

GAO

Testimony

Before Subcommittee on Oversight,
Investigations, and Management,
Committee on Homeland Security, House
of Representatives

For Release on Delivery
Expected at 9:30 a.m. EDT
Thursday, July 19, 2012

UNMANNED AIRCRAFT SYSTEMS

Use in the National Airspace System and the Role of the Department of Homeland Security

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



G A O

Accountability * Integrity * Reliability

UNMANNED AIRCRAFT SYSTEMS

Use in the National Airspace and the Role of the Department of Homeland Security

Highlights of [GAO-12-889T](#), a testimony before the Subcommittee on Oversight, Investigations, and Management, Committee on Homeland Security, House of Representatives.

Why GAO Did This Study

UAS aircraft do not carry a human operator on board, but instead operate on pre-programmed routes or by following commands from pilot-operated ground stations. An aircraft is considered to be a small UAS if it is 55 pounds or less, while a large UAS is anything greater. Current domestic uses of UAS are limited and include law enforcement, monitoring or fighting forest fires, border security, weather research, and scientific data collection by the federal government. FAA authorizes military and non-military UAS operations on a limited basis after conducting a case-by-case safety review. Several other federal agencies also have a role or interest in UAS, including DHS. In 2008, GAO reported that safe and routine access to the national airspace system poses several obstacles.

This testimony discusses 1) obstacles identified in GAO's previous report on the safe and routine integration of UAS into the national airspace, 2) DHS's role in the domestic use of these systems, and 3) preliminary observations on emerging issues from GAO's ongoing work.

This testimony is based on a 2008 GAO report and ongoing work, and is focused on issues related to non-military UAS. In ongoing work, GAO analyzed FAA's efforts to integrate UAS into the national airspace, the role of other federal agencies in achieving safe and routine integration, and other emerging issues; reviewed FAA and other federal agency efforts and documents; and conducted selected interviews with officials from FAA and other federal, industry, and academic stakeholders.

View [GAO-12-889T](#). For more information, contact Gerald Dillingham at (202) 512-2834 or dillingham@gao.gov.

What GAO Found

GAO earlier reported that unmanned aircraft systems (UAS) could not meet the aviation safety requirements developed for manned aircraft and posed several obstacles to operating safely and routinely in the national airspace system. These include 1) the inability for UAS to detect, sense, and avoid other aircraft and airborne objects in a manner similar to "see and avoid" by a pilot in a manned aircraft; 2) vulnerabilities in the command and control of UAS operations; 3) the lack of technological and operational standards needed to guide the safe and consistent performance of UAS; and 4) the lack of final regulations to accelerate the safe integration of UAS into the national airspace. GAO stated in 2008 that Congress should consider creating an overarching body within the Federal Aviation Administration (FAA) to address obstacles for routine access. FAA's Joint Planning and Development Office (JPDO) has taken on a similar role. FAA has implemented GAO's two recommendations related to its planning and data analysis efforts to facilitate integration.

The Department of Homeland Security (DHS) is one of several partner agencies of JPDO working to safely integrate UAS into the national airspace. Since 2005, FAA has granted DHS authority to operate UAS to support its national security mission in areas such as the U.S. northern and southern land borders. DHS's Transportation Security Administration (TSA) has the authority to regulate security of all modes of transportation, including non-military UAS, and according to TSA officials, its aviation security efforts include monitoring reports on potential security threats regarding the use of UAS. Security considerations could be exacerbated with routine UAS access. TSA has not taken any actions to implement GAO's 2008 recommendation that it examine the security implications of future, non-military UAS.

GAO's ongoing work has identified several UAS issues that, although not new, are emerging as areas of further consideration in light of greater access to the national airspace. These include concerns about privacy relating to the collection and use of surveillance data. Currently, no federal agency has specific statutory responsibility to regulate privacy matters relating to UAS. Another emerging issue is the use of model aircraft (aircraft flown for hobby or recreation) in the national airspace. FAA is generally prohibited from developing any rule or regulation for model aircraft. The Federal Bureau of Investigation report of a plot to use a model aircraft filled with plastic explosives to attack the Pentagon and U.S. Capitol in September 2011 has highlighted the potential for model aircraft to be used for unintended purposes. An additional emerging issue is interruption of the command and control of UAS operations through the jamming and spoofing of the Global Positioning System between the UAS and ground control station. GAO plans to report more fully this fall on these issues, including the status of efforts to address obstacles to the safe and routine integration of UAS into the national airspace.

Figure 1: Example of a Small UAS (SkySeer) and a Large UAS (Predator)



Sources: Octatron, Inc. and DHS.

Chairman McCaul, Ranking Member Keating, and Members of the Subcommittee:

I appreciate the opportunity to testify before you today on obstacles to unmanned aircraft systems (UAS) safe and routine operations in the national airspace, the role that the Department of Homeland Security (DHS) has in UAS operations, and emerging UAS issues. Many stakeholders have exhibited increased interest in UAS for border security and disaster assistance, among other uses. Additionally, as combat operations in Afghanistan decrease, all of the United States military services expect to conduct more UAS training flights across the contiguous United States.¹

UAS aircraft do not carry a human operator on board, but instead operate on pre-programmed routes or by following commands from pilot-operated ground stations. These aircraft are also referred to as “unmanned aerial vehicles,” “remotely piloted aircraft,” “unmanned aircraft,” or “drones.” The term “unmanned aircraft system” is used to recognize that a UAS includes not only the airframe, but also associated elements such as a ground station and the communications links. UAS are typically described in terms of weight, endurance, purpose of use, and altitude of operation. Most UAS are considered small, weighing less than 55 pounds; some of which fly less than 400 feet above the ground. According to an industry association, small UAS are expected to comprise the majority of UAS that will operate in the national airspace.

The Federal Aviation Administration (FAA) authorizes military and non-military (academic institutions; federal, state, and local governments including law enforcement entities; and private sector entities) UAS operations on a limited basis after conducting a case-by-case safety review. Only federal, state, and local government agencies can apply for a Certificate of Waiver or Authorization (COA); private sector entities must apply for special airworthiness certificates in the experimental category.²

¹House Permanent Select Committee on Intelligence, *Performance Audit of the Department of Defense Intelligence, Surveillance, and Reconnaissance* (Washington, DC: Apr. 2012).

²COAs and special airworthiness certifications in the experimental category represent exceptions to the usual certification process. FAA examines the facts and circumstances of a proposed UAS to ensure that the prospective operator has acceptably mitigated safety risks.

Between January 1, 2012 and July 17, 2012, FAA had issued 201 COAs to 106 federal, state, and local government entities across the United States, including law enforcement entities as well as academic institutions. Additionally, FAA had issued 8 special airworthiness certifications for experimental use to four UAS manufacturers. Presently, under COA or special airworthiness certification, UAS operations are permitted for specific times, locations, and operations. Thus it is not uncommon for an entity to receive multiple COAs for various missions. Over the years, concerns have been expressed by the Congress and other stakeholders that sufficient progress has not been made to integrate UAS into the national airspace system. In 2008, GAO reported that safe and routine access to the national airspace system poses several obstacles. We also stated that Congress should consider creating an overarching body within FAA to coordinate federal, academic, and private-sector efforts in meeting the safety challenges of allowing routine access to the national airspace system. Additionally, we made two recommendations to FAA related to its planning and data analysis efforts to facilitate the process of allowing UAS routine access to the national airspace. We also recommended that DHS assess the security implications of routine access. FAA is working toward implementing the requirements set forth by its February 2012 reauthorization to accelerate UAS integration.³

Several other federal agencies also have a role or interest in UAS, including the Department of Homeland Security (DHS), the Department of Defense (DOD), and the National Aeronautics and Space Administration (NASA).⁴ DHS's Transportation Security Administration (TSA) has authority to regulate the security of all transportation modes, including non-military UAS, to ensure that appropriate safeguards are in place. According to TSA, its aviation security efforts include addressing risks, threats, and vulnerabilities related to non-military UAS. In addition, According to DHS officials, Customs and Border Protection (CBP) owns ten UAS that it operates for its own missions as well as for missions in conjunction with other agencies. DOD has successfully used UAS for

³FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, §§ 332 – 334, 126 Stat. 11 (2012).

⁴Senior executives from these four federal agencies represent the UAS ExCom, whose mission is to enable increased and ultimately routine access of federal UAS engaged in non-military aircraft operations into the national airspace to support these agencies' operational, training, development, and research requirements.

intelligence, surveillance, reconnaissance, and combat missions.⁵ While many of DOD's UAS operations currently take place outside of the United States, the military services require access to the national airspace to conduct UAS training. DOD has also assisted DHS in border security missions, including two missions since 2006 where the National Guard provided support in four southwestern border states. NASA uses UAS primarily for research purposes, such as the Predator B for wildfire mapping and investigations as well as an expected arctic mission next year on surface sea ice.

My statement today discusses 1) obstacles we identified in our previous report to the safe and routine integration of UAS into the national airspace, 2) DHS's role in the domestic use of these systems, and 3) preliminary observations on emerging issues from our ongoing work examining UAS. This statement is based on our 2008 UAS report⁶ and ongoing work for this subcommittee, the House Committee on Transportation and Infrastructure and its subcommittee on Aviation, and the Senate Committee on Science, Commerce and Transportation. Our ongoing work is focused on issues related to non-military UAS and is based on our analysis of FAA's efforts to integrate UAS into the national airspace, the role of other federal agencies in achieving safe and routine integration, and other emerging issues. Our preliminary observations are based on our review of various FAA and other federal agency efforts and documents; and selected interviews with officials from FAA and other federal, industry, and academic stakeholders. Our 2008 report contains detailed explanations of the methods used to conduct that work. We have discussed the information in this testimony with officials from FAA and DHS, and incorporated their comments as appropriate. The work on which this statement is based 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

⁵GAO, *Unmanned Aircraft Systems: Comprehensive Planning and a Results-Oriented Training Strategy Are Needed to Support Growing Inventories*, [GAO-10-331](#) (Washington, DC: Mar. 26, 2010).

⁶GAO, *Unmanned Aircraft Systems: Federal Actions Needed to Ensure Safety and Expand Their Potential Uses within the National Airspace System*, [GAO-08-511](#) (Washington, D.C.: May 15, 2008).

provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Current domestic uses of UAS are limited and include law enforcement, monitoring or fighting forest fires, border security, weather research, and scientific data collection. UAS have a wide-range of potential uses, including commercial uses such as pipeline, utility, and farm fence inspections; vehicular traffic monitoring; real estate and construction site photography; relaying telecommunication signals; and crop dusting. FAA's long-range goal is to permit, to the greatest extent possible, routine UAS operations in the national airspace system while ensuring safety. Using UAS for commercial purposes is not currently allowed in the national airspace. As the list of potential uses for UAS grows, so do the concerns about how they will affect existing military and non-military aviation as well as concerns about how they might be used.

Domestically, state and local law enforcement entities represent the greatest potential use of small UAS in the near term because small UAS can offer a simple and cost effective solution for airborne law enforcement activities for agencies that cannot afford a helicopter or other larger aircraft.⁷ For example, federal officials and one airborne law enforcement official said that a small UAS costing between \$30,000 and \$50,000 is more likely to be purchased by state and local law enforcement entities because the cost is nearly equivalent to that of a patrol car. According to recent FAA data, 12 state and local law enforcement entities have a Certificate of Waiver or Authorization (COA) while an official at the Department of Justice said that approximately 100 law enforcement entities have expressed interest in using a UAS for some of their missions. According to law enforcement officials with whom we spoke, small UAS are ideal for certain types of law enforcement activities. Officials anticipate that small UAS could provide support for tactical teams, post-event crime scene analysis and critical infrastructure photography. Officials said that they do not anticipate using small UAS for

⁷FAA generally considers UAS in the two broad categories of "small" and "large," and has used these categories to split its efforts to develop rules that would allow government and commercial UAS access to the national airspace. FAA has been developing rules for small UAS for several years. Although there is no widely accepted common classification system for UAS, an aircraft is considered to be a small UAS if it is 55 pounds or less, while a large UAS is anything greater.

routine patrols or missions that would require flights over extended distances or time periods.

FAA has been working with the Department of Justice's National Institute of Justice to develop a COA process through a memorandum of understanding to better meet the operational requirements of law enforcement entities. While the memorandum of understanding establishing this COA process has not been finalized, there are two law enforcement entities that are using small UAS on a consistent basis for their missions and operations. The proposed process would allow law enforcement entities to receive a COA for training and performance evaluation. When the entity has shown proficiency in operating its UAS, it would then receive an operational COA allowing it to operate small UAS for a range of missions. In May 2012, FAA stated that it met its first requirement to expedite the COA process for public safety entities. FAA's reauthorization also required the agency to enter into agreements with appropriate government agencies to simplify the COA process and allow a government public safety agency to operate unmanned aircraft weighing 4.4 pounds or less if flown within the line of sight of the operator, less than 400 feet above the ground, and during daylight conditions, among others stipulations.

Obstacles to Safe and Routine Integration of UAS

In 2008, we reported that UAS could not meet the aviation safety requirements developed for manned aircraft and posed several obstacles to operating safely and routinely in the national airspace system.

- *Sense and avoid technologies.* To date, no suitable technology has been identified that would provide UAS with the capability to meet the detect, sense, and avoid requirements of the national airspace system. Our ongoing work indicates that research has been carried out to mitigate this, but the inability for UAS to sense and avoid other aircraft or objects remains an obstacle. With no pilot to scan the sky, UAS do not have an on-board capability to directly "see" other aircraft. Consequently, the UAS must possess the capability to sense and avoid an object using on-board equipment, or with the assistance of a human on the ground or in a chase aircraft,⁸ or by other means, such

⁸Chase pilots are in constant radio contact with research pilots and serve as an "extra set of eyes" to help maintain total flight safety during specific tests and maneuvers. Chase pilots monitor certain events for the research pilot and are an important safety feature on all research missions.

as radar. Many UAS, particularly smaller models, will likely operate at altitudes below 18,000 feet, sharing airspace with other vehicles or objects. Sensing and avoiding other vehicles or objects represents a particular challenge for UAS, because other vehicles or objects at this altitude often do not transmit an electronic signal to identify themselves and, even if they did, many small UAS, do not have equipment to detect such signals if they are used and may be too small to carry such equipment.

- *Command and control communications.* Similar to what we previously reported, ensuring uninterrupted command and control for UAS remains a key obstacle for safe and routine integration into the national airspace. Without such control, the UAS could collide with another aircraft or crash, causing injury or property damage. The lack of dedicated radiofrequency spectrum for UAS operations heightens the possibility that an operator could lose command and control of the UAS. Unlike manned aircraft that use dedicated radio frequencies, non-military UAS currently use undedicated frequencies and remain vulnerable to unintentional or intentional interference. To address the potential interruption of command and control, UAS generally have pre-programmed maneuvers to follow if the command and control link becomes interrupted (called a “lost-link scenario”). However, these procedures are not standardized across all types of UAS and, therefore, remain unpredictable to air traffic controllers who have responsibility for ensuring safe separation of aircraft in their airspace.
- *Standards.* A rigorous certification process with established performance thresholds is needed to ensure that UAS and pilots meet safety, reliability, and performance standards. Minimum aviation system standards are needed in three areas: performance; command and control communications; and sense and avoid. In 2004, RTCA, a standards-making body sponsored by FAA, established a federal advisory committee called the Special Committee 203 (or SC 203), to establish minimum performance standards for FAA to use in developing UAS regulations.⁹ Individuals from academia and the private sector serve on the committee, along with FAA, NASA, and

⁹RTCA, formerly the Radio Technical Commission for Aeronautics, is a private, not-for-profit corporation that develops consensus-based performance standards regarding communications, navigation, surveillance, and air traffic management system issues. RTCA serves as a federal advisory committee, and its recommendations are the basis for a number of FAA’s policy, program, and regulatory decisions.

DOD officials. ASTM International Committee F38 on UAS, an international voluntary consensus standards-making body, is working with FAA to develop standards to support the integration of small UAS into the national airspace.¹⁰

- *Regulations.* FAA regulations govern the routine operation of most aircraft in the national airspace system.¹¹ However, these regulations do not contain provisions to address issues relating to unmanned aircraft. As we highlighted in our previous report, existing regulations may need to be modified to address the unique characteristics of UAS. Today, UAS continue to operate as exceptions to the regulatory framework rather than being governed by it. This has limited the number of UAS operations in the national airspace, and that limitation has, in turn, contributed to the lack of operational data on UAS in domestic operations previously discussed. One industry forecast noted that growth in the non-military UAS market is unlikely until regulations allow for the routine operation of UAS. Without specific and permanent regulations for safe operation of UAS, federal stakeholders, including DOD, continue to face challenges. The lack of final regulations could hinder the acceleration of safe and routine integration of UAS into the national airspace.

Given the remaining obstacles to UAS integration, we stated in 2008 that Congress should consider creating an overarching body within FAA to coordinate federal, academic, and private-sector efforts in meeting the safety challenges of allowing routine access to the national airspace system. While it has not created this overarching body, FAA's Joint Planning and Development Office has taken on a similar role. In addition, Congress set forth requirements for FAA in its February 2012 reauthorization to facilitate UAS integration. Additionally, we made two recommendations to FAA related to its planning and data analysis efforts to facilitate the process of allowing UAS routine access to the national airspace, which FAA has implemented.

¹⁰ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. ASTM members deliver the test methods, specifications, guides and practices that support industries and governments worldwide.

¹¹Title 14, Code of Federal Regulations (14 CFR).

Role of the Department of Homeland Security in Domestic UAS Use

DHS is one of several partner agencies of FAA's Joint Planning and Development Office (JPDO) working to safely integrate UAS into the national airspace. TSA has the authority to regulate the security of all transportation modes, including non-military UAS, and according to TSA officials, its aviation security efforts include monitoring reports on potential security threats regarding the use of UAS. While UAS operations in the national airspace are limited and take place under closely controlled conditions, this could change if UAS have routine access to the national airspace system. Further, DHS owns and uses UAS.

Security is a significant issue that could be exacerbated with an increase in the number of UAS, and could impede UAS use even after all other obstacles have been addressed. In 2004, TSA issued an advisory in which it stated that there was no credible evidence to suggest that terrorist organizations plan to use remote controlled aircraft or UAS in the United States. However, the TSA advisory also provided that the federal government remains concerned that UAS could be modified and used to attack key assets and infrastructure in the United States. TSA advised individuals to report any suspicious activities to local law enforcement and the TSA General Aviation Hotline.¹² Security requirements have yet to be developed for UAS ground control stations—the UAS equivalent of the cockpit.¹³ Legislation introduced in the 112th Congress would prohibit the use of UAS as weapons while operating in the national airspace.¹⁴

In our 2008 report, we recommended that the Secretary of Homeland Security direct the Administrator of TSA to examine the security implications of future, non-military UAS operations in the national airspace and take any actions deemed appropriate. TSA agreed that consideration and examination of new aviation technologies and operations is critical to ensuring the continued security of the national airspace. According to TSA officials, TSA continues to work with the FAA and other federal agencies concerning airspace security by implementing security procedures in an attempt to protect the National Airspace

¹²Department of Homeland Security, *TSA Advisory: Security Information Regarding Remote Controlled Aircraft and Unmanned Aerial Vehicles* (Washington, DC: Nov. 22, 2004).

¹³Additionally, in response to the events of September 11, 2001, entry doors to passenger airplane cockpits were hardened to prevent unauthorized entry.

¹⁴No Armed Drones Act of 2012, H. R. 5950, 112th Cong. (2012).

System. Examples of this collaboration include the coordinated efforts to allow access to temporary flight restricted airspace such as those put in place for Presidential travel and DHS Security Events. However, to date, neither DHS nor TSA has taken any actions to implement our 2008 recommendation. According to TSA officials, TSA believes its current practices are sufficient and no additional actions have been needed since we issued our recommendation.

DHS is also an owner and user of UAS. Since 2005, CBP has flown UAS for border security missions. FAA granted DHS authority to operate UAS to support its national security mission along the United States northern and southern land borders, among other areas. Recently, DHS officials told us that DHS has also flown UAS over the Caribbean to search for narcotics-carrying submarines and speedboats. According to DHS officials, CBP owns ten UAS that it operates in conjunction with other agencies for various missions. As of May 2012, CBP has flown missions to support six federal and state agencies along with several DHS agencies. These missions have included providing the National Oceanic and Atmospheric Administration with videos of damaged dams and bridges where flooding occurred or was threatened, and providing surveillance for DHS's Immigration and Customs Enforcement over a suspected smuggler's tunnel. DHS, DOD, and NASA, are working with FAA to identify and evaluate options to increase UAS access in the national airspace. DHS officials reported that if funding was available, they plan to expand their fleet to 24 total UAS that would be operational by fiscal year 2016, including 11 on the southwest border.

The DHS Inspector General reviewed CBP's actions to establish its UAS program, the purpose of which is to provide reconnaissance, surveillance, targeting, and acquisition capabilities across all CBP areas of responsibility. The Inspector General assessed whether CBP has established an adequate operation plan to define, prioritize, and execute its unmanned aircraft mission. The Inspector General's May 2012 report found that CBP had not achieved its scheduled or desired level of flight hours for its UAS. It estimated that CBP used its UAS less than 40 percent of the time it would have expected.¹⁵

¹⁵The report made four recommendations intended to improve CBP's planning of its UAS program to address its level of operation, program funding, and resource requirements, along with stakeholder needs.

Preliminary Observations on Emerging UAS Issues

Our ongoing work has identified several UAS issues that, although not new, are emerging as areas of further consideration in light of the efforts towards safe and routine access to the national airspace. These include concerns about 1) privacy as it relates to the collection and use of surveillance data, 2) the use of model aircraft, which are aircraft flown for hobby or recreation, and 3) the jamming and spoofing of the Global Positioning System (GPS).

- *Privacy concerns over collection and use of surveillance data.* Following the enactment of the UAS provisions of the 2012 FAA reauthorization act, members of Congress, a civil liberties organization, and others have expressed concern that the increased use of UAS for surveillance and other purposes in the national airspace has potential privacy implications. Concerns include the potential for increased amounts of government surveillance using technologies placed on UAS as well as the collection and use of such data. Surveillance by federal agencies using UAS must take into account associated constitutional Fourth Amendment protections against unreasonable searches and seizures. In addition, at the individual agency level, there are multiple federal laws designed to provide protections for personal information used by federal agencies. While the 2012 FAA reauthorization act contains provisions designed to accelerate the safe integration of UAS into the national airspace, proposed legislation in the 112th session of Congress, seeks to limit or serve as a check on uses of UAS by, for example, limiting the ability of the federal government to use UAS to gather information pertaining to criminal conduct without a warrant.¹⁶

Currently, no federal agency has specific statutory responsibility to regulate privacy matters relating to UAS. UAS stakeholders disagreed as to whether the regulation of UAS privacy related issues should be centralized within one federal agency, or if centralized, which agency would be best positioned to handle such a responsibility. Some stakeholders have suggested that FAA or another federal agency should develop regulations for the types of allowable uses of UAS to specifically protect the privacy of individuals as well as rules for the conditions and types of data that small UAS can collect. Furthermore,

¹⁶Preserving Freedom from Unwarranted Surveillance Act of 2012, S. 3287, 112th Cong. (2012) and Farmer's Privacy Act of 2012, H.R. 5961, 112th Cong. (2012).

stakeholders with whom we spoke said that developing guidelines for technology use on UAS ahead of widespread adoption by law enforcement entities may preclude abuses of the technology and a negative public perception of UAS. Representatives from one civil liberties organization told us that since FAA has responsibility to regulate the national airspace, it could be positioned to handle responsibility for incorporating rules that govern UAS use and data collection. Some stakeholders have suggested that the FAA has the opportunity and responsibility to incorporate such privacy issues into the small UAS rule that is currently underway and in future rulemaking procedures. However, FAA officials have said that regulating these sensors is outside the FAA's mission, which is primarily focused on aviation safety, and has proposed language in its small UAS Notice of Proposed Rulemaking to clarify this.

- *Model aircraft.* According to an FAA official with whom we spoke and other stakeholders, another concern related to UAS is the oversight of the operation of model aircraft—aircraft flown for hobby or recreation—capable of sustained flight in the atmosphere and a number of other characteristics.¹⁷ Owners of model aircraft do not require a COA to operate their aircraft.¹⁸ Furthermore, as part of its 2012 reauthorization act, FAA is prohibited from developing any rule or regulation for model aircraft under a specified set of conditions.¹⁹ However, the 2012 reauthorization act also specifies that nothing in the act's model aircraft provisions shall be construed to limit FAA's authority to take enforcement action against the operator of a model

¹⁷The 2012 reauthorization act defines the term "model aircraft" to mean an unmanned aircraft that is: (1) capable of sustained flight in the atmosphere, (2) flown within visual line of sight of the person operating the aircraft, and (3) flown for hobby or recreational purposes.

¹⁸FAA's Advisory Circular 91-57 sets out model aircraft operating standards that encourage voluntary compliance with specified safety standards for model aircraft operators.

¹⁹This prohibition on FAA model aircraft rules or regulations only applies where the aircraft is: (1) flown strictly for hobby or recreational use, (2) operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization, (3) limited to not more than 55 pounds (unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization), (4) operated in a manner that does not interfere with and gives way to any manned aircraft, and (5) when flown within 5 miles of an airport, prior notice of the operation is given to the airport operator and the air traffic control tower.

aircraft who endangers the safety of the national airspace system.²⁰ The Federal Bureau of Investigation report of the arrest and criminal prosecution of a man plotting to use a large remote-controlled model aircraft filled with plastic explosives to attack the Pentagon and U.S. Capitol in September 2011 has highlighted the potential for model aircraft to be used for non-approved or unintended purposes.

The Academy of Model Aeronautics, which promotes the development of model aviation as a recognized sport and represents a membership of over 150,000, published several documents to guide model aircraft users on safety, model aircraft size and speed, and use. For example, the Academy's National Model Aircraft Safety Code specifies that model aircraft will not be flown in a careless or reckless manner and will not carry pyrotechnic devices that explode or burn, or any device that propels a projectile or drops any object that creates a hazard to persons or property (with some exceptions).²¹ The Academy of Model Aeronautics also provides guidance on "sense and avoid" to its members, such as a ceiling of 400 feet above ground of aircraft weighing 55 pounds or less. However, apart from FAA's voluntary safety standards for model aircraft operators, FAA has no regulations relating to model aircraft. Currently, FAA does not require a license for any model aircraft operators, but according to FAA, the small UAS Notice of Proposed Rule Making, under development and expected to be published late 2012, may contain a provision that requires certain model aircraft to be registered.

- *GPS jamming and spoofing.*²² The jamming and spoofing of the communication signal between the UAS and ground control station could also interrupt the command and control of UAS operations. In a GPS jamming scenario, the UAS could potentially lose its ability to determine where it is located and in what direction it is traveling. Low

²⁰Pub. L. No. 112-95, § 336, 126 Stat. 11 . 77 (2012).

²¹The Academy of Model Aeronautics National Model Aircraft Safety Code allows members to fly devices that burn producing smoke and are securely attached to the model aircraft and use rocket motors if they remain attached to the model during flight. Model rockets may be flown but not launched from a model aircraft.

²²GPS spoofing is when counterfeit GPS signals are generated for the purpose of manipulating a target receiver's reported position and time. Todd E. Humphreys, *Detection Strategy for Cryptographic GNSS Anti-Spoofing*, IEEE Transactions on Aerospace and Electronics Systems (August 2011).

cost devices that jam GPS signals are prevalent. According to one industry expert, GPS jamming would become a larger problem if GPS is the only method for navigating a UAS. This problem can be mitigated by having a second or redundant navigation system onboard the UAS that is not reliant on GPS. In addition, a number of federal UAS stakeholders we interviewed stated that GPS jamming is not an issue for the larger, military-type UAS, as they have an encrypted communications link on the aircraft. A stakeholder noted that GPS jamming can be mitigated for small UAS by encrypting its communications, but the costs associated with encryption may make it infeasible. Recently, researchers at the University of Texas demonstrated that the GPS signal controlling a small UAS could be spoofed using a portable software radio. The research team found that it was straightforward to mount an intermediate-level spoofing attack but difficult and expensive to mount a more sophisticated attack.²³

The emerging issues we identified not only may exist as part of efforts to safely and routinely integrate UAS into the national airspace, but may also persist once integration has occurred. Thus, these issues may warrant further examination both presently and in the future.

Chairman McCaul, Ranking Member Keating, and Members of the Subcommittee, this concludes my prepared statement. We plan to report more fully this fall on these same issues, including the status of efforts to address obstacles to the safe and routine integration of UAS into the national airspace. I would be pleased to answer any questions at this time.

²³The presentation "Assessing the Civil GPS Spoofing Threat" by Todd Humphreys, Jahshan Bhatti, Brent Ledvina, Mark Psiaki, Brady O'Hanlon, Paul Kintner, and Paul Montgomery sought to assess the spoofing threat of a small civil UAS. The team built a civilian GPS spoofer and tested some countermeasures. They concluded that GPS spoofing is a threat to communications security and civil spoofing has not been the focus of research in open literature.

GAO Contact and Staff Acknowledgements

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. Individuals making key contributions to this testimony include Maria Edelstein, Assistant Director; Amy Abramowitz; Erin Cohen; John de Ferrari; Colin Fallon; Rebecca Gambler; Geoffrey Hamilton; David Hooper; Daniel Hoy; Joe Kirschbaum; Brian Lepore; SaraAnn Moessbauer; Faye Morrison; Sharon Pickup; Tina Won Sherman; and Matthew Ullengren.

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's website (www.gao.gov). Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. To have GAO e-mail you a list of newly posted products, go to www.gao.gov and select "E-mail Updates."

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, <http://www.gao.gov/ordering.htm>.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on [Facebook](#), [Flickr](#), [Twitter](#), and [YouTube](#). Subscribe to our [RSS Feeds](#) or [E-mail Updates](#). Listen to our [Podcasts](#). Visit GAO on the web at www.gao.gov.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Website: www.gao.gov/fraudnet/fraudnet.htm

E-mail: fraudnet@gao.gov

Automated answering system: (800) 424-5454 or (202) 512-7470

Congressional Relations

Katherine Siggerud, Managing Director, siggerudk@gao.gov, (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800 U.S. Government Accountability Office, 441 G Street NW, Room 7149 Washington, DC 20548

