I mentioned, France allows low-risk commercial applications, as does Canada, the United Kingdom, Australia, and many other countries. The United States, typically a leader in aviation, is one of only a few countries that currently prohibits commercial UAV operations, except pursuant to an exemption. While we wait, small and large businesses in the United States are moving UAV testing and operations abroad, where regulations are more advanced.

Delayed and overly restrictive regulations aren't just slowing the growth of the UAV industry. Many of the largest industries and corporations in America see this technology as key for remaining competitive in the global marketplace.

Airware has raised a strategic investment from one of the largest corporations in America, General Electric, who could use UAVs across many of their different business units.

The Farm Bureau has also recently noted that U.S. farmers will not be able to keep up with foreign competitors if they are not allowed to use the same technology.

UAV technology will have a major impact on our economy. In the first 3 years of integration, conservative estimates include creating more than 70,000 jobs and adding $13.6 billion into the economy. With each year of integration delays, the U.S. loses more than $10 billion in potential economic impact. We want the jobs, economic benefits, and core intellectual property created from this work to be here in the United States.

We know that no matter the outcome today, UAV technology will create jobs, it will save lives, and it will grow the economies of those countries with the foresight to act. The United States is poised to lead the way for this growing and game-changing industry. We have the talent and the workforce to create the technology needed to safely integrate into the world's most complex airspace. Let's act quickly before major opportunities are lost.

Thank you. I look forward to answering your questions.

Mr. LoBiondo. Thank you, Mr. Kallman.

Dr. Roy, welcome.

Mr. Roy. Chairman LoBiondo, Ranking Member Larsen, Chairman Shuster, and members of the subcommittee, thank you for the opportunity to appear before you to discuss the unmanned aviation industry in the United States.

I am a professor in the Department of Aeronautics and Astronautics at MIT. I lead a research program on unmanned aerial vehicles, or UAVs, with a focus on unmanned flight in urban, civilian, or populated environments. Most recently, I worked to Google to found Project Wing, a UAV-based package delivery system. I returned to MIT full-time in September of this year. In this testimony, I am speaking today solely for myself, and cannot speak for either MIT or Google.

My main message today is that the U.S. does lead the world in UAV development, but both testing the next wave of technology needed for commercial UAV applications and training the next generation of engineers, both are more difficult in the U.S. than in other countries. Let me explain further.

Firstly, the issues around small UAV commercialization are quite different compared to large, primarily military, UAVs. Large UAVs are as safe and as reliable as manned aircraft. The U.S. is the unquestioned leader in this space, so I am going to focus today on small UAVs for civil use.

The vast majority of small UAVs are basically toy aircraft, such as model airplanes or quadrotor helicopters. This current generation of small UAVs exist because advances in technology, such as computers, GPS receivers or batteries, leading to smaller, cheaper UAVs that are easy for anyone to fly.

There are many companies proposing to use these technologies for commercial use, but right now most commercial vehicles can only fly simple missions, generally with the same reliability as a toy. A lot of example uses have made the news in this country and other countries, but are for the most part prototypes or vaporware.

In reality, the current civil UAV markets around the world are tiny, only hundreds to a couple thousand vehicles at best. There are real technology gaps limiting the growth of UAVs.

The recent FAA call for a center of excellence for unmanned aircraft systems is a pretty good roadmap for what technology is needed for growth, but let me give you some examples. Most people know what it is like for the GPS in their car to get confused. This can and does happen to UAVs too. The vehicles need to have sensors and algorithms to let them know where they are at all times. UAVs need to know about ground obstacles and aircraft around them and how to avoid collisions.

We need radio spectrum and new radio technologies that ensure the pilot in command can control the vehicle at all times.

As the number of UAVs grows, the air traffic management infrastructure must grow alongside in order to coordinate the large number of UAVs flying through the National Airspace System at any altitude.

Lastly, an unmanned vehicle only makes sense when the operational cost is less than a manned aircraft. Onboard vehicle intelligence is needed to drive down the human labor costs in more applications.

My point is that another wave of technology is required to scale up to products for imaging, agriculture, emergency response or package delivery.

U.S. researchers and companies absolutely lead in these and other technology areas. We do have a demonstrated track record in autonomy, algorithms, sensors and communication, but there are hurdles.

Firstly, from the Wright Cycle Exchange 100 years ago in Ohio, to Hewlett-Packard, to Apple, the creation myth of some of the most successful technology companies in the world is the small team of investors tinkering in a garage. The point is not the garage itself, but it gives the ability to test anywhere that is safe, and this massively accelerates the development cycle. Unfortunately, it is much harder to test UAV technology in the U.S. than in other countries. It is not impossible, the FAA does have a number of authorization mechanisms, but there is a considerable bar to enter for people who just want to work on the technology.

The current processes might be right for authorizing a UAV-based pipeline inspection service across the length of North Dakota, but they are onerous for a two-person start creating basic technology.

Unfortunately, there isn't a single set of rules or procedures I can point to that can be adopted from another country that would work here, but there may be ideas to be learned. For example, a clear definition of legal test flight instead of a case-by-case approval process will let engineers know where they can literally set up their garage and start to work.

Secondly, and perhaps most importantly, the U.S. position of leadership depends on our ability to train engineers and scientists with the skills necessary to develop the requisite technologies. There are a growing number of universities teaching UAV technology to undergrads.

To learn the foundations of UAVs requires flight, requires real flight. While some institutions have access to COAs or are near one of the approved test sites, there are too few and the cost is substantial. The same processes that inhibit access to test areas limit how our educational institutions provide training in UAV technology.

Furthermore, the support for basic research in UAV technologies is diminishing. Much of the progress in unmanned vehicles in the U.S. has been funded by forward-thinking program managers in ONR, ARO, AFOSR, DARPA and NASA. These program managers have not only funded the technology to enable UAVs, but have funded the students who write software that is running on UAVs today. It is these students that are going to solve the technology challenges. Universities outside the U.S. are acting both as training grounds for a generation of UAV researchers and as incubators for UAV companies.

Let me conclude by saying that the U.S. is not currently lagging other countries regardless of the publicity around prototype demonstrations. The same technical hurdles will need to be overcome in any country before commercial UAVs become a reality of everyday life; nevertheless, there are issues and constraints in this country that may allow other countries to overtake the U.S. both in technology development and in training the generation of engineers required to carry out that development.

Thank you very much for this opportunity.

Mr. LOBIONDO. Thank you, Dr. Roy.

Chairman Shuster.

Mr. SHUSTER. Thank you, Mr. Chairman.

Thank you all for being here. We appreciate you bringing your expertise here, but I think it is important to point out that on this subcommittee, on the full committee, we have members that have expertise, we have pilots on this subcommittee. And I think I got them all down here: Congressman Graves is a pilot; Congressman Hanna; Scott Perry, Congressman Perry is a helicopter pilot, but a pilot; we are going to be joined next Congress by Congressman Rokita, who is a pilot; and Congressman Jeff Denham, when he served in the Air Force, was an aircraft mechanic; and our counsel, Naveen Rao, is a pilot. So we have a lot of expertise here, a lot of folks that understand what you are saying, and so I think it is going to be important as we move forward, listening to you, but listening to the experts that we have here on the subcommittee is very, very beneficial to us, and I am happy that they are here and with us and able to help us, guide us through this.

The first question to Captain Moak, in your written testimony, you stated that commercial UAS operators should hold a commercial pilot's license and instrument ratings. And we have heard that the skills to fly UAS are different, significantly different, from those to fly a passenger jet. Some parts of the curriculum really seem to have little relevance to flying UASs. For example, UAS operators need to master stall and recovery techniques in a Cessna if they plan on flying a quadcopter. So what would be the relevance there, how would it benefit safety, and is there a scientific basis for your recommendation?

Mr. MOAK. So even on another committee I sat on, we have had the Air Force, where they were working—initially all their UAS pilots over the last several years were coming out of the pilot pipeline, but as the need for more UAS operators for U.S. Air Force increased, they set up a separate UAS track, which you may be familiar with. In that track, they do go through all the all the basic skills of flying, for a couple reasons: one is to understand when they are in the airspace, and the other is to make sure they are operating the UAS properly. So the Air Force has briefed us on that. We think it is a good model.

With what the FAA has been doing, treating and—treating these as an airplane and go through—going through a process of certificating the aircraft, certificating the operator, the person trying to operate it, the company, and then certificating the pilots, OK, and then monitoring and oversight of all that, I think, is one of the precepts, the foundations of having a—continuing with a safe national airspace.

Mr. SHUSTER. And so——

Mr. MOAK. On your specific on should they——

Mr. SHUSTER. Cessna.

Mr. MOAK [continuing]. Be able to recover from a stall or each of that, I think there is room for that in any curriculum. I agree with you on that. I just think we need to be focused on that safety part of it.

Mr. SHUSTER. All right.

Mr. MOAK. Yes, sir.

Mr. SHUSTER. So to modify it, you are not opposed to that if it doesn't make sense. OK.

Mr. MOAK. Absolutely.

Mr. SHUSTER. The second thing is that we have got some reports from newspapers and other media sources that are leaking out some of the proposed rulemaking. And this question is to Captain Moak, Mr. Kallman and Mr. Roy. There appears to be a rule not to be permitted to operate beyond the line of sight. And if that were the case, my concern is it would significantly reduce or almost eliminate the benefits that a UAS system brings to us. So can you comment on beyond the line of sight?

Mr. MOAK. Right. So you have seen the—there are news stories all the time, but there have been two recent ones, one at JFK and one at Heathrow. And this would be a different hearing if this would have went down the engine of an aircraft. It would have been, you know, catastrophic, and we would have a different hearing today.

I think what is important is if it is going to be operated in that—in that method that you are talking about, there needs to be a way to have pilots that are flying be able to see it. And it is very difficult, if not impossible, to see this, because much like other things in the air, if there is not relative motion, your eye can't pick it up. All right?

And on the airspace issues, for example, for helicopters, you know, 500 feet and below is where helicopters, Life Flight and lots of other planes operate. So I would just suggest this: if we are going to be operating it beyond line of sight in densely—in dense areas, you know, big sky, little airplane, but lots of airplanes, there needs to be a way for air traffic control to see it, for the airplanes to see it, for the person who is operating it to be able to communicate with air traffic control and with the airplanes in the area. And that—I believe with that, you could very easily operate beyond line of sight.

And then the only other thing, and we have experts over here, if you are in an area that is not populated by other airplanes, then of course you could operate it in that manner, but the only thing would be what do you do with a lost link, which, you know, has happened quite a bit in the military.

Mr. SHUSTER. Mr. Kallman, based on what Mr. Captain Moak said there, can you comment?

Mr. KALLMAN. Thank you. I think this gets back to the earlier point I made on taking a risk-based approach. So in the case of beyond-line-of-sight operations, you would be in a scenario where there are higher risks, but think you can mitigate that through technology. So, for example, in France today, what they are doing for beyond-line-of-sight operations is they are only operating at very low altitudes, where there isn't general aviation traffic or commercial traffic, and they are enhancing it through technologies, such as cameras onboard, the system where an operator can actually see if there is other traffic in the area, to the point on lost link scenarios, they are utilizing technology, I mentioned earlier, for a contingency management.

So in the case where you do lose link with your operator, you are able to pre-program in so the UAV knows exactly how to respond in those cases. So depending on what the area is, what the environment is, it knows what a safe location is to return to. So these are the types of technologies that are already in place today.

Mr. SHUSTER. Mr. Chairman, I wonder if you would yield me 1 more minute so that Mr. Roy can respond to that, because I know he has worked with Google and MIT, and this would be beneficial.

Mr. LOBIONDO. Without objection.

Mr. ROY. So my answer is very consistent with the previous two answers in the sense that beyond line of sight is eminently doable. A risk-based profile makes a lot of sense. It is more feasible in unpopulated environments or where you have some notion of what the airspace contains.

The technology issues are very consistent. Loss of link, there needs to be a contingency plan. Loss of link is a challenge. Maintaining situational awareness as the vehicle returns, that is a technology question that needs to be addressed, but these are eminently doable.

Mr. SHUSTER. All right. Thank you very much.

For the benefit of the FAA, I hope you heard a lot. To me it was loud and clear. Safety is paramount, absolutely. I think we all agree with that. This can be done, and as we move forward, making sure that we are looking at the technology and the safety aspect. And, again, one size doesn't fit all. Thank you.

Mr. LOBIONDO. Mr. Larsen.

Mr. LARSEN. Thank you, Mr. Chairman.

I am going to focus my initial questions on this end of the table. I know folks from my side of the aisle have some questions on the—for folks down here, and—but I wanted to talk a little bit about on the technology side.

And is it doctor? Dr. Roy. Have you looked at the use of the six test sites and made any assessment about whether they are being used as much as they can? And if you have made that assessment, what would you suggest be done otherwise?

Mr. ROY. So I—the six test sites are not my area of expertise, so I personally haven't done an assessment. MIT was heavily involved in setting up the NUAIR test site. And I got back to MIT this September, so been a bit busy, haven't done—haven't looked at what is available there, but we hope to be flying there soon.

Mr. LARSEN. Well, given—given your research and your course of study, what would be an ideal environment?

Mr. ROY. So that is a good question. One of the limitations, I think, is the distance with which one has to go in order to get to the test sites and the—I guess the onus on setting up operations there. In an ideal world, I describe in my written testimony the ability to designate local test areas anywhere—local flight areas anywhere as test areas, have clear rules so that, for instance, if you are more than 150—I am picking these numbers up entirely arbitrarily, but 150 meters from people on the ground or a ground structure and you have secured the airspace, then if you had the ability to do that, that would allow—you know, presumably you could not do that in downtown Cambridge, but you could go further afield to an area where, you know, you could take your student more easily than having to drive through Griffiss Air Force Base and fly.

Mr. LARSEN. Yeah. Mr. Kallman, do you have some comments on just generally what an ideal environment for these test sites would look like?

Mr. KALLMAN. Absolutely.

Mr. LARSEN. Or how they would operate, that is.

Mr. KALLMAN. Yeah. And I agree. I mean, I think the important thing for test sites is the ease of access so that small companies, large companies all have the same opportunities to go utilize the airspace. Obviously safety is of utmost importance, so being able to do that safely through, for example, issuing a NOTAM to other operators in the area so that they understand that there is some testing going on in these areas, but ensuring that these areas are able to allow for companies to get that approval and be able to come and utilize that space quickly and rapidly and at low cost to these companies.

Mr. LARSEN. Yeah. Well, we will talk to the test sites about whether that is happening as well as some of the stakeholders.

You talked a little bit about the risk-based approach and what it would look like. Is there—is there any scenario where, since you are in the private sector, where you can envision a test-to-operation scenario where you—you know, where—like, on the Armed Services Committee, we sort of broke through some of the acquisition on certain things to sort of—you know, to break through the slowness of the Pentagon to act on things.

Is there—using that model, is there a scenario where we can get to a test-to-operation scenario at these test sites in certain cases?

Mr. KALLMAN. Absolutely. And I think that could be very valuable. And I know organizations like NASA Ames are already engaged in looking at things like this to allow companies to bring their technology to showcase what it is capable of doing and ensuring that it will respond safely in a variety of different scenarios. I think that will be very important to have, and I think that there should be infrastructure for that.

Mr. LARSEN. Yeah. Dr. Roy?

Mr. ROY. I completely agree with that. I think that is essential, because there are going to be operational scenarios that can't be represented in the test sites. So, for instance, as the commercial application of infrastructure inspection, package delivery and so on, they are going to require more urban environments for testing. And so as we want—as we stand up those markets, the test-to-operation is going to be an important part of that.

Mr. LARSEN. Yeah. In the minute I have left, I just want to come down to Ms. Gilligan about—on the test sites and the issue of designated air worthiness representatives.

Ms. GILLIGAN. Yes.

Mr. LARSEN. You have designated one for Nevada, the Nevada test site. What about the others, and is that something that test sites need to request or is FAA trying to conclude that they ought to have these?

Ms. GILLIGAN. We have offered that as a tool, a technique for the test sites to be able to attract industry into those locations. We did it in Nevada. We have offered the training to all of the test sites. They have not yet offered a candidate for that training. We are ready whenever they are ready. And, after the training, the designee then has to actually demonstrate that they have the skill. That will be done with one of our engineers, and after that, the designee will be able to actually approve the operation of the vehicle for the test sites. We think that will help to enhance the attraction for industry to come to those test sites.

Mr. LARSEN. So is this an ODA model, essentially?

Ms. GILLIGAN. At this point it is individual designees. It is not necessary that it actually be an organizational designation, because we haven't seen that level of demand. Certainly, if the demand expands and we think an organizational model makes sense, we could move to that.

Mr. LARSEN. OK. I am going to—I will yield back, Mr. Chairman, and look forward to the rest of the questions. Thanks.

Mr. LOBIONDO. Thank you.

Ms. Gilligan, the question I am going to try to get to is the effectiveness interaction with FAA and the test sites. And there is a lot of FAA activity with UAS arena, with the test sites and section 333 and so on.

Could you explain the respective roles of the FAA Tech Center, the test sites, the centers of excellence, cooperative research and development agreements, section 333 in terms of how they are getting us towards UAS integration? I mean, it seems like there is a lot of stuff out here, but we are getting reports that the test centers are somewhat frustrated because there is not the interaction that they were expecting and were not getting results. Can you talk about this?

Ms. GILLIGAN. I would be glad to, Mr. Chairman. We have biweekly conferences with all of the test sites, and so I think we have begun to alleviate some of those early concerns.

I do think the test sites got off to perhaps a slower start than we and they were anticipating as they really came to understand what it was that they had undertaken. I think we are seeing good movement there. They all have approved COAs, and they all have flight operations underway. We are collecting some amount of information from those, but, of course, the numbers are still small, because they really are all just getting underway.

I believe the improvement that Mr. Larsen referred to with the ability for the test sites to have a designated airworthiness representative who can work with companies that want to use the test sites will go a long way to increasing the appeal of the test sites to some of the companies that my colleagues on the panel have talked about, who want to do research in these areas. So we think that will be an important improvement as well.

Mr. LOBIONDO. So does the FAA have a plan to use these assets in a coordinated fashion?

Ms. GILLIGAN. For FAA research, we are looking at what our research needs are, and to the extent the test centers can help us fulfill those needs, and to the extent that we have funding for that research, we will certainly look to use the test sites. Right now, FAA has not placed research at any of the test sites.

These test sites, as I say, were set up in accordance with the intent that we saw in the act, which was to allow industry to complete research. As my colleagues have said, right now it is difficult for industry to have access to airspace for the purposes of research and development. We believe the test sites offer the perfect opportunity to meet those research needs here in the U.S., and that is why we are working with the test sites to expand their ability to attract that kind of research.

Again, if FAA needs can be met at the test sites, we will certainly look to fund projects at those test sites as well.

Mr. LoBiondo. So when you say you are working with the test sites to expand that opportunity, can you tell me a little bit more about that?

Ms. Gilligan. Again, we are trying to keep them well informed about what they are able to do under the agreements that they have with the FAA. We now have individuals actually from the FAA Technical Center who will be traveling to each of the test sites to work with them more closely on what it is that we might be looking for to be able to get research data through the test sites. Once the test sites take advantage of the ability to have a designee on site, we think that that will really open the doors for industry to take advantage of the test sites.

Mr. LoBiondo. Can you tell us a little bit about how you are engaging with U.S. companies that might want to do research and development here in the U.S. versus overseas and—what I am after is about some of these media reports that companies are frustrated. Are you interacting with these companies, or how are we trying to keep them to keep the jobs here, is what I am getting at?

Ms. Gilligan. Yes, sir. The staff in our UAS office are interacting with industry constantly. There is a large annual conference, for example, this week out in New Mexico. We are well represented there and we are reaching out not only in public sessions, but in private meetings with manufacturers to try to understand what are their needs and whether and where they can meet those needs.

In terms of the recent newspaper report that you saw, we have been working with that applicant. They are looking at both an exemption under part 333 as well as what we are recommending, which is that they seek certification for their vehicle under our special certification rules for the purposes of research. And we think that we can actually enable them to accomplish what they need to accomplish here in the U.S. through the test sites and through their own certification.

Mr. LoBiondo. Well, there are obviously a lot of areas of interest here that we as the committee want to try to keep our fingers on. But while keeping safety paramount, the economic opportunities in an economy that can desperately use it is also at the top of our list. Thank you.

Mr. DeFazio.

Mr. DeFazio. Thank you, Mr. Chairman.

Ms. Gilligan, there is this inanity of the Antideficiency Act where you can't give direction to someone utilizing a test site because they are providing an uncompensated service. Have your lawyers really looked at that to see whether or not there is a way around that, or are we going to need to legislate to fix that?

Ms. GILLIGAN. Our lawyers have looked at it, sir, at this point, and that is the advice that they have given us. I certainly will ask them to look more closely to see if there is some alternative. But at this point, we are, again, supporting the test sites by trying to make them attractive to industry which really is the party that is interested in the research.

Mr. DEFAZIO. Right. And I have also heard from some who use the test sites that there is quite a bureaucratic process that comes in. And if you want to run one flight you have to file all these papers, and then you want to modify something and run another, you can't just like do it. You can't just say, well, we are going to change eight parameters and we are going to do another flight.

Ms. GILLIGAN. We are working with the test sites. We have actually asked them to come in with a proposal for what we are calling a broad co-authorization. They are working on that proposal so that we can start to address some of these concerns.

Mr. DEFAZIO. Right. I mean, you have got the test site, you know, we will get all those parameters in place, and then someone comes there and says, oh, well, come back and another 30 days if you want to run a little modified operate. They should be able to do it on a test site, be able to do multiple operations with different parameters would be useful for your people to observe. It would be useful, obviously, for their development or greatly facilitate things. So I hope that we can do that very quickly.

Why aren't there more test sites? We limited it to six, but why couldn't we have more? I mean, we just limited it to six. Is there any reason why we couldn't have more test sites? It doesn't cost you anything, right?

Ms. GILLIGAN. Well, it does cost us in——

Mr. DEFAZIO. In terms of personnel monitoring, yes, et cetera.

Ms. GILLIGAN. Yes. We have people who work very closely with the test sites, and so there is a resource——

Mr. DEFAZIO. Yeah, but I don't consider them very well geographically dispersed. There is a lot, I mean, as the point was made down here, for a small startup to have to travel 1,000 miles to a test site. That is another thing we ought to look at.

Are we seriously pursuing a risk-based approach, which just makes so much sense to me, living in the West and knowing that there are vast areas with agriculture where you could be operating safely and there are no potential conflicts or virtually none.

Ms. GILLIGAN. Yes, sir. We are using a risk-based approach as we look at each of the 333 requests for exemption, for example, to make sure that we understand the level of risk and what limitations need to be added to it. I think one of the panelists referred to it. We do have applicants who want to actually certify the systems, and we are using the same risk-based approach there. We are looking at our certification rules, and, with the applicant, we are looking at the risks that need to be addressed by design standards and what we can pick from the standards that exist right now for——

Mr. DEFAZIO. Right. Well, geographic makes a lot of sense as a starting point for risk-based approach, in terms of density of operations, proximity to secondary tertiary, general airports, you know, critical airspace, whole different problem. So I hope you are seriously working on that.

There is one other question to you, and that is, the staff has provided something they say that in the case of the film industry that after they got the section 333, they have to get a separate operating authorization which has not yet been granted. So——

Ms. GILLIGAN. Yes, they need approval to operate in the airspace, and we need to be able to put out a notice to airmen where the operations are occurring. I believe all but one of them have now gotten that approval for at least one location.

Mr. DEFAZIO. OK.

Ms. GILLIGAN. But we agree that under the exemptions process, we might be able to make that more efficient as well. We are looking closely as how we could do that.

Mr. DEFAZIO. OK. And this is to the panel generally or maybe that end. I mean, transponders, how small can a useful transponder be these days?

Mr. KALLMAN. Some of the smaller transponders that can be used now in UAVs can be right now about the size of a cell phone, maybe even smaller.

Mr. DEFAZIO. A what? Cell phone?

Mr. KALLMAN. Yeah, about cell phone size. So those are some of the smaller systems. There is still some cost associated, but I think it could be a helpful technology when you are at a higher altitude when there could be other traffic in the area.

Mr. DEFAZIO. Yeah. We said over a certain altitude get out a transponder. In certain kinds of critical airspace, you have got to have a transponder. I mean, because right now these things are invisible——

Mr. KALLMAN. Yeah.

Mr. DEFAZIO [continuing]. Through our crude radar systems. So that is correct.

OK. And then this lost link. I mean, that has been a problem with the military. You know, you think you have got that nailed in terms of if you have the geospatial restrictions and that is all somehow programmed in, and these things can find a safe harbor point remotely and they know they have lost a link so they are going to go to that point?

Mr. KALLMAN. Uh-huh. Typically how that would work is the manufacturers of the vehicles know what a safe, you know, amount of lost link time is. And, for example, they can specify in certain applications where lost link is absolutely critical, and if there is any sort of lost link, it needs to be immediately returned to the landing location in a way that is safe.

In other cases, a lot of these systems are so highly autonomous that interruptions in the link may not be as important if it is in an area where it is controlled. So it is all depending on the risk of the situation, and you can actually program a lot of that into the actual avionics of the system.

Mr. DEFAZIO. OK. Thank you.

Thank you, Mr. Chairman.

Mr. LOBIONDO. Mr. Meadows.

Mr. MEADOWS. Thank you, Mr. Chairman.

I want to follow up on some of what you were just sharing, Mr. Kallman. You know, you talked a lot about technology and where we are. You know, we see an aircraft sitting in front of Captain Moak there. Is it possible to put in the type of technology, or can you expand on the types of technology that would increase safety but yet not require an aircraft license as the gentleman to your right is advocating that would keep us safe? What other technologies are out there?

Mr. KALLMAN. Yes. So I mentioned two very important ones: The geo-fence technology, which is very common in the industry and can be used on vehicles as small as the ones you see here; the contingency management functionality, it gets to a lost link; also, loss of GPS functionality so that should the vehicle no longer be able to make itself aware of where it is, it knows how to land safely.

There is a lot of really great research going on right now here in the United States and other parts of the world that Professor Roy talked about on sense-and-avoid technology. I think that is going to be a critical piece for enabling a lot of these higher risk applications at higher altitude with, you know, other traffic in the air, and there is already very significant advancements in that area as well.

Mr. MEADOWS. So how confident are you that if we do not change our regulatory scheme that Canada, Australia, Europe will own this type of technology, and on a scale of one to ten being most confident that if we don't change things that we are going to lose out?

Mr. KALLMAN. I would say I am pretty confident, because we are seeing a lot of the highly skilled manufacturers in Europe really surpassing a lot of the U.S. companies because of their ability to go and iterate, do very frequent testing, do a lot of research on their products where they are able to actually go two or three generations in their products where a U.S. company may only be able to do it once. So we are starting to see some of that.

Mr. MEADOWS. So they are actually doing a lot more testing in Europe or Canada or other places than we are here?

Mr. KALLMAN. So it is because a lot of the main manufacturers there have easy access to testing facilities.

Mr. MEADOWS. So Ms. Gilligan, let me come to you. From an FAA standpoint, obviously, we have some six sites that we are talking about, but if there is so much work going on in these foreign countries, are you gathering data in terms of commercial activity from them, successes, failures, or are we just being more focused on the United States and not learning from their mistakes or their successes?

Ms. GILLIGAN. No, sir. There is a lot of coordination at the international level, both in terms of what we as an industry should be establishing as the standards for these operations, as well as sharing experiences seen around the world. But, I do want to comment on the vast differences in the complexity of our airspace and our aviation system over some of the other countries where there is some easier access.

We have 10 times the number of registered airplanes than our friends to the north. We have multiple times the numbers of operations——

Mr. MEADOWS. And that is without a doubt, but as Mr. DeFazio is talking about, there are certainly areas where the risk would be minimal. I have learned today that I probably violated a Federal law by taking pictures of a golf course. Now, there was more danger of somebody getting hit by a golf ball than there is from the drone that flew over it to take the pictures. But as we see that, can we not look at it on a risk-based assessment and really open up the testing so that our airline pilots can feel comfortable with what we have but yet not keep it so confined?

Ms. GILLIGAN. We are working closely with the test site in North Dakota, for example, with just that in mind, recognizing that there is lower level of air traffic over most of the State of North Dakota and they are looking at how they can broaden access for that test site. So yes, sir, we agree that there are areas where this can safely be accomplished, and we are looking at working with the test sites on how we can expand that.

Mr. MEADOWS. So have we implemented any recommendations that we have received from foreign countries that would actually help alleviate some of this, or are we just gathering data?

Ms. GILLIGAN. I am not aware that we have recommendations from foreign countries that would address this, but we are learning from their experience and looking at how we——

Mr. MEADOWS. If we are learning and not implementing, that is not doing any good, is it?

Ms. GILLIGAN. I am sorry, what I was going to say is we are learning from them and looking at how we can implement what they have learned safely here in this system. We continue to look for ways to do this safely.

Mr. MEADOWS. All right. I thank you, Mr. Chairman. I yield back.

Mr. LOBIONDO. OK. Thank you, Mr. Meadows.

I want to thank the Members for watching the clock. You may have noticed Mr. Larsen and I kept ourselves on the clock. We have a lot of folks who want to ask questions so I appreciate that.

We will now go to Ms. Titus.

Ms. TITUS. Thank you, Mr. Chairman. I represent Las Vegas, so there is a lot of enthusiasm in Nevada for the development of drones or UAS. We have got a lot of open space. We have got Creech Air Force Base. We have got a very creative gaming industry that wants to provide bottle service by the pool with these things. I mean, the potential is great. We applied to become a test center. We got that. I was supportive of that. We have been working on it. But the enthusiasm is starting to wane because that test site is not producing like we thought it would.

Now, I hear Ms. Gilligan being positive about it, but the things that I hear from people who have briefed me from Nevada are more in line with what Dr. Dillingham pointed out. They just don't think it is getting off the ground, so to speak. And I have heard Ms. Gilligan say about three different times, "We are working on this so we can start to address some of the concerns." Well, that doesn't give me a lot of comfort because you have been working on the rule for such a long time, I don't think working on it address the concerns is going to get us there in time to be competitive. I don't know why business wouldn't just go test in Canada instead of going to one of our test centers.

Seems to me there are three problems that I hear over and over from the different folks from Nevada who come and talk to me. One is, they don't know what information should be collected. It has just not been clear to them what data is needed, how to put it together, what procedure should be followed. Now, I hear Dr. Dillingham say you are working on establishing that, but there is no timeframe for when that is going to be done so that could be—who knows when that might be.

Second problem that they seem to have is this speeding up the COA process. We heard some reference to that. You have to do it over every single time, takes so long. I wonder why we couldn't maybe prioritize the COAs for the test sites over others because that seems to be where we want to put our emphasis.

Third, the problem of intellectual property, protecting industrial secrets, so to speak, of companies that come and test there that have to give all this information to the FAA and the public. I just wonder if you would address some of these questions, Ms. Gilligan; and, Dr. Dillingham, would you give us your perspective on it?

Ms. GILLIGAN. Yes, ma'am, I would be glad to. If I could start with the last one first. That is why we are very pleased to see that Nevada has stepped up to begin the approval process for a designee. We believe, and I think they believe, that using a designee will allow them to bring industry into the site without having to jeopardize the intellectual property of the folks who want to work at that site. So we think that is an important step forward.

I believe the approval for that designee should be completed this month. And so I think with that, the test site will see that they can now sort of market that they have the ability for industry to bring their research projects to this test site and not put at risk intellectual property, which was a concern earlier on. So I think that is an important improvement, and we applaud Nevada for stepping out first to take that on.

In terms of the COAs, we do prioritize the requests. All of the test sites have approved authorities now for airspace. There are some that are still pending. We are, again, trying to work through those as quickly as we can, because we agree with you; the test sites have been designated as a location where we can take advantage of our ability to continue to integrate UAS safely. So we are pursuing that as well.

And I am sorry, I forget the first one.

Ms. TITUS. I have forgotten the first one myself. What information should be collected?

Ms. GILLIGAN. The data. I am sorry, yes. Again, we saw these sites initially and primarily—and continue to see them primarily—as a place where industry can go to do the research and development that they want to do, the work that some of my colleagues here on the panel have talked about. In terms of what data the FAA needs, we now realize that that is a valuable piece of information for this test sites to have.

With the applications for the Centers of Excellence, we have identified the research needs that the FAA has, and, again, in our biweekly conference calls with the test sites as well as now with the visits that will be made by our staff from the Technical Center, we are going to be working closely with the test site operators to make sure is that we and they understand what could be helpful to FAA based on the work that they are seeing at their test sites. So we will be——

Ms. TITUS. Dr. Dillingham.

Dr. DILLINGHAM. Well, Ms. Titus, you hit on all the key points, the same stories that we have been hearing from the test sites. We have had the opportunity to interview half of them and visit some of the test sites and those are the key issues.

I think in terms of increasing their value and their capacity to input, I think Ms. Gilligan, as FAA fulfills those things that Ms. Gilligan talked about, that will go a long way. But I think sort of key to this is something that Mr. DeFazio said about looking at this antideficiency law and seeing is there a way that funds could be made available to pay for research or support research at the test sites.

And also, in terms of the idea that we only have six test sites, I mean, our information suggests that in Canada, for example, they are ready to designate a very large airspace up to 18,000 feet for testing beyond visual line of sight. So perhaps as we move towards the next stage of this, that not only additional test sites and maximum use of the current ones that we again think in terms of this risk-based approach to it.

Ms. TITUS. Thank you.

Thank you, Mr. Chairman.

Mr. LOBIONDO. Mr. Perry.

Mr. PERRY. Thank you, Mr. Chairman. I appreciate the opportunity to question. I don't sit on this subcommittee, but I have a great interest in it.

From the context of safety juxtaposed with the industry and the things that we are missing out on, I think, as well as the time it has taken to come by the rule, my mindset is many, but I am just looking at an article in the local paper. On November 14 of this year, which is not too long ago, at 4:30 in the afternoon, on a Wednesday, so it is not on the weekend, an EMS helicopter flown by a guy that I used to fly with in the military at about 600 or 700 feet AGL encountered a UAS about 50 feet away from the aircraft and, you know, did a pretty strong evasive maneuver to make sure that he didn't hit the aircraft.

Now, he didn't have his patient on board. He was coming back from having the patient on board, but that concerns me. It is not just EMS, it is, you know, reports from Kennedy where just in the same month, on November 16, one came within 10 feet of a left wing of a Delta Airlines flight, which is concerning. And so we want everybody to—hobbyists, people that want to use them for business and so on and so forth to be able to access the airspace, but we also need to make sure that we all understand what the rules are and that they make sense.

With that in mind, just one question for you, Mr. Moak. What is the cost of one of the engines on the airplane you fly?

Mr. MOAK. Millions and millions of dollars.

Mr. PERRY. I mean, literally over a million dollars just for the engine?

Mr. MOAK. Absolutely.

Mr. PERRY. So if, I mean, if it is fodded out——

Mr. MOAK. No, no.

Mr. PERRY [continuing]. If the UAS were to fly through it or hit it——

Mr. MOAK. Well, this is, just to be clear, because I think maybe this wasn't clear, this has a GPS in it. This has geocoding in it. It has the ability to do the things. When it loses lost-link, it is supposed to come back. So this going through an engine would do that damage that we showed in the earlier picture.

And to really be clear, we are all over this risk-based security, risk-based approach to it, and we also commend the steady hand of the FAA in making sure that as we bring them on they are safe. But, again, we would have a different conversation if it ran into that EMS helicopter or it was 10 feet closer to that Delta jet, you know. We need to be focused on——

Mr. PERRY. Ms. Gilligan, can I ask you a question in that regard. What specifications, if you can enumerate at this point or give us some insight, is the FAA contemplating to incorporate into UAS to ensure that pilots can detect and avoid and—pilots don't look just straight ahead in the direction they are flying. You have to look almost in 360 degrees. You can't look behind you, but—and then if you could address all-weather capability of UAS and what the plan is for that anonymous operation. If that aircraft were to hit the other aircraft, how do we know who owned it? And then maybe liability, if that is germane to this current conversation?

Ms. GILLIGAN. Thank you, Congressman. On the question of standards, we have several groups that are industry groups that are working on advising us on what those standards should be. Through the RTCA, we have had a special committee working on UAS standards. They expect to put forward their first set of draft standards around this time next year, with final standards due about a year after that, which is the standard process that we use when we are setting new design standards.

In the meantime, we do have some applicants who have come in to get certification for their vehicles. They are working out of our Los Angeles Aircraft Certification Office. We are approaching the certification basis with those applicants by looking at our current regulations and identifying those that are appropriate for this kind of technology.

As it relates to small UAS, we do have a rule that will be coming out shortly which will make proposals around a number of these areas, and we will look for comments back on those as well.

Mr. PERRY. For instance, lighting, a strobe or after hours a darkness required lighting, proximity warning or TCAS or something of that magnitude. And then if you could address the anonymous component or the ability to track who owns it if there is a liability issue?

Ms. GILLIGAN. Again, we do not have existing standards for the design or manufacturer of unmanned aerial systems for civil use. That is why we are working with RTCA and ASTM, both of them internationally recognize standards setting organizations to define working with the industry, what should those standards be. And that is work that is underway and that the community completely agrees needs to be well developed to address just the kinds of risks that you are talking about.

The other issue, which is something we are seeing now, the operation of small UAS by people who are able to buy them but who have no aviation history or experience, and who, in many cases, don't even realize they have a responsibility to know that they are operating in the National Airspace System.

Our first approach to that is through education. We are doing a tremendous amount of outreach. We are working with manufacturers who are voluntarily putting information into the kit, into the box when you get it, about what those responsibilities are, if you are going to operate a small UAS. They are directing people who buy them to look at the, modeling the American Modelers Association Web site, which has a tremendous amount of safety information for the operation of these kinds of small vehicles.

The dilemma is not many of the folks who buy these are really modelers as you and I might have understood that, which was about building the airplane and the joy of that. As Captain Moak indicates, you can now purchase small UAS very easily and fly them pretty quickly after you have gotten them to your home.

Mr. PERRY. Thank you. I yield.

Mr. LOBIONDO. Ms. Esty.

Ms. ESTY. Thank you, Mr. Chairman, for holding this hearing on the future of unmanned aircraft systems, and I want to thank all the witnesses.

I am sort of at the opposite end of our spectrum from Representative Titus. I live in the State of Connecticut where we have some of the most congested airspace in the country. And so for my State, which has been long at the forefront of aerospace design, I see both tremendous opportunity for American businesses and for workers in my State, but also serious risk. I was at an event recently, a charity event, which I had my first encounter with a drone, which was a little hard to actually be appropriately reflective during a benediction while a drone was overhead. So it kind of brought home what the reality of that is.

So I want to return to one of my favorite topics, which is NextGen, and ask several of you, and it really goes to your point, Ms. Gilligan, I don't think we can rely on the hobbyists here to take the time that modelers have always taken because they see themselves in the aviation space. These are people who are enjoying toys in some cases and don't have that sense of responsibility of if seagulls can take down an aircraft, what do we think something out of metal can do? And all it is going to take is one horrific accident.

So I would like to ask you, Captain Moak, can you talk a little bit about how you see what we need to do in NextGen to keep your pilots and all of the air passengers safe in this country, what we need to be doing with NextGen and how quickly and what resources and how we need to integrate—and, Mr. Hampton, you are next on deck on this—about the utter importance of integrating both of these together, which I think is tremendously important. We need to move very rapidly. Thank you.

Mr. MOAK. OK. So we work with the unmanned aircraft systems groups, and they shouldn't be defined by this because they also have the same concerns we have of one of these causing an accident, all right. So the risk-based approach where we are working with them on, we are working with the FAA.

On NextGen, the larger type of systems that would be in the airspace, there has to be a way for the pilot in the cockpit, if it is going to be in the same airspace to be able to see it. There has to be a way for our controllers, who keep the airspace very safe, to be able to see it on their scopes, in their control room.

Currently, you know, we do that with IFF. We have ADS–B In and Out with NextGen coming on line, and I am confident that these technological challenges that we are facing here, going through a process, same kind of process we use to certify aircraft and operators, that we will be able to do that at some point. But right now, they are being defined by this. And what we have to be mindful of is, as the airspace gets more crowded, not less, that we have those same capabilities. When the Air Force comes and the NextGen Committee sits on it, their concern is how they are going to be integrated in the airspace, ADS–B In and Out and whatnot. So I think that is really the focus and the tie-in with NextGen, Congressman.

Ms. ESTY. Mr. Hampton, about this integration effort of NextGen with UAS.

Mr. HAMPTON. Currently a lot of today's discussion has been focused on the smaller UAS. When we did our review last year, we noted that some UAS are operating today. Of those that are authorized, referred to as "COA," there are about 500. DOD operates them now in the NAS. They are on the border, Albuquerque Center, Los Angeles Center. And only preliminary work has begun to look at the air traffic control systems and the adjustments that have to be made.

In particular, the automation systems such as the $2.4 billion ERAM system, a flight planning system, are going to have to be adjusted. Another one we talk about is the voice switch. Today, most of the discussion has been about how pilots talk to controllers via voice commands. Now that discussion is going to have to be with the person that is operating the system that is on the ground, not in the cockpit of the aircraft.

So a great deal of work has to begin to think about how air traffic control systems will need to be adjusted. Some work has begun. It is in its infancy and that has to be done now. I think the planning and requirements adjustments, that is something that has to be done very quickly.

Ms. ESTY. And if anyone has got thoughts on the funding, you know, if this is appropriate to go to the industry to seek the resources to realize both the safety but also the opportunity for industry. And if anyone would care to get into that, I would love to hear your thoughts.

Mr. LOBIONDO. Your time is just about expired.

Ms. ESTY. Thank you.

Mr. LOBIONDO. Mr. Farenthold.

Mr. FARENTHOLD. Thank you very much, Mr. Chairman.

We will start with Ms. Gilligan. We created section 333 to push the FAA to begin allowing small U.S. operations before finalizing the rule. You all stated the goal was to approve these petitions within 120 days; however, only 7, according to my figures, have been granted to date, and 60 applications are past the 120-day window. What is the status of these petitions, and can we expect to see more timely response to them, especially with regard to areas you have predesignated as the test site? It seems obvious that you can let the airmen know that in these areas, there is going to be a presence of UAVs, you can dedicate airspace to them. You certainly ought to be able to streamline around the test centers.

Ms. GILLIGAN. Yes, sir. I am pleased to say that there were 5 additional exemptions that were issued today, so there are now 12 exemptions that have been granted. But——

Mr. FARENTHOLD. There are 200 filed?

Ms. GILLIGAN. I believe it was slightly over 160, but we will confirm that number for you. Having said that, we agree that we need to speed this up a little bit. Each of them is somewhat more unique than we were anticipating, but we are learning quickly as we thumb through this first set.

As to the test sites, we actually believe that the statute intended for them to be separate from the test sites. They are for commercial service, which is actually not the reason for the test sites. The test sites are about research and development.

Mr. FARENTHOLD. Let me ask you real quick with commercial service.

Ms. GILLIGAN. Sure.

Mr. FARENTHOLD. First off, I am also worried about the cat being out of the bag. I have got a quadcopter on my Christmas list, as I suspect quite a few people do. So at some point, there are going to be so many of these that are out without—we are not going to know who owns them. I mean, you can look back to the FCC and the walkie-talkies, they came with a card where you are supposed to register them but nobody did. And I think this is a more dangerous scenario, and it is something that I think you guys need to be putting a priority on. When there are too many of these out here capable of going, you know, beyond a couple hundred feet and actually being able to go up to 6,000 feet, we have got a problem, and our failure to regulate them we are going to have a genie-out-of-the-bottle issue.

So I am going to ask Dr. Dillingham: You studied this; how can we speed this up? I mean, things move at Internet speed now. These are considered tech devices. Silicon Valley gets stuff done in weeks not years.

Dr. DILLINGHAM. Yes, sir. This is a situation that, although we have studied, we don't have an answer before because, as you pointed out, we are talking about civilians, regular public using these kind of platforms, and there are already existing regulations that the modelers follow but the public has not adhered to it. Because I would argue——

Mr. FARENTHOLD. Do we have the resources to enforce that against, you know, tens of thousands of these that are going to be sold this Christmas?

Dr. DILLINGHAM. It is going to be a difficult or almost impossible task because FAA already has so many calls on its resources. I think what Ms. Gilligan said earlier, probably is one of the best steps, that is, education for the public that there are, in fact, rules and regulations that they need to follow. And when we see these public announcements of individuals being fined or otherwise, the FAA acting on them, that probably is going to have to be one of the incentives as well.

Mr. FARENTHOLD. I mean, even the existing regulations, assuming they were enforced, let's say I buy a quadcopter, put a GoCam on it and go out to my friend's ranches and film some deer around a deer feeder. I am perfectly legal at that point. I post that to my blog that has Google ads on it, all of a sudden I have probably crossed into a gray area of commercial use. And, I mean, that is a lot of fine line distinctions to have to educate the public about.

Dr. DILLINGHAM. I can't argue with that, sir. You are right.

Mr. FARENTHOLD. All right. And Ms. Gilligan, I will give you an opportunity to answer my question or concern that we are operating at the speed of the Internet, and if our regulations can't keep up with technology and there are so many of those out there, we are really going to have a dangerous situation. Is there a sense of urgency?

Ms. GILLIGAN. Yes, sir, there is within the FAA. As I commented in my opening remarks, our small UAS rule has been delayed beyond what any of us think is acceptable, but we believe our balanced proposal will be out shortly and will start to get comment and finalize those rules.

Mr. FARENTHOLD. Thank you very much. I see my time is expired.

Mr. LOBIONDO. Mr. Massie.

Mr. MASSIE. Thank you, Mr. Chairman.

Ms. Gilligan, you mentioned that a rule would be coming out shortly, and Mr. Hampton, you have documented the ways that we are kind of behind schedule. I understand that things rarely go according to schedule, whether you are in the private sector or the public sector, but when you say a rule is going to be coming out shortly, to quote a colleague, is that in a geological time scale or in Internet speed?

Ms. GILLIGAN. The proposal is under executive review at this point, sir, so I really can't tell you exactly what the timeframe is. But as I said, I think all of us who are involved in the project understand how important it is to get this out as quickly as we can.

Mr. MASSIE. I would be remiss in my oversight responsibility here if I didn't get a date or some kind of commitment at this hearing so that when we are at the next hearing we can measure progress toward that. What are some of your goals in the next year?

Ms. GILLIGAN. Well, for the rulemaking, the Department of Transportation has a Web site which shows the rule as scheduled for release at the end of this year. Once the rule is released it will go out for public comment. That period will last anywhere between 60 to 90 days, depending on what the community asks for. There is some concern that we will get a substantial number of comments which will delay how quickly we can get to the final rule, but we will certainly keep the committee informed of how we are progressing once we are able to publish the rule.

Mr. MASSIE. To Ms. Esty's point earlier, how are we going to make sure these rules are copacetic with the NextGen? Is putting

ADS–B in every drone, is that going to be one of the answers? Would that allow them to interoperate?

Ms. GILLIGAN. Well, sir, I can't really comment on what is in the rule because it is a pending rulemaking. But, as I said, we have the industry very tightly involved with us in determining what should be the design standards for these kinds of platforms, when they are to be certified by the FAA. So we will base our decisions on what the community recommends.

Mr. MASSIE. One of my concerns for drones and the commercial development of them is if you require something like ADS–B and there is no low-cost solution to that, are we throwing up another impediment, because the low-cost solution to ADS–B doesn't exist right now for private aircraft? And do you see any progress in that field?

Ms. GILLIGAN. Well, again, the industry and members of the committees who are advising us know that they must address the risks that are posed by the ability to sense and avoid other aircraft and for the unmanned platform to be able to be seen by both controllers and pilots in the system. They are working hard on what exactly those technology solutions can be, and we are sure they will find them.

Mr. MASSIE. I know you don't want to comment on a rule because it has not been released, but can you give us some indication, is it going to be risk based, or to what degree will you incorporate those recommendations of a risk-based strategy?

Ms. GILLIGAN. I can tell you that we did take a risk-based approach. It is the approach we use now for all of our standards. We also look at performance standards rather than directing particular technology solutions, for example. Those are just the general policies that we follow.

Mr. MASSIE. So I have got a question for Mr. Kallman, or Dr. Roy here. Some experts have talked about integrating privacy by design. You know, we are talking about safety, what about privacy here? This is a concern, a genuine concern that the larger public has, I think. Are you aware of any technology solutions to the privacy issue?

Mr. KALLMAN. To the privacy issue, and I think it is important to state that privacy is definitely one of the things of utmost importance for the UAV industry and a lot of companies in it. And to your point on privacy by design, I think a lot of manufacturers are engaging this today and doing things like restricting, for example, where cameras can and cannot turn on and board the aircraft, protecting that valuable information. But ultimately, I feel that privacy is really independent of the type of technology that is collecting that information. I feel that privacy is really about what information is private, what information is public, and ensuring that we protect that independent of the different types of collection methods.

Mr. MASSIE. Dr. Roy.

Mr. ROY. I would also like to add that privacy is a little bit of a moving target and it varies from not just country to country, but across the U.S. as well. And it is really a question of expectations. I think that when we talk about, your suggestion of privacy technology, I think so long as the public understands what information is being collected and has clarity into that, then that will go a long way towards actually defining privacy.

Mr. MASSIE. Quick question. I don't know if there will be time for an answer. But one of the things in addition to a ceiling that I would like to see is a floor. What is a reasonable expectation on your property? If something is an inch above the ground, is it trespassing? If it is 10 feet above the ground, is it trespassing? And do you have the right to engage a trespasser? So that is something that I would like to see considered along the privacy lines. I think my time is expired.

Mr. LOBIONDO. It has.

Mr. MASSIE. OK. Thank you, Mr. Chairman.

Mr. LOBIONDO. Mr. Larsen.

Mr. LARSEN. Thank you, Mr. Chairman. I understand, because of the number of folks you have and the number of folks we have, we will kind of go at two to your side and one to our side and get through this.

I want to yield a little bit of time to Mr. DeFazio who has a question and then I will take the rest of the 5 minutes.

Mr. DEFAZIO. I thank the gentleman and try to do this quickly. You know, when we see these things in the New York airspace, have we found anybody operating illegally who was putting people at risk? I mean, you have talked about some commercial violations. Have you caught anybody who has like put people at risk with one of these things?

Ms. GILLIGAN. I can't make the correlation, sir, to some of the reports that we had and some of the cases that we have pursued.

Mr. DEFAZIO. Right, because we don't know who is operating them, who owns them or anything. How about a system where we require registration, licensure with user fees. The user fees go to help you with the deficiencies in your budget and you vary the license according to the uses and the weight and the capabilities so the cost, you know, would be appropriate, so it is not going to be burdensome on, you know, little small—but, so anyway, think about that. There is no real answer now, but I think that is the way to go. We need to know who has these things, who is operating them. And, you know, people are putting people at risk, taking a plane down. They have got to be prosecuted. Thank you.

Mr. LARSEN. Thank you.

So Mr. Hampton, the FAA UAS working group has recommended the integration office be placed at a higher level with the FAA. Have you looked at or do you have an assessment of whether or not you think moving the UAS integration office would help coordinate efforts better across the agency?

Mr. HAMPTON. That is a very good question, and for industry that is a significant concern. At this time, I think we are more concerned about outcomes. And going forward in the reauthorization process, I think we would have to look a year from now and see the outcomes and whether things have advanced. The FAA is going to quickly move from a situation of planning to actual execution on a number of fronts. I think we would have to wait until about a year from now and see where we have gone with the execution of the rule, where we have gone on FAA's response to a number of our recommendations, such as developing and executing a framework for collecting data, and where we have come with the test sites. So I think that is a very real possibility.

I am not too concerned about how FAA is organized and structured, but rather on outcomes, sir. And I think that is a very good question. The office is structured and it does a very good job of coordinating. A year ago we were concerned about staffing levels. They staffed up. We are also concerned about the requirements of what is important for it to actually begin to develop the regulatory framework and do controller training. We are concerned about requirements and the position of the office to execute plans and make things happen with a sense of urgency. So I think we would have to take a look at that in about 6 months to a year, sir.

Mr. LARSEN. All right. Just for the record, I am hopeful we will be done with this reauthorization well before that year is up.

Mr. HAMPTON. Yes, sir.

Mr. LARSEN. Dr. Dillingham, from your discussion with test site operators and other stakeholders, do you have any thoughts about how test sites could increase level of participation in the UAS integration efforts?

Dr. DILLINGHAM. Yes, Mr. Larsen. In our conversations with the test sites, in addition to the blanket COA that Ms. Gilligan talked about and the appointment of the air worthiness director, the test sites also talked about perhaps they could be a part of FAA's approval process of the section 333. That number is going to increase, and it is a workload burden on FAA. We are hearing that it will be 2 or 3 years before we have a rule. So in the meantime, any tools that are available to further the idea of commercial use of UAS will certainly be helpful.

Something was talked about earlier, again, is the development of an integrated budget that allows FAA to be more supportive of the test sites, as well as, again, we bring back, the issues around the antideficiency law that can be somehow dealt with so that it allows FAA to adhere to the law but also be supportive of the test sites.

Mr. LARSEN. Yeah. OK.

Captain Moak, just one final question on this: How are ALPA pilots communicating their misses of unmanned aircraft to FAA? Is there a structured way to do that, and are you confident that every near-miss that is seen is being reported?

Mr. MOAK. So if you see one of these, you are going to take action to avoid it. You are then going to report it to the controlling authority. So if we are out in the approach corridor, we are going to be talking to the approach and let them know immediately so that they can make sure someone else doesn't go in the same airspace. If we are on the tower frequency, we would report it to tower at that time. Then once we are on the ground safely and have gotten to the gate, we have an ASAP reporting program that we work with the FAA and the companies with. We report it through that so that everybody can know about it.

I am confident that when someone sees it we are reporting it; I am not confident that we are seeing them, because they are very small. And like I was saying earlier, we don't have any indication in the airplane like we do with TCAS with the other aircraft, and the relative motion necessary for your eye to be able to pick it up is difficult, especially this size, maybe just a little bigger. So it is a real issue. Our pilots are reporting them and we just need to stay on top of it.

I would like to see us take some kind of construct on this type of problem that we took with the green laser problem we were having and we became a lot more successful on reporting and also prosecution of people that were pointing those lasers at pilots on final.

Mr. LARSEN. Thank you.

Mr. LOBIONDO. Mr. Davis.

Mr. DAVIS. Thank you, Mr. Chairman.

I echo the comments that Chairman LoBiondo and Chairman Shuster on UAS, both from a safety perspective as well as an opportunity for economic growth. The briefing materials that we were provided by the committee cite that UAS systems will have an $82 billion economic impact and possibly provide up to 100,000 jobs by the year 2025. So my questions should be viewed through that lens.

I would like to start with Associate Administrator Gilligan. One of the benefits I see with the UAS is more efficiency in rural areas, like the one I represent, especially viewing farmland and precision agriculture could be aided by UAVs and we could reduce the costs of the farmers' input and also make sure that we have proper drainage and better production, better environmental impact. So one thing that can hamper this is a requirement, if the rule required a pilot's license in order for a farmer to operate a UAV.

Can you confirm that the small UAS rule would require a farmer in my district to actually get a pilot's license in order to use one?

Ms. GILLIGAN. Unfortunately, sir, because we are in rulemaking, I am not able to talk about what is contained in the rule. We are very mindful, however, of how easily UAS could be applied to agricultural operations. Of course, we also have a very active ag pilot community that we are dealing with, as well, who are very concerned about operating in airspace with these kinds of platforms. So we are looking at how we can address all of those safety risks and how they can be mitigated.

Mr. DAVIS. Thank you. Please note my concern of requiring that, if that is going to be part of the rule.

Dr. Roy, the FAA's slow pace may be causing our best and brightest to maybe leave the United States, especially when you look at major U.S. tech companies that have moved their research and development operations overseas. Do your students have better job opportunities outside the United States in this field?

Mr. ROY. So the field is small right now in commercial UAVs, so the job opportunities are few and far between in the U.S. and in other countries. But I think you have heard from several people that the rate at which the opportunities are growing in other countries possibly is going to lead to a lot more opportunities. I would say that it is immeasurably small around the world right now, but I would worry that there are many more—I personally am seeing more startups, very, very small startups, but more startups outside the U.S. than in the U.S.

Mr. DAVIS. Mr. Kallman, one of the major issues with UAVs is the flyaway problem, you know, where they lose connectivity and fly away. It affects consumer UAVs but also very high-end aircraft with the military. How do we mitigate that risk and how do we integrate this into our aviation system?

Mr. KALLMAN. Yeah, and I think to reiterate also that safety again is of utmost importance, and I think with the flyaway issues, that is a matter of technology. I think that the technology is increasing at a very rapid pace. I mentioned earlier a lot of the functionality in a lot of these systems to manage a lot of issues that happen on board the aircraft, typically that is where you will see those types of things. You will lose the GPS or something along those lines, so making sure that systems have the ability to know how to automatically respond should any system fail on board the aircraft and be able to return it to a location that is determined safe before the flight. So I think those will be very, very important to ensure.

Mr. DAVIS. All right. Captain Moak, safety is paramount on the flight simulators that many of your pilots use to train. Is there a simulation for UAVs?

Mr. MOAK. Not per se, but there is simulation for, you know, detect and avoid, you visually pick up something, or if you have a situation where you are losing control of the aircraft because perhaps you had to maneuver it, maneuver it in a manner that you wouldn't normally be maneuvering it, meaning you were banking it excessively and how you recover from that upset situation. We do have that.

Mr. DAVIS. Thank you, Captain. And thank you, all, for being here today. Obviously, this is an issue that we should be able to address. We have seen unmanned aircraft fly sorties within the theater of war in a much smaller area than they have done it safely. We ought to be able to not fall behind countries like Canada in putting together a rulemaking process so that we can get commercial UAVs into the marketplace and do it in a way that is going to be safe.

I have concerns too with our medical helicopters. I am in the flight line of my house in Taylorville, Illinois. I want to make sure that we have these rules in place. We can do this. So I appreciate your work and look forward to hearing you at the next hearing.

Mr. LOBIONDO. Thank you.

Mr. Graves.

Mr. GRAVES. Thank you, Mr. Chairman. I think most all the questions have been asked, but a couple of comments I would like to make, and I was pleased to hear Ms. Gilligan mention agriculture, because I am very concerned about that. During the periods between May and August, at least in the Midwest, we have heavy traffic at and below 300 feet that is going to and from the airport and that is on the site where they are spraying too, and it is a big concern. And there is a huge potential out there for UAVs and in the agriculture sector, but they are in that same airspace and it concerns me a great deal.

And, you know, this comes down to, and Captain Moak mentioned it, it comes down to visibility and being able to see these things. And I don't necessarily know what the answer is. I don't think transponders are necessarily the answer. That certainly gives air traffic control visibility on them, but if you are on a VFR flight plan, you are not talking to air traffic control. You don't have the benefit of that site.

ADS–B, you know, if we put ADS–B Out on them, obviously, that is going to paint them. But you have got to have ADS–B In to be able to, you know, read that as well. And it still comes down to situational awareness. And, you know, obviously the people that are flying the aircraft, or at least the manned aircraft, they have got that situational awareness.

But just as Captain Moak pointed out, you know, a VFR aircraft traveling at 100 knots, right on up to our airlines traveling at 350 knots, and everything in between. You are moving pretty fast and that is awful small and it is very hard to see it, particularly if there is no relative motion. So I have got a huge concern with how we are going to move forward. And, you know, I hope you are—and I know you are being very diligent in this, and I am not so sure that we don't need to take a more active role in Congress as well when it comes to reauthorization.

But it concerns me. It concerns me in a big way. And we haven't even began to talk about this safety of individuals on the ground when these things do go rogue and what happens to those folks. We are just talking about aviation and the potential, and I don't want to run into one. I don't. You know, interestingly enough, there are a lot of birds out there and we have bird strikes, but birds have situational awareness too, and they will get out of your way, for the most part. But this is a big concern, I guess. There is no question in that, but we need to move very, very carefully as we move forward.

Mr. LoBiondo. Thank you, Mr. Graves.

Mr. Williams.

Mr. Williams. Thank you, Mr. Chairman.

And I would like to thank all of you for being here today. Appreciate it. I am from Texas. We have got a lot of airspace in Texas. And my question to you would be, Ms. Gilligan, as companies look for economical ways to modernize their delivery systems, unmanned aircraft systems are looking more and more attractive as we learned today.

Amazon Prime Air is currently investigating the possibility of using small drones to quickly deliver their packages to their customers. My office has met with Amazon Prime Air and learned that they are having some difficulties getting permission from the FAA to test their delivery system outdoors in a rural area in Washington State. Would you please give this subcommittee an update on Amazon Prime Air's petition for an exemption under section 333 of the FAA Modernization Reform Act of 2012 that would allow them to test the system outside here and in the U.S.?

Ms. Gilligan. Yes, sir, I would be glad to. They have applied for the exemption, and we have worked closely with Amazon. We have been in regular contact with Amazon since, I would say, over a year ago when they began pursuing this project. We believe though, to some extent, that what they want to be able to do they can do with a research certification for the vehicle, and we are also working with them on taking that approach because we think that will fit their needs better.

We and they are having those conversations. We know they are not satisfied that they have to go that path, but I am certain that we will reach some conclusions shortly so that we and they can figure out exactly how to support what it is they are trying to do.

Mr. WILLIAMS. Thank you. My second question would be also to you, Ms. Gilligan. Looking to the future, do you see a time when the FAA will have an Assistant Administrator for unmanned aircraft systems, and if not, why, and if so, what do you think the FAA is doing to prepare for this change?

Ms. GILLIGAN. We believe that unmanned systems are actually like many other of the technologies that we have brought into the system over the years, and so we do believe that there will be full integration and that that will be handled within the structure that we currently have. We do not see a need at this point for a separate organization, because, again, we need to make sure that the aircraft itself in those systems are integrated in both design and manufacture with the aviation system and that the operations are integrated with the operation of the rest of the aviation system. So that is the approach that we are pursuing.

Mr. WILLIAMS. Thank you. And Mr. Chairman, I yield back.

Mr. PETRI [presiding]. Thank you. Mr. Rokita.

Mr. ROKITA. I thank the Chair for the indulgence. I am not on the committee yet, but I appreciate the time to ask some questions. I have six pages of notes here, which for me has been kind of an all-time record, so I can tell I am going to hate being on this committee.

I thank the witnesses for their testimony. Mr. Roy, let me start with you. If I heard your testimony correctly, it seemed like you were defending the FAA process here and where they are at when you said, look, other countries might be ahead in terms of the regulatory schematic right now, but they are still going to incur the technical difficulties. Did I get that accurately?

Mr. ROY. That is correct.

Mr. ROKITA. OK. So, then, those countries must be acting with reckless abandon or something.

Mr. ROY. No. I don't think that is—that is true. So the——

Mr. ROKITA. So if that is not true, then why can't we follow the same path?

Mr. ROY. So let me draw a distinction between a small number of flights that demonstrate a capability or provide a service and the—what is required in order to service all of, say, agriculture and the U.S. So a good example is Japan. So Japan is sort of a high-water mark in terms of precision agriculture, in that about somewhere between 30 and 40 percent, and the numbers are a little unclear, are sprayed using Yamaha RMAX helicopters. It is interesting that one model of aircraft is providing service for about 77 percent of all the UAV, and it is doing so with about 2,000 aircraft. So that is a very, very small number, and the effort required to actually support that is relatively small.

So it is nice that Japan and the other countries have, you know, the regulatory infrastructure in place, the permission for testing, that allows companies like Airware and others to go and develop their technology, but the—what is required is another way of a technology actually scale up to the Amazon Prime servicing all of

DC or the Boston area. And I think that next step is what is going to be required to really grow the markets everywhere.

Mr. ROKITA. OK. Thank you.

Tangential to that line of questioning, I would like to ask any of you if you are aware of any actuarial studies that have been done. If we are talking about a risk-based approach, right, and you have all indicated that that is a fine approach, well, insurance companies all day long do studies that analyze this using math, right? So if we are worried about a strike, you know, in an—in an approach corridor around an airport, we could take the number of, let's say, birds that are in a square mile of that airport or some area, and then let's say it is 10,000 or 20,000 or 100,000 or whatever it is, and then add the 10 drones that would be in the area potentially at the same time and see what the increased percentage of risk is.

And then we could have a discussion based on science and math and not what—not pictures and beliefs, because the fact of the matter is a bird, which does have situational awareness, I completely agree, but it still can be study—we still can determine what the risk is.

Yeah. Captain?

Mr. MOAK. So we have procedures for birds currently. So if there are birds in the area when you arrive in the terminal area, there is the ATIS system that the controllers are putting bird reports out, meteorologists are putting that information out. You can see some large flocks of birds on your radars. We have procedures if we were to have a bird strike. So there is all kinds of procedures for dealing with birds. It is not preferred method to encounter a bird.

Mr. ROKITA. But not a bird near-miss.

Mr. MOAK. Pardon me?

Mr. ROKITA. You outlined a procedure for a UAS near-miss, and——

Mr. MOAK. Bird near-miss, we have a procedure for that. You report birds in the area, because you know you have another plane coming right behind you, and you don't want them——

Mr. ROKITA. Yeah. You report flocks of birds and that kind of thing on the airport and if it is—if it is in the approach corridor, but there is not—the detailed procedure you indicated for a UAS.

Mr. MOAK. There is. If you are going to hit a flock of birds, you are going to maneuver the airplane in a manner——

Mr. ROKITA. No. I meant you get down, you call, you—then you alluded to a prosecution element that was——

Mr. MOAK. You can't prosecute a bird.

Mr. ROKITA [continuing]. Inherent with the laser stuff, which is an intentional act, you know, so—but my question is about the actuary studies. Have there been any actuarial studies?

Mr. ROY. So——

Mr. ROKITA. Dr. Roy.

Mr. ROY [continuing]. For the larger aircraft, I think that is absolutely the case. For the small aircraft, the vehicles, et cetera, I think the answer is no, and there is a couple reasons for that: one is that we don't have good models of the—we don't have good failure models for a lot of the components; and the second thing we don't have good models yet for the consequences of failures. So a bird strike actually might be one that does exist, but for a lot of the other failure models, I am reasonably certain they don't exist.

Mr. ROKITA. Will they be helpful?

Mr. ROY. They will be extremely helpful.

Mr. ROKITA. Thank you. I yield back.

Mr. PETRI. Thank you.

If there are no further questions, I would like to thank all the witnesses for their testimony, and in absentia, the other Members for their participation in today's program. The subcommittee stands adjourned.

[Whereupon, at 12:07 p.m., the subcommittee was adjourned.]

STATEMENT OF MARGARET GILLIGAN, ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE TRANSPORTATION AND INFRASTRUCTURE COMMITTEE, SUBCOMMITTEE ON AVIATION, U.S. UNMANNED AIRCRAFT SYSTEMS: INTEGRATION, OVERSIGHT, AND COMPETITIVENESS, DECEMBER 10, 2014.

Chairman LoBiondo, Ranking Member Larsen, Members of the Subcommittee:

Thank you for the opportunity to appear before you today to discuss unmanned aircraft systems (UAS). The Federal Aviation Administration (FAA) has successfully integrated new technology into the National Airspace System (NAS) for more than 50 years, while maintaining the safest aviation system in the world. In the FAA Modernization and Reform Act of 2012, Congress mandated the safe and expedient integration of UAS into the NAS. We have been working steadily to accomplish that goal. The FAA has taken several key steps to integrate UAS into the NAS.

Progress Toward Integration

In the 2012 FAA Modernization and Reform Act, Congress mandated that the Secretary of the Department of Transportation (Secretary), in consultation with other government partners and industry stakeholders, develop a Comprehensive Plan to safely accelerate the integration of civil unmanned aircraft systems in the NAS, as well as a five-year Roadmap. Both documents have now been published.

The Integration of Civil UAS in the NAS Roadmap outlines the tasks and considerations necessary to integrate UAS into the NAS. The five-year Roadmap, updated annually, provides stakeholders with proposed agency actions to assist with their planning and development. The UAS Comprehensive Plan was drafted by the Joint Planning and Development Office (JPDO), in coordination with JPDO Board participants from the Departments of Defense (DOD), Commerce (DOC), Homeland Security (DHS), the National Aeronautics and Space Administration (NASA) and the FAA. The Comprehensive Plan details work that has been accomplished, along with future efforts needed to achieve safe integration of UAS into the NAS.[1] It sets overarching, interagency goals, objectives, and approaches to achieving integration. It is a document that considers UAS issues beyond 2015, including technologies necessary for safe and routine operation of civil UAS and the establishment of a process to inform FAA rulemaking projects related to certification, flight standards, and air traffic requirements.

UAS Test Sites

On December 30, 2013, the FAA announced six UAS test sites. In selecting the sites, the FAA followed Congressional direction to consider geographic and climatic diversity and to consult with DOD and NASA. The FAA selected the University of Alaska Fairbanks, the State of Nevada, New York's Griffiss International Airport, the North Dakota Department of Commerce, Texas A&M University Corpus Christi, and Virginia Polytechnic Institute and State University (Virginia Tech) to serve as UAS test sites.

Consistent with the Congressional mandate, the FAA set out to have at least one test site operational within six months. On April 21, 2014, within four months of selecting the site, the FAA announced that the North Dakota Department of Commerce was the first test site to be operational. On May 5, 2014, the second test site, University of Alaska Fairbanks was declared operational. On that day, both operational UAS test sites conducted their first flight operations. On June 9, 2014, the FAA announced that the State of Nevada became the third operational UAS

[1] The Integration of Civil UAS into the NAS Roadmap and Comprehensive Plan are available on the FAA UAS website at http://www.faa.gov/uas/publications/.

test site. On June 20, 2014, the FAA granted the Texas A&M University Corpus Christi approval to conduct operations; four of the test sites were operational within six months of being named. New York State Griffiss International Airport was declared operational on August 7, 2014. On August 13, 2014, the sixth and final UAS test site, Virginia Tech, was declared operational.

To support and accelerate test site activities, the FAA prioritized the processing of the first Certificate of Waiver or Authorization (COA) for each of the test sites. Since then, the FAA has continued to process test site COAs expeditiously. Since the inception of the test site program, the FAA has approved 40 COAs for UAS operations at the test sites with an average processing time of 57 days per COA, which surpasses the FAA goal of 60 days for all COAs. At the FAA/UAS Test Site Technical Interchange Meeting in September, the test sites indicated that they plan to submit 57 COA and 14 experimental certificate requests in the next year. We are prepared to process their requests expeditiously and look forward to continuing to work with the test sites to facilitate their operations and advance our research goals.

The FAA implemented a Designated Airworthiness Representatives program which will permit Test Site designees to issue experimental certificates for unmanned aircraft. To help the test sites develop the capability to assess unmanned aircraft and issue these certificates, the FAA developed both online and in-person training. Once test site designees have completed FAA training, they will be authorized to work within this new program. The State of Nevada was the first test site to participate in the training, and it expects to complete the test site Special Airworthiness Certification this month.

The test sites play a critical role in the safe and efficient integration of UAS into the NAS. The FAA will utilize data from the test sites to help answer key questions and provide critical information about how UAS will interface with the air traffic control system. Our research goals are focused on (1) gathering system safety data, (2) aircraft certification, (3) command and control link issues, (4) control station layout and certification criteria, (5) ground and airborne detect and avoid capabilities, and (6) impacts on affected populations and the environment. The information provided by the test sites will help the FAA to develop regulations and operational procedures for future civil commercial use of UAS in the NAS. Data from the test sites will also help identify elements of the certification and navigation requirements we will need to establish for unmanned aircraft.

UAS operational pre- and post-flight data is currently being collected from all test sites. The test sites are providing data about the types and sizes of aircraft, number of operations, number of flight hours, notable operating parameters (for example, whether the flight was within or beyond visual line of sight), and any incidents and accidents. Each site has also established its own research agenda. I'd like to highlight just a few of the activities underway at each test site.

- The North Dakota Department of Commerce test site has conducted more than 84 flights, with research concentrated on wildlife census and precision agriculture studies.
- The University of Alaska Fairbanks test site encompasses 3,369 cubic miles of airspace in Alaska and Oregon. It is expanding flight operations into Kansas with the recent approval of Kansas State University as a new team member. The research conducted at this test site includes forward-looking infrared technology to support surveying large land mammals and using UAS to meet operational firefighting needs and provide tactical police support.
- The State of Nevada became the first test site to participate in Designated Airworthiness Representative training. Nevada expects to complete the test site Special Airworthiness Certification this month, leading to the first Special Airworthiness Certification issued

under the Designated Airworthiness Representatives for UAS Certification at UAS test sites program. Nevada's research will concentrate on UAS standards and operations, as well as operator standards and certification requirements.

- Griffiss International Airport has conducted 31 flights using three different vehicles. In cooperation with Lockheed Martin, Griffiss International Airport test site has conducted Optional Piloted Aircraft research, testing a rotorcraft with and without an onboard pilot for firefighting research.

- Texas A&M Corpus Christi created a fully operational UAS command center with advanced toolsets and is pursing solutions that will incorporate air traffic control data to augment operational safety mitigation strategies. Research activities include precision agriculture and coastal monitoring.

- The Virginia Polytechnic Institute and State University (Virginia Tech) hosted the second FAA/UAS Technical Interchange Meeting for the FAA and all six test sites in September 2014. This test site includes Virginia, Maryland, and New Jersey. Research in these three states will include agricultural spray equipment testing, developing training and operational procedures for aeronautical surveys of agriculture, and the development of aeronautical procedures for integration of UAS flights in a towered airspace.

We continue to work closely with the test sites to identify the data most useful to the FAA.

FAA personnel at the William J. Hughes Technical Center in Atlantic City, NJ, play a key role in data collection and analysis. The FAA Technical Center has served as the core research facility for modernizing the air traffic management system and for advancing programs to enhance aviation safety, efficiency, and capacity since 1958. The Technical Center is the nation's premier air transportation system laboratory. The Technical Center's highly technical and diverse workforce conducts research and development, test and evaluation, verification and validation, sustainment, and ultimately, de-commissioning of the FAA's full spectrum of aviation systems. Its employees develop scientific solutions to current and future air transportation safety, efficiency, and capacity challenges. Technical Center engineers, scientists, mathematicians, and technical experts utilize a robust, one-of-a-kind, world-class laboratory environment to identify integrated system solutions for the modernization and sustainment of the NAS and for developing and integrating new technology and operational capabilities.

The Technical Center has served a critical function in advancing UAS integration. A significant portion of test site data analysis is being performed at the Technical Center. A Data Lead from the Technical Center, regional representatives, and research engineers, are also visiting each UAS test site to evaluate how data is captured and maintained, ensure data transference and integrity, and determine whether additional data collection would facilitate meeting the FAA's research objectives. We continue to work with the test sites to obtain the most valuable information possible and facilitate further UAS integration.

Rulemaking and Exemptions

Section 332 of the FAA Modernization and Reform Act required the agency to conduct rulemaking to permit the civil operation of small UAS in the NAS. The NPRM is currently under executive review.

Consistent with the authority in section 333 of the FAA Modernization and Reform Act of 2012, the FAA, in coordination with the Secretary of Transportation, is issuing exemptions that allow for commercial activity in the NAS in low-risk, controlled environments. As directed in the Act, an exemption may be granted after a two-step process. First, the Secretary must determine that, based on certain criteria set forth in the statute, the UAS does not pose a risk to those operating in the NAS, the general public, or national security and it can be safely operated without an airworthiness certificate. The FAA will then use its existing exemption authority to grant relief from FAA regulations that may apply. The exemption process allows the FAA to carefully evaluate each request to determine what conditions are required to ensure that the operation will not create an adverse impact on safety. Once an exemption is granted, the applicant must then apply for a civil Certificate of Waiver or Authorization, permitting the operator to conduct the proposed operation. We are looking at ways to streamline the process to enable broader use of civil UAS in the NAS.

Public Aircraft Certificates of Authorization and Partnerships with Law Enforcement

For the last two decades, the FAA has authorized the limited use of unmanned aircraft for important missions in the public interest. These include firefighting, disaster relief, search and rescue, law enforcement, border security, military training, and testing and evaluation. The FAA continues to facilitate the use of UAS by public entities. More than 35 law enforcement agencies operate unmanned aircraft now under certificates of authorization (COA). We have processed COAs on an emergency basis to facilitate the efficient use of UAS technology when it advances law enforcement purposes. We have authorized COAs that allow for UAS to be utilized in search and rescue operations in less than 24 hours. We will continue to work with law enforcement agencies to ensure that UAS technology is a tool available to them when it is sufficiently safe and in the public interest.

We are also working with Federal, State, and local law enforcement agencies to address and educate the public about the unsafe, or unauthorized, use of UAS since they are often in the best position to deter, detect, and immediately investigate such activity. The FAA may take enforcement action against anyone that operates a UAS in a way that endangers the safety of the NAS, or who conducts an unauthorized UAS operation. This authority is designed to protect users of the airspace as well as people and property on the ground. State and local law enforcement can assist us in protecting the safety of the NAS by identifying individuals or entities engaged in unauthorized use, collecting and preserving evidence, and immediately reporting an incident, accident or other suspected violation to one of the FAA Regional Operation Centers (ROC) located around the country. The FAA tracks UAS events, including those reported to the FAA by law enforcement and the general public, as well as events identified by FAA air traffic control facilities. A single UAS-specific event tracking database is currently in development and will be deployed by the end of 2015.

Center of Excellence

Under the Consolidated Appropriations Act of 2014, Congress directed the FAA to establish a UAS Center of Excellence (COE). The goal of this endeavor is to create a cost sharing relationship between academia, industry, and government that will focus on research areas of primary interest to the FAA and the UAS community. We intend to forge a union of public sector, private sector, and academic institutions to create a world-class consortium that will identify solutions for existing and anticipated UAS related issues. The COE will perform short- and long-term basic and applied research through a variety of analyses, development, and prototyping activities. To that end, the FAA solicited proposals from accredited institutions of higher education with their partners and affiliates. The FAA intends to enter into cooperative agreements with core university members, and will award matching grants for public benefit. Initially, grants will be awarded to university members to establish the COE, define the research agenda, and begin UAS research, education, training and related activities. We are currently in the process of reviewing proposals and look forward to establishing the COE.

The FAA has long had successful partnerships with the nation's academic research community, working with U.S. colleges and universities to foster research by COE faculty and students, industry, and other affiliates. These research efforts have provided the agency and the industry a high return on investments and have contributed significantly to the advancement of aviation science and technology over the past two decades. We look forward to continuing these partnerships with respect to UAS research as we establish the COE.

Conclusion

The FAA is committed to safely integrating UAS into the NAS. The FAA has made steady progress toward that goal through the UAS Roadmap, the Comprehensive Plan, the test sites, Section 333 Exemptions, partnerships with public entities, and the proposed Center of Excellence.

The United States has the safest aviation system in the world, and our goal is to integrate this new and important technology while still maintaining safety as our highest priority. We are committed to ensuring that America continues to lead the world in the development and implementation of aviation technology. We look forward to continuing to work together with Congress as we continue to integrate UAS into the NAS.

This concludes my statement. I will be happy to answer your questions at this time.

Questions for the Record for Margaret Gilligan, Associate Administrator for Aviation Safety, Federal Aviation Administration.

Hearing before the House Transportation and Infrastructure Committee, Subcommittee on Aviation, U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness, December 10, 2014.

Questions for the Record from Chairman Frank Lobiondo

Question 1: In his testimony, Dr. Roy indicated that having a set of clear rules to identify safe test environments throughout the U.S., instead of a process for approval or a handful of pre-approved sites, would help the U.S. keep pace with other countries. Mr. Kallman similarly talked about risk-based regulation. Is this something the FAA can achieve?

FAA Response: The six UAS Test sites were created by Congress in the *FAA Modernization and Reform Act of 2012*. They are designed as test environments for industry to have easier access to airspace and related infrastructure to support research, development and the testing of operational scenarios and are locations where industry may test operational vehicles and concepts. The FAA invested significant resources in the selection process for the six test sites and continues to be heavily engaged with providing support and guidance. Although all six test sites have been operational for less than a year, we are confident that the program will achieve the desired results and will provide valuable research and operational data that will help to answer many of the complex questions related to the integration of UAS into the national airspace.

Question 2: Please describe the FAA's process for receiving, organizing, and analyzing UAS test data in its efforts to integrate UAS into the National Airspace System. Please identify all sources of UAS test data and each of the FAA offices and facilities involved in such efforts.

FAA Response: The FAA has recently designated a data specialist for the test sites. This specialist functions as a research and development project lead and is located at the FAA's William J. Hughes Technical Center in Atlantic City, New Jersey. This specialist is responsible for collecting research-related data from the test sites and facilitating the transfer of the data to the appropriate resources in the UAS Integration Office (AFS-80) who defines research requirements and the Research and Development Integration Division (ANG-C2) who oversees the execution of work on various research and development requirements in the FAA's UAS research and development portfolio. In addition to research data, the test sites are required to also provide operational data in accordance with the operational authorization they receive through their Certificate of Waiver or Authorization (COA). This operational data is required from all COA holders, not just the test sites. Other COA holders may include public (governmental operators) and commercial operators who have been granted authorization to operate under Section 333 of the FAA Modernization and Reform Act of 2012. This COA data may be used to identify emerging safety risks or other operational trends.

Question 3: Given that many early innovations of manned flight were developed by entrepreneur-inventors, why no broadly permit low-risk commercial operations today? For example, flights over unpopulated areas or water. If the risks are low, why should the FAA object if people are trying to fine tune business models in the process of testing devices?

FAA Response: Integration of UAS into the national airspace system must be incremental and consider safety implications above all else. The UAS industry needs a location that has access to airspace and infrastructure that will enable them to develop their systems without impacting current national airspace users or create unacceptable levels of risk. This is why Congress created the six test sites – to provide industry with low risk operational areas where business models may be tested and fine tuned. It is up to the Test Sites to secure the agreements with industry partners who will use their facilities to advance their business interests. In addition, Congress specified in the *FAA Modernization and Reform Act of 2012*(FMRA) that the FAA must increase small UAS operations in the Arctic. The FAA has conducted UAS operations in Alaska in both 2013 and 2014. The low risk operations are over sparsely populated areas and overwater. The FAA intends to use the operational experience from these Arctic operations and Test Site operations to inform policy decisions for establishing permanent small UAS operational areas in the Arctic as required by the FMRA. Section 333 of the FMRA enables the Secretary of Transportation to determine if certain low-risk operations do not need an FAA-issued certificate of airworthiness because they do not pose a threat to national airspace users or national security. However, these exemptions must be applied for and granted on an individual basis and would not be applicable for broad use by multiple users.

Question 4: Does the FAA have a plan established yet for how to handle air traffic management for small UAS at low altitudes? If not, what is the status of establishing such a plan, and what stakeholders are being incorporated into that planning?

FAA Response: The FAA has partnered with NASA on research for air traffic management for UAS operating at low altitudes. We expect data from this research activity will be available starting in 2015 that will inform technology development. In addition, the small UAS Notice of Proposed Rulemaking is under executive review. It is anticipated that this rule, once finalized, will provide operational guidance for a variety of UAS operational scenarios.

Questions for the Record for Margaret Gilligan, Associate Administrator for Aviation Safety, Federal Aviation Administration.

Hearing before the House Transportation and Infrastructure Committee, Subcommittee on Aviation, U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness, December 10, 2014.

Questions for the Record from Congressman John J. Duncan

Question 1: Mapping and geospacial firms have invested substantially in research and development for unmanned aerial vehicles and systems (UAV/UAS). Aerial mapping and photography missions are performed by private sector mapping firms for clients including the Federal, state and local agencies, and especially for aviation and highway infrastructure projects and safety priorities. Currently, the only UAV/UAS market for private sector mapping and geospacial firms is to fly their UAV/UAS assets overseas. How soon will mapping and geospacial firms be able to fly their UAV/UAS commercial missions domestically?

FAA Response: The FAA has already granted exemptions under Section 333 of the *FAA Modernization and Reform Act of 2012* for mapping and geospatial firms. In addition to receiving the exemption, these firms must also obtain operational approval via a Certificate of Waiver or Authorization (COA) to ensure the proposed airspace is safe for the intended operation and that right of way requirements for the pilot in command to see and avoid other aircraft have been addressed. The FAA has over 200 petitions for exemption on file right now and is processing them. Many of them are for commercial operation in aerial imaging and mapping.

Question 2: With the FAA approving certificates of authorization (COAs), and these COAs mainly being awarded to universities and government agencies, this creates an unlevel playing field for private sector mapping and geospacial firms. What is the FAA doing to address this unlevel playing field impacting job creation and market opportunities in the private sector for mapping and geospacial firms?

FAA Response: Under Section 333 of the FAA Modernization and Reform Act of 2012, commercial operators, such as mapping and geospatial firms may petition for an exemption to airworthiness and other requirements. Once an exemption is granted these firms must also obtain operational approval via a Certificate of Waiver or Authorization (COA) to ensure the proposed airspace is safe for the intended operation and that right of way requirements for the pilot in command to see and avoid other aircraft have been addressed. Universities and government agencies must also obtain a COA, so there is no advantage process-wise of one entity vs. another. As the FAA has over 200 petitions for exemption on file right now, we are currently evaluating options to streamline the COA process for Section 333 petitioners, with the intent of making it even easier for specific, limited and low-risk UAS commercial interests to obtain operational authorization. Universities who wish to conduct operations that may be considered commercial in nature such as training may apply for operational authorization under Section 333.

Question 3: Earlier this year, the Washington Post covered the Customs and Border Patrol (CBP) UAVs used for 700 non-border missions, and in some cases for law enforcement purposes unrelated to border patrol. What is the FAA/DOT/GAO doing to regulate and account for the inefficient use of taxpayer dollars that the Customs and Border Patrol is using to fly their UAV/UAS along the borders for non-border related missions?

FAA Response: The FAA is responsible for the safety of the national airspace system and for the safety of persons and property on the ground. For government agency operations, such as those by Customs and Border Protection, the FAA is solely responsible for ensuring the operation is safe and does not pose an unacceptable risk to current NAS users. We do not mange or oversee the other government agencies' mission purpose and scope.

Questions for the Record for Margaret Gilligan, Associate Administrator for Aviation Safety, Federal Aviation Administration.

Hearing before the House Transportation and Infrastructure Committee, Subcommittee on Aviation, U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness, December 10, 2014.

Questions for the Record from Congressman Rick Crawford

Question 1: Ms. Gilligan, my district in Arkansas is home to thousands of acres of production farm land. We have significant rice production as well as soybean and cotton acres. As you can imagine, ag-producers have a lot of miles to cover to monitor their crops and recently a company has started to provide aerial monitoring via Unmanned Aircraft Systems for these producers. What are your safety concerns for this type of monitoring in these types of rural areas?

FAA Response: The FAA recognizes that UAS for precision agriculture is a significant area of commercial interest and potential. Exemptions granted under Section 333 of the FAA Modernization and Reform Act of 2012 to commercial precision agricultural operators contain specific conditions and limitations to help ensure operational safety. For example, agricultural operators who have been approved for commercial operations under Section 333 must file a Notice to Airmen (NOTAM) to advise manned aviation operators of their presence and operational profile.

Question 2: As Mr. Kallman stated in his testimony, other countries currently allow unmanned aerial systems to do monitoring of ag-producers. Do you see any similar applications to how you all will allow a company who has a UAS to help ag-producers here in America in similar uses or situations?

FAA Response: The FAA has already granted exemptions under Section 333 of the *FAA Modernization and Reform Act of 2012* for precision agriculture. There is significant interest in this area and the FAA has received numerous agricultural related Section 333 petitions in the over 200 exemptions we are currently processing. The FAA recognizes that, like many other countries, there are significant opportunities for UAS to impact precision agriculture, not only in terms of economic development, but also in terms of farmland productivity.

Questions for the Record for Margaret Gilligan, Associate Administrator for Aviation Safety, Federal Aviation Administration.

Hearing before the House Transportation and Infrastructure Committee, Subcommittee on Aviation, U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness, December 10, 2014.

Questions for the Record from Congressman Hanna

Question 1: Would the FAA be willing to delegate the six UAS test sites, in continued coordination with the FAA, the authority to expedite the certification of UAS platforms that are tested at those sites for any sort of commercial or civil purposes?

FAA Response: The FAA has delegated the authority to the Nevada Test Site to issue experimental certificates. While the other five test sites have expressed interest in this delegation authority, none of them have thus far applied to receive it.

Question 2: What are the primary obstacles that have led to Certificates of Authorization for the UAS test sites taking an average of 57 days to approve when the test sites have already been certified by the FAA and have established comprehensive safety programs and operating procedures?

FAA Response: The FAA has a publically stated metric of 60 days for the processing of Certificate of Waiver or Authorization (COA) applications. Test site COAs, on average, have been awarded in this timeframe. However, the FAA recognizes that the test sites, in order to support their industry partners, need an expedited process to obtain operational authorization. In an effort to provide this expedited process, we are currently evaluating "broad-area" COAs that will give the respective test sites access to much wider areas of airspace. Once we have fully evaluated this concept and considered safety implications we will move forward with a decision.

Question 3: Recommendation 10 of the Department of Transportation's Office of Inspector General (DoT-IG) June 26, 2014 Audit Report entitled "FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems into the National Airspace System" directed the FAA to "establish a more detailed implementation plan with milestones and prioritized actions needed to advance UAS integration in the near, mid, and long term." Within their response, the FAA stated to the DoT-IG that they would develop a UAS Integration Strategy by August 31, 2014. One of the purposes of this strategy was to "define a clear path to external agency and industry engagement and consensus-building." Has this UAS Integration Strategy been finalized yet? If so, can you please provide the text of this UAS Integration Strategy to my office? If it has not yet been finalized, can you provide any updates regarding the status of its completion?

FAA Response: The FAA contracted with MITRE to develop a long-term UAS integration strategy. We received the draft plan in September 2014. We are currently further refining this plan and are developing the mid-term strategy that will lay out the FAA's integration priorities to be considered after the small UAS rule is fully in effect. We anticipate that the further refinement of this long-term plan and the finalization of these mid-term steps will happen in 2015.

Question 4: Does the FAA plan to finalize the second annual edition of the UAS Integration Roadmap by the end of 2014?

FAA Response: The second edition of the UAS Integration Roadmap is in executive review.

Question 5: Does the FAA have a plan established yet for how to handle air traffic management for small UAS at low altitudes? If not, what is the status of establishing such a plan, and what stakeholders are being incorporated into that planning?

FAA Response: The FAA has partnered with NASA on research for air traffic management for UAS operating at low altitudes. We expect data from this research activity will be available starting in 2015 and that it will inform technology development. In addition, we are working with our administration colleagues on finalized the small UAS Notice of Proposed Rulemaking. It is anticipated that this rule, once finalized, will provide additional operational guidance for a variety of UAS operational scenarios.

Question 6: Does the FAA intend to issue "blanket" regulatory policies for the operation of small UAS that would apply universally to all such operations regardless of population density, or have considerations been made that would regulate operations differently in urban versus rural populations?

FAA Response: Although we cannot comment on specifics of the rule, the FAA small UAS Notice of Proposed Rulemaking (NPRM) is under executive review. We will release it for public comment as soon as possible. Once the comment period for the NPRM closes, the FAA is required to release the final rule within 16 months.

Hearing before the House Transportation and Infrastructure Committee, Subcommittee on Aviation, U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness, December 10, 2014.

Question for the Record from Delegate Norton for Margaret Gilligan, Associate Administrator for Aviation Safety, Federal Aviation Administration:

There are a number of potential benefits from implementation of NextGen, including reductions in CO_2 emissions and noise exposure. For example, in the District of Columbia metroplex, the Federal Aviation Administration (FAA) has projected 2.5 million gallons in fuel savings, amounting to roughly $6.4 million in savings, and 25.0 thousand metric tons of carbon savings. At the same time, because of the proximity of the nation's capital, a residential community, to all of the area airports, we need to make sure that there are local community members at the table in preparation for NextGen.

D.C. residents who live in Ward 3, especially the Palisades, Foxhall and Georgetown neighborhoods, and in the Ward 8 Bellevue neighborhood, have reached out to our office over the years repeatedly raising serious concerns about airplane noise from commercial flights leaving Ronald Reagan Washington National Airport (DCA). There has even been an increase over the last three to four months in the number of flights over these residential neighborhoods. DCA has been touted by the FAA as one of the airports where steps have already been taken to implement components of NextGen. For example, jetliners are able to glide their planes as they descend from cruising altitude to land at DCA. However, according to residents, these new flight paths have shifted planes from flying over the Potomac River during departures, a remedy we previously achieved, to flying over residential neighborhoods creating, unbearable noise during all hours of the day and night.

If the FAA fails to engage with residential community members in formulating its NextGen policies and flight paths, it will be faced with complaints throughout the region and possibly undertake inconsistent actions, rerouting planes out of one area into another only to get complaints from the latter in a continuing series of complaints. Airlines for America, the Aircraft Owners and Pilots Association, the Business Roundtable, and the National Air Traffic Controllers Association have participated as stakeholders in the FAA's modernization efforts. In preparation for NextGen flight patterns, are you engaging with representatives of affected communities? If so, how have you engaged communities? If not, are you willing to do so?

FAA Response:

In accordance with the National Environmental Policy Act (NEPA), the FAA released and made available for public review an Environmental Assessment (EA) that was prepared to consider the potential environmental impacts associated with the implementation of the Washington D.C. Optimization of Airspace and Procedures in the Metroplex (DC OAPM) Project. The Draft Environmental Assessment document for the DC OAPM project was released and made available for public review and comment on June 20, 2013. The FAA encouraged interested parties to review the DC OAPM Draft EA, and provide written comments during the public comment period. Written comments were accepted by the FAA until July 20, 2013.

The FAA issued a Finding of No Significant Impact and Record of Decision (FONSI-ROD) for the project on December 30, 2013. The FONSI-ROD includes as an attachment the comments received, responses to comments, and an errata sheet. The FAA received comments from eleven commenters (eight agencies, two individuals, and one tribe). The FAA carefully considered and addressed all substantive comments received and none warranted revision of the Draft EA. The attachment also includes letters of concurrence with the FAA's findings of no adverse effect under Section 106 of the National Historic Preservation Act. Concurrence letters were received from the State Historic Preservation Officers for the District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia, as well as from the Superintendent of the Harpers Ferry National Historic Park. Letters were also received from the Director of Recreation & Parks for Henrico County, Virginia, and the Gettysburg National Military Park concurring with the FAAs findings that there would be no substantial change to the noise environment at the subject properties that would represent a constructive use under Section 4(f) of the Department of Transportation Act. The EA and FONSI-ROD are available electronically via the following link: http://oapmenvironmental.com/dc_metroplex/dc_docs.html

In addition to the engagement through the NEPA process, the FAA typically engages with community representatives through a collaborative approach led by the respective airport authority in order to educate the public on the benefits of NextGen and understand any issues or concerns over aircraft noise resulting from implementation of procedures. Some community concerns may be addressed through further engagement by the airport authority with the airline operators and the FAA. Since multiple communities around an airport may have an interest in procedural changes that might result in changes in noise exposure, we have found it is preferred to handle engagement through a community Roundtable forum established by the airport authority, within which the FAA would participate. This way all communities residing in the vicinity of the airport will have an equal opportunity to engage.

Before the Committee on Transportation and Infrastructure
Subcommittee on Aviation
United States House of Representatives

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FAA's Progress and Challenges in Integrating Unmanned Aircraft Systems into the National Airspace System

Statement of
Matthew E. Hampton
Assistant Inspector General for Aviation
U.S. Department of Transportation

Mr. Chairman and Members of the Subcommittee:

Thank you for inviting me here today to testify on the Federal Aviation Administration's (FAA) efforts to integrate Unmanned Aircraft Systems (UAS)[1] into the National Airspace System (NAS). As you know, demand for UAS technology is growing, and many public- and private-sector entities have identified a number of diverse uses for unmanned aircraft, including enhancing border security, surveying agricultural crops, conducting scientific research, and aiding law enforcement. FAA predicts there will be roughly 7,500 active UAS in the United States in 5 years, with over $89 billion invested worldwide in the emerging technology over the next 10 years.

Given the industry's anticipated rapid expansion, the FAA Modernization and Reform Act of 2012 directed FAA to take multiple steps to advance UAS integration, with the goal of safely integrating UAS into the NAS by 2015. As FAA works to meet this goal, the Agency faces unique challenges while ensuring that safety remains the top priority as new and complex technologies are introduced into the NAS.

My testimony today will focus on FAA's efforts to address these challenges. Specifically, I will discuss (1) FAA's progress in implementing the UAS requirements cited in the act; (2) the technological, regulatory, and management challenges to UAS integration; and (3) key actions needed to advance UAS integration. My testimony is based on our June report[2] and ongoing work. This work did not examine privacy issues related to the use of UAS.

IN SUMMARY

FAA has completed more than half of the UAS milestones in the act, such as publishing a UAS Roadmap outlining the Agency's UAS plans, and selecting six test sites. However, FAA is behind on the act's remaining requirements and will not meet the act's goal of achieving safe UAS integration by September 2015. Although FAA has authorized limited UAS operations on a case-by-case basis, considerable challenges remain to expand UAS operations. These include developing technology to prevent loss of connectivity with aircraft and reaching consensus on critical UAS regulatory standards. To advance UAS integration, we recommended that FAA gather and analyze critical operational safety data; determine the research needed from test sites; and establish timelines and requirements for developing standardized training, automated tools, and procedures for air traffic controllers. Another key action for the Agency is accelerating the development of UAS regulations, particularly for small UAS operations.

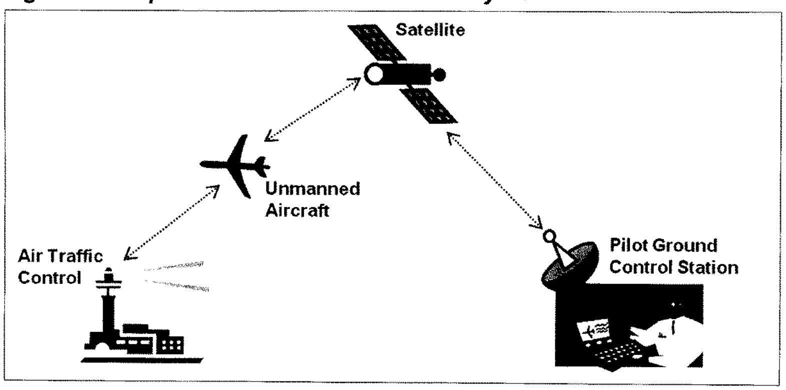
[1] UAS are systems of aircraft and ground control stations where operators control the movements of aircraft remotely. Unmanned aircraft range in size from those smaller than a radio-controlled model airplane to those with a wingspan as large as a Boeing 737.
[2] *FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems into the National Airspace System* (OIG Report No. AV-2014-061), June 26, 2014. OIG reports are available on our Web site at http://www.oig.dot.gov/.

BACKGROUND

On a case-by-case basis, FAA issues Certificates of Waiver or Authorization (COA) for public UAS use[3] and Special Airworthiness Certificates in the experimental and restricted categories for civil (private sector) UAS use. There are currently about 300 active public-use authorizations, 18 experimental special airworthiness certificates, and 2 restricted category airworthiness certificates for over 100 aircraft types. FAA recently broadened commercial UAS use by approving regulatory exemptions for seven film industry companies to operate UAS on a limited basis.

Unlike manned aircraft, UAS pilots operate unmanned aircraft from the ground either through a remote control device or a ground control station via a radio or satellite-based data link (see figure). While the capabilities of unmanned aircraft have significantly improved, they have a limited ability to detect and avoid other air traffic.

Figure. Example of an Unmanned Aircraft System



Source: OIG

FAA HAS IMPLEMENTED MORE THAN HALF OF THE REQUIRED UAS PROVISIONS, BUT IS BEHIND ON THE REMAINING ACTIONS

FAA has completed 9 of the act's 17 UAS provisions, such as publishing its 5-year UAS Roadmap,[4] establishing a comprehensive plan to safely accelerate UAS integration, and streamlining its COA processes (see table 1). However, the Agency missed statutory milestones for most of these provisions. For example, FAA announced its selection of six UAS test ranges over a year after the statutory milestone.

[3] Public use UAS are flown by Federal, state, or local governmental agencies.
[4] The Roadmap is a guide outlining FAA's plans for integrating UAS into the NAS over a 5-year period.

Table 1. Completed UAS Initiatives as of December 2014

Initiative	Date Due	Date Completed
Establish agreements to streamline the COA process	5/14/2012	3/4/2013
Establish a program for integrating UAS into the NAS at six test ranges	8/12/2012	12/30/2013
Develop a plan for small UAS to operate in the Arctic for research and commercial purposes	8/12/2012	11/1/2012
Determine if certain UAS may operate safely in the NAS before completion of the comprehensive plan and rulemaking	8/12/2012	7/19/2013
Issue guidance regarding the operation of public-use UAS, including expediting the UAS approval process	11/10/2012	1/22/2013
Develop a comprehensive plan to safely accelerate the integration of UAS into the NAS	11/10/2012	Sept. 2013
Submit a copy of the comprehensive plan to Congress	2/14/2013	11/6/2013
Make operational at least one project at a test range	2/14/2013	April 2014
Develop and make publically available a 5-year roadmap for the introduction of UAS into the NAS	2/14/2013	11/7/2013

Note: For full status information on these and other initiatives, see attachment 1.
Source: OIG

FAA is also behind schedule in implementing the remaining eight UAS provisions. For example, FAA did not meet the act's August 2014 milestone for issuing a final rule on small UAS operations.[5] Moreover, FAA has yet to issue a Notice of Proposed Rulemaking (NPRM), which it had planned to do in June 2011—over 3 years prior to the August 2014 mandate. FAA expects to issue the NPRM for comment this month. While FAA has stated the standard for issuing a final rule is 16 months, it could take longer as the Agency expects to receive a large number of comments—all of which would have to be considered before the rule can be finalized.

FAA will also not meet Congress' September 2015 milestone for safely integrating UAS into the NAS, but Agency officials told us they will complete some steps towards integration, such as issuing a proposed rule for small UAS operations and establishing operational test ranges. FAA's 5-year UAS Roadmap contains target dates for the Agency's future integration efforts, but FAA officials stated that the target dates do not represent "commitments." As a result, while it is certain that FAA will accommodate UAS at limited locations, it remains unclear when and if full integration of UAS into the NAS will occur.

[5] The rule is intended to establish operating and performance criteria for small UAS (under 55 pounds) in the NAS that are operated within line-of-sight of a pilot or ground observer below 400 feet.

FAA FACES TECHNOLOGICAL, REGULATORY, AND MANAGEMENT CHALLENGES TO UAS INTEGRATION

FAA is working with other Federal agencies to identify ways to resolve barriers to UAS integration; however, FAA will need to resolve technological issues to mitigate safety risks, reach consensus on critical UAS regulatory standards, and address management challenges that limit UAS operations.

First, successfully mitigating UAS safety risks depends on FAA's ability to overcome two significant technological barriers:

- **Lack of mature detect-and-avoid technology to avoid collisions.** With no pilots on board, UAS cannot comply with FAA requirements for aircraft to be able to "see and avoid" other aircraft.[6] Therefore, the safe operation of UAS relies on effective, robust technology to automatically detect other aircraft operating in nearby airspace and successfully maneuver to avoid them. Experts we interviewed said detect and avoid is the most pressing technical challenge to integration yet to be mitigated.

- **Lack of adequate control and communications technology.** The integrity, stability, and security of the link between the ground control station and unmanned aircraft are vital to safe UAS operation. However, technology has not been developed to reduce the potential for "lost link" scenarios—that is, interruptions or complete loss of connectivity. Secure and adequate radio frequencies for communication will also be necessary to ensure sufficient links. While the International Telecommunication Union[7] granted some UAS-specific radio frequency in 2012, many unknowns remain—particularly regarding the amount of frequency spectrum needed, licensing issues, control and communications standards, and security vulnerabilities.

To address these technological barriers, several research projects are under way at FAA and other agencies, such as the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA). For example, FAA is testing communications between ground operators and unmanned aircraft, and DoD is testing a ground-based detect-and-avoid system. However, it remains uncertain when these efforts will provide UAS technology to fully support safe UAS integration.

Second, FAA has yet to establish minimum regulatory standards for UAS. Specifically, the Agency still lacks:

- **Minimum performance standards for civil UAS.**[8] Despite working with a special RTCA advisory committee[9] for more than 9 years, FAA has not reached consensus

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[6] While FAA 14 CFR 91.113 speaks of a pilot's ability to "see and avoid" other aircraft, the UAS community, spearheaded by RTCA SC-228, is using the term "detect and avoid" to describe the desired capability of UAS.
[7] The International Telecommunication Union is the United Nations' specialized agency for information and communication technologies. It allocates global radio spectrum.
[8] Private or commercial use.

among Government and industry stakeholders on minimum performance standards. For example, FAA needs to develop standards for operators regarding UAS control and communication links. In March 2013, FAA tasked RTCA to form a new committee with a more narrow focus to help accelerate this effort.[10]

- **Regulatory requirements or standards for UAS design certification, pilot and crew qualifications,[11] ground control stations, and command and control reliability.** FAA has not established design standards needed to certify new civil UAS. According to FAA officials, the Agency's civil UAS projects have resulted in certification of two aircraft. However, the projects rely on a military certification rule that does not apply to new types of UAS, and the two aircraft are restricted to operations in the Arctic area. FAA officials told us that this would be a first step to developing standards for widespread use.

Table 2 lists other UAS areas that lack safety regulations, standards, and guidance, further limiting UAS operations in the NAS.

Table 2. Sample of UAS Operations Areas Needing Aviation Safety Regulations, Standards, and Guidance

Unmanned Aircraft	Pilot and Crew	Control Station	Data Link
• Policy • Certification Requirements • Technical Standards • Performance Standards • Airworthiness Standards • Procedures • Regulations/ Guidance • Measures of Performance • Maintenance Requirements	• Policy • Certification Requirements • Operational Standards • Procedures • Regulations • Guidance Material • Training Requirements • Medical Standards	• Policy • Certification Requirements • Technical Standards • Airworthiness Standards • Interoperability Requirements • Guidance Material • Maintenance Requirements • Means of Compliance	• Policy • Certification Requirements • Technical Standards • Airworthiness Standards • Interoperability Requirements • Dedicated Aviation Radio Frequency Spectrum • Standardized Control Architectures • Link Security Requirements

Source: OIG analysis of FAA data

[9] Organized in 1935 as the Radio Technical Commission for Aeronautics, RTCA, Inc. is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management system issues. It functions as a Federal Advisory Committee.
[10] RTCA established Special Committee 228, which is focused on more detailed standards regarding detect-and-avoid capabilities and command and control links.
[11] Crew, in addition to the pilot, can include ground-based crew, who must assist the pilot with determining UAS proximity to other aviation activities and help the pilot avoid operating beyond the visual line-of-sight limit.

While FAA continues to develop a regulatory framework for UAS, it is also working to leverage the authority Congress provided to allow some exemptions to certification requirements. Specifically, the 2012 reauthorization act allows FAA to exempt certain UAS users from the requirement to have an airworthiness certificate. This exemption is granted based on the UAS's size, weight, speed, operational capability, proximity to airports and populated areas, operation within visual line of sight, and if the UAS do not create a hazard to other airspace users. Using this authority, FAA recently broadened the commercial use of UAS. According to FAA, as of December 3, 2014, it had received 159 requests for exemptions from companies in industries such as filmmaking, pipeline inspection, aerial surveying, precision agriculture, and real estate. Thus far, FAA has approved seven of these exemption requests for companies from the film industry and is continuing its review of the remaining requests.

Third, the safe integration of authorized UAS into the NAS has been impacted by program management challenges:

- **Lack of standardized UAS-specific air traffic controller procedures and training.** Although FAA provided interim guidance on UAS-specific air traffic control, it has not established national procedures and training, which limits controllers' ability to manage air traffic that includes unmanned aircraft. Currently, air traffic controllers are forced to segregate UAS from other traffic. According to air traffic personnel, current procedures and separation standards were designed for manned aircraft and are not adequate for UAS. For example, controllers told us that the En Route Automation Modernization system, a system for processing high-altitude flight data, cannot adequately manage UAS flight plans, which contain an unusually large amount of navigational data. In addition, due to the lack of training and guidance, controllers at air traffic facilities nationwide have filed reports of problems managing UAS operations.[12] FAA established a corrective action plan in January 2013 but does not expect to resolve these issues until September 2015.

- **Organizational impediments to UAS integration and oversight.** Integrating UAS operations into the NAS presents significant organizational challenges, as it requires the collaboration of many stakeholders. In March 2012, FAA established a new UAS Integration Office, which is comprised of Aviation Safety and Air Traffic Organization (ATO) personnel and consolidates UAS expertise into a single organization. However, the office has to reach out to FAA offices beyond ATO, such as the Aircraft Certification and NextGen organizations. This is important because these offices play a large role in determining aircraft certification requirements and research and development. FAA has had difficulty working across FAA's lines of business in the past. Other organizational barriers further limit FAA's oversight of current UAS operators. For example, regional UAS safety inspectors receive work

[12] Controllers file these reports through FAA's Air Traffic Safety Action Program, a voluntary safety reporting program that enables air traffic personnel to confidentially report air traffic safety events.

assignments from the UAS Integration Office but report to their regional managers, resulting in competing priorities for the same resources.

- **Inadequate framework for sharing and analyzing safety data.** FAA routinely collects safety data from current public-use UAS operators (mainly from DoD), as required by the COAs granted to each operator. However, the Agency does not know whether it is receiving sufficient data from COA operators, as it has no process to ensure that all incidents are reported as required. In addition, FAA has not reached agreement with DoD to obtain useful data. For example, while FAA's Office of Accident Investigation and Prevention receives annual UAS mishap data from DoD, FAA's UAS integration staff told us they do not find this information useful because it lacks detail. DoD has a wealth of other operational data, such as maintenance information, but the Agency has been unable to obtain it due to data sensitivity concerns and resource coordination. FAA and DoD formed a data sharing team to resolve these issues.

  FAA also does not have a formal system to track and classify UAS incidents currently reported outside of the COA process. FAA has stated that it receives about 25 reports per month from pilots who have seen unmanned aircraft or model aircraft operating near their aircraft. According to FAA, while many of these sightings are from general aviation or helicopter pilots, airline crews have also reported them. For example, there were three recent reports filed by air carrier pilots who said they saw unmanned aircraft while they were on final approach to John F. Kennedy International Airport. In one case, two airlines reported seeing unmanned aircraft approximately 10 miles from the runway flying at altitudes between 3,000 and 2,000 feet. According to FAA, the reports did not indicate whether any of the pilots took evasive action, and all three flights landed safely.

  According to FAA, the Agency receives these reports from multiple sources, such as air traffic control facilities and flight standard district offices. FAA officials stated that the reports range from unmanned aircraft sightings without impact to other pilots and aircraft, to pilots altering course to avoid an unmanned aircraft on a few occasions. FAA is currently working to develop a single system to record these incidents and develop a classification system to track their severity. FAA expects to complete this effort by September 30, 2015.

KEY ACTIONS NEEDED TO ADVANCE UAS INTEGRATION

Given the complexities involved, it remains unclear when and if UAS will be fully integrated into the NAS. Further, it is still not clear what "full integration" will entail. Many important questions remain unanswered, such as the timeline for developing reliable detect and avoid technology, and robust certification standards for UAS equipment and crew.

To enhance the effectiveness of the Agency's efforts to safely integrate UAS into the NAS, we made 11 recommendations to FAA in our June 2014 report, including key actions to:

- Gather and analyze critical operational safety data FAA currently receives from UAS operators and obtain the most critical safety data it needs from DoD. Because integrating UAS into the NAS is in the early stages, any and all data regarding the safety of UAS operations are paramount to understanding and mitigating hazards that may arise.

- Determine data needed from test sites to gain a greater understanding of the challenges presented by UAS in an integrated environment and how those challenges can be effectively mitigated. These data will provide critical information related to aircraft certification, air traffic control, and detect and avoid capabilities that can inform FAA's integration decisions.

- Establish timelines for developing standardized training, automated tools, and procedures for air traffic controllers, as well as reaching consensus on design and certification standards for UAS technology. Because UAS currently operate in the NAS at select locations, such as along the Nation's borders, it is critical that FAA develop the procedures, training, and tools for controllers to effectively manage UAS in the same airspace as other aircraft.

FAA has taken or planned actions that meet the intent of 10 of our recommendations. We are currently working with the Agency to fully resolve the remaining one on data sharing agreements. (See attachment 2 for the status of FAA actions for addressing our 11 recommendations.)

Other key actions for the Agency include accelerating the development of UAS regulations, particularly for small UAS operations, as well as developing an integrated budget document for UAS that clearly identifies funding needs for programs, such as pertinent air traffic control systems and operations. Furthermore, FAA will need to consider the impact of UAS integration on a wide range of Agency programs and their corresponding funding requirements. We will continue to monitor FAA's progress on these issues and work with the Agency on resolving and closing our recommendations.

This concludes my prepared statement. I will be happy to answer any questions you or the other members of the Subcommittee may have.

ATTACHMENT 1. STATUS OF FAA'S IMPLEMENTATION OF THE ACT'S UAS MILESTONES (AS OF DECEMBER 2014)

Section	Description	Deadline	Progress	Status
334c	Establish agreements to simplify process for issuing COAs for public UAS in the NAS.	5/14/2012	● ○	Met — FAA made changes to the COA process to shorten the timeframes needed for approval. Implemented Late – FAA completed a streamlined COA process via MOUs with DoD, NASA, and DOJ in March 2013.
332c(1)	Establish program for integrating UAS into the NAS at six test ranges.	8/12/2012	○	Implemented Late – On December 30, 2013, FAA announced the test-site applicants chosen for the six test ranges.
332d	Develop plan to designate permanent areas in the Arctic where small UAS may operate 24 hours/day for research and commercial purposes.	8/12/2012	○	Implemented Late – FAA's Arctic Plan was signed on November 1, 2012, and was made available to the public on FAA's Web site on December 6, 2012.
333	Determine if certain UAS may operate safely in the NAS before completion of the comprehensive plan and rulemaking.	8/12/2012	○	Implemented Late – FAA issued type certificates (using the 21.25 restricted category certification) to ScanEagle and Puma UAS to operate in the Arctic in July 2013, stipulating that certain UAS could operate in restricted areas of the NAS prior to the issuance of the comprehensive plan. FAA also approved seven exemptions for film industry companies.
332a(1)	Develop a comprehensive plan to safely accelerate the integration of UAS into the NAS.	11/10/2012	○	Implemented Late – JPDO was assigned to develop the comprehensive plan. However, the document had to undergo substantial revisions during an interagency review process.
334a	Issue guidance regarding the operation of public-use UAS including expediting the UAS approval process.	11/10/2012	○	Implemented Late – On January 22, 2013, the FAA issued notice N8900.207, which provides policies necessary for reviewing and evaluating the safety and interoperability of proposed UAS flight operations in the NAS, and outlines best practices and procedures that FAA has used in prior UAS approvals.
332a(4)	Submit copy of comprehensive plan to Congress.	2/14/2013	○	Implemented Late – After an extended executive coordination and interagency review process, FAA submitted the plan on November 6, 2013.

● - Provision Implemented and Statutory Deadline Met
○ - Provision Implemented but Missed Statutory Deadline
● - Provision Not Implemented and Statutory Deadline Missed
○ - Deadline in Future

Section	Description	Deadline	Progress	Status
332c(4)	Make operational at least one project at a test range.	2/14/2013	◌	Implemented Late – FAA announced the six test sites in December 2013. The first test site became operational in April 2014.
332a(5)	Develop and make publically available 5-year roadmap for the introduction of UAS into the NAS.	2/14/2013	◌	Implemented Late – OMB required FAA to make substantial revisions to its Roadmap, and the document underwent a Legislative Referral Memorandum process. FAA published the Roadmap on November 7, 2013.
332b(3)	Issue an update to the Administration's policy statement on UAS.	8/14/2014	●	FAA issued an interpretive rule in June 2014 that updates the 2007 policy. However, FAA is not certain this action will meet the mandate until it receives higher level review from the Secretary.
332b(1)	Issue the Final Rule on small UAS.	8/14/2014	●	Missed deadline. FAA expects to issue an NPRM in December 2014, which is required in advance of the final rule.
332b(2)	Issue a NPRM to implement recommendations of the comprehensive plan.	8/14/2014	●	The comprehensive plan does not have specific recommendations, but does include a national objective to amend FAR Part 91.113 related to "see and avoid". This work is ongoing.
332a(3)	The safe integration of civil UAS into the NAS.	9/30/2015	○	Deadline in future. FAA officials stated that, by this date, they will have the test sites operational, issue the proposed rule for small UAS, and approve a ground-based detect-and-avoid system available for certain UAS.
332b(2)	Issue final rule on integration of all UAS into the NAS.	12/14/2015	○	Deadline in future.
334b	Develop and implement operational and certification requirements for the operation of public UAS in the NAS.	12/31/2015	○	Deadline in future.
332c(1)	Termination of program for integrating UAS into the NAS at six test ranges.	2/14/2017	○	Deadline in future.
332c(5)	Submit report of findings and conclusions concerning projects from six test ranges.	5/15/2017	○	Deadline in future.

◉ - **Provision Implemented and Statutory Deadline Met**

◌ - **Provision Implemented but Missed Statutory Deadline**

● - **Provision Not Implemented and Statutory Deadline Missed**

○ - **Deadline in Future**

Attachment 1. Status of FAA's Implementation of the Act's UAS Milestones (as of December 2014)

ATTACHMENT 2. STATUS OF OIG RECOMMENDATIONS TO ADVANCE UAS INTEGRATION

OIG Recommendation	Status/FAA Action Taken and Planned
Publish a report annually detailing ongoing research activities and progress FAA and other entities are making to resolve technical challenges.	**Open**/FAA is developing a detailed inventory of past and ongoing research activities. We are working with FAA to obtain and review the inventory.
Establish milestones for the work needed to determine the appropriate classification system for unmanned aircraft.	**Open**/FAA has work under way to develop milestones and associated tasks with developing a UAS classification system. There are two phases with completion of Phase 1 by September 30, 2015 and Phase 2 by September 30, 2016.
Establish a timeline for developing standardized training and procedures for air traffic controllers responsible for UAS operations.	**Open**/FAA stated it would develop a timeline for providing standardized training for air traffic controllers by October 30, 2014, but the Agency has not yet done so.
Assess and determine the requirements for automated tools to assist air traffic controllers in managing UAS operations in the NAS.	**Open**/FAA expects to complete work by October 31, 2015 to determine the requirements for automated tools to assist air traffic controllers.
Create a standardized framework for data sharing and analysis between UAS operators by: (a) validating a sample of the data it currently receives from UAS operators; (b) finalizing an agreement with DoD for pertinent UAS operational data; and (c) completing development of a sharing and analysis database.	**Unresolved**/FAA has taken some actions by validating mishap data received from DoD and is working with MITRE to establish a sharing and analysis database that will be completed by September 30, 2015. However, we are working to resolve when FAA expects to finalize its work with DoD to obtain other operational data, such as airworthiness data.
Develop and implement a consistent process to review and approve COAs across FAA regions, adopt measures that increase process efficiency and oversight, and provide necessary guidance and training to inspectors.	**Open**/FAA developed training courses for FAA inspectors and established a COA Standardization Working Group to develop a consistent COA process. By September 30, 2015, the team will produce new guidance for Flight Standards and Air Traffic personnel.
Complete airspace simulation and safety studies of the impact of UAS operations on air traffic control.	**Open**/FAA has work under way and expects to have all safety risk management panels completed by October 31, 2015.
Develop a mechanism to verify that the UAS Integration Office, all FAA lines of business, and field safety inspectors are effectively coordinating.	**Open**/FAA developed a process to solicit feedback on effectiveness of coordination during executive-led UAS meetings and weekly staff meetings. By January 31, 2015, FAA expects to implement a Quality Management System process to verify that coordination is effective.

OIG Recommendation	Status/FAA Action Taken and Planned
Determine the specific types of data and information needed from each of the six planned test ranges to facilitate safe UAS integration.	**Open**/FAA has provided the test sites with a report identifying potential research areas based on the September 2012 Concept of Operations. Also, the FAA Technical Center has assigned a lead to coordinate how data is collected. This will be ongoing through December 31, 2017.
Establish a more detailed implementation plan with milestones and prioritized actions needed to in the near, mid, and long term.	**Open**/FAA worked with MITRE to develop a UAS Integration Strategy to assist with development of a UAS Program Plan. FAA expects to issue a detailed program plan by September 30, 2015.
Establish metrics to define progress in meeting implementation milestones as a basis for reporting to Congress.	**Open**/FAA has developed a UAS Roadmap that will be updated annually. The updated roadmap is under review by the Office of Management and Budget.
Complete airspace simulation and safety studies of the impact of UAS operations on air traffic control.	**Open**/FAA has work under way and expects to have all safety risk management panels completed by October 31, 2015.
Develop a mechanism to verify that the UAS Integration Office, all FAA lines of business, and field safety inspectors are effectively coordinating.	**Open**/FAA developed a process to solicit feedback on effectiveness of coordination during executive-led UAS meetings and weekly staff meetings. By January 31, 2015, FAA expects to implement a Quality Management System process to verify that coordination is effective.
Determine the specific types of data and information needed from each of the six planned test ranges to facilitate safe UAS integration.	**Open**/FAA has provided the test sites with a report identifying potential research areas based on the September 2012 Concept of Operations. Also, the FAA Technical Center has assigned a lead to coordinate how data is collected. This will be ongoing through December 31, 2017.
Establish a more detailed implementation plan with milestones and prioritized actions needed to in the near, mid, and long term.	**Open**/FAA worked with MITRE to develop a UAS Integration Strategy to assist with development of a UAS Program Plan. FAA expects to issue a detailed program plan by September 30, 2015.
Establish metrics to define progress in meeting implementation milestones as a basis for reporting to Congress.	**Open**/FAA has developed a UAS Roadmap that will be updated annually. The updated roadmap is under review by the Office of Management and Budget.

Source: OIG

Questions for the Record for Matthew E. Hampton, Assistant Inspector General for Aviation, U.S. Department of Transportation

Hearing before the House Committee on Transportation and Infrastructure, Subcommittee on Aviation, entitled "U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness," December 10, 2014

LoBiondo QFR #1: NextGen Plans

QUESTION:

Are UAS adequately addressed in FAA's NextGen Plans?

ANSWER:

No. FAA is only in the very early stages of factoring UAS integration into the planning of NextGen systems. This will be key going forward because FAA's air traffic control equipment was not developed with UAS operations in mind. For example, controllers have stated that the En Route Automation Modernization (ERAM) system, a controller automation system for processing flight data for high altitude flights, cannot yet adequately manage UAS flight plans because they contain a large amount of navigational information. This forces controllers to implement manual and time-consuming "work-arounds" for handing off UAS between facilities and airspace sectors. According to FAA, future budget requests will highlight the impacts of UAS on key ATC programs.

Questions for the Record for Matthew E. Hampton, Assistant Inspector General for Aviation, U.S. Department of Transportation

Hearing before the House Committee on Transportation and Infrastructure, Subcommittee on Aviation, entitled "U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness," December 10, 2014

LoBiondo QFR #2: UAS Technical Specialists

QUESTION:

UAVs are very advanced, flying robots, very different from manned airplanes. As Nicholas Roy has described, the technology is advancing quickly. Would you know how many aerial roboticists or other technical specialists the FAA employs?

ANSWER:

Having the right technical in-house expertise will be important for FAA to manage the integration of UAS into the National Airspace System. According to FAA, the Agency does not have a roboticist or robotics safety technical specialist but has assigned 29 general engineers and other technical specialists to the UAS Integration Office, including

- 11 general engineers,
- 2 supervisory general engineers,
- 3 aerospace engineers,
- 9 aviation safety inspectors.

United States Government Accountability Office

GAO

Testimony
Before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

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UNMANNED AERIAL SYSTEMS

Efforts Made toward Integration into the National Airspace Continue, but Many Actions Still Required

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GAO Highlights

Highlights of GAO-15-254T, a testimony before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

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Why GAO Did This Study

UASs are aircraft that do not carry a pilot aboard, but instead operate on pre-programmed routes or are manually controlled by following commands from pilot-operated ground control stations. The FAA Modernization and Reform Act of 2012 put greater emphasis on the need to integrate UASs into the national airspace by requiring that FAA establish requirements governing them. FAA has developed a three-phased approach in its 5-year *Roadmap* to facilitate incremental steps toward seamless integration. However, in the absence of regulations, unauthorized UAS operations have, in some instances, compromised safety.

This testimony discusses 1) progress toward meeting UAS requirements from the 2012 Act, 2) key efforts underway on research and development, and 3) how other countries have progressed in developing UAS use for commercial purposes.

This testimony is based on GAO's prior work and an ongoing study examining issues related to UAS integration into the national airspace system for civil and public UAS operations.

View GAO-15-254T. For more information, contact Gerald L. Dillingham at (202) 512-2834 or dillinghamg@gao.gov.

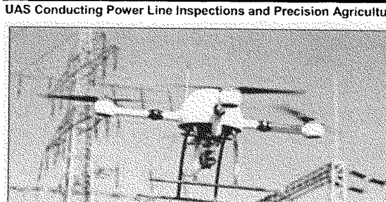
What GAO Found

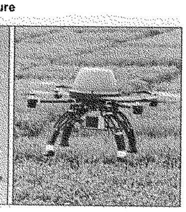
The Federal Aviation Administration (FAA) has made progress toward implementing the requirements defined in the FAA Modernization and Reform Act of 2012 (the 2012 Act). As of December 2014, FAA had completed 9 of the 17 requirements in the 2012 Act. However, key requirements, such as the final rule for small unmanned aerial systems (UAS) operations, remain incomplete. FAA officials have indicated that they are hoping to issue a Notice of Proposed Rulemaking soon, with a timeline for issuing the final rule in late 2016 or early 2017. FAA has established the test sites as required in the Act, sites that will provide data on safety and operations to support UAS integration. However, some test site operators are uncertain about what research should be done at the site, and believe incentives are needed for industry to use the test sites. As of December 4, 2014, FAA granted seven commercial exemptions to the filmmaking industry allowing small UAS operations in the airspace. However, over 140 applications for exemptions were waiting to be reviewed for other commercial operations such as electric power line monitoring and precision agriculture.

Previously GAO reported that several federal agencies and private sector stakeholders have research and development efforts under way focusing on technologies to allow safe and routine UAS operations. During GAO's ongoing work, FAA has cited many accomplishments in research and development in the past fiscal year in areas such as detect and avoid, and command and control. Other federal agencies also have extensive research and development efforts supporting safe UAS integration, such as a National Aeronautics and Space Administration (NASA) project to provide research that will reduce technical barriers associated with UAS integration. Academic and private sector companies have researched multiple areas related to UAS integration.

GAO's ongoing work found that other countries have progressed with UAS integration and allow limited commercial use. A 2014 MITRE study found that Japan, Australia, the United Kingdom, and Canada have progressed further than the United States with regulations that support commercial UAS operations. For example, as of December 2014, Australia had issued 180 UAS operating certificates to businesses in industries including aerial surveying and photography. In addition, Canada recently issued new regulations exempting commercial operations of small UASs weighing 25 kilograms (55 lbs.) or less from receiving special approval.

UAS Conducting Power Line Inspections and Precision Agriculture





Source: FAA. | GAO-15-254T

Chairman LoBiondo, Ranking Member Larsen, and Members of the Subcommittee:

I appreciate the opportunity to testify on the Federal Aviation Administration's (FAA) efforts to integrate unmanned aerial systems (UAS) into the National Airspace System (NAS).[1] The United States has been on a path toward UAS integration for years. The agency's rulemaking efforts related to UAS began in 2008, when the FAA established a committee to develop rules for the operation of small UASs.

The FAA Modernization and Reform Act, enacted in February 2012 (the 2012 Act),[2] required the development of regulations for the safe integration of civil UAS into the national airspace by December 2015 and therefore put greater emphasis on the need to integrate UAS. In the absence of regulations governing UAS, some United States businesses are going overseas to test UAS technology, while other civilian users continue to wait to launch commercial operations.[3] However, some individuals are conducting domestic operations illegally or unsafely. For example, one UAS nearly collided with a New York Police Department helicopter over New York City, another came dangerously close to a US Airways regional jet over the Florida panhandle, and numerous UASs have been spotted flying over professional and college football stadiums full of people.

My statement today focuses on 1) FAA's progress toward meeting requirements from the 2012 Act, 2) key efforts under way on UAS

[1]These aircraft are also referred to as unmanned aircraft vehicles, remotely piloted aircraft, or drones. They do not carry a pilot aboard, but instead operate on pre-programmed routes or are manually controlled by commands from pilot-operated ground control stations. Generally, UAS size is considered small or large based on weight. Under the 2012 Act, small UASs are defined as weighing less than 55 pounds, thereby leaving those UASs 55 pounds or more being described as large. UASs are being used for law enforcement, national defense, academic research, commercial, and recreational purposes.

[2]FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, §§ 331 – 335, 126 Stat. 11 (2012).

[3]Examples of commercial use could include delivering packages, precision agriculture, and power line inspection. According to a UAS industry association, these industries represent examples of commercial potential that in the first decade following integration will contribute to more than 100,000 jobs and $82 billion in economic impact.

research and development, and 3) how other countries have progressed toward UAS integration into their airspace for commercial purposes.

My statement is based on our prior products on UAS issued since 2012,[4] selected updates on this work, as well as preliminary observations of our ongoing study of UAS integration into the NAS underway for this committee and others. Detailed information on our scope and methodology can be found in those products. For this testimony we updated our prior work on the status of FAA's efforts to meet UAS requirements in the 2012 Act, by reviewing FAA documents, applicable laws, regulations, and program guidance. For our ongoing work, we reviewed FAA's *Comprehensive Plan*[5] and *Roadmap* for UAS integration.[6] To identify the key efforts and opportunities associated with the FAA's obtaining research, development, and operations data to support UAS integration, we reviewed documents from each of the six test sites where FAA has recently allowed UAS operations and spoke with officials from three of the test sites. To identify how other countries have progressed toward UAS integration for civil and commercial purposes, we spoke with the International Civil Aviation Organization (ICAO) and other stakeholders familiar with the UAS activities currently occurring in other countries.[7] We also conducted semi-structured interviews with FAA officials and a wide range of stakeholders, including representatives of federal agencies such as Department of Defense (DOD), National Aeronautics and Space Administration (NASA), test site officials, research organizations, academics, and industry experts. We also reviewed relevant empirical literature and media reports to obtain information and perspectives on current developments and future

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

[5]JDPO, *Unmanned Aircraft Systems Comprehensive Plan: A Report on the Nation's UAS Path Forward (Washington, D.C.: Sept., 2013).*

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

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

challenges, and spoke with representatives from Canada's aviation authority to understand their regulations related to UAS and associated activities.[8] We obtained agency views on preliminary work and made changes as appropriate. The work this statement was based on was performed in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

In November 2013, FAA released the *Roadmap* that describes its three-phased approach—Accommodation, Integration, and Evolution— to facilitate incremental steps toward its goal of seamlessly integrating UAS flight in the national airspace. Under this approach, FAA's initial focus will be on safely allowing for the expanded operation of UASs by selectively accommodating some UAS use. In the integration phase, FAA plans to shift its emphasis toward integrating more UAS use once technology can support safe operations. Finally, in the evolution phase, FAA plans to focus on revising its regulations, policy, and standards based on the evolving needs of the airspace.

Currently, FAA authorizes all UAS operations in the NAS—military, public (academic institutions and, federal, state, and local governments including law enforcement organizations), and civil (private sector entities). Federal, state, and local government agencies must apply for Certificates of Waiver or Authorization (COA), [9] while civil (commercial) operators must apply for special airworthiness certificates in the experimental category. Civil operators may also apply for a section 333 exemption, under section 333 of the 2012 Act, Special Rules for Certain Unmanned Aircraft Systems, which requires the Secretary of Transportation to determine if certain UAS may operate safely in the NAS prior to the completion of UAS rulemakings and gives the Secretary of

[8]The aviation authority in Canada is Transport Canada.

[9]A COA is an authorization generally for up to two years issued by the FAA to a public operator for a specific UAS activity. As of December 4, 2014, FAA had approved 526 COAs of 723 applications received in for the year.

Transportation the authority to determine whether to allow certain UAS aircraft to operate in the NAS without an airworthiness certification.[10]

As we previously reported, research and development continue in areas related to a UAS's ability to detect and avoid other aircraft, as well as in command and control technologies and related performance and safety standards that would support greater UAS use in the national airspace. Some of this research is being conducted by DOD and NASA. Until this research matures most UAS operations will remain within visual line of sight of the UAS operator.[11]

Foreign countries are experiencing an increase in UAS use, and some have begun to allow commercial entities to fly UASs under limited circumstances. According to industry stakeholders, easier access to these countries airspace has drawn the attention of some U.S. companies that wish to test their UASs without needing to adhere to FAA's administrative requirements for flying UASs at one of the domestically located test sites, or obtaining an FAA COA.

FAA Has Made Progress Meeting Statutory UAS Requirements, but Commercial Operation Is Limited

As we most recently reported in February 2014, the 2012 Act contained provisions designed to accelerate the integration of UAS into the NAS. These provisions outlined 17 date specific requirements and set deadlines for FAA to achieve safe UAS integration by September 2015 (See app. 1). While FAA has completed several of these requirements, some key ones, including the publication of the final small unmanned aerial systems rule, remain incomplete. As of December 2014, FAA had completed nine of the requirements, was in the process of addressing four, and had not yet made progress on four others. Some stakeholders told us in interviews that FAA's accomplishments to date are significant and were needed, but these stakeholders noted that the most important provisions of the 2012 Act have been significantly delayed or are unlikely

[10]FAA has granted regulatory exemptions to a few companies under section 333 of the 2012 Act - Special Rules for Certain Unmanned Aircraft Systems FAA officials said that as of December 4, 2014, FAA had received 160 section 333 exemption requests.

[11]Visual line of sight UAS operations, according to FAA, are defined as unaided (corrective lenses and/or sunglasses exempted) visual contact between a pilot-in-command or a visual observer and a UAS sufficient to maintain safe operational control of the aircraft, know its location, and be able to scan the airspace in which it is operating to see and avoid other air traffic or objects aloft or on the ground.

to be achieved by the mandated dates. Both the FAA and UAS industry stakeholders have emphasized the importance of finalizing UAS regulations as unauthorized UAS operations in the national airspace continue to increase and present a safety risk to commercial and general aviation activities.

Development of the Small UAS Rule

Before publication of a final rule governing small UAS, FAA must first issue a Notice of Proposed Rulemaking (NPRM). As we previously reported, the small UAS rule is expected to establish operating and performance standards for a UAS weighing less than 55 pounds, operating under 400 feet, and within line of sight. FAA officials told us in November 2014 that FAA is hoping to issue the NPRM by the end of 2014 or early 2015.[12] According to FAA, its goal is to issue the final rule 16 months after the NPRM. If this goal is met, the final rule would be issued in late 2016 or early 2017, about two years beyond the requirement of the congressional mandate. However, during the course of our ongoing work, FAA told us that it is expecting to receive tens of thousands of comments on the NPRM. The time needed to respond to such a large number of comments could further extend the time to issue a final rule. FAA officials told us that it has taken a number of steps to develop a framework to efficiently process the comments it expects to receive. Specifically, they said that FAA has a team of employees assigned to lead the effort with contractor support to track and categorize the comments as soon as they are received. According to FAA officials, the challenge of addressing comments could be somewhat mitigated if industry groups consolidated comments, thus reducing the total number of comments that FAA must be addressed while preserving content.

During our ongoing work, one industry stakeholder has expressed concern that the small UAS rule may not resolve issues that are important for some commercial operations. This stakeholder expects the proposed rule to authorize operations of small UASs only within visual line of sight of the remote operator and to require the remote operator to have continuous command and control throughout the flight. According to this stakeholder, requiring UAS operators to fly only within their view would

[12]The *NPRM* was being reviewed by the Office of Management and Budget (OMB), and FAA officials told us they could not be more specific about when it would be released. They noted that once OMB's review was complete, and the *NPRM* was approved, then it would be released.

prohibit many commercial operations, including large-scale crop monitoring and delivery applications. Furthermore, they formally requested that FAA establish a new small UAS Aviation Rulemaking Committee (ARC) with the primary objective to propose safety regulations and standards for autonomous UAS operations and operations beyond visual line of sight. According to FAA, the existing UAS ARC recently formed a workgroup to study operations beyond visual line of sight in the national airspace and to specifically look at the near- and long-term issues for this technology.

Planning for Integration

In November 2013, FAA completed the required 5-year *Roadmap*, as well as, the *Comprehensive Plan* for the introduction of civil UAS into the NAS. The *Roadmap* was to be updated annually and the second edition of the *Roadmap* was scheduled to be published in November 2014. Although FAA has met the congressional mandate in the 2012 Act to issue a *Comprehensive Plan* and *Roadmap* to safely accelerate integration of civil UAS into the NAS, that plan does not contain details on how it is to be implemented, and it is therefore uncertain how UASs will be safely integrated and what resources this integration will require. The UAS ARC emphasized the need for FAA to develop an implementation plan that would identify the means, necessary resources, and schedule to safely and expeditiously integrate civil UAS into the NAS. According to the UAS ARC the activities needed to safely integrate UAS include:

- identifying gaps in current UAS technologies, regulations, standards, policies, or procedures;
- developing new technologies, regulations, standards, policies, and procedures; and
- identifying early enabling activities to advance routine UAS operations in the NAS integration, and developing guidance material, training, and certification of aircraft, enabling technologies, and airmen (pilots).

Establishment of Test Sites

FAA has met two requirements in the 2012 Act related to the test sites by setting them up and making a project operational at one location.[13] In our 2014 testimony, we reported that in December 2013, 16 months past the deadline, FAA selected six UAS test ranges.[14] Each of these test sites became operational, during our ongoing work, between April and August 2014, operating under an Other Transaction Agreement (OTA) with FAA.[15] These test sites are affiliated with public entities, such as a university, and were chosen, according to FAA during our ongoing work, based on a number of factors including geography, climate, airspace use, and a proposed research portfolio that was part of the application. Each test site operator manages the test site in a way that will give access to other parties interested in using the site. According to FAA, its role is to ensure each operator sets up a safe testing environment and to provide oversight that guarantees each site operates under strict safety standards.[16] FAA views the test sites as a location for industry to safely access the airspace. FAA told us, during our ongoing work that they expect data obtained from the users of the test ranges will contribute to the continued development of standards for the safe and routine integration of UAS.

Under the OTAs, test sites are required to apply for a COA to operate a UAS,[17] and the COA requires the test sites to provide safety and operations data collected for each flight. However, while the test sites are operational, there are still questions regarding how they can contribute to

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

[14]GAO-14-285T.

[15]OTAs are administrative vehicles used by the agency that take many forms and are generally not required to comply with federal laws and regulations that apply to contracts, grants, or cooperative agreements. OTAs enable the federal government and others entering into these agreements to freely negotiate provisions that are mutually agreeable.

[16]As part of these ranges, FAA designated airspace for integrated manned and unmanned flight operations, developed certification standards, and is working with each of the test site operators to verify the safety of UAS and related navigation procedures before integrating them into the national airspace.

[17]In order to fly under a COA the commercial entity leases its UAS to the public entity for operation.

the research and development supporting integration. According to FAA, it cannot direct the test sites to address specific research and development issues, nor specify what data to provide FAA, other than data required by the COA. FAA officials told us that some laws may prevent the agency from directing specific test site activities without providing compensation.[18] As a result, according to some of the test site operators we spoke to as part of our ongoing work, there is uncertainty about what research and development should be conducted to support the integration process. However, FAA states it does provide support through weekly conference calls and direct access for test sites to FAA's UAS office. This level of support requires time and resources from the FAA, but the staff believes test sites are a benefit to the integration process and worth this investment. In order to maximize the value of the six test ranges, FAA is working with MITRE Corporation (MITRE), DOD, and the test sites to define what safety, reliability, and performance data are needed and develop a framework, including procedures, for obtaining and analyzing the data. However, FAA has not yet established a time frame for developing this framework.

During our ongoing work, test site operators have told us that there needs to be incentives to encourage greater UAS operations at the test sites. FAA is, however, working on providing additional flexibility to the test sites to encourage greater use by industry. Specifically, FAA is willing to train designated airworthiness representatives for each test site. These individuals could then approve UASs for a special airworthiness certificate in the experimental category for operation at the specific test site. Test site operators told us that industry has been reluctant to operate at the test sites because under the current COA process, a UAS operator has to lease its UAS to the test site, thus potentially exposing proprietary technology. With a special airworthiness certificate in the experimental category, the UAS operator would not have to lease their UAS to the test site, therefore protecting any proprietary technology. According to FAA and some test site operators, another flexibility they are working on is a broad area COA that would allow easier access to the test site's airspace for research and development. Such a COA would allow the test sites to

[18]As a general proposition, an agency may not augment its appropriations from outside sources without specific statutory authority. The Antideficiency Act prohibits federal officers and employees from, among other things, accepting voluntary services except for emergencies involving the safety of human life or the protection of property. 31 U.S.C. § 1342.

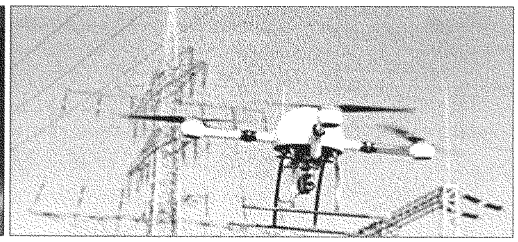
handle the airworthiness certification, typically handled by FAA, and then allow access to the test site's airspace.

Granting Exemptions for Limited Commercial UAS Operations

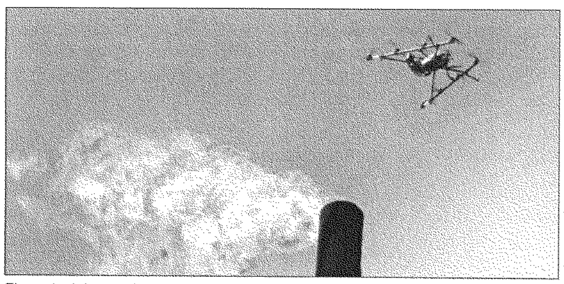
FAA has started to use the authority granted under section 333 of the 2012 Act to allow small UASs access to the national airspace for commercial purposes, after exempting them from obtaining an airworthiness certification. While FAA continues to develop a regulatory framework for integrating small UASs into the NAS these exemptions can help bridge the gap between the current state and full integration. According to FAA, this framework could provide UAS operators that wish to pursue safe and legal entry into the NAS a competitive advantage in the UAS marketplace, thus discouraging illegal operations and improving safety. During our ongoing work, FAA has granted seven section 333 exemptions for the filmmaking industry as of December 4, 2014. FAA officials told us that there were more than 140 applications waiting to be reviewed for other industries, for uses such as precision agriculture and electric power line monitoring, and more continue to arrive.

Figure 1: Examples of Potential Commercial UAS Operations

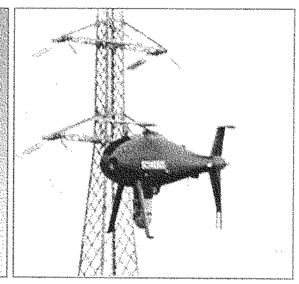
Precision agriculture



Powerline inspection



Flare stack inspection



Powerline inspection

Source: FAA. | GAO-15-254T

While these exemptions do allow access to the NAS, FAA must review and approve each application and this process takes time, which can affect how quickly the NAS is accessible to any given commercial applicant. According to FAA, the section 333 review process is labor intensive for its headquarters staff because most certifications typically occur in FAA field offices; however, since exemptions under section 333 are exceptions to existing regulations, this type of review typically occurs at headquarters. FAA officials stated that to help mitigate these issues, it is grouping and reviewing similar types of applications together and working to streamline the review process.

Additional Challenges for FAA Integration

While FAA is making efforts to improve and accelerate progress toward UAS integration, additional challenges remain, including in the areas of authority, resources, and potential leadership changes. As we reported in February 2014, the establishment of the UAS Integration office was a positive development because FAA assigned an Executive Manager and combined UAS-related personnel and activities from the agency's Aviation Safety Organization and Air Traffic Organization. However, some industry stakeholders we have interviewed for our ongoing work have expressed concerns about the adequacy of authority and resources that are available to the office.[19] A UAS rulemaking working group, comprised of both government and industry officials, recently recommended that the UAS Integration Office be placed at a higher level within FAA in order to have the necessary authority and access to other FAA lines of business and offices. In addition, according to FAA officials, the Executive Manager's position may soon be vacant. Our previous work has found that complex organizational transformations involving technology, systems, and retraining key personnel—such as another FAA major initiative—NextGen—require[20] substantial leadership commitment over a sustained period, and also found that leaders must be empowered to make critical decisions and held accountable for results.[21]

[19]As of December 2014, FAA told us that they cannot identify total resources, both funding and personnel, dedicated to UAS integration because many different appropriations that support UAS work are managed by numerous organizations within the FAA. We plan on attempting to identify and report on the resources and budget that has been appropriated and planned for the integration of UAS into the national airspace as part of our on ongoing study.

[20]NextGen is a new satellite-based air-traffic management system that will replace the current radar-based system.

[21]GAO, *Results Oriented Cultures: Implementation Steps to Assist Mergers and Organizational Transformations*, GAO-03-669 (Washington, D.C.: July 2013); and *NextGen Air Transportation System: FAA Has Made Some Progress in Midterm Implementation, but Ongoing Challenges Limit Expected Benefits*, GAO-13-264 (Washington, D.C.: April 2013).

FAA and Others Have Made Some Progress in Carrying Out Research and Development in Support of UAS Integration

Several federal agencies and private sector stakeholders have research and development efforts under way to develop technologies that are designed to allow safe and routine UAS operations. As we have previously reported, agency officials and industry experts told us that these research and development efforts cannot be completed and validated without safety, reliability, and performance standards, which have not yet been developed because of data limitations. On the federal side, the primary agencies involved with UAS integration are those also working on research and development, namely, FAA, NASA, and DOD.

FAA uses multiple mechanisms—such as cooperative research and development agreements (CRDA),[22] federally funded research and development centers (FFRDC),[23] and OTAs (discussed earlier in this statement)—to support its research and development efforts. In support of UAS integration, FAA has signed a number of CRDAs with academic and corporate partners. For example, FAA has CRDAs with CNN and BNSF Railway to test industry-specific applications for news coverage and railroad inspection and maintenance, respectively. Other CRDAs have been signed with groups to provide operational and technical assessments, modeling, demonstrations, and simulations. Another mechanism used by FAA to generate research and development for UAS integration are FFRDCs. For example, MITRE Corporation's Center for Advanced Aviation System Development is an FFRDC supporting FAA and the UAS integration process. Specifically, MITRE has ongoing research and development supporting air traffic management for UAS detection and avoidance systems, as well as other technologies.[24]

FAA has cited many accomplishments in research and development in the past fiscal year, as we were conducting our ongoing work. According to FAA, it has made progress in areas related to detect and avoid

[22]A CRDA is an agreement that commemorates the collaborative partnership between the federal laboratory/agency and academia, local and state governments, and private entities.

[23]FAA's FFRDC's are located at MITRE and MIT's Lincoln Lab. FFRDC's are designed to meet long-term research and development needs that cannot be met effectively by other means.

[24]In addition, MITRE also has ongoing research and development supporting the development of standards and technologies for command and control communications link, analysis of safety and operational data.

technologies supporting ongoing work by RTCA Special Committee 228.[25] Other areas of focus and progress by FAA include command and control, as well as operations and approval. According to FAA, progress for command and control was marked by identifying challenges for UAS operations using ground-to-ground communications. FAA also indicated, during our ongoing work, that it conducted simulations of the effects of UAS operations on air traffic management. Furthermore, in support of research and development efforts in the future, FAA solicited for bids for the development of a Center of Excellence. The Center of Excellence is expected to support academic UAS research and development for many areas including detect and avoid, and command and control technologies. FAA expects to announce the winner during fiscal year 2015.

We have previously reported that NASA and DOD have extensive research and development efforts supporting integration into the NAS.[26] NASA has a $150-million project focused on UAS integration into the NAS. NASA officials that the current goal of this program is to conduct research that reduces technical barriers associated with UAS integration into the NAS, including conducting simulations and flight testing to test communications requirements and aircraft separation, among other issues. DOD has research and development efforts primarily focused on airspace operations related to detect and avoid systems. However, DOD also contributes to research and development focused on certification, training, and operation of UAS.

We reported in 2012 that outside the federal government, several academic and private sector companies are conducting research in support of advancing UAS integration.[27] Research by both groups focuses on various areas such as detect and avoid technologies, sensors, and UAS materials. For example, several private sector companies have developed technologies for visual sensing and radar sensing. Academic institutions have conducted extensive research into the use of various technologies to help the maneuverability of UASs.

[25]Formerly the Radio Technical Commission for Aeronautics, RTCA, is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (system issues). It is utilized as a federal advisory committee.

[26]GAO-13-346T, GAO-12-981.

[27]GAO-12-981.

Other Countries Have Progressed in UAS Integration to Allow Some Level of Commercial Use

A number of countries allow commercial UAS operations under some restrictions. A 2014 study, conducted by MITRE for FAA, revealed that Japan, Australia, United Kingdom, and Canada have progressed further than the United States with regulations supporting integration.[28] In fact, Japan, the United Kingdom, and Canada have regulations in place allowing some small UAS operations for commercial purposes.[29] According to this study, these countries' progress in allowing commercial access in the airspace may be attributed to differences in the complexity of their aviation environment.

Our preliminary observations indicate that Japan, Australia, United Kingdom, and Canada also allow more commercial UAS operations than the United States. According to the MITRE study, the types of commercial operations allowed vary by country. For example, as of December 2014, Australia had issued over 180 UAS operating certificates to businesses engaged in aerial surveying, photography, and other lines of business. Furthermore, the agriculture industry in Japan has used UAS to apply fertilizer and pesticide for over 10 years. Several European countries have granted operating licenses to more than 1,000 operators to use UASs for safety inspections of infrastructure, such as rail tracks, or to support the agriculture industry. While UAS commercial operations can occur in other countries, there are restrictions controlling their use. For example, the MITRE study showed that several of the countries it examined require some type of certification and approval to occur before operations. Also, restrictions may require operations to remain within line of sight and below a certain altitude. In Australia, according to the MITRE study, commercial operations can occur only with UASs weighing less than 4.4 pounds. However, the rules governing UASs are not consistent worldwide, and while some countries, such as Canada, are easing restrictions on UAS operations, other countries, such as India, are increasing UAS restrictions.

For our ongoing work, we spoke with representatives of the aviation authority in Canada (Transport Canada) to better understand UAS use and recently issued exemptions. In Canada, regulations governing the

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

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

use of UAS have been in place since 1996. These regulations require that UAS operations apply for and receive a Special Flight Operations Certificate (SFOC). The SFOC process allows Canadian officials to review and approve UAS operations on a case-by-case basis if the risks are managed to an acceptable level. This is similar to the COA process used in the United States. As of September 2014, over 1,000 SFOCs had been approved for UAS operations this year alone. Canada issued new rules for UAS operations on November 27, 2014. Specifically, the new rules create exemptions for commercial use of small UASs weighing 2 kilograms (4.4 pounds) or less and between 2.1 kilograms to 25 kilograms (4.6 pounds to 55 pounds). UASs in these categories can commercially operate without a SFOC but must still follow operational restrictions, such as a height restriction and a requirement to operate within line of sight. Transport Canada officials told us this arrangement allows them to use scarce resources to regulate situations of relatively high risk. For example, if a small UAS is being used for photography in a rural area, this use may fall under the new criteria of not needing an SFOC, thus, providing relatively easy access for commercial UAS operations.

Finally, our ongoing work has found that FAA interacts with a number of international bodies in an effort to harmonize UAS integration across countries. According to FAA officials, the agency's most significant contact in Europe has been with the Joint Authorities for Rulemaking for Unmanned Systems (JARUS). JARUS is a group of experts from the National Aviation Authorities (NAAs) and the European Aviation Safety Agency. A key aim of JARUS is to develop recommended certification specifications and operational provisions, which countries can use during the approval process of a UAS. In addition, FAA participated in ICAO's UAS Study Group, an effort to harmonize standards for UAS. ICAO is the international body that, among other things, promotes harmonization in international standards. ICAO plans to release its UAS manual in March 2015, which will contain guidance about UAS integration for the states. Additional international groups that FAA interacts with in support of UAS integration include the Civil Air Navigation Services Organization, European Organization for Civil Aviation Equipment, and North Atlantic Treaty Organization (NATO).

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

Appendix 1: Selected Requirements and Status for UAS Integration under the FAA Modernization and Reform Act of 2012, as of December 2014

Deadline	FAA Modernization and Reform Act of 2012 requirement	Status of action
05/14/2012	Enter into agreements with appropriate government agencies to simplify the process for issuing COA or waivers for public UAS.	In process – MOA with DOD signed Sept. 2013; MOA with DOJ signed Mar. 2013; MOA with NASA signed Mar. 2013; MOA with DOI signed Jan. 2014; MOA with DOD's Director of Test & Evaluation signed Mar. 2014; MOA with NOAA still in draft.
05/14/2012	Expedite the issuance of COA for public safety entities	Completed
08/12/2012	Establish a program to integrate UAS into the national airspace at six test ranges. This program is to terminate 5 years after date of enactment.	Completed
08/12/2012	Develop an Arctic UAS operation plan and initiate a process to work with relevant federal agencies and national and international communities to designate permanent areas in the Arctic where small unmanned aircraft may operate 24 hours per day for research and commercial purposes.	Completed
08/12/2012	Determine whether certain UAS can fly safely in the national airspace before the completion of the Act's requirements for a comprehensive plan and rulemaking to safely accelerate the integration of civil UASs into the national airspace or the Act's requirement for issuance of guidance regarding the operation of public UASs including operating a UAS with a COA or waiver.	Completed
11/10/2012	Develop a comprehensive plan to safely accelerate integration of civil UASs into national airspace.	Completed
11/10/2012	Issue guidance regarding operation of civil UAS to expedite COA process; provide a collaborative process with public agencies to allow an incremental expansion of access into the national airspace as technology matures and the necessary safety analysis and data become available and until standards are completed and technology issues are resolved; facilitate capability of public entities to develop and use test ranges; provide guidance on public entities' responsibility for operation.	Completed
02/12/2013	Make operational at least one project at a test range.	Completed
02/14/2013	Approve and make publically available a 5-year roadmap for the introduction of civil UAS into national airspace, to be updated annually.	Completed
02/14/2013	Submit to Congress a copy of the comprehensive plan.	Completed
08/14/2014	Publish in the *Federal Register* the Final Rule on small UAS.	In process
08/14/2014	Publish in the *Federal Register* a Notice of Proposed Rulemaking to implement recommendations of the comprehensive plan.	None to date
08/14/2014	Publish in the *Federal Register* an update to the Administration's policy statement on UAS in Docket No. FAA-2006-25714.	None to date
09/30/2015	Achieve safe integration of civil UAS into the national airspace.	In process

Appendix 1: Selected Requirements and Status for UAS Integration under the FAA Modernization and Reform Act of 2012, as of December 2014

Deadline	FAA Modernization and Reform Act of 2012 requirement	Status of action
12/14/2015	Publish in the Federal Register a Final Rule to implement the recommendations of the comprehensive plan.	None to date
12/31/2015	Develop and implement operational and certification requirements for public UAS in national airspace.	In process
05/14/2017	Report to Congress on the test ranges	None to date

GAO analysis of FAA information. | GAO-15-254T

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

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

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GAO U.S. GOVERNMENT ACCOUNTABILITY OFFICE

January 26, 2015

Representative Frank A. LoBiondo
Chairman
Subcommittee on Aviation
Committee on Transportation and Infrastructure
United States House of Representatives

Subject: Response to questions for the record from unmanned aircraft systems hearing on December 10, 2014.

Dear Chairman LoBiondo:

On December 10, 2014, the Subcommittee on Aviation for the Committee on Transportation and Infrastructure held a hearing entitled "U.S Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness." The attachment contains my response to the questions for the record following my testimony at this hearing. If you have any questions regarding these responses please contact me at (202)512-4803 or dillinghamg@gao.gov.

Signed,

Gerald Dillingham

Gerald L. Dillingham, Ph.D.

Director, Physical Infrastructure Issues

Enclosure

GAO U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Enclosure

1. **What indicators or signs would indicate that we are on a reasonable and acceptable trajectory towards safe UAS integration?**

   A number of indicators or signs would demonstrate that FAA is moving towards safe UAS integration:

   - First, FAA's issuance of a Notice of Proposed Rulemaking (NPRM) for small UAS use will be an important step that will indicate progress towards the creation of a final rule. FAA officials stated they expect to issue the NPRM in early 2015 and the final rule 16 months after.

   - Second, FAA's continued use of the regulations and FAA resources that support UAS operations will be a sign of progress towards safe integration. FAA's Certificate of Waiver or Authorization (COA) and the Section 333 of the FAA Modernization and Reform Act of 2012 (2012 Act) exemption provide two means for FAA to continue approving operators' use, which will increase the safety of UAS operations.[1] Furthermore, FAA's resources include the designated test sites. FAA's continued support of the test sites and working to provide additional flexibilities such as a broad area COA that would allow easier access to a test site's airspace potentially increasing UAS operations. Additional safe UAS operations will support further data gathering and standards development based on that data.

   - Finally, efforts to develop a detailed implementation plan for expanded use would be a sign of progress toward safe integration. Although the FAA 5-year *Roadmap* and *Comprehensive Plan* met the congressional mandate in the 2012 Act, these plans do not contain details on how broader UAS operations are to be implemented; it is therefore uncertain how further UAS use will be safely integrated and what resources this integration will require. The UAS ARC emphasized the need for FAA to develop an implementation plan that would identify the means, necessary resources, and schedule to safely and expeditiously integrate civil UAS into the NAS. The Roadmap was to be updated annually, and meeting this requirement and continuing to add details to the plans

[1] Pub. L. No. 112-95, 126 Stat. 11 (2012). Under section 333 of the 2012 Act, Special Rules for Certain Unmanned Aircraft Systems the Secretary of Transportation must determine if certain UAS may operate safely in the NAS prior to the completion of UAS rulemakings. This also gives the Secretary the authority to determine whether to allow certain UAS aircraft to operate in the NAS without an airworthiness certification.

and assess the resources will demonstrate progress towards safe UAS integration.

2. **Has Canada made greater progress towards UAS integration than the United States? What parts of Canada's regulatory approach do you think would work in the United States?**

Canada's aviation regulations governing UAS operations have been in place since 1996 and incorporate a risk-based approach to approving UAS operations. Under these regulations, Canada has progressed further than the United States, in terms of the number of operations approved. Specifically, Canadian regulators used this risk-based approach to approve over 1,000 Special Flight Operations Certificates (SFOC) in 2014 alone. Furthermore, on November 27, 2014, Canada issued new rules incorporating a risk-based approach for UAS operations that allow some commercial UAS operations without review and approval for an SFOC. The new rules create exemptions for commercial use of small UASs weighing 2 kilograms (4.4 pounds) or less and between 2.1 kilograms to 25 kilograms (4.6 pounds to 55 pounds). UASs in these categories can commercially operate without a SFOC but must still follow operational restrictions, such as a height restriction and a requirement to operate within line of sight. Transport Canada officials told us this arrangement allows them to use scarce resources to regulate situations of relative high risk. For example, if a small UAS is being used for photography in a rural area, this use may fall under the new criteria of not needing an SFOC, thus providing relatively easy access for commercial UAS operations.

Canada and the United States have similarities in their regulatory approach to UAS, thus this risk-based approach could work in the United States. In this country, public UAS operators must apply to FAA for a COA and civil UAS operators must apply for a special airworthiness certificates in the experimental category or apply for an exemption, under Section 333 of the 2012 act.[2] By first requiring review and approval, to assess safety risk before allowing a commercial operator access to the airspace, FAA's approach is similar to Canada's SFOC process. However, unlike Canada, the United States does not allow any UAS commercial operations without first going through a review and approval process whereas Canada now allows some. According to FAA officials, they will discuss a similar approach for UAS in an upcoming advisory circular. Thus, there are lessons to be learned from UAS operations in Canada, and FAA might carefully consider Canada's risk-based approach for approving UAS operations.

[2]As of December 4, 2014, FAA had approved 526 COAs of 723 applications received in for the year. As of January 21, 2014, FAA has approved 14 Section 333 applications.

GAO U.S. GOVERNMENT ACCOUNTABILITY OFFICE

3. GAO has conducted several studies for the Congress regarding FAA's ability to implement various technologies and programs. More often than not GAO has reported the FAA is behind schedule, sometimes by years. What has your work shown as the reasons why FAA had difficulty meeting milestones?

In looking at the UAS requirements contained in the FAA Modernization and Reform Act, enacted in February 2012, we found that FAA has completed most of the requirements but key ones remain incomplete.[3] However, in completing these requirements, FAA has missed the mandated timeframes on some requirements by as much as 2 years. A variety of reasons may have contributed to FAA missed milestone deadlines, such as:

- Tight timeframes to meet the mandates from the actual passage of the legislation in 2012;
- Complexities of integrating UASs into airspace with manned commercial and general aviation traffic;
- Lack of safety, reliability, and performance data required to develop and certify standards; and
- Concerns over privacy and determining those responsible for addressing these concerns.

While FAA has missed some UAS milestones, it has met other milestones related to aircraft certification. For example, FAA reported in May 2014 that its Aircraft Certification Service has completed 1 of the 14 initiatives and 10 initiatives are on track for completion within planned time frames.[4] However, 2 of the 14 initiatives would not meet the planned milestones, and the final was at risk of missing the planned milestones.

[3] FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, §§ 331 – 335, 126 Stat. 11 (2012).

[4] See GAO, *Aviation Manufacturing: Status of FAA's Efforts to Improve Certification and Regulatory Consistency*, GAO-14-829T (Washington, D.C.: July 31, 2014).

STATEMENT OF

CAPTAIN LEE MOAK, PRESIDENT

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL

BEFORE THE

COMMITTEE ON TRANSPORTATION & INFRASTRUCTURE

U.S. HOUSE OF REPRESENTATIVES

WASHINGTON, DC

DECEMBER 10, 2014

"U.S. UNMANNED AIRCRAFT SYSTEMS:
INTEGRATION, OVERSIGHT, AND COMPETITIVENESS"

Air Line Pilots Association, International
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STATEMENT OF
CAPTAIN LEE MOAK, PRESIDENT
AIR LINE PILOTS ASSOCIATION, INTERNATIONAL
BEFORE THE
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
UNITED STATES HOUSE OF REPRESENTATIVES
ON
U.S. UNMANNED AIRCRAFT SYSTEMS – INTEGRATION, OVERSIGHT AND COMPETITIVENESS
DECEMBER 10, 2014

Good morning, Mr. Chairman and members of the Committee. I am Captain Lee Moak, President of the Air Line Pilots Association, International (ALPA). ALPA represents over 51,000 pilots who fly for 30 passenger and all-cargo airlines in the United States and Canada. On behalf of our members, I want to thank you for the opportunity to provide our perspectives on the critical importance of safely integrating Unmanned Aircraft Systems into the most complex airspace in the world which is enabled for air transportation by the people, equipment, and procedures of the National Airspace System (NAS). The NAS is the most dynamic and diverse such system in the world and it must be protected and maintained to the best of our ability to deliver the safest, most efficient air transportation services in the world.

Introduction and Capabilities of UAS/RPA

The need to modernize aviation extends beyond simply upgrading today's ground and airborne equipment. Among the most dramatic and challenging revolutions in aviation technology and operational capability to be introduced into the NAS is the Unmanned Aircraft System (UAS) some of which are more appropriately called Remotely Piloted Aircraft Systems (RPAS). UAS/RPAS include aircraft that range in size from as small as a bird to as large as a Boeing 737, along with a wide range of technology on the ground that forms the entire system that must be considered in evaluating the safety of integrating these aircraft into the National Airspace System.

Some UAS aircraft are operated completely autonomous in that their flight route is completely computer programed and the device operates without a "pilot in the loop". Other UAS aircraft, RPA aircraft, are flown remotely by pilots from an operational center or control stations that can be located at the launch and recovery site or thousands of miles away. UAS is a broader descriptor and includes both autonomous and RPA aircraft. Pilots/operators are not currently required by Federal Aviation Regulations to be FAA-licensed or qualified as pilots or even have a common level of proficiency. In fact, in many cases, these operators are recruited from recreational modeling. Most of the current larger designs were developed for the Department of Defense (DOD) for use in combat areas and are not necessarily designed, built, maintained, or able to safely interoperate with other civil users in the same manner as other aircraft in the National Airspace System. As a result, today they are typically flown in segregated airspace, i.e., military restricted airspace or equivalent, but these UAS have demonstrated over and over again that they may potentially stray out of their assigned airspace in the event of a malfunction.

The UAS/RPAS may be used to perform flight operations that may expose more risk for a human to accomplish reliably and repeatedly in potentially austere environments. The uniqueness of UAS/RPAS operations has revealed many safety and technological challenges to be addressed before integration in order to maintain the current level of safety for the NAS, its users, and the travelling public. The introduction of small and large UAS to the NAS has become the most challenging enterprise for the FAA and the aviation community in many years. UAS proponents have a growing interest in expediting access to the NAS as evidenced by an increase in the number and scope of UAS flights in our busy NAS.

FAA has identified research and development efforts to be conducted at six specific test sites. Other operations in restricted capacities have been authorized in remote or segregated areas of the NAS. However, as the drumbeat to integrate the UAS/RPA as quickly as possible grows louder, many current and future-state technological issues raise yet-unanswered questions about the ability of these UAS/RPAS to safely interoperate with today's certified aircraft in the NAS.

Until comprehensive end-to-end solutions are developed and promulgated by FAA, our overarching position is that no unmanned or remotely piloted aircraft, public or civil, should be allowed unrestricted access to conduct flight operations into the NAS unless it meets all of the high standards currently required for every other airspace user. This means UAS/RPA must be designed to interoperate, with similar performance and functional requirements at the heart of their system, architectures embodying state-of-the-art safety technologies and system redundancies as required by currently certified commercial and general aviation airspace users. Of particular importance and concern is the ability of commercial passenger carrying aircraft operating in the NAS to be able to see and avoid UAS and RPAS aircraft that may be operating in the same area.

We believe that the fundamental functions of operating the aircraft in a safe manner must be maintained at the same level of safety regardless of the location of the pilot or levels of automation. At the center of current commercial aviation flight operations is a well-trained, well-qualified professional pilot, and a well-qualified pilot remains the single most important safety component of any commercial aircraft. A UAS/RPAS should be able to operate as a part of commercial or general aviation, as the case may be, through compliance with FAA regulations and accompanying certification standards to meet the target level of safety that is performed reliably and repeatedly by well-trained airline pilots and their aircraft in the NAS today. Accordingly, UAS/RPA operators performing commercial or "For Hire" operations should be required to meet all the certification and equivalent safety requirements of a commercial operator and the pilots flying the aircraft must meet equivalent training, qualification, and licensing requirements of pilots of manned aircraft in the same airspace.

Harmonization of UAS/RPA Platforms

UAS/RPA aircraft themselves are necessarily part of a larger system that includes the supporting ground station or control station, along with the command and control communications system which may employ a wide range of ground- or space-based elements.

Development of a common description of the UAS/RPA remains an unresolved technical issue with different interpretations either by country, regulatory body, or the media when described in publications. The main point of contention is that an Unmanned Aircraft System is not truly unmanned in today's context; more accurately, it is an aircraft operated and managed by a pilot-in-command in a cockpit located in a ground station. So, while the term UAS sounds more autonomous or robotic, in reality, the FAA has stated that autonomous flights in the NAS are currently not authorized nor envisioned in the near term. A more apt description for these aircraft platforms and their support is the Remotely Piloted Aircraft System or RPAS for short, which is the accepted ICAO nomenclature. The term RPAS actually describes these platforms quite well, as the pilot is remotely located in the ground station but an integral part of the system. The FAA has representatives serving on international committees to harmonize the definitions, descriptions, procedures, and related documentation and we are optimistic that the FAA will begin the adoption of products from these groups to harmonize terminology with other regulatory organizations ongoing work efforts.

UAS Design Standard Barriers

The futuristic visions of unmanned operations promise possibilities and convenience that offers the attraction of a flying technology unbound from the conventions and constraints of modern aviation. The reality is quite different; new UAS/RPAS technology currently lack—but must have—the standardization of safely integrated and interoperable certified systems, which the FAA requires of commercial operators in the NAS today. Without mature standards, technologies without certification standards and regulations, safety in the NAS today would be significantly and negatively impacted, adding risk to commercial airline operations to an overburdened Air Traffic Control system.

There are UAS/RPAS proponents within government and industry who are insistent that within the next few years, UAS/RPAS should begin a much broader scope of civil commercial operations than is permitted today. Some proposals even advocate fully autonomous systems, that is, aircraft operations without pilots actively flying or commanding the aircraft (e.g., package delivery and survey) but individuals who merely monitor the end-to-end flight operation. At this time, the UAS/RPAS technologies, safety, certifications for an end-to-end solution for NAS integration are quite immature; patience, and more importantly collaboration, is needed to diligently examine all the barriers and successfully develop comprehensive and fully mature solutions prior to widespread operational implementation into the NAS. We simply cannot afford to miss critical steps in safety analyses in an attempt to satisfy a market demand.

The introduction of multiple variations of UAS/RPAS without first completing architectural standards, analysis, rigorous testing, and robust aircraft and pilot certifications would impair aviation safety and the public's perception of safe air travel. We believe that all aviation stakeholders should examine UAS/RPAS integration to determine how these RPA platforms may impact their operations.

Technological Barriers Impacting Operations in the NAS

American aviation technology is experiencing its own "space race" akin to the 1960s, with phenomenal growth in aviation science and technological advancements in this modern digital age, the results are testimony of the advanced applications underpinning NextGen and associated programs. These technologies are designed at their core architectures to be safe, reliable, and repeatable to provide the efficiencies required maintain the target level of safety as aviation transportation continues to grow. The target level of safety for commercial air travel in the NAS should be proactively, not reactively, protected. We are fully aware that there is a strong desire by UAS/RPAS operators, and those who wish to become operators, to begin flying in the NAS as quickly as possible. Clearly, there are commercial, social, business and international competitive advantages to a strong UAS industry. However, the government and industry must take a longer view of this present situation and ensure that robust UAS/RPAS are developed that completely integrate with commercial airline operations, and above all, do so safely. An imprudent rush to create and implement minimum standards will not only harm safety, but potentially produce a setback for the future expansion of UAS/RPAS operations for years to come.

A June 20, 2014, newspaper article1 reported that 47 UAS/ RPA accidents involving U.S. military and federal agencies' aircraft have occurred since 2001, which is a safety record that no commercial business or airline could survive. These federal institutions have the authority to self-certify the airworthiness of their own UAS/RPA which can involve modifying compliance with FAA certification standards to accommodate these agencies' unique mission requirements. This latitude and difference in priorities relative to commercial aviation is likely a contributing factor to the number of UAS/RPA accidents.

As such, it is easily understood that without the FAA's and other safety organizations' experience and collective guidance in aviation safety, lesser airworthiness standards and certification procedures will produce greater UAS/RPA accident rates. Moreover, these accident

[1] "When Drones Fall from the Sky," *Washington Post*, June 20, 2014

rates expose the importance of developing civil standards tailored explicitly to UAS/RPA technologies, airworthiness, and related certifications through established civil procedures.

Unlike their manned counterparts, a key system on a UAS/RPA is the Communication and Control System (C^2). This is what allows the pilot to control the aircraft. The system transmits and receives command inputs (e.g., flight controls, navigation, aircraft status, and ATC communications) from the ground station via radio frequency to the UA/RPA. The criticality of the C^2 system becomes self-evident, as it is the most vital single-system link depended upon for the UAS/RPA to successfully and safely operate. Link failure—which is exactly analogous to the pilot of an aircraft suddenly disappearing from the cockpit—may cause a multitude of unintentional, cascading events. The sole dependence on this vital link is a necessary aspect of UAS/RPAS operations but its failure is one of the primary causal factors why UAS/RPA have accidents.

The primary C^2 contributing failures are associated with latency issues, that is, the time between transmission and reception of a command to successfully operate the UAS/RPA. Unlike the human on-board pilot, whose control input is instantaneous, latency times can be from 3 seconds to as much as 30 seconds, perhaps more. In the NAS, where immediate communication and required actions are expected to provide separation between aircraft, latency could cause more significant problems for Air Traffic Control (ATC) and manned aircraft in that airspace. The term "lost link," as the phrase implies, is the result of the UAS/RPA having no communication or control whatsoever to successfully operate and command the UAS/RPA until C^2 two-way link is re-established, if that is accomplished.

The varying degrees of UAS/RPA C^2 vulnerabilities and failures creates complex safety issues for UAS integration. The C^2 data, voice, and video requirements placed on operating UAS/RPA using radio waves or satellite creates limitations that currently prevent UAS from performing to the safety level of manned commercial aircraft operations. If a UAS/RPA cannot maintain a C^2 link, the normal expectation of a UAS/RPA to perform the critical functions of ensuring separation from terrain, obstacles, and other aircraft, as well as collision avoidance responsibilities, will unduly place safety burdens on other NAS users. Since 1931, ALPA's professional airline pilots and safety professionals have worked together to advocate for the safety of the NAS. Manned aircraft flown by pilots in the NAS today use Instrument Flight Rules (IFR) to take advantage of the benefits of FAA's ATC separation services, however, a pilot's responsibility to "See and Avoid" to remain well-clear of other aircraft is a constant responsibility in their line of work, regardless of who or what else is monitoring the flight. Simply stated, pilots visually scan the airspace, especially when traffic is being reported to them by ATC, to identify the aircraft in question when a traffic alert is initiated or simply when a flight crew is flying into an airport that may not have a control tower, to avoid all potential conflicts. The UAS/RPA needs to be equipped with the technological ability to maintain well-clear of and a avoid collision with other operators if it is to truly replicate the actions expected of every aircraft in the NAS.

A robust and safe UAS/RPA system design will not result in the transference of safety burdens—such as maintaining separation—for other operators and users to mitigate. Accordingly, one of the most important capabilities yet to be developed for UAS/RPA operations is the Detect and Avoid (DAA) technology that is fully capable of performing two primary functions, staying well-clear of other aircraft and if that cannot be done, the ability to avoid an imminent collision. While those capabilities in manned aircraft are accomplished by a combination of pilot skill and electronic means, UAS must rely on electronic means. The responsibility to avoid coming hazardously close to other aircraft is a two-way street. In addition to the UAS/RPAS ability to detect and avoid other aircraft, other aircraft in the NAS must likewise be able to "see" any UAS/RPA that could pose a collision threat. Realistically, given sizes too small to be seen by the human eye until the aircraft is dangerously close, the ability to be seen must be electronic.

A promising system to enable that capability is called ACAS X. Unfortunately no funding exists to develop ACAS for UAS/RPAS to implement this groundbreaking technology. Specific funding for ACAS X would benefit manned and unmanned aircraft and play a vital role in the safe integration of UAS platforms into the NAS RPA's and harmonize with NextGen requirements in the near future, as well.

Government and Industry Initiatives

FAA Reauthorization legislation was introduced and Congress passed the "FAA Modernization and Reform Act reauthorization of 2012" on February 14, 2012. However, the FAA anticipating the growing advocacy of UAS/ RPAS expansion in the NAS stood up the UAS/ RPAS Integration Office, AFS-80. In general, AFS-80's purpose is to develop the overarching aviation coordination of UAS/RPAS integration standards, regulatory issues, certifications required for the aircraft and for the pilots who fly them, as well.

In Section 332 of the FAA Reauthorization Act of 2012, "Integration of civil unmanned aircraft systems into national airspace system," the Act required the FAA to develop a comprehensive plan for integration of UAS/RPA into the NAS by September 2015. FAA is working hard on an integration plan, but has yet to release a long-awaited NPRM for small unmanned aircraft (sUAS). This delay has resulted in mounting pressure by the UAS industry to gain access to the NAS for commercial applications as evidenced by nearly 140 petitions for exemption under Section 333 of the 2012 FAA Reauthorization Act. The UAS/RPA industry is focused on the much publicized military and domestic law enforcement UAS operations but, simultaneously, is rapidly moving forward on UAS many roles in civil applications.

Small UAS petitions for exemption under Section 333 are requesting exemption from several regulations in 14 CFR Parts 61 and 91, in order to perform operations in areas like film making, environmental surveying, infrastructure inspection, 3-dimensional map making, and agriculture applications. Without a small UAS/RPAS rule promulgated, operators file a petition to seek exemption from compliance with these regulations that the rest of the U.S. aviation community must be in compliance with every day. Proponents must, in their petitions for exemption, describe each and every means they intend to use to provide an equivalent level of safety. The FAA, in turn, if they grant the petition, must then check each and every operation for compliance with a set of requirements that is custom tailored for every operator. This need for FAA to react to the legislated ability for proponents to request exemptions from multiple regulations taxes and already strained FAA oversight capability.

Even as designs and procedures are refined, these UAS/RPAS routinely fail. However, without quantitative failure data analyses, what components and how often failure occurs has not been made publically available. Small UAS/RPAS have failure conditions much like their larger brethren, C2 links, GPS, navigational and flight control failures appear to be quite common. Without robust standards, system architectures and redundant safety systems receiving certification through the FAA, the approved operators under Section 333 will certainly encounter failure conditions and create potential safety issues in the NAS. A significantly growing problem is unapproved small UAS/RPAS operations creating near mid-air collisions currently in the NAS also demonstrate why safety-based standards, certifications, and regulatory enforcement are required immediately to address this very serious potential safety problem.

The FAA has been challenged in completing a plan for integration that incorporates a complete set of standards development, rulemaking, certification and safety analyses to meet the September 2015 deadline required in the Act. We believe in order to guarantee an "equivalent level of safety" for UAS in the NAS, realistic timelines for safety and aviation technology studies, accompanied by stable sources of funding to identify all potential hazards and ways to mitigate those hazards, must be developed at a pace that does not compromise safety. As a result of these challenges, the FAA has chartered Aviation Rule-Making Committees (ARC) and tasked RTCA to create a Special Committees (SC), both of which play pivotal roles in standards, regulatory and policy development for many types of technological challenges in aviation.

The pressure mounted by the UAS/RPA industry The FAA established the Small UAS/ RPAS Aviation Rulemaking Committee (ARC) in 2008 to develop standards and regulations unique and appropriate to small UAS/RPAS (55 lbs and less). In 2011, another ARC (more than 55 lbs) was chartered to make recommendations for standards and regulations for the remainder of UAS/RPAS certification and operation. RTCA, NASA and other organizations have multiple efforts underway, many of which include participation by ALPA safety representatives.

Currently, the research and analysis work continues for Detect and Avoid (DAA) and Communication and Control Links (C^2). Technological dependencies and proposed architectures surrounding these systems lack maturity and do not yet meet the safety, performance, and functional requirements to operate reliably and repeatedly in an integrated and dynamic airspace of the current NAS.

Conclusions

The pressure for rapid integration into the NAS must not result in incomplete safety analyses or technologies prior to any authorization approvals to operate.

Standards and technologies for UAS/RPA must be in place to ensure the same high level of safety as is currently present in the NAS before a UAS/RPA can be authorized to occupy the same airspace as airlines, or operate in areas where UAS/RPA might inadvertently stray into airspace used by commercial flights.

Critical to safe UAS/RPA integration, the decisions being made about UAS/RPA airworthiness and operational requirements must fully address safety implications of UAS and complete interoperability functionalities (e.g., DAA) of UAS flying in, around, or over the same airspace as manned aircraft, and, perhaps more importantly, airline aircraft.

A well-trained and experienced commercial pilot is the most important safety component of the commercial aviation system. The role of the pilot is a major area of concern within the UAS/RPA and piloted aircraft communities. UAS/RPA operators using RC model pilots, non-licensed or private pilots for commercial or "For Hire" operations should not be allowed to operate UAS/RPAS in any commercial or "For Hire" operation. Another concern is that, by definition, it is impossible for a UAS/RPAS pilot to react to anything other than an explicitly annunciated malfunction. A pilot on board an aircraft can see, feel, smell, or hear many indications of an impending problem and begin to formulate a course of action before even sophisticated sensors and indicators provide positive indications of trouble. This capability is necessarily lost without a pilot on board, so the margin of safety it represents must be replace by other means. UAS/RPAS pilots should be highly trained, qualified, and monitored to meet the equivalent standards of pilots who operate manned aircraft in either private or commercial operations.

While many UAS/RPAS have preprogrammed instructions on which that aircraft relies in a lost link event, the fact that the pilot is no longer in control of the aircraft when the aircraft is potentially near airspace occupied by other conventionally piloted aircraft is a safety concern. At present, no requirement exists to report all such events to a government agency (e.g., FAA or NTSB) so ALPA is concerned that the frequency of "lost link" with the UAS/RPAS is more prevalent than is currently being reported.

Recommendations

1. A comprehensive, proactive safety UAS/RPA program should incorporate technology standards, safety analyses, certifications, and flight standards to ensure that introduction of UAS/RPA into the NAS will not degrade the existing NAS Target Level of Safety.

2. Federal Aviation Regulations that specifically addresses UAS/RPA operators, operations, and pilots must be developed. Any UAS/RPA unique or UAS/RPA-specific regulations must be comparable and compatible with other existing regulations for other airspace users.

3. UAS/RPAS are inherently different aircraft from manned aircraft, and should be required to be equipped with safety-based technologies designed with "Well-Clear" and "Collision Avoidance" functionalities at the heart of their system architectures, in order to maintain the current level of safety in the NAS.

4. Support FAA efforts to ensure that all the components of UAS/RPA certified by the Department of Defense and other government agencies do not adversely affect the NAS level of safety prior to their operating in other than segregated airspace.

5. Certification standards for UAS/RPA pilots must be commercially licensed with an instrument rating for the aircraft to be flown to ensure the continuity of safety that now exists in the NAS.

6. Regulatory directives containing certification standards, continuing airworthiness standards, and Minimum Equipment List requirements for UAS/RPA that are intended to operate in the NAS must be developed.

7. Congress should work with industry to develop an appropriate UAS/RPA integration funding mechanism within the FAA Reauthorization.

8. Any person or persons in direct control of a UAS/ RPAS must be limited to the control of a single aircraft unless operations are conducted in Special Use Airspace or FAA Certificate of Authorization.

9. The FAA's limited resources will be significantly taxed without a stable source of funding for this purpose, combined with realistic timelines and a systematic approach that builds the path of integration based on proactive safety methodologies.

We appreciate the opportunity to testify on this important subject and look forward to working with Congress as it progresses.

# # #

Airware

Testimony of Jesse Kallman

Head of Business Development & Regulatory Affairs, Airware

Before the House Transportation and Infrastructure Subcommittee on Aviation

December 10, 2014

Chairman LoBiondo, Ranking Member Larsen, and members of the subcommittee, thank you for inviting me to testify here today in this crucial hearing on Unmanned Aerial Vehicle (UAV) technology. I am the Head of Business Development and Regulatory Affairs for Airware, a San Francisco-based company developing flight control systems for commercial unmanned aircraft, enabling companies to use commercial UAVs to collect, analyze and disseminate data for a growing number of commercial applications around the world. At Airware we're building a development platform. As a result, we work closely with companies across the industry including vehicle and sensor manufacturers, operators and software developers, giving us a unique and holistic perspective of the industry and impact of the regulatory environment. Airware has raised over $40 million from several of the world's leading venture capital firms including Andreessen Horowitz, Kleiner Perkins Caufield & Byers, Google Ventures, and most recently GE Ventures. Our team has more than doubled over the last year. I also serve on the board of the Small UAV Coalition, which was formed earlier this year to promote safe commercial operations of small UAVs in the United States, as well as the President of the Silicon Valley chapter of the Association for Unmanned Vehicle Systems International (AUVSI).

This is a critical time for the UAV industry, and Airware, The Small UAV Coalition and others in the community would like to ensure that the United States becomes the global leader for commercial UAV technology development and operations while maintaining the safest airspace in the world. Today, I will focus on three key issues for this subcommittee:

1. The current state of UAV technology, and potential implications in various industries;
2. The need for a risk-based approach to UAV regulations;
3. The effect of current and expected regulations on U.S. businesses.

I. The current state of UAV technology

First, the UAV industry is one of the fastest growing markets in the United States and I would like to share some information about the landscape of this industry. Many here today may be familiar with the small consumer UAVs, those used for personal enjoyment or photography, but I would like to focus on the commercial-grade UAVs which are tackling some of the biggest problems across a variety of industries. Commercial UAVs are being used for purposes such as disaster management, search and rescue, for inspection of oil and gas platforms and pipelines, cell towers, wind turbines, and for inspection of property damage following catastrophic events. These UAVs are equipped with many technological features to ensure the safety and reliability of operations, such as geo-fencing, which is a technology that keeps a UAV within certain altitude and distance limits; and contingency management procedures, which, in the case of a loss of communications, GPS signal, or if the UAV encounters an unexpected obstacle or other

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emergency, enables the UAV to make intelligent decisions based on a pre-programmed set of procedures in order to return to a safe location. Just as advancements in automation in the medical and even manned aviation industry have increased levels of safety by orders of magnitude, the same will be true in the UAV industry. These types of technologies are developing at an increasingly rapid rate and are enabling safe operations, even beyond line of sight, in many parts of the world.

With increasing technology, the risks are being reduced and therefore providing equivalent levels of safety, which the FAA will require to open up additional operational environments like those beyond line of sight and above 400 feet. In addition to the FAA, other federal agencies such as NASA, are working to develop systems such as the UAS Traffic Management System (UTM) at NASA Ames alongside Airware and others in the industry in order to provide a means to safely manage these small systems even at low altitude.

II. The need for a risk-based approach to regulate UAVs

The FAA's utmost responsibility is to protect people and property in the air and on the ground through regulating our national airspace. However, small UAVs are very different from the Boeing 737s, Gulfstream 550s, or even the Cessna 172s that the FAA is accustomed to regulating. They pose vastly different risks to people and property in the air and on the ground. Through my past experience working at the FAA, I understand what a difficult challenge it is to regulate this new and revolutionary technology in the U.S. National Airspace Systems, but there are steps we can be taking in the interim to begin to open up operational environments sooner. This brings me to my second point: We must take a new, risk-based approach to regulating UAVs, one that recognizes both the technological capabilities of UAVs and the fact that safety risks are directly proportional to a few key factors and are inherently different from manned aircraft.

Currently, the FAA has been taking rules made for manned aircraft and applying them to small, unmanned vehicles because those are the rules they have available to them. Take for example, the FAA requiring manned pilot certification for commercial UAV operations in the United States. I believe the FAA understands this is not the ideal solution in the long run and is taking steps to create new standards, but these standards need to be accelerated. Today highly-skilled and qualified UAV operators are being substituted for manned aircraft pilots but the skills required to operate a UAV are vastly different than the skills required to fly manned aircraft.

Most commercial UAV operations will take place below 400 feet, 100 feet below the typical minimum safe altitude of 500 feet for manned aviation. Many commercial UAV applications, like inspecting cell towers, monitoring crops, and surveying quarries, will all fall outside of the typical airspace used by commercial and general aviation. Imagine within this type of environment a simple, regulatory structure based on the risks posed. So for example, a very small aircraft operating over a remote farm field would be subject to minimal regulatory requirements where as a larger aircraft operating over a populated area would require highly reliable avionics, additional training, and failsafe mechanisms like parachutes. These are the types of risk models being used to allow commercial operations in Europe today. UAV companies in France for example are already being certified for operations beyond line of site based on this risk matrix approach.

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The correct approach for the FAA is one that is based on, and proportionate to, the safety risks exposed. As recently as Monday, the FAA stated its intentions to shift to this type of model which we applaud them for, but hope we can see this implemented in the very near future.

III. The effect of current and expected regulations on U.S. businesses

Finally, I'd like to discuss the effect that the FAA's current approach is having on U.S. businesses. I referenced earlier that France allows low-risk commercial operations; as does Canada, the United Kingdom, Germany, Australia, Denmark, and many other countries. The United States, typically a leader in aviation, is one of only a few countries that currently prohibits commercial UAV operations, except pursuant to an exemption. As of today, however only seven petitions for exemption have been granted out of the more than 150 that have been filed. Months after the FAA granted those petitions, those companies are still trying get Air Traffic Control authorization to operate. There are also many within the industry concerned that the small UAV rulemaking, soon to be released for comment, will not likely be effective until 2016. Additionally, we expect the rule to be unduly restrictive on commercial operations and testing, and will limit the ability for operators to perform commercial work even in scenarios that pose little to no risk to people and property.

This has consequences. There are hundreds if not thousands of small UAV businesses here in the United States either operating in the shadows or struggling to follow the current rules. There are even more companies that would have started here in the U.S. but are moving abroad because of the uncertain regulatory environment here in the U.S. These companies want and need regulations so they can test and sell their products, but don't have years to wait as their profits are being narrowed by foreign competitors.

Delayed regulations aren't just slowing growth of the UAV industry. Many of the largest industries and corporations in America see this technology as vital to the growth of their companies and a key for remaining competitive in the global marketplace. Airware recently announced a strategic partnership with one of the largest corporations in America, General Electric. GE could use UAVs across many of their business units including oil and gas, energy management, transportation, to name a few. The Farm Bureau recently noted that U.S. farmers will not be able to keep up with foreign competitors if they are not allowed to use the same technology. Likewise, oil and gas companies in the United States cannot use the same UAV inspection technology as oil companies in other nations, and are forced to undergo more costly procedures. AUVSI states that in the first three years of integration, conservative estimates include creating more than 70,000 jobs and adding $13.6 billion into the economy. This technology will have a major impact our economy. We want the jobs, economic benefits, and core intellectual property produced from this work to be here; in the United States.

IV. Conclusion

We know that UAV technology is already revolutionizing industries - helping farmers get higher crop yields, aiding in efforts of first responders and search and rescue teams, making infrastructure safer through more frequent inspections, keeping workers out of harm's way and

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ultimately saving lives. These applications are happening around the world, today, in countries where regulations are more mature and advanced than ours. They are also happening here in the United States, but in the shadows and by operators who want risk-based guidelines to safely operate and allow them to keep their businesses here in the United States. We know that no matter what actions are taken today, the technology will create jobs, save lives and grow the economies of those countries with the foresight to act. I also know that the United States is poised to lead the way for this growing and game-changing industry and that we have the talent and the workforce to create the technology needed to safely integrate into the world's most complex and safest airspace. But only if we are willing to act quickly. Thank you for your time. I look forward to answering your questions.

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Committee on Transportation and Infrastructure
U.S. House of Representatives
Washington, D.C. 20515

Dear Chairman LoBiondo:

I greatly appreciate the Committee's invitation to participate in the opening hearing and am happy to provide a response to the question: *Based on your understanding of the safety, business and regulatory issues of UAS, could you generally describe the "ideal" regulatory environment to foster safe integration and economic growth?*

The ideal regulatory environment to foster safe integration and economic growth is one that takes into account the inherent risks of different operations. We must have a mechanism for allowing testing and commercial operations that pose little to no risk to the general public and property, this year.

An environment that is working well in Europe is a risk matrix framework which assigns a risk category for operations by taking into account the weight and velocity of the vehicle, proximity to people and structures, and vertical/lateral distance from the operator. Each risk category has different standards and requirements associated with it so that, for example, to fly over people an operator would need high-quality avionics with proven software and hardware, a trained operator and contingency management procedures, like returning to a safe location or a parachute deployment in the case of any issues. As the weight, velocity, proximity to people, and distance from the operator (eg. beyond line of site) increases, so does the amount of requirements placed on the operation. Each risk category would need a set of standards. The standards for low-risk categories already exist today and standards for higher risk categories are being developed by ASTM. In addition, companies like Airware, are developing the technology to enable safe operation of UAVs across all risk categories. Since we have standards and the technology to operate safely in the low-risk category, those operations should be allowed. Since technology exists for high-risk operations, like beyond line of sight or flights over populated areas, we must accelerate the development of standards for high-risk operations as well.

There is still work to be done to allow fully-integrated flights with manned aviation in controlled airspace, but a large amount of commercial applications can be performed by small aircraft under 55 pounds, operating below 400 ft. The FAA should create an additional class of airspace (class U - unmanned airspace) in some of this underutilized, low-altitude class G airspace reserving it for UAV operations with clear guidelines for how manned aviators can enter, if needed.

A risk matrix can be implemented in the United States this year. Let's look to countries like Canada, France and the UK, who have implemented the ability for low-risk applications to take place right away. Thank you for your support of this crucial industry.

Sincerely,

Jesse Kallman
Head of Business Development & Regulatory Affairs
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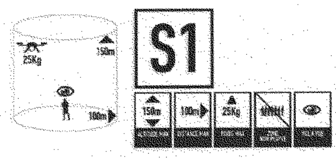
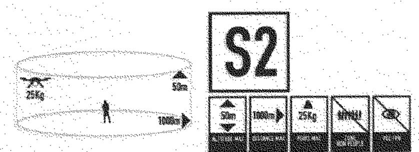
Supporting Information

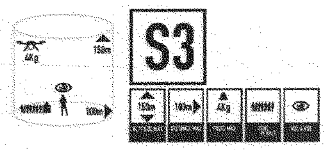
French Regulatory Scenarios



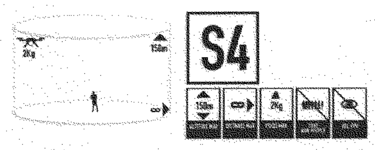
S1 : opération en vue du télépilote se déroulant hors zone peuplée à une distance horizontale maximale de 100 mètres du télépilote.



S2 : opération se déroulant hors vue directe, hors zone peuplée, dans un volume de dimension horizontale maximale de rayon d'un kilomètre et de hauteur inférieure à 50 m. **Afin de répondre aux attentes, un scenario S2+ a été mis en place par la DGAC. Ainsi la hauteur de vol à été augmenté à 100m.**



S3 : opération se déroulant en agglomération ou à proximité de personnes ou d'animaux, en vue directe et à une distance horizontale maximale de 100 mètres du télépilote.



S4 : activité particulière (relevés, photographies, observations et surveillances aériennes) hors vue directe, hors zone peuplée et ne répondant pas aux critères du scénario S2.

Austrian Risk Matrix Regulatory Framework

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Categorisation of UAS Class 1 (VLOS) by Austrocontrol (LBTH 67)

see: www.austrocontrol.at/en/aviation_agency/licenses__permissions/flight_permissions/rpas

- Four categories (A to D), depending on weight and area of operation
- Light UAS in unpopulated areas face easier rules (certific./operation)
- Heavier UAS or UAS flying above populated areas face stricter rules

austro CONTROL	UAS Class 1 (VLOS) – Area of Operation			
	I undeveloped (no buildings)	II unpopulated	III populated	IV densely populated (except crowds)
MTOW up to and including 5 kg	A	A	B	C
MTOW up to and including 25 kg	A	B	C	D
MTOW above 25 kg and up to and including 150 kg	B	C	D	D

Austrian RPAS Regulations

The extent of the technical investigation is determined by the category and ranges from self declaration to a sample inspection

	Category A	Category B	Category C	Category D
Airworthiness Requirements	no compliance with CS needed	≤25kg: Model aircraft certification >25kg: CS for model aircraft (self declaration)	Case-by-Case basis (CS-LURS, CS-LUAS, ...)	Case-by-Case basis (CS-LURS, CS-LUAS, ...)
Continuing Airworthiness	Pre-flight check	Pre-flight check	Maintenance by check list	Maintenance by check list
Control System	Non complex manual control	Non complex with stabilization	Complex with stabilization and automation	Complex with stabilization and automation and navigation
Record Keeping	Date, time, duration, pilot...	Date, time, duration, pilot...	Date, time, duration, pilot...	Date, time, duration, pilot...
Failure Tolerance	none	FMEA	FMEA	FMEA

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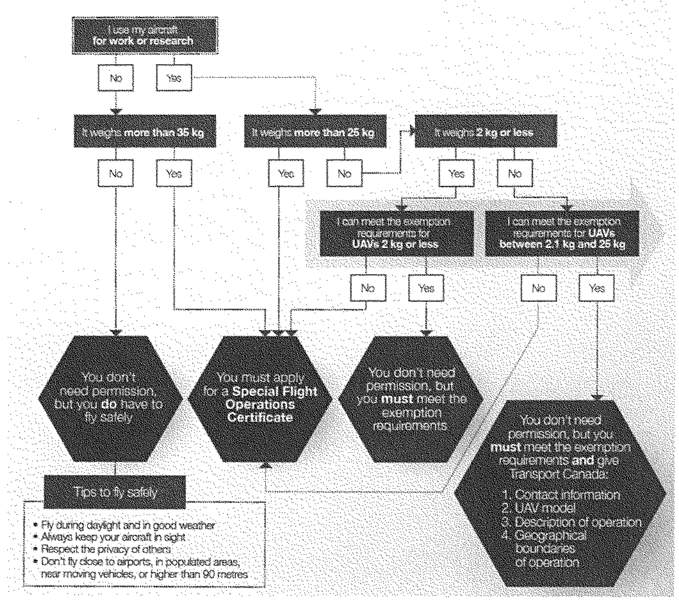
Canadian Low Risk Regulatory Framework

Flying an unmanned aircraft?

You may need permission from Transport Canada



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Exemption requirements for operating UAVs without permission

THIS INFOGRAPHIC IS FOR EASE OF REFERENCE ONLY. YOU MUST CONSULT THE OFFICIAL EXEMPTIONS.

UAVs 2 kg or less

- Be safe, well trained and know the rules of the sky
- Be 18 years old, or at least 16 years old to conduct research under academic supervision
- Have at least $100,000 liability insurance
- Be alert—not tired or under the influence of alcohol or drugs
- Inspect your UAV and site before flight to ensure they are safe
- Get permission before you go onto private property
- Inform Air Traffic Services if your UAV enters controlled airspace
- Give right-of-way to manned aircraft
- Fly during daylight and in good weather
- Keep your aircraft in direct line of sight and always be able to see it with your own eyes
- Verify that radio frequencies/transmissions won't affect control of your UAV
- Have an emergency plan ahead of time
- Carry a copy of your UAV exemption, proof of liability insurance, contact information, and aircraft system limitations
- Follow the manufacturer's operating and emergency procedures, including those if the remote control loses contact with the aircraft
- Respect laws from all levels of government
- Operate only one UAV at a time, with a single remote control
- Immediately stop all operations if you can no longer meet the exemption requirements or if the safety of a person, property or other aircraft is at risk
- Stay at least 30 metres away from people, animals, buildings, structures, and vehicles not involved in the operation

UAVs between 2.1 kg and 25 kg

- Be safe, well trained and know the rules of the sky
- Be 18 years old
- Have at least $100,000 liability insurance
- Be alert—not tired or under the influence of alcohol or drugs
- Inspect your UAV and site before flight to ensure they are safe
- Get permission before you go onto private property
- Carry a copy of your UAV exemption, proof of liability insurance, contact information, and UAV system limitations
- Respect laws from all levels of government
- Keep your UAV in direct line of sight and always be able to see it with your own eyes
- Operate only one UAV at a time, with a single remote control
- Give right-of-way to manned aircraft
- Fly during daylight and in good weather (no clouds, snow or icy conditions)
- Create and follow procedures for landing and recovering your UAV and for contacting emergency responders and air traffic control.
- Have an emergency plan ahead of time
- Follow the manufacturer's operating and emergency procedures, including those if the remote control loses contact with the aircraft
- Verify that radio frequencies/transmission and eletronic devices won't affect control of your UAV
- Assess the risk of losing connection with the UAV and decide when to use the flight termination setting
- Have a fire extinguisher on site
- Inform Air Traffic Services if your UAV enters controlled airspace
- Follow the manufacturer's maintenance/assembly instructions
- Ensure the UAV does not have an emergency locator transmitter
- Report accidents to Transport Canada and stop operations until you have addressed the risks
- Immediately stop all operations if you can no longer respect the exemption requirements or if the safety of a person, property or other aircraft is at risk
- Stay at least 150 metres away from people, animals, buildings, structures, and vehicles not involved in the operation

DO NOT

- Fly closer than 9 km from forest fires, airports, heliports, aerodromes, or built-up areas
- Fly over military bases, prisons or in controlled or restricted airspace
- Fly over crowds or higher than 90 metres
- Participate in special aviation events, air shows or system demonstrations
- Carry dangerous goods or lasers

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Testimony of Nicholas Roy
Associate Professor of Aeronautics and Astronautics
Massachusetts Institute of Technology
on

U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness

before the
Subcommittee on Aviation
Committee on Transportation and Infrastructure
U.S. House of Representatives

December 10, 2014

Chairman LoBiondo, Ranking Member Larsen, and Members of the Subcommittee:

Thank you for the opportunity to appear before you to discuss the unmanned aviation industry in the United States.

I am a professor in the Department of Aeronautics and Astronautics and the Computer Science and Artificial Intelligence Laboratory at MIT. I have conducted research on unmanned aerial vehicles for 11 years, primarily focused on developing UAVs for operation in urban, civilian and populated environments. I have collaborated closely with a number of US companies to develop and deploy technologies to enable unmanned aerial vehicles to fly autonomously. Most recently I worked with Google to found Project Wing, a UAV-based package delivery system. I returned to MIT full-time in September of this year.

In this testimony, I am speaking solely for myself and cannot speak for either MIT or Google.

My main message is that the US leads the world in UAV development. However, the commercial UAV market, while predicted to grow in coming years, is currently very small due to substantial technical limitations. The US is very well-positioned to develop the next wave of UAV technologies that are needed for safe, reliable and cost-effective commercial UAV operation. Unfortunately, the process of testing new UAV technologies and training new engineers is more difficult in the US than in other countries. The hurdles to testing and to training may very well affect the US position of leadership in the future.

There is currently a great deal of excitement around the world at the idea of using UAVs in a variety of ways and in a variety of industries. Agriculture, civil infrastructure inspection, emergency medical response, film-making and local transportation or delivery are examples of real applications where UAVs could provide substantial cost savings or provide considerable increase in productivity. There are three primary reasons for the recent excitement and popularity of UAVs. Firstly, the requisite component technologies for UAVs have shrunk considerably in size. Secondly, the cost of manufacturing small UAVs has fallen enormously. Thirdly, substantial advances in computation and information processing have allowed much of the aircraft control to be carried out by the vehicle itself, reducing the level of expertise needed of the pilot. Technologies such as on-board computers, GPS receivers and battery power are now powerful enough yet small enough and cheap enough to allow us to create little "drones" that are easy, safe and cheap for everyone to fly under the proper conditions, such as the guidelines of the Academy of Model Aeronautics. This is without a doubt a new phenomenon.

Let me contrast these small UAVs with the larger UAVs which are primarily, if not exclusively, military assets. The large UAVs are complex to operate, require large support organizations, and as a consequence have limited interaction with the general public. The large UAVs have compelling safety records, and unparalleled reliability as demonstrated by the remarkable performance of the X-47B. The US is and has been an unquestioned leader in the technical development of these vehicles for many years. Because of the current excitement around small UAVs, the potential for these vehicles to integrate into our daily life, and the commercial markets that might result from doing so, I will focus the rest of my remarks on small UAV technology in civil and commercial domains.

What is the current state of small unmanned aircraft?

The vast majority of small UAVs that are sold today are essentially toy vehicles, whether they are traditional RC aircraft like model airplanes, or quadrotor helicopters that have become popular very recently. The technology in these toy aircraft has evolved rapidly in recent years, and many have an impressive level of autonomy. They can fly reliably from place to place using GPS and databases of maps, execute entertaining flight manoeuvers, and some are starting to perform rudimentary collision avoidance. Nevertheless, small UAVs available commercially are all more or less at the same level of performance: they can carry very limited useful payload, and the market for these vehicles is recreation. There are a small number of companies that sell products that promise to support useful commercial applications such as agricultural imaging or inspection, but these UAVs are not yet significantly more capable than the recreational vehicles. As a result, the current markets for commercial UAVs are not particularly large. The exact numbers are difficult to determine, but in Europe the current market for inspection UAVs appears to be less than 1000 vehicles per year, and in Japan, the entire agricultural UAV system appears to be supported by about 3000 vehicles.

Why is the commercial market for small unmanned aircraft not larger?

Put simply, the commercial market for small unmanned aircraft is not larger because the state of current UAV technology does not yet support a robust functional market. The numerous recent example demonstrations of commercial applications overseas, especially the various delivery examples, have demonstrated prototypes at best, and "vaporware" at worst. The UAV technology certainly exists today to support a video showing one-off prototype missions, and these demonstration videos and prototypes sketch a compelling vision of a future for UAVs. Nevertheless, before the vision can become reality, there are currently significant technology gaps. Another wave of UAV technology is still required to scale up current UAV systems into widely available products that the general public can use for applications such as imaging or package delivery.

The recent FAA call for proposals to establish a Center of Excellence for Unmanned Aircraft Systems is a good roadmap for what the open problems are, but some of the key areas include:

- Technologies for reliable vehicles. The majority of small UAVs are built using consumer-grade components that have highly variable reliability, affecting how reliable the UAVs themselves are. By virtue of size, energy and operational conditions, the consequences of a small UAV failing are often much less than a manned aircraft, and it is important not to over-react to the recent spike in small UAV failures reported in the news, but as the population of vehicles increases, the failures may eventually become significant. For safe and reliable operation, commercial vehicles must have the ability to monitor their own health and be able to react to component failures appropriately by themselves.
- Technologies for reliable navigation: Many people have experienced the sometimes-comic effects of large position errors in our GPS-enabled cellphones while walking down the street. For reliable operation, UAVs need to know where they are, even when GPS is unreliable, the so-called "GPS-denied" problem. Similarly, UAVs must know about objects

around them and be able to avoid collisions, the so-called "detect-and-avoid" problem. Algorithms and sensors must be developed to solve both these problems that match the size, weight, power and computation that can be supported on small UAVs.

- Technologies for reliable communications: It is essential that a pilot-in-command be able to give commands to an autonomous UAV at all times. Cellphone infrastructure was not designed for communication with fast-moving, high-altitude entities, nor is it designed to support reliable command-and-control. This is partly an issue of spectrum regulation, but as the number of UAVs grows, the air traffic management infrastructure must grow alongside to support large numbers of UAVs in the national airspace system.
- Technologies to reduce operational costs: Commercial UAV markets will only be viable if the operational cost of a UAV is less than the cost of a manned aircraft. Despite being unmanned, current UAVs rely heavily on the pilot-in-command to monitor the flight and react to unexpected conditions. Algorithms must be developed to support a much higher degree of autonomy with minimal operator intervention in order to become economically justifiable.

US researchers and companies lead in these and other technology areas. As but one example, GPS-denied navigation and collision avoidance are maturing to support autonomous ground vehicles such as the self-driving cars, even if the technologies are not yet commodities that can be adopted immediately for use on UAVs. US companies have publicly demonstrated technologies that do not exist elsewhere. No other country currently has the same advantage in the technologies required to grow the UAV market from recreational or one-off demonstrations to fully viable commercial applications.

Will the US leadership continue?

The essential issues that will affect the future US position of leadership are the ability for engineers and researchers to carry out technology development at will and in unexpected ways, and the ability to train the engineers who will do this technology development.

The creation myth of some of the most successful technology companies in the world is the small team of inventors tinkering in a garage. Hewlett-Packard, Apple and others have turned garages in Santa Clara valley into historic landmarks. Perhaps the most relevant example is the brick house in Ohio that housed the Wright Cycle Exchange in 1892. The garage narrative makes a great story about the humble beginnings of these companies, but there is a real purpose to letting people develop technology literally out of their garage. A key requirement for creating any new technology is the ability to rapidly test and iterate during development. Giving engineers latitude to develop and test anywhere that is safe can massively accelerate the development cycle.

Unfortunately, this latitude for development and testing in the UAV domain is much harder to obtain in the US than it is in other countries. The FAA has established a number of mechanisms for companies and research agencies to obtain legal authorization to fly UAVs, from special airworthiness certificates, to petitions for exemption under Section 333, to the six UAS test sites. Given these mechanisms, it would be incorrect to state that the US has blanket prohibitions against testing for technology development. However, the current authorization mechanisms still represent a considerable bar to entry for businesses and individuals who are interested in addressing the technical challenges that will lead to a robust UAV system and the real problem is that the barrier to entry for testing and technology development in the US is as high as the barrier to entry for commercial deployment. These processes are reasonable for authorizing a UAV-based pipeline inspection service to run 24/7 across the length of North Dakota, but are onerous for authorizing testing operations for small UAVs in unpopulated areas. The current US processes are only realistic for large organizations, inhibiting the organic growth of startups building new technologies.

Garage development has indeed been the hallmark of the recreational RC community in the US, but the lower bar to entry elsewhere means we are starting to see in other countries much more of a UAV startup culture. For example, jurisdictions such as Australia or the UK draw an explicit distinction between flight areas that are lightly regulated, and flight areas that are strongly regulated, such as unpopulated areas and populated areas respectively. The definition of unpopulated areas varies around the world, but authorization requirements for flight in unpopulated areas are typically easy to meet. The clear definition of a legal flight area gives engineers the confidence to establish test operations in these countries; to know where they can literally set up their garage and start developing. In contrast, in the US, operational areas are evaluated on a case-by-case basis without clear parameters, with considerable delays in the evaluation.

Unfortunately, there is not a single set of rules or procedures that can be adopted wholesale from another country that would immediately enable US companies to begin testing and development. The US is a unique country, with a unique airspace and cultural acceptance of technology. The ubiquity of general aviation, and the specific air traffic management system require rules specific to this country. Nevertheless, there may be ideas to be learned from other jurisdictions. For example, a set of clear rules to identify safe test environments throughout the country, rather than a process for approval or a small set of pre-approved sites, would help US companies and researchers to develop the necessary technologies at the same rate as other countries.

Finally, and perhaps most importantly, the US position of leadership is fundamentally affected by the numbers of engineers and scientists that are being trained in this country with the skills necessary to develop the requisite technologies.

There are a growing number of universities and educational institutions offering courses of instruction in UAV technology at the undergraduate level. Learning the foundations of flight for UAVs necessarily requires the students to actually fly vehicles. While some of these institutions have access to COAs and are near one of the approved test sites, there are far too few and the cost is substantial. For the same reasons that inhibit access to test areas, our processes in the US are not suited to allowing enough educational institutions in the nation to provide training areas for undergraduates.

Furthermore, the support for graduate students to conduct basic research in UAV technologies has diminished recently. Much of the progress in unmanned vehicles in the US has been funded by forward-thinking program managers in ONR, ARO, AFOSR, DARPA and NASA. These program managers have not only funded the development of autonomy, control and sensing technologies to enable autonomous UAVs, but have funded the students who in the course of their education wrote software that is running on UAVs today. Whether it is properly the role of government or private industry to fund doctoral students, it is these students that will ultimately solve the technology challenges I have outlined, and there are now more opportunities for these students outside the US. Educational institutions outside the US are acting both as training grounds for a generation of UAV researchers and as incubators for UAV companies.

In conclusion, the US is not currently lagging other countries, regardless of the publicity around prototype demonstrations. There are significant technical hurdles that must be overcome in any country, before safe, scalable operations of UAVs becomes a reality. Nevertheless, there are issues and constraints that may allow other countries to overtake the US both in developing the next generation of UAV technology and in training the next generation of UAV engineers.

Supplemental Testimony of Nicholas Roy
Associate Professor of Aeronautics and Astronautics
Massachusetts Institute of Technology
on

U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness

before the
Subcommittee on Aviation
Committee on Transportation and Infrastructure
U.S. House of Representatives

January 26, 2015

Chairman LoBiondo, Ranking Member Larsen, and Members of the Subcommittee:

Thank you for the opportunity to address your additional Questions for the Record.

1. **What steps should be taken by the FAA to ensure that our universities may conduct research and other educational activity using small UAS? How do we ensure that those federal dollars for research using small UAS at our universities are not languishing or going to waste due to uncertain or unduly lengthy FAA approvals processes?**

There are multiple mechanisms that a university may obtain approval to operate a UAS for research or educational, regardless of the size of the vehicle. However, the number of applications for the different approvals will inevitably grow and will place an unacceptable load on the FAA in terms of review, approval and oversight. As one example, there are over 30 research labs at MIT working on the different robotic or unmanned vehicle technologies relevant to UAS operation, with a dozen or more different students and research experiments. If each experimental protocol involving a small UAS from each of these labs must be approved by the FAA even once per year, the numbers across all institutions will quickly swamp any single regulator's ability to evaluate these experiments from a safety perspective.

The current processes by which a university may obtain FAA approval to conduct research or other educational activities are therefore not sustainable. My primary recommendation is for the FAA to identify a mechanism by which the FAA itself does not have to approve or oversee small UAS flight operations performed by a university in the US.

One possible solution is to follow the example of Canada which has enumerated classes of UAS and operating conditions which are exempt from approval such as a Special Flight Operations Certificate. (Similar models have been adopted by other countries.) The conditions for exemption are particularly relevant to small UAS. The essential property is that Transport Canada does not need to approve all small UAS flight operations, and has stated the conditions under which small UAS flights are pre-approved. With a clear definition of acceptable vehicle specifications and operational conditions, such a model could work well in the US.

A second solution may be to establish conditions under which universities may regulate their own UAS flight operations, under guidance from the FAA. A good example of a similar process is the Institutional Review Board (IRB) oversight of research that involves human subjects. The National Research Act of 1974 established the IRB process that is governed by Title 45 Code of Federal Regulations Part 46. In short, all research that involves human subjects in any way and is supported by the US federal government must be reviewed by a registered IRB. The IRB consists of people with a range of expertise, experience and affiliation, including at least one member who is not affiliated with the institution performing the research.

The key property of the IRB process is that within the parameters described by the Code of Federal Regulations, each university or research institution can operate its own review process of human subjects research, with freedom to address its own needs as the type and volume of research varies. Different types of experiments are often subject to different levels of scrutiny (e.g., expedited vs full review). Just as both industry and the FAA have advocated for a risk-based evaluation of UAS flight approval, the IRB process can have similar risk-based evaluation criteria, assessing each experimental protocol both in terms of the risk to the subjects and the potential benefit to the subject and society.

At MIT, our IRB is known as the Committee on the Use of Humans as Experimental Subjects (COUHES) and has oversight of any educational or research activity involving human subjects at MIT. MIT has allocated sufficient resources to support an efficient COUHES approval process; the committee has a healthy relationship with MIT researchers and understands our research goals. Across the nation, IRBs are very effective and efficient at evaluating proposed experiments and educational activities, and have rarely led to a lengthy or burdensome approval process.

If the FAA were to provide similar guidelines for UAS operated by universities that established a review board with diverse and independent membership, the speed of research would be considerably accelerated. The IRB process also exists at non-academic entities that perform research with support from the federal government. If an FAA-approved model of a review body were successful at universities, this model may open a path to reducing the load on the FAA in terms of approving broader research and educational UAS flight operations as well.

2. **Based on your understanding of the safety, business and regulatory issues of UAS, could you generally describe the "ideal" regulatory environment to foster safe integration and economic growth?**

Unfortunately, I do not think there exists a single ideal regulatory environment that can be articulated at this time. Several key pieces of technology must be developed to foster integration and economic growth, such as the ones I enumerated in my previous testimony. The industry will move through different stages of capability before becoming integrated with the national airspace system and acting as a driver in the US economy. The different stages will require different regulatory environments. Current regulations must be focused on enabling wide-spread research and development in safe conditions, before transitioning to an environment where safe integration is based on known solutions to the system-wide technical challenges.

Nevertheless, there are two key attributes of a regulatory environment that would substantially improve the transition to a regulatory environment that enables safe integration and economic growth.

Firstly, the FAA, in conjunction with industry, academia and other key stakeholders, must establish new guiding principles for safe operation of small UAS. There is no question that the FAA's mission is to enable the safe and efficient use of the US navigable airspace. However, existing guiding principles may not be well-aligned with efficient use of the airspace by UAS, especially for small UAS operation. As one example, the FAA's 2013 report entitled "Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap" clearly identified the "pilot-in-command" (PIC) concept as a foundational principle for safe operation of both manned aircraft and UAS. The roadmap further specifies that safe UAS operation is expected to require a single PIC per aircraft over the next 10 years. Requiring a single PIC per aircraft, and with specific minimum qualifications and currency requirements, may be reasonable for large UAS, but less obviously so for small UAS. This principle is unlikely to be viable from an economic perspective for many civilian applications of UAS technology and an ideal regulatory environment would support multiple vehicles under the control of a single operator.

Having such guiding principles is important to allow the industry to understand what is and is not likely to be acceptable. It is noteworthy that the FAA has developed these principles. Nevertheless, an ideal regulatory environment must be based on new principles that balance safety against the efficiency gains of evolving UAS technology.

Secondly, the regulatory environment must explicitly treat different concepts of operations, or Con-Ops, differently. Several international jurisdictions have identified that different vehicles and environments have different risk profiles with different approval processes. The current FAA regulatory environment treats all operational scenarios identically, allowing variations only through waivers or other exceptional processes. While there are system-level questions that must be answered through basic research on how different operations will occur, an ideal regulatory environment will have standards for representative Con-Ops, their risk profiles and corresponding processes to mitigate the risks.

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Statement of Mark Baker
President

Aircraft Owners and Pilots Association

To The

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
AVIATION SUBCOMMITTEE
U.S. HOUSE OF REPRESENTATIVES

Concerning

Unmanned Aircraft Systems in the National Airspace System

December 10, 2014

Chairman LoBiondo, Ranking Member Larsen, members of the Subcommittee, on behalf of the nearly 350,000 members of the Aircraft Owners and Pilots Association (AOPA), I am pleased to provide our views for this important hearing on "Unmanned Aircraft Systems." Since 1939, AOPA has protected the freedom to fly for thousands of pilots, aircraft owners and aviation enthusiasts. AOPA is the world's largest aviation member association and its mission is to effectively represent the interests of its members as aircraft owners and pilots concerning the economy, safety, utility, and popularity of flight in general aviation (GA) aircraft.

AOPA is asking the Subcommittee to reinforce the need for the Federal Aviation Administration (FAA) to expedite the small commercial UAS rule. AOPA also recommends that the FAA take steps to address and preclude harmful and negligent operations by recreational users of UAS technology. The safety of our skies should be a top priority and that is why AOPA supports regulations to govern use of the technology and define possible enforcement actions.

To integrate small commercial UAS into the National Airspace System (NAS), the FAA must implement rules and procedures that ensure UAS are operated safely and compatibly with other NAS users. As a general policy, commercial UAS should:

- Be certified with a standard airworthiness certificate or FAA approval
- Be flown by an FAA approved pilot/operator
- Be flown in compliance with current operating rules and airspace requirements

AOPA has been concerned about the impact of UAS operations on GA. Our biggest concerns are safety and the possibility that the FAA would implement special use airspace for exclusive use by UAS, limiting general aviation access to the NAS.

AOPA has been involved in this issue since 1991, when the FAA tasked an Aviation Rulemaking Advisory Committee (ARAC) with developing UAS guidance. While the FAA had a goal of publishing a Notice of Proposed Rulemaking in 1992, this never occurred.

In 2004, AOPA asked the FAA to create a working group under the auspices of the RTCA industry-government advisory group with the goal of developing consensus standards for small UAS operations (UAS that weigh 55 pounds or less). AOPA actively participated on this and the FAA accepted the resulting consensus standards in 2007, but has yet to release a proposed rule.

Additionally, AOPA is concerned with the rising number of reports from our member pilots and the media detailing unsafe drone activity near airports and aircraft. It is clear that many of the people flying UAS have little or no knowledge of the rules under which other airspace users operate. It is also clear from online videos that operators are flying near airports, in the clouds, and in congested airspace. Since the beginning of the year, the FAA has received pilot and air traffic controller reports describing 193 UAS encounters. UAS operations are of two primary types: 1. Recreational operations flown by hobbyists and 2. Commercial operations flow in support of a business interest. The problem is compounded by the two primary types of UAS operations: (1) recreational operations flown by hobbyists and (2) commercial operations flown in support of a business interest.

Radio-controlled model aircraft have been around for decades and most radio-controlled aircraft hobbyists have been flying small aircraft safely and responsibly in accordance with FAA guidelines (Advisory Circular 91-57) and model aircraft industry best practices.

With the proliferation of low-cost, multi-rotor aircraft that require little or no skill or training to operate, however, existing guidance is no longer sufficient. One reason the technology has become so significant in such a short time is because the "Go-Pro" generation has embraced these multi-rotor aircraft as the preferred platform for capturing video images from a perspective not possible just a few years ago.

The FAA advisory (AC 91-57) was drafted in 1981 and in its current form, falls short on addressing the kinds of operations that are happening today. For example, AC 91-57 does not address commercial UAS operations or line-of-sight or point-of-view (POV) operations because in 1981 commercial applications for model aircraft were almost non-existent and having images beamed back to the user to be displayed in Google glasses was science fiction.

Since lawful commercial operators are essentially grounded, current UAS operators are either breaking the rules or are recreational hobbyists. Based on numerous pilot reports many of these operators are flying in a manner that endangers pilots, planes and people on the ground, which raises a grave concern among members of the pilot community.

If reckless operations of UAS go unchecked, there will inevitably be a mid-air collision with an aircraft. AOPA would like to see the FAA get ahead of the problem and preclude potentially catastrophic accidents. At a minimum, the FAA should:

- Issue clear, definitive guidance for recreational UAS operations. Current Agency guidance contains conflicting information on reporting requirements near airports and conflicting guidance on altitude limits.
- Encourage small UAS manufacturers to include information on FAA guidance for UAS operations.
- Work cooperatively with AOPA and radio controlled aircraft associations to assist with educational outreach efforts.
- Publish guidance to pilots on how to file timely reports of reckless UAS operations.

The FAA has taken some steps to police unlawful and reckless operations. For example, in June 2014 the FAA published a Federal Register notice on its interpretation of the statutory special rules for model aircraft in the FAA Modernization and Reform Act of 2012. The law is clear that the FAA may take enforcement action against model aircraft operators who operate their aircraft in a manner that endangers the safety of the NAS. In the notice, the FAA explains that this enforcement authority is designed to protect users of the airspace as well as people and property on the ground.

Also, the NTSB recently ruled UAS are "aircraft" and therefore are subject to FAA rules. The four board members of the NTSB overturned an earlier ruling that had dismissed a $10,000 FAA fine against an Austrian UAS pilot, Raphael Pirker, for allegedly operating a UAS recklessly to film the University of Virginia in 2011.

Lastly, the FAA recently addressed the rise in unlawful use of drones in a public notice issued Oct. 27, 2014. The FAA updated a long-standing ban notice on airplane flights over open-air stadiums with 30,000 or more spectators by extending the prohibition to "unmanned aircraft and remote controlled aircraft." The notice went on to say that violators could be fined and imprisoned for up to a year, the first time the agency has explicitly stated that reckless drone pilots could wind up behind bars.

While these steps are important, they are not sufficient to safely integrate UAS into the national airspace system.

UAS present a challenge because they operate unlike any other aircraft in the airspace system – by remote control. With the exception of UAS, there is not an aircraft operating in today's NAS that has not complied with Federal Aviation Regulations (FARs) governing its certification and maintenance. And with the exception of UAS operators, there is not a pilot operating today that has not undergone some level of pilot certification training and testing. Pilots also comply with very specific FAA general operating and flight rules as outlined in the Federal Aviation Regulations (FARs), including the FAA's important see-and-avoid mandate. These regulations provide the historical foundation of the FAA regulations governing the aviation system.

However, if the FAA doesn't take action to address operational issues, unregulated operations will continue to proliferate. The FAA has jurisdiction and should assert its authority for the safety and operating efficiencies of the nation's airspace.

AOPA appreciates the opportunity to provide our views on this important safety issue and looks forward to working with the members of the Subcommittee as UAS regulations are developed.

Statement by Modovolate Aviation, LLC

on

U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness

for inclusion in the record of hearings

before the

Subcommittee on Aviation

Committee on Transportation and Infrastructure

U.S. House of Representatives

December 10, 2014

Modovolate Aviation, LLC ("Movo Aviation") is an Illinois limited liability company engaged in research and development, testing, demonstration, consulting, and public education related to small Unmanned Aircraft Systems ("sUAS"), popularly known as "microdrones." Its owners and managers are Henry H. Perritt, Jr. and Eliot O. Sprague. Mr. Perritt is a Professor of Law and former Dean at Chicago-Kent College of Law, the law school of Illinois Institute of Technology. He is a private airplane and helicopter pilot and is a respected scholar on administrative law and law and technology. Mr. Sprague is a full-time professional news helicopter pilot who flies daily in the airspace of the Chicago Metropolitan Area. Together, they have written a number of recent articles published by aviation and journalism magazines. One of the articles is attached as an addendum to this statement. Mr. Perritt, in his individual capacity as an attorney, is representing two private sUAS operators in section 333 petitions filed with the FAA. Movo Aviation has filed an application with the FAA for a Special Airworthiness Certificate to allow it to fly its sUAS. It has filed a comment supporting a Section 333 request by news photographer Colin Hinkle to fly his sUAS over the Chicago metropolitan area for aerial photography and news gathering. It also filed a petition for rulemaking with the FAA, urging it to adopt the regulatory approach proposed in this statement.

The advances in technology that have enabled strong but light composite structures, miniaturization of GPS guidance and navigation systems, autonomous flight-control systems, and video imaging have coalesced into sUAS products widely available for a few hundred to a few thousand dollars.

Hundreds of newspaper, magazine, and television stories, and hundreds of website and YouTube videos—many of which portray activities that almost certainly violate the FAA's current ban--demonstrate how useful these small aerial devices can be in supporting real estate marketing, agricultural and construction-site surveying, electronic news gathering, public safety activities, infrastructure inspection, and, eventually, small package delivery. Realtors, construction contractors, powerline and pipeline operators, movie makers, reporters and photojournalists, law enforcement personnel, firefighters, and disaster-relief agencies are eager to get their hands on one.

This represents only the latest disruptive innovation for aviation in the United States, which is justly proud of a regulatory system that has accommodated successive innovations while keeping American skies safe. The sUAS phenomenon, however, is different in that it puts aircraft in the hands of almost anyone, including many people with no ties to the aviation community. Many people now flying sUAS have no awareness of the FAA, its regulations, or of the communities of pilots, mechanics, and operators who have been trained intensively on safe practices.

Movo Aviation and its pilot owners are concerned about the risk that uncontrolled proliferation of drone flight presents. As a small technology enterprise, Movo Aviation is also enthusiastic about the potential for sUAS. It is concerned that the FAA is not thinking about the problem in the right way. The central flaw in much of the public debate about drones is a failure to distinguish between microdrones and machodrones. Microdrones are the little ones that anyone can buy from Amazon and fly right out of the box. These are consumer products, not 787s. Their low weight, range, and altitudes present much lower risks than flight of larger ones. The risk does not change depending on whether they are being flown for fun or for money.

A risk-based approach, already implemented by Canada, France, Australia, and the UK, among others, recognizes that assuring safe operation of sUAS depends on a close assessment of the risks associated with different types of vehicles and differences in the places where they operate. To be sure, the National Airspace System ("NAS") of the

United States is vastly more complex than that of many other countries, but sUAS do not operate in the NAS in general; they operate locally, in very small areas, almost always close to their operators.

Everyone is eagerly awaiting the FAA's release of a proposed rule for sUAS. Having missed its statutorily mandated deadline of August, 2014, the FAA now promises to have a Notice of Proposed Rulemaking ("NPRM") out before the end of the month. The FAA recently declined to consider Movo Aviation's petition for rulemking, instead making it part of the docket for comment during the comment period for the NPRM. General statements by FAA personnel raise concerns that the content of the proposed rules will not be well-suited to reality. The FAA is trying too hard to stuff the square peg of sUAS into the round hold of traditional manned aircraft regulation.

sUAS have already outrun traditional FAA regulation. The FAA's ban on commercial flight is largely a dead letter. The problem will only get worse the longer the FAA waits to get regulations in place, and the bigger the gap between the content of the eventual regulations and reality.

No conceivable level of enforcement resources for the FAA will enable it to apply traditional aviation regulation to sUAS. Traditional airworthiness certification for aircraft, pilot certification taking years and costing tens to hundreds of thousands of dollars, and thousands of pages of operating rules are unsuitable for devices that cost only a thousand dollars and fly low-level, close-in, missions a few hundred feet above the ground within a few hundred yards of a human operator

For the FAA to have any hope of controlling microdrones, it needs to think small. No one is going to spend thousands of dollars getting a traditional pilot's license, let alone $20 million to get an airworthiness certification for these vehicles.

The FAA must recognize that these are consumer products, not multi-million-dollar capital assets. The leverage over pilot certificates, aircraft registration, and operator certificates available to reinforce rules for traditional airplanes and helicopters is entirely lacking in the sUAS world. The FAA must borrow strategies from regulatory agencies that have long experience in regulating consumer electronic devices, lawnmowers, and automobiles. The FCC, the CPSC, and the NHTSA recognize that the key to success is to focus on the point of sale as the choke point in the marketplace, not to try to oversee the details of thousands of operators and operations. One cannot buy a lawnmower unless it has certain safety features built in. One cannot buy a WiFi point of presence unless it has been designed to minimize RF interference. One cannot buy an automobile unless it has seatbelts and flashers.

The only viable regulatory approach is to regulate microdrones like this--at the point of sale, taking advantage of their existing capabilities to restrict where they fly and to return to their launching points safely if some kind of failure occurs. Elaborate requirements for operators, vehicle design, and detailed flight rules, are unnecessary. Let the technology make them law abiding, right out of the box.

This approach to assure that microdrones be law-abiding need not involve further delay. The vast majority of sUAS now on the market come equipped with avionics and flight-control systems that limit sUAS operations to minimize risk. To be sure they have been designed to military and international aviation systems standards. But maybe they do not need to be. The FAA's commitment to performance-based regulation should focus on what actual products can do; not on detailed specifications developed through cumbersome international consultation.

The FAA can ease its burden and accelerate the availability of benefits of sUAS technology by issuing an interim rule that would allow anyone to fly an sUAS for any legal purpose as long as its avionics can be programmed to limit flight altitudes to no more than 400 feet AGL and to return to its launching point if the aircraft tries to fly into class B, C, or D airspace, if it loses its control link, if it loses GPS capability, or if its operator becomes unresponsive. The most popular sUAS products now on the market already have these capabilities.

Only with much more extensive data than is now available, can the FAA determine whether this approach adequately reduces risk. A risk-based and performance-based approach to regulation requires data on failure rates, failure modes, and hazards resulting from failure. This can only be developed through widespread experience with actual operational flight of sUAS, whose weight and performance characteristics involve minimal risk even if things go wrong.

This does not mean tolerance for reckless operation. Local criminal law and tort-liability, backed up by the FAAs' authority under 14 C.F.R. § 91.13(a) to impose penalties for reckless or careless operation of aircraft, reaffirmed by the National Transportation Safety Board's ("NTSB's") decision in Huerta v. Pirker, NTSB Order No.

EA-5730, Docket CP-217 (Nov. 18, 2014), offer legal protection for now, while experience is gained. This legal regime provides adequate enforcement authority to impose penalties against sUAS operators who fly their aircraft in disregard of their features to assure safe operation.

American law works best when it tailors itself to the realities of innovation and entrepreneurship in a market-based economy. Law should not try to be out in front of technology, based on guesses and fears of what harm new and untried technology might do. It should stand in the background, waiting to see what engineers and entrepreneurs actually do with the technology. Some worries may prove unwarranted because economics discourages risky or unproductive activities. Then it should wait a little longer to see what disputes or hazards actually emerge as new products become more pervasive. Then, regulators and lawmakers should monitor how courts and insurance carriers handle these problems. Only when they can identify shortcomings in how the decentralized, private, marketplace is responding, are they ready to write law. A complete laissez-faire approach to sUAS may not be politically feasible, but a sound regulatory regime, one that has any hope of being enforceable, will get out of the way and see what actually happens in the real world.

Respectfully submitted,

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NAAA

NATIONAL AGRICULTURAL AVIATION ASSOCIATION

December 18, 2014

Hon. Chairman Frank LoBiondo and Ranking Member Rick Larsen
Committee on Transportation and Infrastructure
Subcommittee on Aviation
2251 Rayburn House Office Building
Washington, DC 20515

Written Statement of the National Agricultural Aviation Association for the Hearing "U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness"

Dear Chairman LoBiondo and Ranking Member Larsen:

The National Agricultural Aviation Association (NAAA) appreciates the opportunity provide this written testimony for the December 10, 2014 hearing "U.S. Unmanned Aircraft Systems: Integration, Oversight, and Competitiveness." As you both know, Unmanned Aircraft Systems (UAS) are one of the most hot button issues facing the National Airspace System (NAS) today. While NAAA sees enormous potential for UAS, we also see a considerable safety risk facing all users of the NAS should integration occur improperly, or be rushed along without proper consideration of all NAS users—particularly safety considerations.

Importance of Aerial Application Industry

The aerial application industry consists of more than 1,350 small business owners in the U.S. The owners are licensed as commercial applicators that use aircraft to enhance the production of food, fiber and bio-fuel; protect forestry; protect waterways and ranchland from invasive species; and control health-threatening pests. Aerial application is so important to agricultural, forestry and public health protection because it is by far the fastest method of application. Furthermore, when the presence of water, wet soil conditions, rolling terrain or dense plant foliage prevents the use of other methods of pesticide application, aerial application may be the only remaining method of treatment. Aerial application is also conducive to higher crop yields, as it is non-disruptive to the crop and causes no soil compaction. Applying crop protection products by air is an essential component of no-till or reduced tillage farming operations which limit storm water runoff and reduces soil erosion. These farming methods, through their preservation of organic matter and topsoil, help maintain productive soils and reduce greenhouse gas emissions through the sequestration of carbon. According to the USDA's Economic Research Service, there are a total of 408 million cropland acres in the U.S., of which approximately 70 percent are commercially treated with crop protection products. Further, according to NAAA data nearly 20 percent of commercial crop protection product applications are made through aerial applications. As a result, NAAA estimates that 71 million acres of cropland are treated via aerial application in the U.S. each year. This does not include the aerially treated pasture and rangeland of which there are 614 million total acres in the U.S. or the 671 million total forestry acres and 61 million total urban acres in the U.S.—a portion of which are treated by air.

Because of the importance of the aerial application industry, it is vital a safe low-level airspace exists to ensure these pilots can continue to do their jobs safely. Ensuring safe low-level airspace includes minimizing obstructions which are difficult to be seen and identified by the pilots. In addition to aerial application operations, aircraft users of low-level airspace include: Emergency Medical Services (EMS), air tanker firefighting aircraft and their lead aircraft; power line and pipeline patrol aircraft; power line maintenance helicopters; fish and wildlife service aircraft; animal control aircraft (USDA-APHIS-ADC); military helicopter and fixed-wing operations; seismic operations (usually helicopters); livestock roundup (ranching or animal relocation); aircraft GIS mapping of cropland for noxious weed populations and the like; and others.

Safety Concerns Associated with UAS

NAAA is concerned that the widespread use of UAS without proper safe integration, will result in conditions ripe for low-level aviation accidents.

UAS present a hazard to low-level pilots similar to that presented by birds and other low-level obstacles such as other aircraft and towers. According to a joint report by the FAA and the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS), between 1990 and 2012 over 131,000 wildlife strikes occurred with civil aircraft, 97 percent of which were the result of collisions with birds, with 25 producing fatalities. Accident records maintained by NAAA, as taken from NTSB accident reports, show there were 10 collisions between aircraft, in which at least one of the aircraft was an ag aircraft during the last 10 years (2004-2013) and since 2004 there have been 12 accidents between ag aircraft and towers, resulting in 7 fatalities.

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The agricultural aviation industry places a great amount of importance on the ability to see and avoid obstructions and other aircraft in the airspace in which they operate. While this principal is the backbone of safety for our industry and all air traffic operating under visual flight rules (VFR), it can only be utilized effectively when other aircraft do their part in avoiding collisions. The necessary technology to allow UAS to "sense and avoid" other aircraft is currently in the nascent stages of development and is nowhere near commercial viability. Furthermore, the U.S. Government Accountability Office (GAO), an independent federal agency, determined in September, 2012 that no adequate technology currently exists that would allow UAS to adequately sense and avoid other aircraft. NAAA believes until this technology is developed, UAS operators should be required to post a Notice to Airmen (NOTAM) 48-72 hours prior to their operations. Such a requirement is already in place by the FAA for the Certificates of Waiver or Authorization granted for current limited commercial operations. UAS operators should also be required to have radios on the ground tuned to a locally defined frequency, allowing them to monitor air traffic in the area, and alert local manned and unmanned aircraft operators to their presence. Whenever a manned low level aircraft is detected operating in the immediate area, the UAS should land as soon as practicable and remain grounded until the manned aircraft is clear of the area.

NAAA believes UAS should also be painted in colors which make them readily distinguishable from the background. Strobe lighting should be required on the UAS itself, and to assist with identification of UAS operating areas, on the UAS operator's ground vehicle. Automatic Dependent Surveillance-Broadcast (ADS-B) Out technology is a key component of the FAA's Next Generation Air Transport System (NextGen) that allows the identification of aircraft based on transponder and GPS signals, and allows nearby aircraft with the proper reading equipment to identify their exact location. Proven, ADS-B systems designed for UASs are currently on the market and should be a requirement for commercial UAS operations, allowing low-level manned aircraft to identify them.

Operational Safety

NAAA requests that operators of UAS develop ways of making the presence of UAS known to VFR air traffic if they are to be integrated into the National Airspace System (NAS). NAAA believes it is imperative for users of the NAS and residents and landowners within the areas of UAS usage to be able to safely utilize the services of agricultural aircraft and other low level operations without jeopardizing the aircraft occupant's safety. Agricultural producers are aware of the necessity of quickly treating their crops by air when a potential yield threat such as plant disease or insects strike.

Without the ability to safely use aerial application services, blocks of farm land in UAS high-usage areas may be untreatable when field conditions require application by air. In addition to the above recommendations to better identify UAS', NAAA recommends the following measures be taken in the near term regarding small unmanned aircraft systems (sUAS). This list is similar to that presented by the North Dakota Agricultural Aviation Association to the North Dakota Department of Commerce; the organization awarded the North Dakota UAS test site:

UAS Operations

1. UAS operators should be attending/monitoring UAS at all time and attentive to surroundings (no headphones, etc., or other distractions).

2. UAS must be equipped with strobe lights.

3. UAS support vehicles should be equipped with a strobe light that is activated when UAS is operating.

4. For authorized use of UAS in the national airspace system (NAS) – either as a public operator under a COA or as a civil operator under a Special Airworthiness Certificate - the UAS operator must issue a Notice to Airmen (NOTAM) 48-72 hours in advance of an operation.

5. UAS operator should be trained and equipped with an aviation radio set to a locally defined frequency to account for various areas.

6. UAS operator procedure if an agricultural aircraft or any other type of low-flying aircraft is within two miles should be to immediately ground the UAV as soon as practicable.

7. UAS operators should comply with all current FAA regulations, policies and procedures and state department of agriculture and EPA procedures if appropriate.

8. UAS operator should have a commercial pilot's license and as such can demonstrate knowledge of aviation safety and communication procedures (similar to FAA private pilot written exam) including requiring a Class 2 medical.

9. UAS are required to have a separate visual observer as part of the crew who possesses a Class 2 medical certificate and is responsible to clear the flight path of the UAS from any other airborne traffic.

10. UAS should be required to have an airworthiness certificate.

11. UAS operators should maintain line-of-sight with the UAS to ensure the operator is able to visually recognize other aircraft operating in close proximity or physical obstructions which may exist in the area.

12. UAS should be required to have liability insurance.

13. UAS observers should be present and able to communicate with the UAS operator from the most minimal distance possible and are not allowed to perform crew duties for more than one UAS at a time.

14. UAS must be equipped with ADS-B Out technology or the like pending its effectiveness and usability to track UAVs.

15. UAS operator must be well-versed in UAS operator manual and UAS must be properly maintained.

16. UAS must be coated in a highly visible color(s) markedly contrasted from the surrounding airspace and ground.

17. UAS should have a registered N-number on an indestructible and unmovable plate attached to the UAS.

18. UAS conducting low-level aerial application work must comply with 14 CFR Part 137

Just as manned aircraft pilots are required to undergo a rigorous training curriculum and show that they are fit to operate a commercial aircraft, so too must UAS operators. Holding a commercial certificate holds UAS operators to similar high standards as commercial aircraft operators and ensures they are aware of their responsibilities as commercial operators within the NAS. Medical requirements ensure they have the necessary visual and mental acuity to operate a commercial aircraft repeatedly over a sustained period of time.

It is vital that commercial aircraft, manned and unmanned, have received airworthiness certification by the FAA to ensure they can safely operate in the NAS without posing a hazard to persons or property. ADS-B Out equipage, strobe lighting, and marking, as discussed above, ensures the aircraft is visible to manned aircraft, law enforcement, the public and other UAS.

The issue of protecting all pilots from mid-air collisions, when they are operating in close proximity to unmanned aircraft is vitally important. In the case of agricultural aviators, timely treatment of the crop is an issue of great importance to the safe, affordable and abundant production of food, fiber and bio-fuel to our global population.

NAAA is aware of the important functions which can be accomplished by UAS, potentially even to agriculture but at the same time protecting the safety of current and future users of the NAS is mandatory. NAAA appreciates the FAA addressing this life-saving issue vital to the agricultural aviation industry, and urges the Agency to consider the above stated comments in an effort to strengthen aviation safety overall.

Thank you for the opportunity to provide this testimony.

Sincerely,

Andrew D. Moore
Executive Director