Excerpts from FAA, Gao, and Other Federal Documents Governing UAS Use

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DEFINITIONS

Certificate of Waiver or Authorization (COA)—The terms "certificate of waiver" and "certificate of authorization" mean a Federal Aviation Administration grant of approval for a specific flight operation. Applications for a COA are only accepted from public entities. An application may be referred to the FAA Office of the Chief Counsel (AGC), for determination of the status of an applicant, i.e., public or civil. COAs are typically issued for a period of up to one year, but may be issued for a lesser duration if requested or deemed appropriate.

Civil Applicants – Approvals for civil applications using the special airworthiness process receive their airworthiness certification as part of the review process with the FAA.

Civil UAS – Obtaining an experimental airworthiness certificate for a particular UAS is currently the only way civil operators of unmanned aircraft are accessing the NAS. Experimental certificate regulations preclude carrying people or property for compensation or hire, but do allow operations for research and development, flight and sales demonstrations and crew training. The FAA is working with civilian operators to collect technical and operational data that will help refine the UAS airworthiness certification process. The agency is currently developing a future path for safe integration of civil UAS into the NAS as part of NextGen implementation.

Model Aircraft – Recreational use of airspace by model aircraft is covered by FAA Advisory Circular 91-57, which generally limits operations to below 400 feet above ground level and away from airports and air traffic. In 2007, the FAA clarified that AC 91-57 only applies to modelers, and specifically excludes individuals or companies flying model aircraft for business purposes.

Pilot in Command (PIC): The person who has final authority and responsibility for the operation and safety of flight, has been designated as pilot in command before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the pilot in command as described by 14 CFR 91.3, *Responsibility and Authority of the Pilot in Command*, apply to the unmanned aircraft PIC. The pilot in command position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight.

Public Aircraft – An aircraft operated by a public user which is intrinsically governmental in nature (i.e. federal, state, and local agencies). Examples of public entities are Department of Defense (DoD) and its military branches; other local, state, and federal government agencies; and state universities. Refer to 14 CFR 1.1, *General Definitions*, for a complete definition of a public aircraft.

Public UAS – COAs are available to public entities that want to fly a UAS in civil airspace. Common uses today include law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions.

Unmanned Aircraft—The term "unmanned aircraft" means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.

Unmanned Aircraft System—The term "unmanned aircraft system" means an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft) that are required for the pilot in command to operate safely and efficiently in the national airspace system.

UAS Test Sites
In the FAA Modernization and Reform Act of 2012, Congress directed the FAA to establish a program to integrate UAS into the national airspace system at six test ranges.

Department of Transportation Advisory Circular 91-57

- Simply stated, an unmanned aircraft is a device that is used, or is intended to be used, for flight in the air with no onboard pilot.
- These devices may be as simple as a remotely controlled model aircraft used for recreational purposes or as complex as surveillance aircraft flying over hostile areas in warfare.
- They may be controlled either manually or through an autopilot using a data link to connect the pilot to their aircraft.
- They may perform a variety of public services: surveillance, collection of air samples to determine levels of pollution, or rescue and recovery missions in crisis situations.
- They range in size from wingspans of four inches to 246 feet (like a Boeing 737); and can weigh from approximately four ounces to over 25,600 pounds.

The one thing they have in common is that their numbers and uses are growing dramatically. In the United States alone, approximately 50 companies, universities, and government organizations are developing and producing some 155 unmanned aircraft designs. Regulatory standards need to be developed to enable current technology for unmanned aircraft to comply with Title 14 Code of Federal Regulations (CFR).

FAA Fact Sheet: The FAA first authorized use of unmanned aircraft in the NAS in 1990. Since then, the agency has authorized limited use of UAS for important missions in the public interest, such as firefighting, disaster relief, search and rescue, law enforcement, border patrol, military training and testing and evaluation.

Unmanned aircraft are flying now in the national airspace system under very controlled conditions. Operations potentially range from ground level to above 50,000 feet, depending on the specific type of aircraft. However, UAS operations are currently not authorized in Class B airspace, which exists over major urban areas and contains the highest density of manned aircraft in the National Airspace System.

There are currently two ways to get FAA approval to operate a UAS. The first is to obtain an experimental airworthiness certificate for private sector (civil) aircraft to do research and development, training and flight demonstrations. The second is to obtain a Certificate of Waiver or Authorization (COA) for public aircraft. Routine operation of UAS over densely-populated areas is prohibited.

A New Office for New Technology

In 2012, the FAA established the Unmanned Aircraft Systems Integration Office to provide a one-stop portal for civil and public use UAS in U.S. airspace. This office is developing a comprehensive plan to integrate and establish operational and certification requirements for UAS. It will also oversee and coordinate UAS research and development.

Public Law 112-95 Feb 14, 2012
SEC. 332. Integration of Civil Unmanned Aircraft Systems into National Airspace System
(a) REQUIRED PLANNING FOR INTEGRATION.—
(1) COMPREHENSIVE PLAN.
(3) DEADLINE.—The plan required under paragraph (1) shall provide for the safe integration of civil unmanned aircraft systems into the national airspace system as soon as practicable, but not later than September 30, 2015.
(b) STANDARDS FOR OPERATION AND CERTIFICATION.—Not later than December 31, 2015, the Administrator shall develop and implement operational and certification requirements for the operation of public unmanned aircraft systems in the national airspace system.

FAA Interim Operational Approval Guidance 08-01; Unmanned Aircraft Systems Operations in the US National Airspace System

The proliferation of UAS into the NAS has resulted in an increased demand for the FAA to process a large number of applications to review for operational approvals. These approvals are required due to the fact that unmanned aircraft (UA) are not compliant with various sections of Title 14 of the Code of Federal Regulations (14 CFR) and therefore, require an alternate means of compliance. Most notably, the lack of an on-board pilot requires an alternate method of the "see-and-avoid" provisions of 14 CFR 91.113. **Restrictions/Requirements:**

8.2.5 Flight Over Populated Areas Routine UAS operations shall not be conducted over urban or populated areas. UAS operations may be approved in emergency or relief situations if the proposed mitigation strategies are found to be acceptable.

8.2.6 Flight Over Heavily Trafficked Roads or Open-air Assembly of People UAS operations shall avoid these areas.

8.2.7 Day/Nighttime Operations All UAS operations outside of Class A airspace must be conducted during daylight hours.

8.2.9 Autonomous Operations It is generally understood that most UAS have some level of autonomy associated with its operation. Although it is possible to have a completely manual UAS, which requires a pilot-in-the-loop, the majority of UAS are autonomous to a certain degree. Only those UAS that have the capability of pilot intervention, or pilot-on-the-loop, shall be allowed in the NAS outside of Restricted, Prohibited, or Warning areas. UAS that are designed to be completely autonomous, with no capability of pilot intervention, are not authorized in the national airspace system.

9.1 UAS Pilot Qualifications

The FAA is focused on insuring that UAS pilots have a common level of understanding of federal aviation regulations applicable to the airspace where the UA will operate. Pilots are responsible for a thorough preflight inspection of the UAS. They are accountable for controlling their aircraft to the same responsible standards as the pilot of a manned aircraft. Pilot qualifications for UAS operations conducted under IFR are addressed in this section. The following items apply to the pilots of all UAS:
• One pilot in command (PIC) must be designated at all times.
• The PIC of an aircraft is directly responsible, and is the final authority of, the operation of that aircraft.
• Pilots must not perform crew duties for more than one UAS at a time.
• Pilots are not allowed to perform concurrent duties both as pilot and observer.

GAO: Unmanned Aircraft Systems:

Why GAO Did This Study

UAS do not carry a pilot on board, but instead operate on pre-programmed routes and by following commands from pilot-operated ground stations. UAS can be small, generally 55 pounds or less, or large. Current domestic uses include law enforcement, forest fire monitoring, border security, weather research, and scientific data collection. However, current uses are limited. FAA authorizes UAS operations on a case-by-case basis after conducting a safety review.

Currently, FAA authorizes all domestic military; public (academic institutions, federal, state, and local governments including law enforcement organizations); and civil (private sector entities) UAS operations on a limited basis after conducting a case-by-case safety review. Federal, state, and local government agencies must apply for Certificates of Waiver or Authorization (COA), while civil operators must apply for special airworthiness certificates in the experimental category. Because special airworthiness certificates do not allow commercial operations, there is currently no means for FAA to authorize commercial UAS operations.

Since FAA started issuing COAs in January 2007, 1,428 COAs have been issued. At present, under COA or special airworthiness certification, UAS operations are permitted for specific time frames (generally 12 to 24 months); locations; and operations. So, one agency can be issued multiple COAs to operate one UAS for the same purpose. In 2012, FAA issued 391 COAs to 121 federal, state, and local government entities across the United States, including law enforcement entities as well as academic institutions

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.

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.

GAO July 2012: 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.

Table 1: Key Federal UAS Stakeholders and Their Roles Integrating UAS into the National Airspace Key stakeholders	UAS integration role
Federal Aviation Administration (FAA)	FAA's UAS Integration Office is responsible for ensuring that UAS operate safely in the national airspace.
Department of Defense (DOD)	DOD provides FAA with UAS operational and safety data, as well as research and development support.
National Aeronautics and Space Administration (NASA)	NASA provides research and development and testing on UAS integration efforts.
Department of Homeland Security (DHS)	DHS's Customs and Border Patrol has provided flight demonstrations to FAA's Next Generation Air Transportation System (NextGen) Office.
General Services Administration (GSA)	The General Services Administration (GSA) is responsible for tracking the federal government's UAS inventory. Federal agencies that own or lease UAS report their UAS inventory, cost and utilization data to GSA.
Department of Justice (DOJ)	DOJ's National Institute of Justice is responsible, in part, for assisting the technology needs—including UAS—of local, state, and tribal law enforcement agencies.

Meeting the 2012 Act's Requirements Will Continue to Challenge FAA

January 31, 2013 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 COAs or waivers for public UAS.	In process
05/14/2012	Expedite the issuance of a COA for public safety entities.	Completed
08/12/2012	Establish a program to integrate UAS into the national airspace at 6 test ranges. This program is to terminate 5 years after date of enactment.	In process
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 UAS into the national airspace or the Act's requirement for issuance of guidance regarding the operation of public UAS including operating a UAS with a COA or waiver.	In process
11/10/2012	Develop a comprehensive plan to safely accelerate integration of civil UAS into national airspace.	In process
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.	In process

GAO July 2012: Obstacles to Safe and Routine Integration of UAS:

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.

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.

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.

Regulations. FAA regulations govern the routine operation of most aircraft in the national airspace system. However, these regulations do not contain provisions to address issues relating to unmanned aircraft.

Security requirements have yet to be developed for UAS ground control stations—the UAS equivalent of the cockpit

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.

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.

Currently, no federal agency has specific statutory responsibility to regulate privacy matters relating to 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,

Model Aircraft flyers:

Owners of model aircraft do not require a COA to operate their aircraft

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. 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.

Public Law 112-95 Feb 14, 2012

SEC. 336. Special Rule for Model Aircraft.

(a) IN GENERAL.—Notwithstanding any other provision of law relating to the incorporation of unmanned aircraft systems into Federal Aviation Administration plans and policies, including this subtitle, the Administrator of the Federal Aviation Administration may not promulgate any rule or regulation regarding a model aircraft, or an aircraft being developed as a model aircraft, if—

This document and the processes prescribed do not apply to hobbyists and amateur model aircraft users when operating systems for sport and recreation. Those individuals should seek guidance under Advisory Circular (AC) 91-57, Model Aircraft Operating Standards, which is currently under revision.

Federal Aviation Administration

Fact Sheet – Unmanned Aircraft Systems (UAS)

For Immediate Release

February 19, 2013
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Unmanned Aircraft Systems (UAS) come in a variety of shapes and sizes and serve diverse purposes. They may have a wingspan as large as a Boeing 737 or smaller than a radio-controlled model airplane. Regardless of size, the responsibility to fly safely applies equally to manned and unmanned aircraft operations.

Because they are inherently different from manned aircraft, introducing UAS into the nation's airspace is challenging for both the FAA and aviation community. UAS must be integrated into a National Airspace System (NAS) that is evolving from ground-based navigation aids to a GPS-based system in NextGen. Safe integration of UAS involves gaining a better understanding of operational issues, such as training requirements, operational specifications and technology considerations.

The FAA's Role: Safety

Safety is the FAA's top mission, and the agency maintains the world's safest aviation system. As a provider of air traffic control services, the FAA also must ensure the safety and efficiency of the nation's entire airspace.

The FAA first authorized use of unmanned aircraft in the NAS in 1990. Since then, the agency has authorized limited use of UAS for important missions in the public interest, such as firefighting, disaster relief, search and rescue, law enforcement, border patrol, military training and testing and evaluation. Today, UAS perform border and port surveillance by the Department of Homeland Security, help with scientific research and environmental monitoring by NASA and NOAA, support public safety by law enforcement agencies, help state universities conduct research, and support various other missions for public (government) entities.

Unmanned aircraft are flying now in the national airspace system under very controlled conditions. Operations potentially range from ground level to above 50,000 feet, depending on the specific type of aircraft. However, UAS operations are currently not authorized in Class B airspace, which exists over major urban areas and contains the highest density of manned aircraft in the National Airspace System.

There are currently two ways to get FAA approval to operate a UAS. The first is to obtain an experimental airworthiness certificate for private sector (civil) aircraft to do research and development, training and flight demonstrations. The second is to obtain a Certificate of Waiver or Authorization (COA) for public aircraft. Routine operation of UAS over densely-populated areas is prohibited.

Civil UAS

Obtaining an experimental airworthiness certificate for a particular UAS is currently the only way civil operators of unmanned aircraft are accessing the NAS. Experimental certificate regulations preclude carrying people or property for compensation or hire, but do allow operations for research and development, flight and sales demonstrations and crew training. The FAA is working with civilian operators to collect technical and operational data that will help refine the UAS airworthiness certification process. The agency is currently developing a future path for safe integration of civil UAS into the NAS as part of NextGen implementation.

Public UAS

COAs are available to public entities that want to fly a UAS in civil airspace. Common uses today include law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions.

Applicants make their request through an online process and the FAA evaluates the proposed operation to see if it can be conducted safely.

The COA allows an operator to use a defined block of airspace and includes special provisions unique to the proposed operation. For instance, a COA may require flying only under Visual Flight Rules (VFR) and/or only during daylight hours. COAs usually are issued for a specific period—up to two years in many cases.

Most COAs require coordination with an appropriate air traffic control facility and may require a transponder on the UAS to operate in certain types of airspace.

Because UAS technology cannot currently comply with "see and avoid" rules that apply to all aircraft, a visual observer or an accompanying "chase plane" must maintain visual contact with the UAS and serve as its "eyes" when operating outside airspace restricted from other users.

COAs Issued:

2009	146
2010	298
2011	313
2012	257

There were 327 COAs active as of February 15, 2013.

Streamlining the Process

The FAA has been working with its government partners to streamline COA procedures. In 2009, the FAA, NASA and the Departments of Defense and Homeland Security formed a UAS Executive Committee, or "ExCom" to address UAS integration issues. The ExCom established a working group that developed suggestions to expedite the COA process and increase transparency.

For new applications from public users, the FAA has an on-line process that ensures paperwork is complete and ready to be assessed. Today, the average time to issue an authorization for non-emergency operations is less than 60 days, and the renewal period is two years. The agency has expedited procedures in place to grant one-time COAs for time-sensitive emergency missions, such as disaster relief and humanitarian efforts.

Model Aircraft

Recreational use of airspace by model aircraft is covered by FAA Advisory Circular 91-57, which generally limits operations to below 400 feet above ground level and away from airports and air traffic. In

2007, the FAA clarified that AC 91-57 only applies to modelers, and specifically excludes individuals or companies flying model aircraft for business purposes.

The FAA guidance is available at: http://www.faa.gov/documentLibrary/media/Advisory_Circular/91-57.pdf

Operation and Certification Standards

Integrating UAS into the nation's airspace presents both opportunities and challenges. However, everything the FAA does is focused on ensuring the safety of the nation's aviation system. New policies, procedures and approval processes will address the increasing desire by civilian operators to fly UAS in the NAS. Developing and implementing new UAS standards and guidance is a long-term effort.

The FAA chartered a UAS Aviation Rulemaking Committee in 2011 to develop inputs and recommendations on appropriate operational procedures, regulatory standards and policies before allowing routine UAS access to the nation's airspace.
The FAA has asked RTCA – organized in 1935 as the Radio Technical Commission for Aeronautics, a group that facilitates expert advice to the agency on technical issues – to work with industry to assist in the development of UAS standards. RTCA's technical group will address how UAS will handle communication, command and control and how they will "sense and avoid" other aircraft.
The FAA continues to work closely with its international aviation counterparts to harmonize standards, policies, procedures and regulatory requirements.

UAS Test Sites

In the FAA Modernization and Reform Act of 2012, Congress directed the FAA to establish a program to integrate UAS into the national airspace system at six test ranges. The designation and operation of test sites will be a tool for testing all aspects of UAS integration. Some facets of test site selection and operation include:

Safe designation of airspace for integrated manned and unmanned flight operations in the national airspace system
Development of certification standards and air traffic requirements for unmanned flight operations
Coordinating with and leveraging the resources of NASA and the Department of Defense
Addressing both civil and public unmanned aircraft systems
Ensuring that the program is coordinated with the Next Generation Air Transportation System
Ensuring the safety of unmanned aircraft systems and related navigation procedures before they are integrated into the national airspace system

The FAA issued a Screening Information Request on February 14, 2013 for proposals to manage these sites. You can read the press release here: (http://www.faa.gov/news/press_releases/news_story.cfm?newsId=14313)
http://www.faa.gov/news/press_releases/news_story.cfm?newsId=14313
(http://www.faa.gov/news/press_releases/news_story.cfm?newsId=14313)

Small Unmanned Aircraft

Small unmanned aircraft (sUAS) are likely to grow most quickly in civil and commercial operations because of their versatility and relatively low initial cost and operating expenses. The FAA is working on a proposed rule governing the use of a wide range of small civil unmanned aircraft systems.

The 2012 reauthorization bill also directed the FAA to "allow a government public safety agency to operate unmanned aircraft weighing 4.4 pounds or less" under certain restrictions. The bill specified these UAS must be flown within the line of sight of the operator, less than 400 feet above the ground, during daylight conditions, inside Class G (uncontrolled) airspace and more than five miles from any airport or other location with aviation activities.

Prior to the congressional action, the FAA and the Justice Department had been working on an agreement to streamline the COA process for law enforcement – an agreement that also meets the mandate. Initially, law enforcement organizations will receive a COA for training and performance evaluation. When the organization has shown proficiency in flying its UAS, it will receive an operational COA. The agreement expands the allowable UAS weight up to 25 pounds.

A New Office for New Technology

In 2012, the FAA established the Unmanned Aircraft Systems Integration Office to provide a one-stop portal for civil and public use UAS in U.S. airspace. This office is developing a comprehensive plan to integrate and establish operational and certification requirements for UAS. It will also oversee and coordinate UAS research and development.

Over more than 50 years, the FAA has a proven track record of introducing new technology and aircraft safely into the NAS. The agency will successfully meet the challenges posed by UAS technology in a thoughtful, careful manner that ensures safety and addresses privacy issues while promoting economic growth.

For more information: http://www.faa.gov/about/initiatives/uas/ (http://www.faa.gov/about/initiatives/uas/)

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This page can be viewed online at: http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=14153

(e) USE OF DESIGNEES.—The Administrator may use designees to carry out subsection (a) to the extent practicable in order to minimize the burdens on pilots.

(f) REPORT TO CONGRESS.—

(1) IN GENERAL.—Not later than 1 year after the date of enactment of this Act, and annually thereafter, the Administrator shall submit to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the issuance of improved pilot licenses under this section.

(2) EXPIRATION.—The Administrator shall not be required to submit annual reports under this subsection after the date on which the Administrator has issued improved pilot licenses under this section to all pilots.

Subtitle B—Unmanned Aircraft Systems

49 USC 40101 note. Applicability.

SEC. 331. DEFINITIONS.

In this subtitle, the following definitions apply:

(1) ARCTIC.—The term "Arctic" means the United States zone of the Chukchi Sea, Beaufort Sea, and Bering Sea north of the Aleutian chain.

(2) CERTIFICATE OF WAIVER; CERTIFICATE OF AUTHORIZATION.—The terms "certificate of waiver" and "certificate of authorization" mean a Federal Aviation Administration grant of approval for a specific flight operation.

(3) PERMANENT AREAS.—The term "permanent areas" means areas on land or water that provide for launch, recovery, and operation of small unmanned aircraft.

(4) PUBLIC UNMANNED AIRCRAFT SYSTEM.—The term "public unmanned aircraft system" means an unmanned aircraft system that meets the qualifications and conditions required for operation of a public aircraft (as defined in section 40102 of title 49, United States Code).

(5) SENSE AND AVOID CAPABILITY.—The term "sense and avoid capability" means the capability of an unmanned aircraft to remain a safe distance from and to avoid collisions with other airborne aircraft.

(6) SMALL UNMANNED AIRCRAFT.—The term "small unmanned aircraft" means an unmanned aircraft weighing less than 55 pounds.

(7) TEST RANGE.—The term "test range" means a defined geographic area where research and development are conducted.

(8) UNMANNED AIRCRAFT.—The term "unmanned aircraft" means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.

(9) UNMANNED AIRCRAFT SYSTEM.—The term "unmanned aircraft system" means an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft) that are required for the pilot in command to operate safely and efficiently in the national airspace system.

SEC. 332. INTEGRATION OF CIVIL UNMANNED AIRCRAFT SYSTEMS INTO NATIONAL AIRSPACE SYSTEM.

49 USC 40101 note.

(a) REQUIRED PLANNING FOR INTEGRATION.—

(1) COMPREHENSIVE PLAN.—Not later than 270 days after the date of enactment of this Act, the Secretary of Transportation, in consultation with representatives of the aviation industry, Federal agencies that employ unmanned aircraft systems technology in the national airspace system, and the unmanned aircraft systems industry, shall develop a comprehensive plan to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system.

Deadline.

(2) CONTENTS OF PLAN.—The plan required under paragraph (1) shall contain, at a minimum, recommendations or projections on—

(A) the rulemaking to be conducted under subsection (b), with specific recommendations on how the rulemaking will—

(i) define the acceptable standards for operation and certification of civil unmanned aircraft systems;

(ii) ensure that any civil unmanned aircraft system includes a sense and avoid capability; and

(iii) establish standards and requirements for the operator and pilot of a civil unmanned aircraft system, including standards and requirements for registration and licensing;

(B) the best methods to enhance the technologies and subsystems necessary to achieve the safe and routine operation of civil unmanned aircraft systems in the national airspace system;

(C) a phased-in approach to the integration of civil unmanned aircraft systems into the national airspace system;

(D) a timeline for the phased-in approach described under subparagraph (C);

(E) creation of a safe

(F) airspace designation for cooperative manned and unmanned flight operations in the national airspace system;

(G) establishment of a process to develop certification, flight standards, and air traffic requirements for civil unmanned aircraft systems at test ranges where such systems are subject to testing;

(H) the best methods to ensure the safe operation of civil unmanned aircraft systems and public unmanned aircraft systems simultaneously in the national airspace system; and

(I) incorporation of the plan into the annual NextGen Implementation Plan document (or any successor document) of the Federal Aviation Administration.

(3) DEADLINE.—The plan required under paragraph (1) shall provide for the safe integration of civil unmanned aircraft systems into the national airspace system as soon as practicable, but not later than September 30, 2015.

(4) REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the Secretary shall submit to Congress a copy of the plan required under paragraph (1).

Deadlines.
Publication.
Web posting.

(5) ROADMAP.—Not later than 1 year after the date of enactment of this Act, the Secretary shall approve and make available in print and on the Administration's Internet Web site a 5-year roadmap for the introduction of civil unmanned aircraft systems into the national airspace system, as coordinated by the Unmanned Aircraft Program Office of the Administration. The Secretary shall update the roadmap annually.

Deadline.
Federal Register, publication.

(b) RULEMAKING.—Not later than 18 months after the date on which the plan required under subsection (a)(1) is submitted to Congress under subsection (a)(4), the Secretary shall publish in the Federal Register—

(1) a final rule on small unmanned aircraft systems that will allow for civil operation of such systems in the national airspace system, to the extent the systems do not meet the requirements for expedited operational authorization under section 333 of this Act;

(2) a notice of proposed rulemaking to implement the recommendations of the plan required under subsection (a)(1), with the final rule to be published not later than 16 months after the date of publication of the notice; and

(3) an update to the Administration's most recent policy statement on unmanned aircraft systems, contained in Docket No. FAA–2006–25714.

(c) PILOT PROJECTS.—

Deadline.

(1) ESTABLISHMENT.—Not later than 180 days after the date of enactment of this Act, the Administrator shall establish a program to integrate unmanned aircraft systems into the national airspace system at 6 test ranges. The program shall terminate 5 years after the date of enactment of this Act.

Termination date.

(2) PROGRAM REQUIREMENTS.—In establishing the program under paragraph (1), the Administrator shall—

(A) safely designate airspace for integrated manned and unmanned flight operations in the national airspace system;

Standards.

(B) develop certification standards and air traffic requirements for unmanned flight operations at test ranges;

(C) coordinate with and leverage the resources of the National Aeronautics and Space Administration and the Department of Defense;

(D) address both civil and public unmanned aircraft systems;

(E) ensure that the program is coordinated with the Next Generation Air Transportation System; and

(F) provide for verification of the safety of unmanned aircraft systems and related navigation procedures before integration into the national airspace system.

(3) TEST RANGE LOCATIONS.—In determining the location of the 6 test ranges of the program under paragraph (1), the Administrator shall—

(A) take into consideration geographic and climatic diversity;

(B) take into consideration the location of ground infrastructure and research needs; and

Consultation.

(C) consult with the National Aeronautics and Space Administration and the Department of Defense.

(4) TEST RANGE OPERATION.—A project at a test range shall be operational not later than 180 days after the date on which the project is established. Deadline.

(5) REPORT TO CONGRESS.—

(A) IN GENERAL.—Not later than 90 days after the date of the termination of the program under paragraph (1), the Administrator shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure and the Committee on Science, Space, and Technology of the House of Representatives a report setting forth the Administrator's findings and conclusions concerning the projects.

(B) ADDITIONAL CONTENTS.—The report under subparagraph (A) shall include a description and assessment of the progress being made in establishing special use airspace to fill the immediate need of the Department of Defense—

(i) to develop detection techniques for small unmanned aircraft systems; and

(ii) to validate the sense and avoid capability and operation of unmanned aircraft systems.

(d) EXPANDING USE OF UNMANNED AIRCRAFT SYSTEMS IN ARCTIC.—

(1) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Secretary shall develop a 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. The plan for operations in these permanent areas shall include the development of processes to facilitate the safe operation of unmanned aircraft beyond line of sight. Such areas shall enable over-water flights from the surface to at least 2,000 feet in altitude, with ingress and egress routes from selected coastal launch sites. Deadline. Plans.

(2) AGREEMENTS.—To implement the plan under paragraph (1), the Secretary may enter into an agreement with relevant national and international communities.

(3) AIRCRAFT APPROVAL.—Not later than 1 year after the entry into force of an agreement necessary to effectuate the purposes of this subsection, the Secretary shall work with relevant national and international communities to establish and implement a process, or may apply an applicable process already established, for approving the use of unmanned aircraft in the designated permanent areas in the Arctic without regard to whether an unmanned aircraft is used as a public aircraft, a civil aircraft, or a model aircraft. Deadline.

SEC. 333. SPECIAL RULES FOR CERTAIN UNMANNED AIRCRAFT SYSTEMS. 49 USC 40101 note.

(a) IN GENERAL.—Notwithstanding any other requirement of this subtitle, and not later than 180 days after the date of enactment of this Act, the Secretary of Transportation shall determine if certain unmanned aircraft systems may operate safely in the national airspace system before completion of the plan and rulemaking required by section 332 of this Act or the guidance required by section 334 of this Act. Deadline. Determination.

Determination.

(b) ASSESSMENT OF UNMANNED AIRCRAFT SYSTEMS.—In making the determination under subsection (a), the Secretary shall determine, at a minimum—

(1) which types of unmanned aircraft systems, if any, as a result of their size, weight, speed, operational capability, proximity to airports and populated areas, and operation within visual line of sight do not create a hazard to users of the national airspace system or the public or pose a threat to national security; and

(2) whether a certificate of waiver, certificate of authorization, or airworthiness certification under section 44704 of title 49, United States Code, is required for the operation of unmanned aircraft systems identified under paragraph (1).

(c) REQUIREMENTS FOR SAFE OPERATION.—If the Secretary determines under this section that certain unmanned aircraft systems may operate safely in the national airspace system, the Secretary shall establish requirements for the safe operation of such aircraft systems in the national airspace system.

49 USC 40101 note.

SEC. 334. PUBLIC UNMANNED AIRCRAFT SYSTEMS.

Deadline.

(a) GUIDANCE.—Not later than 270 days after the date of enactment of this Act, the Secretary of Transportation shall issue guidance regarding the operation of public unmanned aircraft systems to—

(1) expedite the issuance of a certificate of authorization process;

(2) provide for a collaborative process with public agencies to allow for an incremental expansion of access to the national airspace system as technology matures and the necessary safety analysis and data become available, and until standards are completed and technology issues are resolved;

(3) facilitate the capability of public agencies to develop and use test ranges, subject to operating restrictions required by the Federal Aviation Administration, to test and operate unmanned aircraft systems; and

(4) provide guidance on a public entity's responsibility when operating an unmanned aircraft without a civil airworthiness certificate issued by the Administration.

Deadline.

(b) STANDARDS FOR OPERATION AND CERTIFICATION.—Not later than December 31, 2015, the Administrator shall develop and implement operational and certification requirements for the operation of public unmanned aircraft systems in the national airspace system.

(c) AGREEMENTS WITH GOVERNMENT AGENCIES.—

Deadline.

(1) IN GENERAL.—Not later than 90 days after the date of enactment of this Act, the Secretary shall enter into agreements with appropriate government agencies to simplify the process for issuing certificates of waiver or authorization with respect to applications seeking authorization to operate public unmanned aircraft systems in the national airspace system.

(2) CONTENTS.—The agreements shall—

(A) with respect to an application described in paragraph (1)—

(i) provide for an expedited review of the application;

(ii) require a decision by the Administrator on approval or disapproval within 60 business days of the date of submission of the application; and Deadline.

(iii) allow for an expedited appeal if the application is disapproved;

(B) allow for a one-time approval of similar operations carried out during a fixed period of time; and

(C) allow a government public safety agency to operate unmanned aircraft weighing 4.4 pounds or less, if operated—

(i) within the line of sight of the operator;

(ii) less than 400 feet above the ground;

(iii) during daylight conditions;

(iv) within Class G airspace; and

(v) outside of 5 statute miles from any airport, heliport, seaplane base, spaceport, or other location with aviation activities.

SEC. 335. SAFETY STUDIES. 49 USC 40101 note.

The Administrator of the Federal Aviation Administration shall carry out all safety studies necessary to support the integration of unmanned aircraft systems into the national airspace system.

SEC. 336. SPECIAL RULE FOR MODEL AIRCRAFT. 49 USC 40101 note.

(a) IN GENERAL.—Notwithstanding any other provision of law relating to the incorporation of unmanned aircraft systems into Federal Aviation Administration plans and policies, including this subtitle, the Administrator of the Federal Aviation Administration may not promulgate any rule or regulation regarding a model aircraft, or an aircraft being developed as a model aircraft, if—

(1) the aircraft is flown strictly for hobby or recreational use;

(2) the aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;

(3) the aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;

(4) the aircraft is 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, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation (model aircraft operators flying from a permanent location within 5 miles of an airport should establish a mutually-agreed upon operating procedure with the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport)).

(b) STATUTORY CONSTRUCTION.—Nothing in this section shall be construed to limit the authority of the Administrator to pursue enforcement action against persons operating model aircraft who endanger the safety of the national airspace system.

(c) MODEL AIRCRAFT DEFINED.—In this section, the term "model aircraft" means 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.

Subtitle C—Safety and Protections

SEC. 341. AVIATION SAFETY WHISTLEBLOWER INVESTIGATION OFFICE.

Section 106 (as amended by this Act) is further amended by adding at the end the following:

"(t) AVIATION SAFETY WHISTLEBLOWER INVESTIGATION OFFICE.—

"(1) ESTABLISHMENT.—There is established in the Federal Aviation Administration (in this subsection referred to as the 'Agency') an Aviation Safety Whistleblower Investigation Office (in this subsection referred to as the 'Office').

"(2) DIRECTOR.—

"(A) APPOINTMENT.—The head of the Office shall be the Director, who shall be appointed by the Secretary of Transportation.

"(B) QUALIFICATIONS.—The Director shall have a demonstrated ability in investigations and knowledge of or experience in aviation.

"(C) TERM.—The Director shall be appointed for a term of 5 years.

"(D) VACANCIES.—Any individual appointed to fill a vacancy in the position of the Director occurring before the expiration of the term for which the individual's predecessor was appointed shall be appointed for the remainder of that term.

"(3) COMPLAINTS AND INVESTIGATIONS.—

"(A) AUTHORITY OF DIRECTOR.—The Director shall—

"(i) receive complaints and information submitted by employees of persons holding certificates issued under title 14, Code of Federal Regulations (if the certificate holder does not have a similar in-house whistleblower or safety and regulatory noncompliance reporting process) and employees of the Agency concerning the possible existence of an activity relating to a violation of an order, a regulation, or any other provision of Federal law relating to aviation safety;

"(ii) assess complaints and information submitted under clause (i) and determine whether a substantial likelihood exists that a violation of an order, a regulation, or any other provision of Federal law relating to aviation safety has occurred; and

Recommendations.

"(iii) based on findings of the assessment conducted under clause (ii), make recommendations to the Administrator of the Agency, in writing, regarding further investigation or corrective actions.

"(B) DISCLOSURE OF IDENTITIES.—The Director shall not disclose the identity of an individual who submits a complaint or information under subparagraph (A)(i) unless—

"(i) the individual consents to the disclosure in writing; or

AVIATION SAFETY
UNMANNED AIRCRAFT PROGRAM OFFICE
AIR-160

Interim Operational Approval Guidance 08-01

Unmanned Aircraft Systems Operations in the U. S. National Airspace System

March 13, 2008

Purpose

Aviation Safety Unmanned Aircraft Program Office (UAPO) Interim Operational Approval Guidance, *Unmanned Aircraft Systems Operations in the U. S. National Airspace System,* provides guidance to be used to determine if unmanned aircraft systems (UAS) may be allowed to conduct flight operations in the U. S. national airspace system (NAS). UAPO and Air Traffic Organization (ATO) personnel will use this policy guidance when evaluating each application for a Certificate of Waiver or Authorization (COA) and special airworthiness certificates (normally issued in an experimental category). UAPO Interim Operational Approval Guidance provides additional information on a number of items in the COA processor application developed by the Air Traffic Organization. Used in conjunction with the COA online application system, this guidance will simplify the COA evaluation process.

1.0 Introduction

The proliferation of UAS into the NAS has resulted in an increased demand for the FAA to process a large number of applications to review for operational approvals. These approvals are required due to the fact that unmanned aircraft (UA) are not compliant with various sections of Title 14 of the Code of Federal Regulations (14 CFR) and therefore, require an alternate means of compliance. Most notably, the lack of an on-board pilot requires an alternate method of the "see-and-avoid" provisions of 14 CFR 91.113, *Right-of-Way Rules: Except Water Operations*.

This document is intended to provide guidance and information to Aviation Safety (AVS) and ATO personnel who are charged with the processing, reviewing, and approving of UAS operations. The interim guidance presented in this document represents the culmination of best practices and procedures used in prior UAS approvals, as well as input from other government agencies, industry and user stakeholders. It should be noted that the material presented in this document is a recommended approach to approving typical UAS operations, however, each application needs to be assessed on its own technical merits and may require unique authorizations which are based on the specific needs or capabilities of the UAS in question.

It should be further noted that due to the rapid evolution of UAS technology, this guidance material will be subject to continuous review and may be updated when appropriate.

Note: In general, and as a minimum, applicants must observe all applicable regulations of 14 CFR parts 61 and 91. This document is intended to identify alternate methods of compliance with the regulations when evaluating proposed UAS operations.

For a complete listing of regulations, refer to the following website:
http://www.faa.gov/regulations_policies/faa_regulations/

2.0 Background

UAS operations have increased dramatically during the past several years in both the public and private sectors. In response to this increasing activity, it has become necessary to develop guidance for Federal Aviation Administration to use when evaluating applications for certificate(s) of waiver or authorization and special airworthiness certificates. This guidance is

not meant as a substitute for any regulatory process. This guidance was jointly developed by, and reflects the consensus opinion of:

- The Unmanned Aircraft Program Office (UAPO), FAA Aircraft Certification Service (AIR-160)
- The Production and Airworthiness Division, FAA Aircraft Certification Service (AIR-200)
- The Flight Technologies and Procedures Division, FAA Flight Standards Service (AFS-400)
- The FAA Air Traffic Organization's Office of System Operations and Safety, (AJR-3).

3.0 Definitions

The following definitions apply to terms used in this document.

- **Airworthiness:** For the UAS to be considered airworthy, both the aircraft and all of the other associated support equipment of the UAS must be in a condition for safe operation. If any element of the systems is not in condition for safe operation, then the UA would not be considered airworthy.
- **Chase aircraft:** A manned aircraft flying in close proximity to an unmanned aircraft that carries, in addition to the pilot in command (PIC) of the aircraft, a qualified visual observer.
- **Cooperative aircraft:** Aircraft that have an electronic means of identification (i.e., a transponder) aboard and operating.
- **Inspection:** The routine performance of inspection tasks at prescribed intervals. The inspection must ensure the airworthiness of an aircraft up to and including its overhaul or life limits.
- **Non-Cooperative aircraft:** Aircraft that do not have an electronic means of identification (i.e., a transponder) aboard or not operating such equipment due to malfunction or deliberate action.
- **Off-Airport:** Any location used to launch or recover an unmanned aircraft that is not considered an airport (i.e., an open field).
- **Pilot in Command (PIC):** The person who has final authority and responsibility for the operation and safety of flight, has been designated as pilot in command before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the pilot in command as described by 14 CFR 91.3, *Responsibility and Authority of the Pilot in Command*, apply to the unmanned aircraft PIC. The pilot in command position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight.
- **Public aircraft:** An aircraft operated by a public user which is intrinsically governmental in nature (i.e. federal, state, and local agencies). Examples of public entities are Department of Defense (DoD) and its military branches; other local, state, and federal government agencies; and state universities. Refer to 14 CFR 1.1, *General Definitions*, for a complete definition of a public aircraft.

- **Scheduled Maintenance (Routine):** The performance of maintenance tasks at prescribed intervals.
- **Supplemental Pilot:** Supplemental pilots are those pilots assigned unmanned aircraft flight duties to augment the pilot in command. It is common for applicants to have both an "internal" and an "external" unmanned aircraft pilot. The supplemental pilot can assume either of these positions. The supplemental pilot may also assume duties of the pilot in command if they meet the qualifications.
- **Unmanned Aircraft:** A device used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot. Unmanned aircraft are understood to include only those aircraft controllable in three axes and therefore, exclude traditional balloons
- **Unscheduled Maintenance (Non-Routine):** The performance of maintenance tasks when mechanical irregularities occur. These irregularities are categorized as to whether or not they occur during flight time.
- **Visual Line-of-Sight:** A method of control and collision avoidance that refers to the pilot or observer directly viewing the unmanned aircraft with human eyesight. Corrective lenses (spectacles or contact lenses) may be used by the pilot or visual observer. Aids to vision, such as binoculars, field glasses, or telephoto television may be employed as long as their field of view does not adversely affect the surveillance task.
- **Visual Observer:** A trained person who assists the unmanned aircraft pilot in the duties associated with collision avoidance. This includes, but is not limited to, avoidance of other traffic, clouds, obstructions and terrain.

4.0 Methods of Authorization and Applicability

Guidance in this document of an operational nature always applies to both civil and public operators. In the areas of pilot certification, crew certification, pilot currency, medical certificates, and airworthiness, it is assumed that all public aircraft comply with processes and policies established by the public entity, in a manner similar to publicly operated manned aircraft. If no established policies exist regarding pilot certification, crew certification, pilot currency, medical certificates, and airworthiness, it is highly recommended that the public agency/department apply the guidance outlined in this document.

The procedures contained in this document are applicable for operations in the contiguous United States, Alaska, Hawaii, and the Flight Information Regions delegated to the United States and areas where the FAA is the Air Traffic Service Provider.

In general, specific authorization to conduct unmanned aircraft operations in the NAS outside of active Restricted, Prohibited, or Warning Area airspace must be requested by the applicant. Airspace inside buildings or structures is not considered to be part of the NAS and is not regulated. The two methods of approval are either a certificate of waiver or authorization (COA) or the issuance of a special airworthiness certificate.

The guidance information presented in this document applies to approvals for both COA and special airworthiness certificates. Unless otherwise stated, recommended procedures and guidance that appear in this document apply to both.

The applicability and process to be used in a UAS operational approval is dependent on whether the applicant is a civil user or a public user. A public user is one that is intrinsically governmental in nature (i.e., federal, state, and local agencies). Public applicants should utilize the COA application process. Civil applicants must apply for an airworthiness certificate.

Regardless of authorization method, all UAS applications are ultimately processed through ATO, UAPO, Flight Standards, and Aircraft Certification staff at the headquarters level for final approval and disposition.

Notes:

- ***This document and the processes prescribed do not apply to hobbyists and amateur model aircraft users when operating systems for sport and recreation. Those individuals should seek guidance under Advisory Circular (AC) 91-57, Model Aircraft Operating Standards, which is currently under revision.***
- ***Civil UAS operations require a special airworthiness certificate and should follow the process as specified in this document.***
- ***AC 91-57 shall not be used as a basis of approval for UAS operations and is applicable to recreational and hobbyists use only.***

4.1 Certificate of Waiver or Authorization (COA)

Applications for a COA are only accepted from public entities. An application may be referred to the FAA Office of the Chief Counsel (AGC), for determination of the status of an applicant, i.e., public or civil. COAs are typically issued for a period of up to one year, but may be issued for a lesser duration if requested or deemed appropriate. COAs are not required for operations conducted wholly within an active Restricted, Prohibited or Warning Area airspace when operating with permission from the appropriate authority or using agency of that airspace.

4.1.1 General Process Air Traffic Operations (ATO) is responsible for the COA process. Applications can be made on the internet or can be made on FAA Form 7711-2, *Application for Certificate of Waiver or Authorization.* If the application is made on FAA Form 7711-2 it will be sent to Headquarters ATO, through the local Air Traffic Service Area. ATO has developed a guidance checklist covering the application and approval process. This form and guidance material can be found on the internet at www.faa.gov/uas via the Air Traffic Airspace (ATA), Unmanned Aircraft Systems (UAS) Group link.

Prior to issuance of a COA, ATO normally requests a review of the COA application by the UAPO. Specifically, the AFS-400 members of the UAPO evaluates each application to determine if risks associated with the operation have been acceptably mitigated. Formal recommendations are forwarded to ATO from the UAPO at the conclusion of the review process.

4.1.2 National Security Considerations When the Department of Defense or the Department of Homeland Security declares a UAS operation is a matter of "national security," the FAA may approve an application for a COA which, under normal circumstances, might not otherwise conform to the guidelines set forth in this guidance document. In this case, national security itself may override risk mitigation requirements and the applicant must declare in the COA application acceptance of all risks associated with the UAS operations. In general, such requests should be directed to the Administrator, Federal Aviation Administration, from an equivalent level individual of the applicant's organization.

4.2 Special Airworthiness Certificate

Civil applicants are required to apply for a special airworthiness certificate, typically, an experimental certificate. The applicant is required to submit the requisite data to support a determination that the aircraft and its systems, including the control station(s) is designed, built, and maintained in a safe and airworthy condition. Experimental certificates are typically issued for a period of up to one year. Experimental certificates are typically issued to industry and manufacturers wishing to accomplish UAS research and development, testing, crew training, and market survey in accordance with 14 CFR Part 21.191. In cases where an applicant has been issued a special airworthiness certificate, and concurrently operates a corresponding UAS on a COA in support of a public activity, the applicant must elect, prior to each flight, what authority is to be used to conduct the flight. The use of both a special airworthiness certificate and a COA authorization on a single flight is not permitted.

4.2.1 General Process For civil UAS operations, the Aircraft Certification Service, Production and Airworthiness Division, AIR-200, at FAA headquarters is responsible for the issuance of special airworthiness certificates. The issuance of an experimental certificate is coordinated with the UAPO as well as AVS and ATO personnel at the headquarters and regional levels. A thorough review is conducted by this team to evaluate the system's airworthiness and operational specifics and to determine mitigations required to meet acceptable standards of safety.

5.0 Alternate Methods of Compliance

All limitations and procedures presented in this guidance document are to be considered as general guidelines only. Each application is evaluated on its own technical merit based on its own set of operational parameters and proposed operational profiles, mitigations, and systems. As such, deviations and alternate methods of compliance may be approved and may differ from the information presented in this document. Therefore, if the applicant makes a safety case and presents sufficient data for an alternate means of compliance, then this data should be taken into consideration and evaluated for possible approval.

6.0 UAS Airworthiness

All UAS must be shown to be airworthy to conduct flight operations in the NAS. UAS should be maintained and conform to the same airworthiness standards as defined for the 14 CFR parts

under which UAS are intended to be operated. The FAA recognizes that some of the requirements can differ from those for manned aircraft and appropriate changes can be defined. In the future, UAS Maintenance Technician certification will parallel existing standards for manned aviation. As with airworthiness standards, Maintenance Technicians Requirements will be reviewed as part of the data collection process.

6.1 Public Applicants

The applicant must provide an airworthiness statement specifying compliance with the proponent's applicable airworthiness policy or criteria. Examples of acceptable policy/criteria include, but are not limited to:

- DoD: MIL-HDBK 516B, *Airworthiness Certification*
- Air Force: AFPD 62-6, *USAF Aircraft Airworthiness Certification*
- Army: AR 70-62, *Airworthiness Qualification Of US Army Aircraft Systems (Level 1)*
- Navy and Marine Corps: NAVAIRINST 13034.1C, *Flight Clearance Policy for Air Vehicles and Aircraft Systems.*

Note: As an example, an airworthiness statement could include words to this effect: This COA application for (name of UAS) has been reviewed on behalf of the (name of applicant or agency) in accordance with (MIL-HDBK-516 or specified alternative method) and has been determined to be airworthy to operate as specified in this application subject to the following restrictions (specify the conditions). The statement should be on letterhead paper and both dated and signed by the responsible reviewing authority.

6.2 Civil Applicants

Approvals for civil applications using the special airworthiness process receive their airworthiness certification as part of the review process with the FAA.

7.0 Continued Airworthiness

Applicants for UAS operational approvals must address continued airworthiness procedures as part of their application. It is highly recommended that all applicants provide the following information: a Continuing Airworthiness Program, a Maintenance Training Program, any unique skill sets or maintenance practices relating to their aircraft and/or aircraft operations that may be outside the current scope and practices of manned aviation and a process to report any applicable data relating to the operation and maintenance of the UAS. All information that is received from UAS operators will aid the FAA in tracking the various existing UAS types and operations. This data will help expedite the regulatory process for UAS and allow the FAA to have a historical data base from which to base current and future UAS regulatory guidance. Accurate recordkeeping is essential in assuring positive operational and quality airworthiness control.

8.0 Flight Operations

8.1 General

The guidance presented in this document applies only to those UAS operations affecting areas of the NAS other than active Restricted, Prohibited, or Warning Areas. The FAA is particularly concerned that UAS operate safely among all users of the NAS, including non-cooperative aircraft and other airborne operations not reliably identifiable by radar (i.e., balloons, gliders, parachutists, etc).

Unless specifically authorized, UAS operations in other than active Restricted, Prohibited, or Warning Areas, or Class A airspace shall require visual observers, either airborne or ground-based.

While considerable work is ongoing to develop a certifiable "detect, sense, and avoid" system, no current solution exists. Compliance with the "see and avoid" aspect of 14 CFR 91.113, *Right-of-Way Rules: Except Water Operations*, becomes one of the primary issues in UAS operational approvals. As a result, alternate methods of compliance are required to accomplish the "see and avoid" function. See and avoid risk mitigation strategies are normally based on the use of visual observers or other methods of segregation. Risk mitigations may also include other methods or systems that an applicant may propose for consideration. An applicant may propose any reasonable type of mitigation or system, however, the FAA approves UAS flight activities that can demonstrate that the proposed operations can be conducted at an acceptable level of safety.

Applicants proposing "see and avoid" strategies in lieu of visual observers, need to support proposed mitigations with system safety studies which indicate the operations can be conducted safely. Acceptable system safety studies must include a hazard analysis, risk assessment, and other appropriate documentation that support an "extremely improbable" determination.

It is the applicant's responsibility to demonstrate that injury to persons or property along the flight path is extremely improbable. UA with performance characteristics that impede normal air traffic operations may be restricted in their operations.

8.1.1 System Considerations

- **Onboard Cameras/Sensors:** Although onboard cameras and sensors that are positioned to observe targets on the ground have demonstrated some capability, their use in detecting airborne operations for the purpose of deconfliction is still quite limited. Therefore, these types of systems may not be considered as a sole mitigation in the see and avoid risk assessment. In general, current designs are not mature and have shown to be insufficient to provide the sole mitigation in the see and avoid risk assessment. Although these systems are currently immature, applicants may be allowed to propose any system solution that provides a mitigation strategy and should be evaluated as a potential solution.
- **Radar and Other Sensors:** If special types of radar or other sensors are utilized to mitigate risk, the applicant must provide supporting data which demonstrates that:

- both cooperative and non-cooperative aircraft, including targets with low radar reflectivity, such as gliders and balloons, can be consistently identified at all operational altitudes and ranges, and,
- the proposed system can effectively deconflict a potential collision.

- **Lost Link Procedures:** In all cases, the UAS must be provided with a means of automatic recovery in the event of a lost link. There are many acceptable approaches to satisfy the requirement. The intent is to ensure airborne operations are predictable in the event of lost link.
- **Flight Termination System (FTS)**: It is highly desirable that all UAS have system redundancies and independent functionality to ensure the overall safety and predictability of the system. If a UAS is found to be lacking in system redundancies, an independent flight termination system that can be activated manually by the UAS PIC, may be required to safeguard the public.

8.2 Operational Requirements

Unless operating in an active Restricted, Prohibited, or Warning Area, UAS operations must adhere to the following requirements.

8.2.1 Observer Requirement VFR UAS operations may be authorized utilizing either ground-based or airborne visual observers onboard a dedicated chase aircraft. A visual observer is required to perform the see and avoid function as alternative compliance to 14 CFR 91.113, *Right-of-Way Rules: Except Water Operations.*

The task of the observer is to provide the pilot of the UAS with instructions to steer the UA clear of any potential collision with other traffic. Visual observer duties require the ability to maintain visual contact with the UA at all times while scanning the immediate environment for potential conflicting traffic. At no time will the visual observer permit the UA to operate outside their line-of-sight. This ensures that any required maneuvering information can be reliably provided to the PIC.

The visual limitation will specify both a lateral and vertical distance and shall be regarded as a maximum distance from the observer where a determination of a conflict with another aircraft can be made. When an application is approved by the FAA, the visual limitation distance becomes a directive upon the observer.

Generally, observers are to be positioned no greater than one nautical mile laterally and 3000 feet vertically from the UA. The use of nautical miles is based on the fact that the UA is being positioned by the pilot via control stations that typically use moving map displays that are referenced in nautical miles.

This distance is predicated on the observer's normal unaided vision. Corrective lenses, spectacles, and contact lenses may be used.

When using other aids to vision, such as binoculars, field glasses, or telephoto television, visual observers must use caution to ensure that the UA remains within the approved visual limitation distance of the observer. Due to field of view and distortion issues, the

use of such aids can be used to augment the observer's visual capability but cannot be used as the primary means of visual contact.

Although this guidance specifies an observer distance, the small size of some UA may not allow for adequate observation at the one mile limit. It should be understood that this limit is the maximum range allowed and that a practical distance may be something less, with the determination of such at the discretion of the applicant. Therefore, until an on site validation of observer distance is conducted by the FAA, it will remain the responsibility of the applicant to ensure the safety of flight and adequate visual range coverage to mitigate any potential collisions. Conversely, larger UA may accommodate an observer distance greater than the one mile limit. The applicant may establish a distance greater than one mile based on a variety of factors. Increased observer distances may be proposed by the applicant and will be subject to review by the FAA either by on site demonstration or other means.

If UAS applications are approved for nighttime operations with flight operations that will depart or arrive between sunset and sunrise, the ground observer(s) must be in place one hour prior to that operation to ensure acclimation to the twilight/nighttime environment.

8.2.2 ATC Communications Requirements The UAS pilot must have immediate radio communication with appropriate ATC facilities anytime:

- the UA is being operated in Class A, D or sometimes E airspace (See 9.2.14 for operations in Class B or C Airspace)
- the UA is being operated under instrument flight rules (IFR)
- it is stipulated under the provisions of any issued COA or a special airworthiness certificate.

It is preferred that communications between the UAS pilot and ATC be established through onboard radio equipment to provide a voice relay; this is required for IFR flight.

8.2.3 Inter-Communications Requirements Any visual observer, sensor operator, or other person charged with providing collision avoidance for the UA must have immediate communication with the UAS pilot. If a chase aircraft is being utilized, immediate communication between the chase aircraft and the UAS pilot shall be required at all times. If the UAS pilot is talking to air traffic control, monitoring of the air traffic control frequency by all UAS crew members (UAS pilots, observers, and chase pilots) is recommended for shared situational awareness. However, unless it is necessary, the UAS PIC or the supplemental pilots are the only crewmembers that will talk to Air Traffic Control.

8.2.4 Dropping Objects/Hazardous Materials If the UA's intended operation includes the dropping or spraying of aircraft stores outside of active Restricted, Prohibited, or Warning Areas, the application must specifically address the hazard and make a clear case that injury to persons on the ground is extremely remote and operational risks have been sufficiently mitigated. A similar case must be made for hazardous materials carried aboard the UA.

8.2.5 Flight Over Populated Areas Routine UAS operations shall not be conducted over urban or populated areas. UAS operations may be approved in emergency or relief situations if the proposed mitigation strategies are found to be acceptable.

8.2.6 Flight Over Heavily Trafficked Roads or Open-air Assembly of People UAS operations shall avoid these areas. If flight in these areas is required, the applicant will be required to support proposed mitigations with system safety studies that indicate the operations can be conducted safely. Acceptable system safety studies must include a hazard analysis, risk assessment, and other appropriate documentation that support an "extremely improbable" determination. Additionally, it is the applicant's responsibility to demonstrate that injury to persons or property along the flight path is extremely improbable. UAS with performance characteristics that impede normal air traffic operations may be restricted in their operations.

8.2.7 Day/Nighttime Operations All UAS operations outside of Class A airspace must be conducted during daylight hours. Nighttime operations may be considered in other airspace if the applicant provides a safety case and sufficient mitigation to avoid collision hazards at night. Examples of such may be transit operations in Class D airspace over a non-joint use military airfield adjacent to restricted airspace.

8.2.8 Flights Below Class A Airspace All UAS operations (IFR or VFR) outside of active Restricted, Prohibited or Warning Areas and below flight level (FL) 180 shall be conducted in visual meteorological conditions (VMC) and in accordance with 14 CFR 91.155, *Basic VFR Weather Minimums*, however, a minimum flight visibility of not less than three statue miles (SM) shall be maintained at all times. Cloud clearance requirements shall remain as specified in 14 CFR 91.155, *Basic VFR Weather Minimums*. Special VFR requirements per 14 CFR 91.157, *Special VFR Weather Minimums*, do not apply to UAS operations and cannot be exercised.

8.2.9 Autonomous Operations It is generally understood that most UAS have some level of autonomy associated with its operation. Although it is possible to have a completely manual UAS, which requires a pilot-in-the-loop, the majority of UAS are autonomous to a certain degree. Only those UAS that have the capability of pilot intervention, or pilot-on-the-loop, shall be allowed in the NAS outside of Restricted, Prohibited, or Warning areas. UAS that are designed to be completely autonomous, with no capability of pilot intervention, are not authorized in the national airspace system. Although the pilot may be technically considered out-of-the-loop in a lost link scenario, this restriction does not apply to UAS operating under lost link.

8.2.10 Operations from Off-Airport Locations In most cases, an off-airport location should be situated no closer than five nautical miles (NM) from any airport or heliport. The operational areas, including the launch and recovery zones, should be free from obstructions and reasonable efforts should be made to keep operations away from structures and heavily trafficked roads. Due to the unique attributes of off-airport locations, approval requests need to be evaluated on a case-by-case basis.

8.2.11 Other Mitigations in lieu of Observers See Alternate Methods of Compliance section.

8.2.12 Operating Under Instrument Flight Rules (IFR) While operating on an instrument flight plan, the following must exist, be completed, or be complied with:

- The pilot in command must hold a current instrument rating in a manned aircraft.
- The aircraft's airworthiness statement includes IFR flight and all equipment is certified and working (including pitot static and transponder checks).
- Aviation database and charts are current and available to the UAS pilot.
- An IFR flight plan is filed.
- An ATC clearance has been obtained and all clearances followed.
- Direct two-way radio communication between the UAS pilot and ATC is available. Communication relay through the UA is required.
- Pre-coordination with ATC has been accomplished.
- The UA is equipped with a certified operating mode C (mode S preferred) transponder.
- Visual observers are utilized in accordance with this guidance document.
- ATC radar monitoring is available throughout the portion of the flight in Class A airspace.
- All operations outside of Class A airspace and active Restricted, Prohibited, or Warning Areas shall be conducted in VMC conditions only.

8.2.13 Chase Aircraft Operations The chase aircraft must remain at a safe distance from the UA to ensure collision avoidance should a UAS malfunction occur, but remain close enough to provide visual detection of conflicting aircraft in the path of the UA in a timely manner to advise the UAS PIC of the situation. Should the UAS pilot operate the UA from the chase aircraft, the chase aircraft must remain within radio control range of the UA to maintain appropriate signal coverage for flight control or activation of the flight termination system. Chase aircraft may be required to have communication with appropriate ATC facilities based on the applicant's application or mission profile.

- Chase aircraft are not required in Class A, active Restricted, Prohibited, or Warning Area airspace.
- Chase operations shall be conducted during daylight hours only.
- Flight visibility for all UAS chase operations shall be three statute miles or greater.
- Chase aircraft pilots must not concurrently perform either observer or UA pilot duties along with chase pilot duties.
- Chase aircraft operating as a formation flight will immediately notify ATC if they are using a non-standard formation.

Note: A standard formation is one in which a proximity of no more than 1 mile laterally or longitudinally and within 100 feet vertically from the flight leader is maintained by each wingman.

Note: Nonstandard formations are those operating under any of the following conditions:

- ***When the flight leader has requested and ATC has approved other than standard formation dimensions.***
- ***When operating within an authorized altitude reservation (ALTRV) or under the provisions of a letter of agreement.***
- ***When the operations are conducted in airspace specifically designed for a special activity.***

8.2.14 Airspace Considerations by Airspace Designation:

Note: UA operating in airspace designated as reduced vertical separation minimum (RVSM) airspace must comply with 14 CFR 91.180, Operations within Airspace Designated as Reduced Vertical Separation Minimum Airspace.

- **Class A:** Observers are not required in Class A. All UAS must be operating on an instrument flight plan. UAS operations approved for Class A must comply with 14 CFR 91.135, *Operations in Class A Airspace.*
- **Class B:** UAS operations are currently not authorized. Class B airspace contains terminal areas highest density of manned aircraft in the National Airspace System. As with all applications, the FAA will consider exceptional circumstances.
- **Class C and airspace within 30 nautical miles of an airport listed in 14 CFR 91.215:** Requests for approval will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. UAS operations approved for Class C must comply with 14 CFR 91.130, *Operations in Class C Airspace*, and 14 CFR 91.215, *ATC Transponder and Altitude Reporting Equipment and Use*. The transponder requirement will not be waived.
- **Class D:** Requests for approval will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. UAS operations approved for Class D must comply with 14 CFR 91.129, *Operations in Class D Airspace.*
- **Class E:** If there is an operating Air Traffic Control Tower Class D rules may apply. UAS operations approved for Class E must comply with 14 CFR 91.127, *Operating on or in the Vicinity of an Airport in Class E Airspace.*
- **Class G:** UA operations approved for Class G must comply with 14 CFR 91.126, *Operating on or in the Vicinity of an Airport in Class G Airspace.*

8.3 Oceanic Operations

8.3.1 UAS operations wholly contained within Warning areas are handled in the same manner as those operations conducted in active Restricted and Prohibited areas, that is, no specific approval is required and observers or chase aircraft are not required.

8.3.2 Flight Information Region Operations. FAA rules and policies apply in the flight information regions (FIRs) where the FAA is the air traffic service provider. As such, the guidelines specified in this document apply to UAS operations conducted in these FIRs.

9.0 Personnel Qualifications

This section addresses the qualifications of UAS pilots, observers, maintainers, and other personnel as appropriate. All references to a pilot certificate refer to an FAA issued private pilot certificate or higher.

9.1 UAS Pilot Qualifications

The FAA is focused on insuring that UAS pilots have a common level of understanding of federal aviation regulations applicable to the airspace where the UA will operate. Pilots are responsible for a thorough preflight inspection of the UAS. They are accountable for controlling their aircraft to the same responsible standards as the pilot of a manned aircraft. Pilot qualifications for UAS operations conducted under IFR are addressed in this section.

The following items apply to the pilots of all UAS:

- One pilot in command (PIC) must be designated at all times.
- The PIC of an aircraft is directly responsible, and is the final authority of, the operation of that aircraft.
- Pilots must not perform crew duties for more than one UAS at a time.
- Pilots are not allowed to perform concurrent duties both as pilot and observer.

9.1.1 Pilot in Command (PIC) The designated PIC is the pilot responsible for the UAS flight operation. The PIC may be augmented by supplemental pilots; however, the PIC retains complete and overall responsibility of the flight, regardless of who may be piloting the UA. It is common for applicants to have both an "internal" and an "external" UAS pilot. The PIC can assume any of these positions. The PIC duty may be rotated as necessary to fulfill operational requirements.

9.1.1.1 Ratings Rating requirements for the UAS PIC depend on the type of operation conducted and fall into two categories:

- Operations that require a pilot certificate
- Operations that do not require a pilot certificate.

The requirement for the PIC to hold a pilot certificate is based on various factors including the location of the planned operations, mission profile, size of the UA, and whether or not the operation is conducted within or beyond visual line of sight. Operations without a pilot certificate may be allowed, permitting smaller UA to operate below certain altitudes while controlled strictly by visual line of sight. The cutoff point at which the smaller UA criteria will be utilized is yet to be defined; therefore, each application will be carefully reviewed to assess the feasibility of allowing that type of operation.

Operations requiring a pilot certificate: The PIC shall hold, at a minimum, an FAA pilot certificate under the following circumstances:

- All operations approved for conduct in Class A, C, D, and E airspace.
- All operations conducted under IFR (FAA instrument rating required).
- All operations approved for nighttime operations.
- All operations conducted at joint use or public airfields.
- All operations conducted beyond line of sight.
- At any time the FAA has determined the need based on the UAS' characteristics, mission profile, or other operational parameters.

***Note:** The FAA may require specific aircraft category and class ratings in manned aircraft depending on the UAS seeking approval and the characteristics of its flight controls interface.*

Operations not requiring a pilot certificate: The PIC *may not* be required to hold a pilot certificate for operations approved and conducted solely within visual line of sight in Class G airspace. For the PIC to be exempt from the pilot certificate requirement the following conditions must exist and the alternate compliance method described below must be followed:

Pilot certificate

- The operation is conducted in a sparsely populated location, and,
- The operation is conducted from a privately owned airfield, military installation, or off-airport location.
- Visual line of sight operations conducted no further than 1 NM laterally from the UAS pilot and at an altitude of no more than 400 feet above ground level (AGL) at all times.
- Operations shall be conducted during daylight hours only.
- Operations shall be conducted no closer than 5 NM from any airport or heliport.
- **Alternate Compliance Method**: In lieu of a pilot certificate, the PIC must have successfully completed, at a minimum, FAA private pilot ground instruction, and have passed the written examination.

***Note:** The FAA may require an instrument rating in a specific aircraft category in manned aircraft depending on the UAS seeking approval and the characteristics of its flight controls interface.*

9.1.1.2 **Currency** The applicant shall provide a process that ensures that the pilots receive an appropriate level of currency in the UAS being operated. At a minimum, the PIC must demonstrate three takeoffs (launch) and landings (recovery) in the specific UAS in the previous 90 days.

For those operations approved for night operations, the PIC must demonstrate three takeoffs (launch) and landings (recovery) in the specific UAS at night to a full stop in the previous 90 days.

For those operations that require a certificated pilot per section 9.1.1.1 above, the PIC, in order to exercise the privileges of his certificate, shall have flight reviews and maintain currency in manned aircraft per 14 CFR 61.56, *Flight Review* and 61.57, *Recent Flight Experience: Pilot in Command.*

For operations approved for night or IFR, the PIC shall maintain currency per 14 CFR 61.57, *Recent Flight Experience: Pilot in Command*, as applicable.

9.1.1.3 **Medical** The PIC shall maintain, at a minimum, a valid FAA Class 2 medical certificate issued under 14 CFR part 67, and have it in their possession.

9.1.1.4 **Training** In addition to the aforementioned training required for a pilot certificate, UAS pilots will have additional training in all specific details of the UAS being operated including normal, abnormal, and emergency procedures. This must include manufacturer specific training (or military equivalent), demonstrated proficiency, and testing in the UAS being operated.

9.1.2 **Supplemental Pilots** Supplemental pilots are those pilots assigned UA flight duty to augment the PIC. It is common for applicants to have both an "internal" and an "external" UA pilot. The supplemental pilot can assume any of these positions.

9.1.2.1 **Ratings** No specific rating is required for supplemental pilots unless they are assuming the role of pilot in command. However, at a minimum, they must have successfully completed private pilot ground school and have passed the written test.

9.1.2.2 **Currency** The applicant shall provide a process that ensures that the pilots maintain an appropriate level of currency in the UAS being operated.

9.1.2.3 **Medical** Supplemental pilots shall maintain, at a minimum, a valid FAA Class 2 medical certificate issued under 14 CFR part 67, and have it in their possession. Any supplemental pilot acting as a dedicated visual observer or flying the UA on a visual basis shall also maintain a valid FAA Class 2 medical certificate.

9.1.2.4 **Training** In addition to all training required for receiving and maintaining a pilot certificate, the UAS pilot shall be additionally trained in all specific details of the UAS being operated including normal, abnormal, and emergency procedures.

9.2 Observer Qualifications

All observers must have an understanding of federal aviation regulations applicable to the airspace where the UA will operate. Observers are considered a crewmember of the UAS. Observers must not perform crew duties for more than one UAS at a time. Observers are not allowed to perform concurrent duties both as pilot and observer.

9.2.1 **Medical** All observers shall maintain, at a minimum, a valid FAA Class 2 medical certificate issued under 14 CFR 67, and have it in their possession. 14 CFR 91.17, *Alcohol or Drugs*, applies to all UAS crewmembers, including observers.

9.2.2 Training Observers must have completed sufficient training to communicate to the pilot any instructions required to remain clear of conflicting traffic. This training, at a minimum, shall include knowledge of the rules and responsibilities described in 14 CFR 91.111, *Operating Near Other Aircraft;* 14 CFR 91.113, *Right-of-Way Rules: Except Water Operations;* and 14 CFR 91.155, *Basic VFR Weather Minimums;* knowledge of air traffic and radio communications, including the use of approved ATC/pilot phraseology; and knowledge of appropriate sections of the *Aeronautical Information Manual.*

9.3 Other Personnel Qualifications

Ancillary personnel such as systems operators or mission specialists must be thoroughly familiar with and possess operational experience of the equipment being utilized. If the subject systems being utilized are for observation and detection of other aircraft for collision avoidance purposes, they must be thoroughly trained on collision avoidance procedures and techniques and have direct communication with the UAS pilot, observer, and other applicable personnel on an inter-communication system.

9.4 Maintenance Personnel Qualifications

9.4.1 Ratings Will be established as more data is collected and a regulatory guideline is developed.

9.4.2 Currency It is suggested that applicants follow applicable guidelines of 14 CFR 65.83 as appropriate until final UAS regulatory guidelines are available.

9.4.3 Medical No medical requirements have been defined at this time.

9.4.4 Training It is highly recommended that a Maintainer/Operator of a UAS submit a training program. This requirement will be further defined as more data is collected and the regulatory process better defines these guidelines.

Revision History

Date	Action
6-01-2005	Initial release as AFS-400 Policy Memo 05-01, *Unmanned Aircraft Systems Operations in the U.S. National Airspace System – Interim Operational Approval Guidance.*
3-13-2008	Cancelled AFS-400 Policy Memo 05-01 and Reissued Updated Document as *Interim Operational Approval Guidance 08-01, Unmanned Aircraft Systems Operations in the U. S. National Airspace System.*

Signed

March 13, 2008

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United States Government Accountability Office

GAO

Testimony

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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

GAO-12-889T

July 19, 2012

UNMANNED AIRCRAFT SYSTEMS

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

GAO
Accountability * Integrity * Reliability
Highlights

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 dillinghamg@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 2011has 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]

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

[2]COAs 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

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

[4]Senior 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 report[6] 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

[5]GAO, *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).

[6]GAO, *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

[7]FAA 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

[8]Chase 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

[9]RTCA, 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.

[10]ASTM 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.

[11]Title 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

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

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

[14]No 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]

[15]The 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,

[16]Preserving 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).

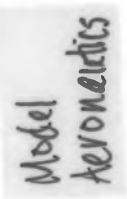
stakeholders with whom we spoke said that developing guidelines for technology use on UAS ahead of widespread adoption by law enforcement entities may preclude abuses of the technology and a negative public perception of UAS. Representatives from one civil liberties organization told us that since FAA 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

[17]The 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.

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

[19]This 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

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

[21]The 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.

[22]GPS 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.

[23]The 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.

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Academy of Model Aeronautics National Model Aircraft Safety Code

Effective January 1, 2011

A. **GENERAL**: A model aircraft is a non-human-carrying aircraft capable of sustained flight in the atmosphere. It may not exceed limitations of this code and is intended exclusively for sport, recreation and/or competition. All model flights must be conducted in accordance with this safety code and any additional rules specific to the flying site.

1. Model aircraft will not be flown:
   (a) In a careless or reckless manner.
   (b) At a location where model aircraft activities are prohibited.
2. Model aircraft pilots will:
   (a) Yield the right of way to all man carrying aircraft.
   (b) See and avoid all aircraft and a spotter must be used when appropriate. (AMA Document #540-D-See and Avoid Guidance.)
   (c) Not fly higher than approximately 400 feet above ground level within three (3) miles of an airport, without notifying the airport operator.
   (d) Not interfere with operations and traffic patterns at any airport, heliport or seaplane base except where there is a mixed use agreement.
   (e) Not exceed a takeoff weight, including fuel, of 55 pounds unless in compliance with the AMA Large Model Aircraft program. (AMA Document 520-A)
   (f) Ensure the aircraft is identified with the name and address or AMA number of the owner on the inside or affixed to the outside of the model aircraft. (This does not apply to model aircraft flown indoors).
   (g) Not operate aircraft with metal-blade propellers or with gaseous boosts except for helicopters operated under the provisions of AMA Document #555.
   (h) Not operate model aircraft while under the influence of alcohol or while using any drug which could adversely affect the pilot's ability to safely control the model.
   (i) Not operate model aircraft carrying pyrotechnic devices which explode or burn, or any device which propels a projectile or drops any object that creates a hazard to persons or property.
   Exceptions:
   - Free Flight fuses or devices that burn producing smoke and are securely attached to the model aircraft during flight.
   - Rocket motors (using solid propellant) up to a G-series size may be used provided they remain attached to the model during flight. Model rockets may be flown in accordance with the National Model Rocketry Safety Code but may not be launched from model aircraft.
   - Officially designated AMA Air Show Teams (AST) are authorized to use devices and practices as defined within the Team AMA Program Document (AMA Document #718).

   (j) Not operate a turbine-powered aircraft, unless in compliance with the AMA turbine regulations. (AMA Document #510-A).
3. Model aircraft will not be flown in AMA sanctioned events, air shows or model demonstrations unless:
   (a) The aircraft, control system and pilot skills have successfully demonstrated all maneuvers intended or anticipated prior to the specific event.
   (b) An inexperienced pilot is assisted by an experienced pilot.
4. When and where required by rule, helmets must be properly worn and fastened. They must be OSHA, DOT, ANSI, SNELL or NOCSAE approved or comply with comparable standards.

B. ***RADIO CONTROL (RC)***

1. All pilots shall avoid flying directly over unprotected people, vessels, vehicles or structures and shall avoid endangerment of life and property of others.
2. A successful radio equipment ground-range check in accordance with manufacturer's recommendations will be completed before the first flight of a new or repaired model aircraft.
3. At all flying sites a safety line(s) must be established in front of which all flying takes place (AMA Document #706-Recommended Field Layout):
   (a) Only personnel associated with flying the model aircraft are allowed at or in front of the safety line.
   (b) At air shows or demonstrations, a straight safety line must be established.
   (c) An area away from the safety line must be maintained for spectators.
   (d) Intentional flying behind the safety line is prohibited.
4. RC model aircraft must use the radio-control frequencies currently allowed by the Federal Communications Commission (FCC). Only individuals properly licensed by the FCC are authorized to operate equipment on Amateur Band frequencies.
5. RC model aircraft will not operate within three (3) miles of any pre-existing flying site without a frequency-management agreement (AMA Documents #922-Testing for RF Interference; #923- Frequency Management Agreement)
6. With the exception of events flown under official AMA Competition Regulations, excluding takeoff and landing, no powered model may be flown outdoors closer than 25 feet to any individual, except for the pilot and the pilot's helper(s) located at the flight line.
7. Under no circumstances may a pilot or other person touch a model aircraft in flight while it is still under power, except to divert it from striking an individual. This does not apply to model aircraft flown indoors.
8. RC night flying requires a lighting system providing the pilot with a clear view of the model's attitude and orientation at all times.
9. The pilot of a RC model aircraft shall:
   (a) Maintain control during the entire flight, maintaining visual contact without enhancement other than by corrective lenses prescribed for the pilot.
   (b) Fly using the assistance of a camera or First-Person View (FPV) only in accordance with the procedures outlined in AMA Document #550.

C. **FREE FLIGHT**

1. Must be at least 100 feet downwind of spectators and automobile parking when the model aircraft is launched.
2. Launch area must be clear of all individuals except mechanics, officials, and other fliers.
3. An effective device will be used to extinguish any fuse on the model aircraft after the fuse has completed its function.

D. **CONTROL LINE**

1. The complete control system (including the safety thong where applicable) must have an inspection and pull test prior to flying.
2. The pull test will be in accordance with the current Competition Regulations for the applicable model aircraft category.
3. Model aircraft not fitting a specific category shall use those pull-test requirements as indicated for Control Line Precision Aerobatics.
4. The flying area must be clear of all utility wires or poles and a model aircraft will not be flown closer than 50 feet to any above-ground electric utility lines.
5. The flying area must be clear of all nonessential participants and spectators before the engine is started.

AC 91-57

DATE June 9, 1981

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

Subject: MODEL AIRCRAFT OPERATING STANDARDS

1. PURPOSE. This advisory circular outlines, and encourages voluntary compliance with, safety standards for model aircraft operators.

2. BACKGROUND. Modelers, generally, are concerned about safety and do exercise good judgement when flying model aircraft. However, model aircraft can at times pose a hazard to full-scale aircraft in flight and to persons and property on the surface. Compliance with the following standards will help reduce the potential for that hazard and create a good neighbor environment with affected communities and airspace users.

3. OPERATING STANDARDS.

a. Select an operating site that is of sufficient distance from populated areas. The selected site should be away from noise sensitive areas such as parks, schools, hospitals, churches, etc.

b. Do not operate model aircraft in the presence of spectators until the aircraft is successfully flight tested and proven airworthy.

c. Do not fly model aircraft higher than 400 feet above the surface. When flying aircraft within 3 miles of an airport, notify the airport operator, or when an air traffic facility is located at the airport, notify the control tower, or flight service station.

d. Give right of way to, and avoid flying in the proximity of, full-scale aircraft. Use observers to help if possible.

e. Do not hesitate to ask for assistance from any airport traffic control tower or flight service station concerning compliance with these standards.

R. J. VAN VUREN
Director, Air Traffic Service

Initiated by: AAT-220

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 91

Docket No. FAA-2006-25714

Unmanned Aircraft Operations in the National Airspace System

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of policy; opportunity for feedback.

SUMMARY: This notice clarifies the FAA's current policy concerning operations of unmanned aircraft in the National Airspace System.

FOR FURTHER INFORMATION CONTACT: Kenneth D. Davis, Manager, Unmanned Aircraft Program Office, Aircraft Certification Service, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591, (202) 385-4636, email: *kenneth.d.davis@faa.gov.*

Background

Simply stated, an unmanned aircraft is a device that is used, or is intended to be used, for flight in the air with no onboard pilot. These devices may be as simple as a remotely controlled model aircraft used for recreational purposes or as complex as surveillance aircraft flying over hostile areas in warfare. They may be controlled either manually or through an autopilot using a data link to connect the pilot to their aircraft. They may perform a variety of public services: surveillance, collection of air samples to determine levels of pollution, or rescue and recovery missions in crisis situations. They range in size from wingspans of six inches to 246 feet; and can weigh from approximately four ounces to

over 25,600 pounds. The one thing they have in common is that their numbers and uses are growing dramatically. In the United States alone, approximately 50 companies, universities, and government organizations are developing and producing some 155 unmanned aircraft designs. Regulatory standards need to be developed to enable current technology for unmanned aircraft to comply with Title 14 Code of Federal Regulations (CFR).

The Federal Aviation Administration's current policy is based on whether the unmanned aircraft is used as a public aircraft, civil aircraft or as a model aircraft.

Unmanned Aircraft Systems Operating as Public Aircraft

The most common public use of unmanned aircraft today in the United States is by the Department of Defense. U.S. operations in Iraq, Afghanistan and elsewhere have fueled a huge increase in unmanned aircraft demand. In Iraq alone, more than 700 unmanned aircraft are in use for surveillance and weapons delivery.

Other agencies have also found public uses for unmanned aircraft. For example, the Customs and Border Protection uses them to patrol along the US/Mexican border. In the future, unmanned aircraft could be used to provide first responder reports of damage due to weather or other catastrophic causes.

In response to this growing demand for public use unmanned aircraft operations, the FAA developed guidance in a Memorandum titled "Unmanned Aircraft Systems Operations in the U.S. National Airspace System – Interim Operational Approval Guidance" (UAS Policy 05-01). In this document, the FAA set out guidance for public use of unmanned aircraft by defining a process for evaluating applications for Certificate(s) of Waiver or Authorization (COA's) for unmanned aircraft to operate in the National Airspace System. The concern was not only that unmanned aircraft operations might interfere with

commercial and general aviation aircraft operations, but that they could also pose a safety problem for other airborne vehicles, and persons or property on the ground. The FAA guidance supports unmanned aircraft flight activity that can be conducted at an acceptable level of safety. In order to ensure this level of safety, the operator is required to establish the Unmanned Aircraft System's (UAS) airworthiness either from FAA certification, a DOD airworthiness statement, or by other approved means. Applicants also have to demonstrate that a collision with another aircraft or other airspace user is extremely improbable as well as complying with appropriate cloud and terrain clearances as required. Key to the concept are the roles of pilot-in-command (PIC) and observer. The PIC concept is essential to the safe operation of manned aircraft. The FAA's UAS guidance applies this PIC concept to unmanned aircraft and includes minimum qualifications and currency requirements. The PIC is simply the person in control of, and responsible for, the UAS. The role of the observer is to observe the activity of the unmanned aircraft and surrounding airspace, either through line-of-sight on the ground or in the air by means of a chase aircraft. In general, this means the pilot or observer must be, in most cases, within 1 mile laterally and 3,000 feet vertically of the unmanned aircraft. Direct communication between the PIC and the observer must be maintained at all times. Unmanned aircraft flight above 18,000 feet must be conducted under Instrument Flight Rules, on an IFR flight plan, must obtain ATC clearance, be equipped with at least a Mode C transponder (preferably Mode S), operating navigation lights and / or collision avoidance lights and maintain communication between the PIC and Air Traffic Control (ATC). Unmanned aircraft flights below 18,000 feet have similar requirements, except that if operators choose to operate on other than an IFR flight plan, they may be required to pre-coordinate with ATC.

The FAA has issued more than 50 COA's over the past 2 years and anticipates issuing a record number of COA's this year.

For more information, Memorandum on UAS Policy (05-01) and other policy guidance is available at the FAA Website: *http://www.faa.gov/uas.*

Unmanned Aircraft Systems Operating as Civil Aircraft

Just as unmanned aircraft have a variety of uses in the public sector, their application in commercial or civil use is equally diverse. This is a quickly growing and important industry. Under FAA policy, operators who wish to fly an unmanned aircraft for civil use must obtain an FAA airworthiness certificate the same as any other type aircraft. The FAA is currently only issuing special airworthiness certificates in the experimental category. Experimental certificates are issued with accompanying operational limitations (14 CFR § 91.319) that are appropriate to the applicant's operation. The FAA has issued five experimental certificates for unmanned aircraft systems for the purposes of research and development, marketing surveys, or crew training. UAS issued experimental certificates may not be used for compensation or hire.

The applicable regulations for an experimental certificate are found in 14 CFR §§21.191, 21.193, and 21.195. In general, the applicant must state the intended use for the UAS and provide sufficient information to satisfy the FAA that the aircraft can be operated safely. The time or number of flights must be specified along with a description of the areas over which the aircraft would operate. The application must also include drawings or detailed photographs of the aircraft. An on-site review of the system and demonstration of the area of operation may be required. Additional information on how to apply for an

experimental airworthiness certificate is available from Richard Posey, AIR-200, (202) 267-9538; email: *richard.posey@faa.gov.*

Recreational/Sport Use of Model Airplanes

In 1981, in recognition of the safety issues raised by the operation of model aircraft, the FAA published Advisory Circular (AC) 91-57, Model Aircraft Operating Standards for the purpose of providing guidance to persons interested in flying model aircraft as a hobby or for recreational use. This guidance encourages good judgment on the part of operators so that persons on the ground or other aircraft in flight will not be endangered. The AC contains among other things, guidance for site selection. Users are advised to avoid noise sensitive areas such as parks, schools, hospitals, and churches. Hobbyists are advised not to fly in the vicinity of spectators until they are confident that the model aircraft has been flight tested and proven airworthy. Model aircraft should be flown below 400 feet above the surface to avoid other aircraft in flight. The FAA expects that hobbyists will operate these recreational model aircraft within visual line-of-sight. While the AC 91-57 was developed for model aircraft, some operators have used the AC as the basis for commercial flight operations.

Policy Statement

The current FAA policy for UAS operations is that no person may operate a UAS in the National Airspace System without specific authority. For UAS operating as public aircraft the authority is the COA, for UAS operating as civil aircraft the authority is special airworthiness certificates, and for model aircraft the authority is AC 91-57.

The FAA recognizes that people and companies other than modelers might be flying UAS with the mistaken understanding that they are legally operating under the authority of

AC 91-57. AC 91-57 only applies to modelers, and thus specifically excludes its use by persons or companies for business purposes.

The FAA has undertaken a safety review that will examine the feasibility of creating a different category of unmanned "vehicles" that may be defined by the operator's visual line of sight and are also small and slow enough to adequately mitigate hazards to other aircraft and persons on the ground. The end product of this analysis may be a new flight authorization instrument similar to AC 91-57, but focused on operations which do not qualify as sport and recreation, but also may not require a certificate of airworthiness. They will, however, require compliance with applicable FAA regulations and guidance developed for this category.

Feedback regarding current FAA policy for Unmanned Aircraft Systems can be submitted at www.faa.gov/uas. (Scroll down to the bottom of the page and find Contact UAPO. Click into this link.)

Issued in Washington, DC on February 6, 2007

/s/ Nick Sabatini

Nicholas Sabatini
Associate Administrator for Aviation Safety

NOTICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

N 8900.207

National Policy

Effective Date:
1/22/13

Cancellation Date:
1/22/14

SUBJ: Unmanned Aircraft Systems (UAS) Operational Approval

1. Purpose of this Notice. This notice provides policies necessary for reviewing and evaluating the safety and interoperability of proposed Unmanned Aircraft Systems (UAS) flight operations conducted within the United States (U.S.) National Airspace System (NAS) for the Aviation Safety (AVS) Flight Standards Service (AFS), UAS Integration Office (AFS-80), when assessing applications for a Certificate of Waiver or Authorization (COA) or special airworthiness certificate.

2. Audience. This notice applies to AFS divisions at the Federal Aviation Administration (FAA) Washington headquarters (HQ) and regional field offices.

3. Where You Can Find This Notice. You can find this notice on the MyFAA Web site at https://employees.faa.gov/tools_resources/orders_notices/. Inspectors can access this notice through the Flight Standards Information Management System (FSIMS) at http://fsims.avs.faa.gov. Air carriers and operators can find this notice on the FAA's Web site at: http://fsims.faa.gov. This notice is available to proponents and the public at http://www.faa.gov/regulations_policies/orders_notices.

4. Background.

a. UAS Operations. UAS operations have increased dramatically in both the public and private sectors. This proliferation has introduced greater exposure and elevated risk to the safety of operations within the NAS. This growth in UAS operations has increased the number of applications for operational approvals and increased demand on the FAA to process them. For these activities, the development of a notice is required for the FAA to use when evaluating applications for COAs and special airworthiness certificates.

b. Policy. Policy identifies Unmanned Aircraft (UA) as "aircraft" flown by a "pilot" regardless of where the pilot is located. Aircraft and pilots must demonstrate compliance with applicable sections of Title 14 of the Code of Federal Regulations (14 CFR) to operate in the NAS. However, UA are not compliant with certain sections of 14 CFR. For instance, the absence of an onboard pilot means that the "see-and-avoid" provisions of 14 CFR part 91, § 91.113, cannot be satisfied. Without an onboard pilot, there is a significant reliance on the command and control link, and a greater emphasis on the loss of functionality associated with lost link. Furthermore, for air traffic control (ATC) operations requiring visual means of maintaining

in-flight separation, the lack of an onboard pilot does not permit ATC to issue all of the standard clearances or instructions available under the current edition of FAA Order 7110.65, Air Traffic Control. Consequently, to ensure an equivalent level of safety, UAS flight operations require an alternative method of compliance (AMOC) or risk control to address their "see-and-avoid" impediments to safety of flight, and any problems they may generate for ATC. In the future, permanent and consistent methods of compliance will be needed for UAS operations in the NAS without the need for waivers or exemptions.

5. Consensus Opinion. This notice is subject to continuous review, will be updated when appropriate, is not meant as a substitute for any regulatory process, and was jointly developed by and reflects the consensus opinion of:

- Flight Technologies and Procedures Division (AFS-400);
- UAS Integration Office (AFS-80) and the ATO component of AFS-80; and
- Aircraft Certification Service, Production & Airworthiness Branch (AIR-240).

Note: In general, and as a minimum, proponents must observe all applicable regulations of 14 CFR parts 61 and 91. This notice identifies acceptable AMOC with the regulations when evaluating requests for approval of proposed UAS operations. Refer to the following Web site for a listing of regulations: http://www.faa.gov/regulations_policies/faa_regulations/.

6. Discussion. This notice represents the culmination of input from government agencies, industry, and user stakeholders along with best practices and procedures that have been used by FAA in prior approvals for UAS applications for COAs or special airworthiness certificates. The material presented in this notice represents the process and procedures necessary for approving applications for UAS flight operations. However, because of the uniqueness of various UAS flight operations, each application must be evaluated on its own technical merits, including operational risk management (RM) planning. Each application may require unique authorizations or limitations directly related to the specific needs or capabilities of the UAS and/or the proposed specific mission and operating location.

7. Applicability and Approval Process Criteria. The applicability and process to be used in UAS operational approval are dependent on whether the proposed UAS operation within the territorial airspace of the United States (the airspace above the contiguous United States, Alaska, Hawaii, U.S. territories, and U.S. territorial waters) is defined as public or civil (see 14 CFR part 1, § 1.1 and Public Law 110-181, "The National Defense Authorization Act of 2008"). UAS operations outside the territorial airspace of the U.S. will be classified as either state or civil operations in accordance with international law. A public operation is one that is intrinsically governmental in nature (i.e., Federal, State, and local agencies). Proponents requesting approval of public aircraft operations by UAS will use the COA application process. In contrast, proponents for civil operations approval will use the special airworthiness certificate process. Part 91, § 91.319(a)(2) specifically prohibits operation of an aircraft that has an experimental certificate from "carrying persons or property for compensation or hire."

a. Coordination and Approval. Regardless of the process for the authorization approval, COA applications for UAS flight operation approvals will be coordinated through the ATO component of AFS-80 and AVS. Special airworthiness certificates will be coordinated through the Aircraft Certification (AIR-240) staff as well as the ATO and AFS component of AFS-80 for final approval and disposition.

b. Applicability and Methods of Authorization. Operational policy in this notice applies to both public and civil operations and certain state aircraft operations.

(1) Applicability. These procedures are applicable for all operations in the contiguous United States, Alaska, Hawaii, U.S. territories, and international airspace in the Flight Information Regions (FIR) delegated to the United States where the FAA is the Air Traffic Service (ATS) provider. These procedures do not apply to the territorial airspace of another sovereign country that lies within FIRs delegated to the United States where the FAA is the ATS provider, except by agreement with that country, or airspace in FIRs delegated to other countries. All UAS proponents, operators, and pilots must observe all applicable regulations of 14 CFR.

(a) In general, specific authorization to conduct UAS operations in the NAS outside of active Restricted and Warning Areas designated for aviation use, or approved Prohibited Areas, must be requested by the proponent. Airspace inside buildings or structures is not considered to be part of the NAS and is not regulated. (Refer to the current edition of Order JO 7400.8, Air Traffic Organization Policy.)

(b) This notice and the processes prescribed do not apply to hobbyists and amateur model aircraft users when operating unmanned systems for sport and recreation. Those individuals should seek policy under the current edition of Advisory Circular (AC) 91-57, Model Aircraft Operating Standards. AC 91-57 is not to be used as a basis of approval for operation of any other aircraft, including by Federal, State, and local governments, commercial entities, or law enforcement.

(c) This notice and the processes prescribed also do not apply to UAS operations in FAA-controlled international airspace by an agency of, or a contractor to, the Federal government when those operations are appropriately designated as State aircraft operations and are operated under "due regard" rules and procedures established by the Federal agency responsible for the operation. The designation of flight operations as State aircraft operations normally are made in coordination with the U.S. Department of State. This notice and the processes prescribed do, however, apply where the responsible Federal agency either has not established a formal set of rules and procedures for "due regard" operations, or is not operating the UAS under "due regard" rules and procedures in FAA-controlled international airspace. This notice and the processes prescribed also apply to all UAS operations by an agency of, or a contractor to, the Federal government that transit through U.S. territorial airspace en route to or from international airspace. See Appendix F, UAS COA Requirement. The "due regard" option is not available for state aircraft operations transiting through U.S. territorial airspace en route to or from international airspace.

(d) Oceanic Operations Within Warning Areas. UAS operations contained within Warning Areas are handled in the same manner as those operations conducted in active Restricted and approved Prohibited areas; that is, neither specific FAA approval nor observers or chase aircraft are required by the FAA.

(e) The only public aircraft that can fly under "due regard" are U.S. government aircraft designated as State aircraft.

(2) Methods. The two methods of approval are the issuance of either a COA for public aircraft operations or a special airworthiness certificate for civil operations. In the case of public aircraft operations, the operating entity applying to conduct the UAS operation must comply with its own processes, policies, and standards in the following areas, in addition to complying with all applicable safety provisions in all other parts of 14 CFR:

- Pilot certification,
- Crew certification,
- Recent pilot experience (or, currency),
- Medical certificates, and
- Airworthiness of public UAS.

Note: If no established public entity processes, policies, or standards exist, it is highly recommended that the public agency/department apply the specifics outlined in this notice and comply with the provisions of 14 CFR applicable to civil UAS operations.

8. COA for Public Operations.

a. Applications. Applications for a COA are only accepted from entities that intend to conduct public aircraft operations. An application may be referred to the FAA Office of the Chief Counsel (AGC-200) for determination of the status of a proponent as a government entity under the public aircraft statute. The duration of COAs complies with the time limitations specified under the current edition of FAA Order 7210.3, Facility Operation and Administration. COAs may be issued for a lesser duration if requested or deemed appropriate. COAs are not required for operations conducted within active Restricted or Warning Area airspace designated for aviation use, or approved Prohibited Areas with permission from the appropriate authority or using agency of that airspace. (Refer to the current edition of Order JO 7400.8, Special Use Airspace.)

b. Approving and Reviewing Authority. AFS-80 is responsible for determining whether the proponents' proposed UAS operations can be conducted safely and responsibly in the NAS, and that they comply with all COA limitations and provisions.

(1) In accordance with FAA Order 7210.3, "As a general rule, a waiver or authorization should be canceled when it is no longer required or there is an abuse of its provisions or unforeseen safety factors develop. Failure to comply with the waiver or authorization is cause for cancellation."

(2) The FAA has the authority to suspend or cancel the COA, or to delay any activities if there is a violation of the terms in the COA, or if the safety of persons or property on the ground or in the air is determined to be in jeopardy. That may include, but is not limited to:

- Incidents or accidents occurring during UAS operations in the NAS;
- Habitual noncompliance with administrative requirements, such as failure to provide the FAA with monthly reports on the number of flights, pilot duty time, or unusual equipment malfunctions (e.g., a malfunction or failure of ground control station (GCS) flight control hardware or software (other than loss of control link); a power plant failure or malfunction; a deviation from any provision contained in the COA);
- Deviations from ATC instructions, operational, or coordination issues; and
- Events of intermittent or persistent lost-link as described in the COA or events determined to pose as a risk to the safety of the NAS.

(3) COA suspensions and cancellations are not automatic. Whenever possible, a documented conversation, between the FAA and the proponent, will happen before the suspension/cancellation is issued. Timely and transparent responses to accidents, deviations, and similar safety-related events are expected.

c. Accident and Incident Notification and Investigation. The current edition of FAA Order 8020.11C, Aircraft Accident and Incident Notification, Investigation, and Reporting, and Title 49 of the Code of Federal Regulations (49 CFR) part 830, outlines reporting procedures for accidents and incidents involving civil aircraft and certain public aircraft. All accidents and incidents involving fatalities, injuries, property damage, and fly-away by civil aircraft and those public aircraft subject to part 830 require FAA notification within 24 hours. No additional flights by those aircraft under this COA are allowed before notification. An immediate investigation is required, and when requested to do so, UAS proponents are expected to provide copies of written aircraft accident/incident reports to AFS-80 for review. In accordance with 49 CFR part 1520, § 1520.5, reports will not be released outside of government channels without originator permission.

d. General COA Process. The ATO component of AFS-80 is responsible for the COA process. Applications can be made two ways:

(1) On the Internet using the UAS COA Online System at https://ioeaaa.faa.gov. The UAS COA Online System requires a user name and password; a support desk phone number and e-mail address is provided to assist with obtaining an account.

(2) Using FAA Form 7711-2, Application for Certificate of Waiver or Authorization, available online at http://www.faa.gov/documentLibrary/media/form/faa7711-2.pdf. The completed form can be mailed to: FAA Headquarters, Unmanned Aircraft Systems Integration Office, 490 L'Enfant Plaza SW, Suite 3200, Washington, DC 20024. Mail submittal may encounter significant delay due to current U.S. Postal Service security screening procedures in place.

e. Operational Review. Prior to issuance of a COA, air traffic specialist components of AFS-80 conduct an operational validation that addresses ATC processes. Next, an aviation safety inspector (ASI) evaluates each application to determine if risks to the NAS associated with the operation have been acceptably mitigated. Both the ASI and ATC requirements are merged into the final COA.

f. Safety Risk Management (SRM) Process. ASIs and other FAA personnel use SRM principles outlined in the current edition of AC 120-92, Safety Management Systems for Aviation Service Providers, to maintain or improve the safety of the NAS by identifying safety risks, hazards, and mitigations associated with proposed UAS operations. When deemed appropriate, Safety Risk Management Documents (SRMD) are created through SRM reviews of specific operations or of risks associated with UAS operations in various classes of airspace. SRM reviews may result in the incorporation of additional mitigations or controls into all or some COAs.

g. National Security Considerations. When appropriate levels of Department of Defense (DOD) or Department of Homeland Security (DHS) declare a UAS operation to be a matter of national security, the FAA may approve an application for a COA which, under normal circumstances, might not otherwise conform to the guidelines set forth in this notice. In this case, national security may override risk mitigation requirements. Such requests to the FAA Administrator will originate from an equivalent level of authority from the proponent's parent organization.

h. Special COA.

(1) National Disaster COA. Due to the unpredictability of national disasters, a National Disaster COA is issued in two parts. In part 1 of the COA, AFS-80 completes an evaluation, excluding the location of the disaster. All known information is inserted into a template and signed by appropriate FAA authority. Once the specific location is identified, this information, along with the specific operation, is inserted into part 2 of the COA in the form of an attachment. Part 2 of the COA must then be signed by appropriate FAA authority, which completes and establishes a valid COA.

(2) Emergency COA. An emergency UAS COA may be considered when all of the following conditions apply:

(a) A situation exists that is defined as a condition of distress or urgency, where there is, or that has, the extreme possibility of loss of life, and

(b) The proponent has determined that manned flight operations cannot be conducted efficiently, and

(c) The proposed UAS is operating under a current approved COA for a different purpose or location.

Note: Requests for UAS COAs that fall outside of these parameters will be processed through the normal online COA application process. Emergency UAS COAs will not be considered for:

- Demonstration flights,
- Flights to test capabilities,
- Training,
- Flights in Class B Airspace, or
- Flights over populated areas, unless a suitable mitigation strategy is proposed and found to be acceptable.

9. Special Airworthiness Certificate for Civil UAS Applicants.

a. Airworthiness Determination. Civil applicants may apply for a special airworthiness certificate from the FAA. The proponent is required to submit the requisite data to support a determination that the aircraft and its systems, including the control station (CS), are designed, built, and maintained in a safe and airworthy condition.

b. Special Airworthiness Certificate Issuance. Special airworthiness certificates are typically issued to proponents wishing to conduct UAS research and development (R&D), crew training, and market surveys under 14 CFR part 21, § 21.191. Special airworthiness certificates are issued in accordance with FAA Order 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft, current edition. Refer to Order 8130.34 for in-depth information on special airworthiness certificates.

c. Proponents with both a COA and Special Airworthiness Certification. In cases where a proponent has been issued a special airworthiness certificate, and is concurrently eligible to operate a corresponding UAS on a COA as a public aircraft operation, the proponent must elect, prior to each flight, which authority is to be used to conduct the flight. The use of both a special airworthiness certificate and a COA on a single flight is not permitted.

d. General Process for Civil UAS Operations. For civil UAS operations, the Aircraft Certification Service, Production and Airworthiness Division (AIR-200) at FAA HQ, is responsible for the issuance of special airworthiness certificates according to FAA Order 8130.34. The issuance of a special airworthiness certificate is coordinated with AIR-200, AFS-80 and the ATO component of AFS-80, and AVS at the HQ and regional levels. A thorough review is conducted by the FAA to evaluate the system's airworthiness and operational specifications. In addition, the FAA reviews and accepts mitigations developed by the proponent to meet acceptable standards of safety.

10. UAS Airworthiness. All UAS must be in an airworthy condition to conduct flight operations in the NAS. An "airworthy condition for UAS subject to a COA" means that the UAS meets the applicable standards and requirements of its operating agency and is capable of operating in compliance with the applicable requirements in 14 CFR part 91. The FAA recognizes that some of the requirements can differ from those for manned aircraft and appropriate changes can be defined. As with airworthiness standards, maintenance technician requirements will be addressed as part of the review process.

a. Public Aircraft Proponents. The proponent must provide an airworthiness statement specifying compliance with the proponent's applicable airworthiness criteria. Airworthiness statements must be provided on agency letterhead and include:

- The date the statement is effective,
- A signature of the responsible certifying authority within the agency,
- A point of contact (POC), and
- Any warnings/limitations.

(1) Airworthiness statements are generally written for one UAS. If more than one UAS model is included on a single airworthiness statement, each UAS will be listed and specific information for each UAS will be included in the statement. Airworthiness statements with an expiration date must remain current for the duration of the COA including extensions. If a new airworthiness statement is issued during the period the COA is active, a copy of the airworthiness certificate must be provided to AFS-80.

(2) Examples of acceptable policy/criteria include, but are not limited to:

- Department of Defense (DOD) Handbook, MIL-HDBK 516B, Airworthiness Certification Criteria;
- Air Force Policy Directive (AFPD) 62-6, USAF Aircraft Airworthiness Certification;
- Army Regulations (AR) 70-62, Airworthiness Qualification of Aircraft Systems; or
- Naval Air Systems Command Instruction, NAVAIRINST 13034.1 series, Flight Clearance Policy for Air Vehicles and Aircraft Systems.

b. Civil Aircraft Proponents. Approvals for civil applications using the special airworthiness certificate process receive their airworthiness certification from the FAA.

c. Continued Airworthiness.

(1) Public Aircraft. Proponents for UAS used in public aircraft operations should follow their own agency's procedures and guidelines to maintain continued airworthiness at a level which ensures they continue to operate the aircraft safely.

(2) Civil Aircraft. Proponents for civil UAS operational approvals must address continued airworthiness procedures as part of their application. Civil UAS should be maintained and must conform to the same airworthiness standards defined in 14 CFR parts under which UAS are intended to be operated. It is highly recommended that all proponents provide the following information:

- A Continuing Airworthiness Program,
- A maintenance training program,
- Any unique skill sets or maintenance practices relating to their aircraft and/or aircraft operations that may be outside the current scope and practices of manned aviation, and
- A process to report any applicable data relating to the operation and maintenance of the UAS.

d. Database and Recordkeeping. All information received from UAS proponents aids the FAA in establishing a database for the existing UAS types and operations. This data is critical to our development of future certification criteria for both systems and pilots. It expedites the regulatory process for UAS and allows the FAA to have historical data from which to base current and future UAS policy. Accurate recordkeeping is essential in assuring positive operational and quality airworthiness control. In accordance with 49 CFR § 1520.5, reports will not be released outside of government channels without originator permission.

11. Flight Operations of a UAS.

a. Applicability and Requirements. This notice applies to UAS operations conducted in the NAS other than in active Restricted and Warning Areas designated for aviation use or approved Prohibited Areas. The FAA requires aircraft to operate safely among all users of the NAS, including non-cooperative aircraft (e.g., aircraft operated without a transponder), and other airborne operations not reliably identifiable by ATC radar (e.g., balloons, gliders, parachutists). Unless otherwise specifically authorized, UAS operators must use observers, either airborne or ground-based, to comply with 14 CFR part 91 requirements.

b. Risk Mitigation. While considerable work is ongoing to develop a certifiable detect, sense, and avoid system as an AMOC with the see-and-avoid aspect of §§ 91.113 and 91.115, no current solution exists. As a result, compliance with the see-and-avoid requirement and navigational awareness are primary concerns in UAS operational approvals leading to imposition of AMOC. Risk mitigation for these two issues is normally based on the use of observers or other methods of maintaining flight separation and collision avoidance or 'segregation'; however, they may also include other concepts or systems that a proponent may propose for FAA review. The FAA only approves UAS flight operations that can be conducted at an acceptable level of safety. Refer to the current editions of AC 120-92 and FAA Order 8000.369, Safety Management System Guidance.

> **Note:** Risk mitigations that depend on the establishment of new types and categories of airspace are extremely difficult and time-consuming. The NAS is established and configured through a rigorous regulatory process. Risk mitigations that result in the prohibition of the public's right to transit airspace will require a very long lead time with no guarantee that they will be approved.

(1) Proponents proposing see-and-avoid strategies in lieu of visual observers (VOs) are required to support proposed mitigations with system safety cases which indicate the operations can be conducted safely. Acceptable system safety cases must include a hazard analysis, risk assessment, and other appropriate documentation that identifies the level of risk.

(2) It is the proponent's responsibility to demonstrate that the risk of injury to persons or property along the flightpath is appropriately mitigated. Aircraft with performance characteristics that impede, delay, or divert other normal air traffic operations may be restricted in their operations.

12. System Considerations for UAS.

a. Traffic Alert and Collision Avoidance Systems (TCAS). The use of TCAS by UAS has not been validated as an acceptable alternative for see-and-avoid requirements, and is not an approved means of mitigation for UAS see-and-avoid requirements or strategies.

b. Onboard Cameras/Sensors. Although onboard cameras and sensors positioned to observe targets on the ground have demonstrated some capability, their use in detecting airborne operations for the purpose of segregation is still quite limited. To date, these types of systems have not been approved as a sole mitigation in the see-and-avoid risk assessment.

c. Use of Equipment in Lieu of VOs.

(1) Any equipment proposed for use on UAS to accomplish the function of see-and-avoid in lieu of VOs must:

- Be certified as an aircraft system and equipment using standards, requirements, and processes commensurate with installation of equipment in aircraft by a recognized airworthiness authority, and
- Meet the requirements of 14 CFR part 25, § 25.1309, or equivalent process, for any UAS installation, regardless of its size, performance, or maximum takeoff weight.

Note: For other equipment that is not proposed for use in meeting see-and-avoid requirements, § 23.1309, or equivalent process, should be used.

(2) It is the responsibility of the proponent to show that the contemplated standards, requirements, and processes meet an equivalent level of safety.

d. Radar and Other Sensors. If special types of radar systems or other sensors are utilized to mitigate risk, the proponent must provide supporting data which demonstrates the following can be accomplished safely:

- Both cooperative and non-cooperative traffic can be detected and tracked to ensure appropriate separation and collision avoidance,
- The proposed system can effectively mitigate a potential collision,
- Operators are suitably trained and equipped to use them effectively, and
- Procedures are in place for the pilot in command (PIC) to effectively use the data.

e. Lost Link Procedures. There are many acceptable approaches to satisfy lost link requirements. The intent of any lost link procedure is to ensure airborne operations remain predictable. Proponents will comply with the UAS lost link procedures as specified in the COA.

Note: Lost link is not considered fly-away. Refer to definitions in Appendix A.

(1) Unless otherwise authorized, lost link solutions must comply with the last ATC clearance (if ATC clearance is required), for a period of time sufficient for ATC to ensure conflict resolution without loss of required separation.

(2) Lost link procedures are pre-coordinated by AFS-80 with the appropriate ATC facility and included in the COA. They include, at a minimum, lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points (FTP) or other contingency planning measures in the event recovery of the UAS is not feasible.

(3) If lost link occurs within a Restricted Area, Warning Area, or Class A airspace, or lost link procedure takes aircraft into one of these areas, the aircraft will not exit that airspace, unless otherwise authorized, until link is re-established. All exceptions will be submitted as part of the COA application to AFS-80 for review.

(4) Unless otherwise authorized, lost link procedures will conform to the Contingency Planning Limitations in Appendix E and in general, include the following:

- Limiting of UAS operations to operations over water or sparsely populated areas over the ground to transit to another Restricted Area, Warning Area, or to a pre-planned lost link orbit point within visual line-of-sight to re-establish link. (The UAS lost link procedure will not transit over fixed structures on the water.)
- Lost link programmed procedures will avoid unexpected turn-around and/or altitude changes and will provide sufficient time to communicate and coordinate with ATC.
- Lost link orbit points will not be contained within any published holding area, airway, Jet route, T route, or other area navigation (RNAV) published route.

(5) If the link is not re-established within a pre-determined time as defined by the FAA-approved COA, the aircraft may:

- Autoland; however, the aircraft will not exit the Restricted Area or Warning Area in accordance with subparagraph 12.e.(3) above,
- Proceed to another lost link point (LLP) in an attempt to regain communication link, or
- Proceed to an FTP or the location specified in other contingency planning measures for flight termination.

Note: LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established or fuel exhaustion occurs.

- UAS without auto-land capability will proceed to a pre-planned FTP or other acceptable contingency planning option prior to fuel exhaustion.

(6) Refer to Appendix E for more Contingency Planning Limitations.

f. Flight Termination System (FTS). It is highly desirable that all UAS have system redundancies and independent functionality to ensure the overall safety and predictability of the system. UAS that lack system redundancies may be required to have an independent FTS that can be activated manually by the UAS PIC to safeguard the public.

g. Spectrum Authorization.

(1) Every UAS proponent must have the appropriate National Telecommunications and Information Administration (NTIA) or Federal Communications Commission (FCC) authorization/approval to transmit on the radio frequencies (RF) used for UAS uplink and downlink of control, telemetry, and payload information.

(2) Non-Federal public agencies, such as universities and State/local law enforcement, and all civil UAS proponents generally require a license from the FCC as authorization to transmit on frequencies other than those in the unlicensed bands (900 megahertz (MHz), 2.4 gigahertz (GHz), and 5.8 GHz). This generally will be in the form of an Experimental Radio License or a Special Temporary Authority (STA) issued by the FCC. Non-Federal public agencies and civil UAS proponents that operate systems using frequencies assigned to the Federal government (e.g., the DOD) must demonstrate they have the proper authorization through FCC-issued documentation.

(3) DOD agencies will typically demonstrate UAS spectrum authorization through an STA issued by NTIA or a frequency assignment in the NTIA-administered Government Master File (GMF). Authorizations issued under Title 47 of the Code of Federal Regulations (47 CFR) part 300, in the NTIA Manual, Chapter 7, paragraph 7.11, Use of Frequencies by Certain Experimental Stations, are not appropriate for UAS operations.

(4) Federal public agencies other than DOD, such as National Aeronautics and Space Administration (NASA), U.S. Coast Guard (USCG), and U.S. Customs and Border Protection (USCBP), also need an STA issued by NTIA or a frequency assignment in the NTIA-administered GMF. This is especially important for systems designed to operate on frequencies assigned to DOD.

13. Operational Requirements for UAS. Unless operating in an active Restricted or Warning Area designated for aviation use, or approved Prohibited Areas, UAS operations must adhere to the following requirements.

a. Observer Requirement. Visual flight rules (VFR) UAS operations may be authorized utilizing either ground-based or airborne VOs onboard a dedicated chase aircraft. A VO must be positioned to assist the PIC, to exercise the see-and-avoid responsibilities required by §§ 91.111, 91.113, and 91.115 by scanning the area around the aircraft for potentially conflicting traffic and assisting the PIC with navigational awareness.

(1) VOs:

(a) Must assist the PIC in not allowing the aircraft to operate beyond the visual line-of-sight limit, and

(b) Must be able to see the aircraft and the surrounding airspace sufficiently to assist the PIC with:

- Determining the UA's proximity to all aviation activities and other hazards (e.g., terrain, weather, structures), and

- Exercising effective control of the UA, and
- Complying with §§ 91.111, 91.113, and 91.115, and
- Preventing the UA from creating a collision hazard, and

(c) Must inform the PIC before losing sufficient visual contact with the UA or previously sighted collision hazard. This distance is predicated on the observer's normal vision. Corrective lenses, spectacles, and contact lenses are permitted.

(2) Because of field of view and distortion issues with aids to vision such as binoculars, field glasses, night vision devices, or telephoto lenses, these are allowed only for augmentation of the observer's visual capability; they cannot be used as the primary means of visual contact. When using other aids to vision, VOs must use caution to ensure the aircraft remains within normal visual line-of-sight of the observer. These aids to vision are not to be confused with corrective lenses or contact lenses, which do not alter the field of view or distort vision.

(3) The responsibility of ensuring the safety of flight and adequate visual range coverage to avoid any potential collisions remains with the PIC. The PIC for each UAS operation must identify a location from which the observer will perform his/her duties. This location will be selected to afford the best available view of the entire area within which the operation is to be conducted.

(4) Daisy-chaining of observers to increase operational distance is not normally approved; however, a proponent may provide a safety case for daisy-chaining in accordance with paragraph 16 by demonstrating an acceptable level of risk to the NAS.

(5) Observer(s) must be in place 30 minutes prior to night operations to ensure dark adaptation. Refer to subparagraph 13.i.(2)(b) for night operations information.

b. ATC Communications Requirements.

(1) The UAS pilot must establish and maintain direct two-way radio communication with appropriate ATC facilities anytime:

- The aircraft is being operated in Class A or D airspace (under §§ 91.135 or 91.129) or, when required, in Class E and G airspace (under §§ 91.127 or 91.126). See subparagraph 13.q.(2) and (3) for operations in Class B or C airspace; or
- The aircraft is being operated under instrument flight rules (IFR); or
- It is stipulated under the provisions of any issued COA or Special Airworthiness Certificate.

(2) It is preferred that communications between the UAS pilot and ATC be established through onboard radio equipment to provide a voice relay, however, for IFR flight this method of transmission is required.

c. Inter-Communications Requirements. Any VO, sensor operator, or other person charged with providing see-and-avoid assistance must have immediate communication with the UAS pilot. If a chase aircraft is being utilized, immediate communication between the chase aircraft and the UAS pilot is required at all times. If the UAS pilot is in communication with ATC, monitoring of the ATC frequency by all UAS crew members (pilots, observers, and chase pilots) is recommended for shared situational and navigational awareness. However, unless it is approved for others to do so, the UAS PIC or the supplemental pilots are the only crewmembers that will communicate with ATC.

d. Electronic Devices. The use of electronic devices (including cell phones) other than for UAS flight- and mission-required usage is governed by § 91.21, which ensures these devices do not interfere with the UAS systems. The use of electronic devices (including cell phones) is not authorized for primary communication with ATC unless authorized under the Special Provisions of the COA.

e. Dropping Objects/Expendable Stores or Hazardous Materials. If the intended UAS operation includes the carriage, dropping, or spraying of aircraft stores outside of active Restricted or Warning Area airspace designated for aviation use, or approved Prohibited Areas, the proponent must ensure that specific approval is listed in the special provisions, the operational risks have been sufficiently mitigated as required by 14 CFR § 91.15, and that the hazardous material requirements in 49 CFR have been met. Acceptable procedures for hung stores and loss of control link while carrying stores must be provided to the FAA. A similar case must be made for hazardous materials carried aboard the aircraft and, if approved, will be listed in the special provision section of the COA.

f. Flight Over Populated Areas. Routine UAS operations are prohibited over urban or populated areas, except where the level of airworthiness allows. UAS operations may be approved in emergency or national disaster relief situations if the proposed mitigation strategies are found to be acceptable. See Appendix A for definition of populated or urban area.

g. Air Shows. A proponent is required to provide a safety case in accordance with paragraph 16 that demonstrates an acceptable level of risk and must receive a separate Air Show Waiver in accordance with FAA Order 8900.1, Flight Standards Information Management System (FSIMS).

h. Flight Over Heavily Trafficked Roads or Open-Air Assembly of People. UAS operations must avoid these areas, except where level of airworthiness allows. If flight in these areas is required, the proponent is required to support proposed mitigations with system safety cases that indicate the operations can be conducted safely. Acceptable system safety cases must include information located in paragraph 16. Additionally, it is the proponent's responsibility to demonstrate that risk of injury to persons or property along the flightpath has been mitigated. UAS with performance characteristics that impede, delay, or divert other air traffic operations may be restricted in their operations. Refer to AC 120-92 and FAA Order 8000.369, current editions.

i. Day/Night Operations.

(1) Day Operations. UAS operations outside of Class A airspace, active Restricted or Warning Areas designated for aviation use, or approved Prohibited Areas will be conducted during daylight hours unless otherwise authorized.

(2) Night Operations.

(a) Night operations may be considered if the proponent provides a safety case and sufficient mitigation to avoid collision hazards at night.

(b) UAS night operations are those operations that occur between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time. (Note: this is equal to approximately 30 minutes after sunset until 30 minutes before sunrise, except in Alaska.) External pilots and observers must be in place 30 minutes prior to night operations to ensure dark adaptation.

j. Flights Below Class A Airspace. All UAS operations outside of active Restricted/ Warning/Sensitive Security Information (SSI) airspace designated for aviation use, or approved Prohibited Areas must be conducted in visual meteorological conditions (VMC) if using ground or airborne VOs. In addition, the following weather requirements apply:

- If on IFR flight, remain clear of clouds. This requirement does not relieve the PIC from following the ATC clearance. According to § 91.3, the PIC retains responsibility for, and is the final authority as to the operation of that aircraft.
- If on VFR flight, maintain § 91.155 VFR cloud clearances, except in Class G airspace, where Class E airspace visibility requirements must be applied, but not less than 3 statute miles (SM) in-flight visibility.
- Special VFR is not permitted.
- For chase aircraft, 5 SM in-flight visibility.

k. Autonomous Operations. Although it is possible to have a completely manual (direct pilot intervention) UAS, the majority of UAS are autonomous to a certain degree. Only those UAS which have the capability of direct pilot intervention will be allowed in the NAS outside of active Restricted or Warning Areas designated for aviation use, or approved Prohibited Areas. Because the pilot may be technically considered out-of-the-loop in a lost link scenario, this restriction does not apply to UAS operating under lost link.

l. Operations from Off-Airport Locations. In most cases, an off-airport location should be situated no closer than 5 nautical miles (NM) from any airport or heliport. The operational areas, including the launch and recovery zones, should be free from obstructions; reasonable efforts should be made to keep operations away from structures.

m. Crew Resource Management (CRM). Proponents must train all UAS crewmembers in CRM. The current edition of FAA AC 120-51, Crew Resource Management Training, or an FAA-recognized equivalent applies to UAS operations. Proponents must implement the recommended training and procedures included in AC 120-51, or in an FAA-recognized

equivalent. The PIC of a UAS must ensure no activities other than those duties required for safe flight operation are performed. No UAS crewmember may engage in any activities unrelated to those required for safe operation of the UAS during critical phases of flight such as launch/takeoff and landing/recovery.

n. Sterile Cockpit. Proponents must comply with the current edition of AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers, or the FAA-recognized equivalent, for ensuring the PIC implements sterile cockpit procedures. During critical phases of flight, including all ground operations involving taxi (movement of an airplane under its own power on the surface of an airport), takeoff and landing, and all other flight operations in which safety or mission accomplishment might be compromised by distractions, no crewmember may perform any duties not required for the safe operation of the aircraft. No crewmember may engage in, nor may any PIC permit, any activity during a critical phase of flight which could distract any crewmember from the performance of his/her duties or interfere in any way with the proper conduct of those duties.

o. Operating Under IFR. While operating on an instrument flight plan, the following must exist, be completed, or be complied with:

(1) The PIC must hold a current instrument rating or an FAA-recognized equivalent.

(2) The aircraft's airworthiness signature statement for flight release (not airworthiness document) must include IFR flight and indicate that all equipment required for IFR operations is certified and working (including pitot-static and transponder checks).

(3) Applicable navigation database and charts are current and available to the UAS pilot.

(4) An IFR flight plan is filed.

(5) An ATC clearance has been obtained and all clearances must be followed.

(6) Direct two-way radio communication between the UAS pilot and ATC is established and maintained. (A communication relay through the aircraft may be required.)

(7) Alternate communication capabilities with ATC for the purpose of lost link and/or lost communication are designated and operational during all phases of flight.

(8) The UAS is equipped with a certified operating mode C (mode S preferred) transponder.

(9) ATC radar services are obtained throughout the portion of the flight in Class A airspace whenever possible (overwater non-radar operations may be allowed in the special provisions section).

(10) All operations outside of Class A airspace and active Restricted, Prohibited, Warning Areas, or SSI airspace designated for aviation use, must remain clear of clouds. If operating under IFR, to comply with this provision, the PIC must have an ATC clearance to deviate.

According to § 91.3, the PIC retains responsibility for, and is the final authority as to, the operation of that aircraft.

(11) VOs are not required in Class A airspace unless stipulated in the COA.

p. Chase Aircraft Operations. The chase aircraft:

(1) Must remain at a safe distance from UA to ensure collision avoidance if a malfunction occurs, and

(2) Must remain close enough to the UA to provide visual detection of any conflicting aircraft and advise the PIC of the situation.

(3) Must remain within radio control range of the UA, in the case of pilot operation from the chase aircraft, to maintain appropriate signal coverage for flight control or activation of the FTS.

(4) May be required to have communication with appropriate ATC facilities based on the proponent's application or mission profile.

(5) Is not required by FAA in active Restricted or Warning Area airspace designated for aviation use, or approved Prohibited airspace.

(6) Is not required for Optionally Piloted Aircraft (OPA) if a qualified VO is on board.

(7) Is not required in Class A airspace unless stipulated in the COA.

(8) Operations must be conducted in accordance with the Special Provisions listed in the approved COA.

(9) Must maintain 5 SM in-flight visibility restrictions.

(10) Pilot/observer:

- Will not concurrently perform either observer or UAS pilot duties along with chase pilot duties unless otherwise authorized.
- Must maintain direct voice communication with the UAS pilot.

(11) Pilots operating as a formation flight will immediately notify ATC if they are using a non-standard formation. Non-standard formations must be pre-approved by ATC. Proponents adhere to the current edition of Order JO 7610.4, Special Operations, as applicable. Refer to Appendix A for definitions of standard and non-standard formations.

(12) Operations will not be conducted in IMC.

(13) Operations will be thoroughly planned and briefed.

(14) Pilot, during a lost link situation, must be notified immediately along with ATC. The chase pilot will report to ATC that the UA is performing lost link procedures as planned or if deviations are occurring.

(15) Pilot will ensure safe separation with the UA, and immediately notify ATC and the UA PIC during loss of visual contact with the UA by both the chase pilot and observer, when such contact cannot be promptly re-established. The UA PIC will either execute lost link procedures to facilitate a rejoin, recover the UA, or terminate the flight as appropriate.

q. Airspace Considerations by Airspace Designation.

Note: UAS operating in airspace designated as reduced vertical separation minimum (RVSM) airspace must comply with § 91.180.

(1) Class A. Observers are not normally required in Class A. All UAS must be operating under IFR and on an instrument flight plan. UAS operations approved for Class A must comply with § 91.135.

(2) Class B. UAS operations are currently not authorized. Class B airspace contains terminal areas with the highest density of manned aircraft in the NAS. On a case-by-case basis, the FAA may consider exceptional circumstances. For public aircraft, a Letter of Agreement (LOA) between the affected ATC facility and the proponent describing UAS segregation procedures is required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class B operations.

(3) Class C (and airspace within 30 NM of an airport listed in Appendix D, section 1, § 91.215). UAS operations approved for Class C must comply with §§ 91.130 and 91.215. Requests for operations without this equipment will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. For public aircraft, an LOA between the affected ATC facility and the proponent describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class C operations.

(4) Class D. Requests for approval will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. UAS operations approved for Class D must comply with § 91.129. For public aircraft, an LOA between the affected ATC facility and the proponent describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class D operations.

(5) Class E. If there is an operating ATC tower, Class D rules may apply. UAS operations approved for Class E must comply with § 91.127. For public aircraft, an LOA between the affected ATC facility and the proponent describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class E operations.

(6) Class G. UAS operations approved for Class G must comply with § 91.126.

r. ATC Visual Approach Clearances. The UAS PIC must not accept a visual approach clearance, an instruction to follow another aircraft by visual means, or a clearance to maintain visual separation from another aircraft.

s. In-Flight Emergencies.

- The PIC will notify ATC of any in-flight emergency or aircraft accident as soon as practical.
- The PIC will notify ATC of any loss of control link as soon as practical. Loss of control link scenarios may be handled by ATC as an emergency.

14. Contingency Planning Limitations. See Appendix E.

15. Personnel Qualifications. This paragraph addresses the qualifications of all UAS flightcrew members, observers, maintainers, and other personnel as appropriate. All references to a pilot certificate or FAA written examination refer to an FAA-issued private pilot certificate, higher certification, or an FAA-recognized equivalent.

a. UAS Pilot Qualifications. The FAA is focused on ensuring that UAS pilots have an appropriate level of understanding of 14 CFR applicable to the airspace where UAS operate. UAS pilots are responsible for controlling their aircraft to the same standards as the pilot of a manned aircraft. Civil UAS pilots may be required to have instruction by an FAA-certificated flight instructor.

b. UAS General Operational Requirements. The following operational restrictions apply to all UAS pilots:

- One PIC must be designated at all times.
- The PIC of an aircraft is directly responsible for, and is the final authority of the operation of that aircraft.
- Pilots must not perform crew duties for more than one UAS at a time.
- Pilots are not allowed to perform concurrent duties both as the pilot and the VO. In the case of OPA, the airborne pilot may assume the role of PIC at all times, but will only be the observer when the OPA is operated by the CS pilot.
- Unless undergoing initial qualification training, pilots must be qualified on the aircraft being flown.
- Only one PIC per aircraft is authorized, and the PIC must be in a position to assume control of the aircraft.

c. PIC.

(1) The designated PIC:

- Has been designated as PIC before or during the flight.
- Is responsible for the UAS flight operation as described under § 91.3, or FAA-recognized equivalent.
- Is responsible for determining whether the UAS is in condition for safe flight.

- Must land as soon as safely practical when any condition occurs that causes operations to be unsafe.
- May be augmented by supplemental pilots; however, the PIC retains complete and overall responsibility of the flight, regardless of who may be piloting the aircraft.
- Has the ability to assume the duties of an internal or an external UAS pilot at any point during the flight.
- May rotate duties as necessary to fulfill operational requirements.
- Operating under a public agency, must have a thorough knowledge of the COA issued to the organization and must retain a copy to reference during flight.
- Must be trained and qualified on the specific UAS for the conduct of the flight.
- May assume the duties of VO or PIC, if piloting an OPA when the OPA is being utilized as a UAS and being flown by the CS pilot.

(2) PIC Rating Requirements. Rating requirements for the UAS PIC depend on the type of operation conducted; they fall into two categories:

- Operations that require at least a private pilot certificate or FAA-recognized equivalent, or
- Operations that do not require at least a private pilot certificate or FAA-recognized equivalent.

(a) The requirement for the PIC to hold a pilot certificate or FAA-recognized equivalent is based on various factors including:

- The location of the planned operations,
- The mission profile,
- The size of the aircraft, and
- Whether or not the operation is conducted within or beyond visual line-of-sight.

(b) The PIC must hold, at a minimum, an FAA private pilot certificate or FAA-recognized equivalent for all operations listed below:

- Flight in Class A, B, C, D, E, and G (400 feet above ground level (AGL)) airspace.
- IFR (must have instrument rating) operations.
- Night operations.
- At joint use or public airfields.
- Requiring a chase aircraft.
- At any time the FAA has determined the need, based on the UAS characteristics, mission profile, or other operational parameters.

(c) Operations without a pilot certificate may be allowed when all of the following conditions are met:

- The PIC has successfully completed, at a minimum, FAA private pilot ground instruction and passed the FAA Private Pilot written examination or FAA-recognized equivalents. (Airman Test Reports are valid for the 24 calendar-month period preceding the month the exam was completed, at which time the instruction and written examination must be repeated.)
- Operations are during daylight hours.
- The operation is conducted in a sparsely populated location.
- Operations are approved and conducted solely within visual line-of-sight in Class G airspace.
- Visual line-of-sight operations are conducted no further than ½ NM laterally from the UAS pilot and at an altitude of no more than 400 feet AGL at all times. Refer to Appendix A for the visual line-of-sight definition.
- Operations are conducted no closer than 5 NM from any FAA-designated airport or heliport other than the airport from which the aircraft is operating.
- The operation is conducted from a privately owned airfield, military installation, or off-airport location.

(3) PIC Recent Flight Experience (Currency). The proponent must provide documentation showing the pilots maintain an appropriate level of recent pilot experience in the UAS being operated, or in an FAA-certified simulator. At a minimum, the PIC must conduct three takeoffs (launch) and three landings (recovery) in the specific UAS within the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations); or as prescribed by the proponent's accepted recurrent training and currency program.

(a) For those operations that require a certificated pilot, the PIC, to exercise the privileges of his certificate, must have flight reviews and maintain recent pilot experience in manned aircraft per 14 CFR part 61, as appropriate; or FAA-accepted equivalent.

(b) For flights approved for night operations, the PIC must conduct three takeoffs (launch) and three landings (recovery) each, in the specific UAS at night, to a full stop in the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations).

(c) For operations approved for night or IFR, the PIC must maintain recent pilot experience per § 61.57 or FAA-accepted equivalent as applicable.

(4) PIC Medical. The PIC must maintain, at a minimum, a valid FAA second-class medical certificate issued under 14 CFR part 67 or the FAA-recognized equivalent. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate listed in § 61.23.

(5) Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(6) PIC Training.

(a) In addition to the training required for a pilot certificate, UAS PICs must have the following additional training (or FAA-recognized equivalent):

- Including normal, abnormal, and emergency procedures in all specific details of the UAS being operated,
- Manufacturer-specific training,
- Demonstrated proficiency, and
- Testing in the UAS being operated.

(b) Proponents must maintain individual training records of all UAS personnel. All training and testing will be documented in the individual's training record by the instructor and initialed by the trainee.

d. Supplemental Pilots. Supplemental pilots are those pilots assigned UAS flight duty to augment the PIC. It is common for proponents to have both an internal and an external UAS pilot. The supplemental pilot can assume either of these positions.

(1) Ratings. Supplemental pilots must have, at a minimum, successfully completed private pilot ground school and passed the written test or FAA-recognized equivalents. The ground school written test results are valid for two years from the date of completion, at which time the instruction and written examination must be repeated. If a supplemental pilot assumes the role of PIC, he/she must comply with the PIC rating, currency, medical, and training requirements listed above in subparagraph 15c.

(2) Recent Pilot Experience. The proponent must provide a process that ensures that pilots maintain an appropriate level of recent pilot experience for the position they are assigned in the UAS being operated.

(3) Medical. Supplemental pilots must maintain, at a minimum, a valid FAA second-class medical certificate issued under part 67 or the FAA-recognized equivalent. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate, according to § 61.23. Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(4) Training.

(a) UAS supplemental pilots must have:

- Training in all specific details of the UAS being operated, including normal, abnormal, and emergency procedures;
- Manufacturer-specific training (or FAA-recognized equivalent);
- Demonstrated proficiency and successful testing in the UAS being operated.

(b) Proponents must maintain individual training records for all UAS personnel. All training must be documented by the instructor and initialed by the trainee.

e. UAS Observer Qualifications. All observers must have an understanding of Federal aviation regulations applicable to the airspace where the UAS will operate. Observers are considered crewmembers. Observers must not perform crew duties for more than one UAS at a time. Observers are not allowed to perform concurrent duties both as UAS pilot and observer.

(1) Medical. All observers must have a valid FAA second-class medical certificate issued under part 67; an FAA-recognized equivalent is an acceptable means of demonstrating compliance with this requirement. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate. Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(2) Training. Observers must complete sufficient training to communicate to the pilot any information required to remain clear of conflicting traffic, terrain, and obstructions, maintain proper cloud clearances, and provide navigational awareness. This training, at a minimum, must include knowledge of:

(a) Their responsibility to assist pilots in complying with the requirements of 14 CFR:

- § 91.111, Operating Near Other Aircraft;
- § 91.113, Right-of-Way Rules: Except Water Operations;
- § 91.115, Right-of-Way Rules: Water Operations; and
- § 91.155, Basic VFR Weather Minimums;

(b) Air traffic and radio communications, including the use of approved ATC/pilot phraseology; and

(c) Appropriate sections of the Aeronautical Information Manual (AIM).

f. UAS Maintenance Personnel Qualifications.

(1) Maintenance Ratings. Will be established as more data is collected and a regulatory guideline is developed.

(2) Recent Maintenance Experience. It is suggested that proponents follow applicable guidelines of 14 CFR part 65, § 65.83, as appropriate, until final UAS regulatory guidelines are available.

(3) Maintenance Medical Requirements. At a minimum, the requirements of § 91.17 or FAA-recognized equivalent must be met. No additional medical requirements have been defined at this time.

(4) Maintenance Training. It is highly recommended that a proponent of a UAS submit a training program. This requirement will be further defined as more data is collected and the regulatory process affects these guidelines.

g. Other UAS Personnel Qualifications. Ancillary personnel such as systems operators or mission specialists must be thoroughly familiar with and possess operational experience of the equipment being utilized. If the systems being utilized are for observation and detection of other aircraft for collision avoidance purposes, personnel must be thoroughly trained on collision avoidance procedures and techniques and have direct communication with the UAS pilot, observer, and other applicable personnel.

16. AMOC. This notice defines certain limitations and procedures to conduct UAS operations, but each application is evaluated on its own technical merit based on its own set of operational parameters and proposed operational profiles, mitigations, and systems. When a proponent desires to deviate from these limitations and procedures, an AMOC that includes a safety case (recommended format provided in Appendix D), must be submitted for approval. For a proponent to make an acceptable safety case, information must be provided that outlines all hazards and risks associated with the requested AMOC. In addition, the proponent must provide a description of the methods and procedures or equipment for mitigating each hazard and risk. As such, deviations and AMOC may differ from the information presented in this notice. Therefore, if the proponent provides an acceptable safety case with sufficient data that supports the proposal, the AMOC will be considered and evaluated for approval.

a. Safety Case Information. The proponent should include at a minimum:

(1) A thorough description of the environment in which the aircraft will operate;

(2) Criteria for categorizing hazards (e.g., severity and likelihood);

(3) A detailed airworthiness description of the affected items associated with the proposed AMOC, which includes, as a minimum:

- Certification status of components and systems, or statement of airworthiness for public aircraft,
- Reliability data,
- Redundant systems,
- Failure modes and effects, including system response to loss of control link, and
- An airworthiness determination (for COA proponents only);

(4) Capabilities of the aircraft;

(5) Flight data;

(6) Accident data;

(7) Emergency procedures; and

(8) Pilot/crew roles and responsibilities.

b. Sample Safety Case. Appendix D represents the FAA's approach to documenting the process used for hazard identification and risk mitigation. It is provided as an example for proponents to use when developing and documenting a safety case. In addition to these

guidelines, other government and industry methods similar to the FAA's approach to developing a safety case also provide acceptable hazard analysis tools. These include Preliminary Hazard Analysis, Operational Safety Assessment, Comparative Safety Assessment, and Fault Hazard Analysis. See Appendix D for a complete list.

17. Disposition. We will incorporate the information in this notice into FAA Order 8900.1 before this notice expires. Direct questions concerning the information in this notice to the Unmanned Aircraft Systems Integration Office, AFS-80, at 202-385-4835.

for John M. Allen
John M. Allen
Director, Flight Standards Service

APPENDIX A. DEFINITIONS

1. Aircraft. A device used or intended to be used for flight in the air, including unmanned aircraft (UA).

2. Airworthiness [UAS]. A condition in which the unmanned aircraft system (UAS) (including the aircraft, airframe, engine, propeller, accessories, appliances, and control station (CS)) conforms to its type certificate, if applicable, and is in condition for safe operation.

3. Airworthiness Certification. Process and aircraft qualification for civil UAS proponents to obtain a special airworthiness certificate.

4. Airworthiness Statement. Document required from public UAS proponents during a Certificate of Waiver or Authorization (COA) application process which confirms aircraft airworthiness.

5. Certificate of Waiver or Authorization (COA). An FAA grant of approval for a specific operation. The authorization to operate a UAS in the National Airspace System (NAS) as a public aircraft outside of Restricted, Warning, or Prohibited areas approved for aviation activities.

6. Chase Aircraft. A manned aircraft that carries its own pilot-in-command (PIC) and a separate qualified VO flying in proximity to a UA.

7. Civil Aircraft. Aircraft other than public aircraft.

8. Cooperative Aircraft. Aircraft that have an electronic means of identification (i.e., a transponder or ADS-B transceiver) aboard in operation.

9. Crewmember [UAS]. In addition to the crewmembers identified in 14 CFR part 1, a UAS flightcrew member includes pilots, sensor/payload operators, and VOs, but may include other persons as appropriate or required to ensure safe operation of the aircraft.

10. Crew Resource Management (CRM). The effective use of all available resources including human, hardware, and information resources.

11. Daisy-Chaining. Aviation jargon for the use of multiple, successive observers to extend the flight of a UA beyond the direct visual line-of-sight of any other PIC or VO.

12. Experimental Certificate. A type of special airworthiness certificate issued for the purposes of research and development (R&D), crew training, exhibition, and market survey as defined in 14 CFR part 21, § 21.191(a), (c), and (f). Note: According to § 91.319(a)(2), experimental aircraft may not be used for carrying persons or property for compensation or hire.

a. R&D Aircraft. Aircraft testing new design concepts, equipment, installations, operating techniques, or uses for aircraft. Any unmanned aircraft system (UAS), including an Optionally Piloted Aircraft (OPA) is eligible for an experimental certificate under this purpose. Operations

may be conducted by the proponent only as a matter of research or to determine whether an idea warrants further development.

b. Crew Training. Crew training is limited to the number of flight crews required by the proponent to conduct experimental aircraft operations.

c. Market Survey. Aircraft may be used for the purposes of conducting market surveys, sales demonstrations, and customer crew training of the manufacturer's customers as provided in part 21, § 21.195.

13. External Pilot. A UAS pilot who flies from outside a CS shelter with direct visual contact with the aircraft.

14. FAA-Recognized Equivalent. An FAA recognition that a public agency may exercise its own internal processes regarding airworthiness and pilot, aircrew, and maintenance personnel certification and training; furthermore, the agency has determined that its UAS is capable of safe operation in the National Airspace System (NAS) when conducting public aircraft operations under Title 49 of the United States Code (49 U.S.C.) §§ 40102(a)(41) and 40125.

15. Fly-Away. An interruption or loss of the control link, or when the pilot is unable to effect control of the aircraft and, as a result, the UA is not operating in a predicable or planned manner.

16. Formation.

a. Non-standard formation. A formation operating under any of the following conditions:

- When the flight leader has requested and ATC has approved other than standard formation dimensions;
- When operating within an authorized block altitude or under the provisions of a letter of agreement (LOA);
- When the operations are conducted in airspace specifically designed for a special activity.

b. Standard formation. A formation in which proximity of no more than 1 NM laterally or longitudinally and within 100 feet vertically from the flight leader is maintained by each wingman or UA.

17. Inspection. The routine performance of inspection tasks at prescribed intervals. The inspection must ensure the airworthiness of an aircraft up to and including its overhaul or life limits.

18. Internal Pilot. A UAS pilot who flies from inside a CS shelter without direct visual contact with the aircraft.

19. Lost Link. An interruption or loss of the control link, or when the pilot is unable to effect control of the aircraft and, as a result, the UA will perform a predictable or planned maneuver. Loss of command and control link between CS and aircraft. There are two types of links:

- An uplink which transmits command instructions to the aircraft, and
- A downlink which transmits the status of the aircraft and provides situational awareness to the pilot.

20. Missile. A non-recoverable, powered, guided munition that travels through the air or space.

- Ballistic missiles follow a ballistic trajectory.
- Cruise missiles generate lift.
- Guided missiles are launched from a ship or aircraft and serve as a self-contained precision bomb.

21. Non-Cooperative Aircraft. Aircraft that do not have an electronic means of identification (e.g., a transponder) aboard or that have inoperative equipment because of malfunction or deliberate action.

22. Non-Standard Formation. See Formation.

23. Observer. A trained person who assists a UAS pilot in the duties associated with collision avoidance and navigational awareness through electronic or visual means. (Collision avoidance includes, but is not limited to, avoidance of other traffic, clouds, obstructions, terrain and navigational awareness.) A visual observer (VO) is a trained person who assists the UAS pilot by visual means in the duties associated with collision avoidance. A VO includes the OPA pilot when the OPA is being operated as a UAS.

24. Off-Airport. Any location used to launch or recover aircraft that is not considered an airport (e.g., an open field).

25. Optionally Piloted Aircraft (OPA). An aircraft that can conduct operations as a traditional aircraft with a pilot aboard the aircraft, and can also operate as a UAS when the aircraft is operated and controlled by the CS pilot, allowing the pilot aboard the aircraft to become a qualified observer and remain a PIC. OPA operating as a UAS must meet UAS guidance requirements.

26. Pilot Duty Period. The period beginning when a flightcrew member is required to report for duty, with the intention of conducting a flight, and ending when the aircraft is parked after the last flight. It includes the period of time before a flight or between flights that a pilot is working without an intervening rest period.

27. Pilot-in-Command (PIC)-[UAS]. The person who has final authority and responsibility for the operation and safety of flight, has been designated as PIC before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the PIC as described by 14 CFR part 91, § 91.3 apply to the UA PIC. The PIC position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight. Note: The PIC can only be the PIC for one aircraft at a time. For OPA, PIC must meet UAS guidance requirements for training, pilot licensing, and medical requirements when operating OPA as a UAS.

28. Populated or Urban Areas. Areas depicted in yellow on a Visual Flight Rules (VFR) sectional chart or as determined from other sources.

29. Proponent. A person or agency making an application for a Certificate of Waiver or Authorization (COA).

30. Public Aircraft. An aircraft operated by a governmental entity (including Federal, State, or local governments, and the U.S. Department of Defense (DOD) and its military branches) for certain purposes as described in 49 U.S.C. §§ 40102(a)(41) and 40125. Public aircraft status is determined on an operation by operation basis. See 14 CFR part 1, § 1.1 for a complete definition of a public aircraft.

31. Public Operator. An operator that is classified as government and/or otherwise qualifies for public aircraft operation under 49 U.S.C. §§ 40102(a)(41) and 40125. Not all flights by a public aircraft operator qualify as a public aircraft operation under the statute. Public aircraft operation status is not automatic for flights conducted by a government entity or a contractor to a government entity.

32. Rocket. A powered, unguided munitions (DOD); or an aircraft propelled by ejected expanding gases generated in the engine from self-contained propellants and not dependent on the intake of outside substances. It includes any part which becomes separated during the operation (14 CFR).

33. Safety Risk Management (SRM). A formalized, proactive approach to system safety. SRM is a methodology that ensures hazards are identified, risks are analyzed, assessed, and prioritized; and results are documented for FAA decision-makers to transfer, eliminate, accept, or mitigate risk.

34. Scheduled Maintenance (Routine). The performance of maintenance tasks at prescribed intervals.

35. Segregation. Setting apart from other air traffic operations in the NAS. Segregation is not synonymous with required air traffic separation standards. Therefore, segregation does not prescribe or mandate criteria such as vertical, lateral, or longitudinal distances.

36. Shells. Munitions that are fired from a gun whether guided or not.

37. Smart Bomb. Precision-guided munitions.

38. Standard formation. See formation.

39. Supplemental Pilot. Pilots assigned UAS flight duties to augment the PIC. It is common for proponents to have both an internal and an external UAS pilot. The supplemental pilot can assume either of these positions. The supplemental pilot may also assume duties of the PIC if the specified qualifications are met.

40. Torpedoes. Powered munitions that travel through water.

41. Unmanned Aircraft (UA). A device used or intended to be used for flight in the air that has no onboard pilot. This devise excludes missiles, weapons, or exploding warheads, but includes all classes of airplanes, helicopters, airships, and powered-lift aircraft without an onboard pilot. UA do not include traditional balloons (see 14 CFR part 101), rockets, tethered aircraft and un-powered gliders.

42. Unmanned Aircraft System (UAS). A UA and its associated elements related to safe operations, which may include CSs (ground, ship, or air-based), control links, support equipment, payloads, flight termination systems (FTS), and launch/recovery equipment.

43. Unscheduled Maintenance (Non-Routine). The performance of maintenance tasks when mechanical irregularities occur.

44. Visual Line-of-Sight. Unaided (corrective lenses and/or sunglasses exempted) visual contact between a PIC or a VO 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.

APPENDIX B. ACRONYMS

AC	Advisory Circular
AFPD	Air Force Policy Directive
AFS	Flight Standards Service
AGC	Chief Counsel
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AMOC	Alternative Means of Compliance
AR	Army Regulations
ASI	Aviation Safety Inspector
ATCAA	Air Traffic Control Assigned Airspace
ATCSCC	Air Traffic Control System Command Center
ATO	Air Traffic Organization
ATS	Air Traffic Service
AVS	Aviation Safety
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulations
COA	Certificate of Waiver or Authorization
CRM	Crew Resource Management
CS	Control Station
DCP	Divert/Contingency Points
DHS	Department of Homeland Security
DOD	Department of Defense
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FIR	Flight Information Regions
FL	Flight Level
FSIMS	Flight Standards Information Management System
FTP	Flight Termination Point
FTS	Flight Termination System
GCS	Ground Control Station
GHz	Gigahertz
GMF	Government Master File
HQ	Washington Headquarters
IFR	Instrument Flight Rules
LLP	Lost Link Points
LOA	Letter of Agreement
MHz	Megahertz
MSL	Mean Sea Level
NAS	National Airspace System
NASA	National Aeronautics And Space Administration
NAVAIRINST	Naval Air Systems Command Instruction
NM	Nautical Mile
NTIA	National Telecommunications And Information Administration

OPA	Optionally Piloted Aircraft
PIC	Pilot in Command
POC	Point of Contact
R&D	Research and Development
RF	Radio Frequency
RM	Risk Management
RNAV	Area Navigation
RTB	Return to Base
RVSM	Reduced Vertical Separation Minimum
SM	Statute Mile
SRM	Safety Risk Management
SRMD	Safety Risk Management Document
SSI	Sensitive Security Information
STA	Special Temporary Authority
TAS	Traffic Advisory Systems
TC	Type Certificate
TCAS	Traffic Alert and Collision Avoidance Systems
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
U.S.	United States
USC	United States Code
USCBP	U.S. Customs and Border Protection
USCG	U.S. Coast Guard
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VO	Visual Observer

APPENDIX C. RELATED REGULATIONS AND PUBLICATIONS

1. Title 14 of the Code of Federal Regulations (CFR).

a. Part 1, Definitions and Abbreviations.

b. Part 21, Certification Procedures for Products and Parts.

- Section 21.191, Experimental certificates.
- Section 21.193, Experimental certificates: general.
- Section 21.195, Experimental certificates: Aircraft to be used for market surveys, sales demonstrations, and customer crew training.
- Section 21.197, Special flight permits.
- Section 21.199, Issue of special flight permits.

c. Part 23, § 23.1309, Equipment, Systems, and Installations.

d. Part 25, § 25.1309, Equipment, Systems, and Installations.

e. Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors.

- Section 61.23, Medical Certificates: Requirement and Duration.
- Section 61.56, Flight Review.
- Section 61.57, Recent Flight Experience: Pilot in Command.
- Section 61.58, Pilot-in-Command Proficiency Check: Operation of an Aircraft that Requires more than one Pilot Flight Crewmember or is Turbojet-Powered.

f. Part 65, § 65.83, Recent Experience Requirements.

g. Part 67, Medical Standards and Certification.

h. Part 91, General Operating and Flight Rules.

- Section 91.3, Responsibility and Authority of the Pilot in Command.
- Section 91.13, Careless or Reckless Operation.
- Section 91.15, Dropping Objects.
- Section 91.17, Alcohol or Drugs.
- Section 91.21, Portable Electronic Devices.
- Section 91.111, Operating Near Other Aircraft.
- Section 91.113, Right-of-Way Rules: Except Water Operations.
- Section 91.115, Right-of-Way Rules: Water Operations.
- Section 91.126, Operating on or in the Vicinity of an Airport in Class G Airspace.
- Section 91.127, Operating on or in the Vicinity of an Airport in Class E Airspace.
- Section 91.129, Operations in Class D Airspace.
- Section 91.130, Operations in Class C Airspace.
- Section 91.135, Operations in Class A Airspace.
- Section 91.155, Basic VFR Weather Minimums.

- Section 91.157, Special VFR Weather Minimums.
- Section 91.180, Operations within Airspace Designated as Reduced Vertical Separation Minimum Airspace.
- Section 91.203, Civil Aircraft: Certifications Required.
- Section 91.215, ATC Transponder and Altitude Reporting Equipment and Use.
- Section 91.319, Aircraft having Experimental Certificates: Operating Limitations.

2. Title 49 of the Code of Federal Regulations (CFR).

a. Chapter I, Subchapter C, Hazardous Materials Regulations.

b. Chapter VIII, Part 830, Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft, and Preservation of Aircraft Wreckage, Mail, Cargo, and Records.

c. Chapter XII, Part 1520, § 1520.5, Sensitive Security Information.

3. Related Publications (current editions).

4. Advisory Circulars (AC).

- AC 00-1.1, Government Aircraft Operations.
- AC 91-57, Model Aircraft Operating Standards.
- AC 120-51, Crew Resource Management Training.
- AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers.
- AC 120-92, Introduction to Safety Management Systems for Air Operators.

5. FAA Notices. N JO 7210.766, Unmanned Aircraft Operations in the National Airspace System (NAS).

6. FAA Orders.

- JO 1000.37, Air Traffic Organization Safety Management System.
- JO 7110.65, Air Traffic Control.
- JO 7210.3, Facility Operation and Administration.
- JO 7400.8, Special Use Airspace.
- JO 7610.4, Special Operations.
- 8000.369, Safety Management System Guidance.
- 8020.11C, Aircraft Accident and Incident Notification, Investigation, and Reporting.
- 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft.
- 8900.1, Flight Standards Information Management System.

7. Other Documents.

- Title 47 CFR Part 300, National Telecommunications and Information Administration (NTIA) Manual, Chapter 7.11, Use of Frequencies by Certain Experimental Stations.
- Title 49 United States Code (49 U.S.C.) §§ 40102(a)(41), Definitions.

- FAA Air Traffic Organization (ATO) Safety Management System Manual.
- Memorandum of Agreement Concerning the Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System (DOD-FAA MoA, September 24, 2007).
- Convention on International Civil Aviation ("Chicago Convention"). 7 December 1944, 61 Stat. 1180, 15 U.N.T.S. 295.

APPENDIX D. SAFETY CASE FORMAT

1. **Signature Page.** Include the following information on the signature page:

   - Title: A clear and concise description of the proposed method for AMOC;
   - Originator Information: Originator's name, organization, contact information, etc.;
   - Safety Risk Management Document (SRMD) Information: Safety Case submission date, revision number, etc.

2. **Executive Summary.** The summary should give a general description of the proposed AMOC, including a list of the hazards with associated risk level (high, medium, low) and their corresponding initial and predicted residual risk. Include a high level system description, a summary of how the Safety Case was developed, and what process/method was used to move through the risk assessment process.

3. **Introduction.** Provide a brief reasoning/rationale for the initiative. The scope of the proposed AMOC, whether it is more complex or far-reaching, will determine the need for increased scope and detail of the analysis to be performed.

4. **Section 1.** Current System/System Baseline. Provide a description of the current system or existing procedures as well as the corresponding (operational) system states. If the proposal entails a procedural change, describe the current procedure and its operational environment. If the current system or procedure is unique and has challenges associated with its unique situation, be sure to delineate.

5. **Section 2.** Proposed Change. Provide a description of the proposed change/procedure, identifying which safety parameters are involved.

6. **Section 3.** Safety Risk Management (SRM) Planning and Impacted Organizations. Prior to initiation of the safety analysis, SRM planning is necessary. It is essential to select the appropriate SRM participants, identify the SRM Panel, schedule milestones, and assign tasks and responsibilities. With regard to the organizations that are impacted by the change, describe the method used for collaboration between those organizations during the identification, mitigation, tracking, and monitoring of hazards associated with the change.

7. **Section 4.** Assumptions. If in the process of developing a procedure to validate an AMOC, any assumptions are made to make the evaluation of the change more manageable, clearly define and document them in this section.

8. **Section 5.** Phase 1: System Description. The description of the system/procedure, its operational environment, the people involved/affected by the change/procedure, and the equipment required to accommodate the proposal must be provided.

9. **Section 6.** Phase 2: Identified Hazards. The SRM Panel identifies hazards as a collaborative effort. The tool(s) and technique(s) used to identify hazards should be specified and discussed. The identified hazards are documented as well as their corresponding causes, the corresponding system states considered and the consequent potential outcome. It is important to realize that while identification of the worst credible outcome and the system state in which the worst

credible outcome occurs is required, system states with less severe outcomes should not be ignored.

10. Section 7. Phase 3 & 4: Risk Analysis & Risks Assessed. Describe the process used to analyze the risks associated with the identified hazards. Specify what type of data was used to determine the likelihood of risk occurrence (e.g., quantitative or qualitative) as well as the sources of the data. A risk matrix should provide an illustration of the predicted initial/current risk(s) associated with the identified hazards.

11. Section 8. Phase 5: Treatment of Risks/Mitigation of Hazards. If the existing controls and mitigations do not acceptably mitigate the hazards, then additional recommended safety requirements should be identified. An explanation of how the recommended safety requirements are expected to reduce the initial/current risk to an acceptable predicted residual risk level should be included. Low-risk hazards may still warrant recommended safety requirements.

12. Section 9. Tracking and Monitoring of Hazards. Once the proposal has been approved and implemented, tracking of hazards and verification of the effectiveness of mitigation controls throughout the lifecycle of the system or change are required. Also, the methodology for this tracking and monitoring should be outlined.

13. Appendices.

a. Documents Related to the SRMD. Include a list of documents (orders, directives, regulations, handbooks, and manuals) that pertain to the proposed change, which have been consulted in the development of the proposed change and the corresponding safety analysis.

b. Hazard Identification Tools. Provide information on the different tool(s), method(s), and technique(s) used during the safety analysis. (See Figure D-1, for a chart listing acceptable hazard analysis tools and techniques.)

c. Hazard Analysis and Risk Matrix. Depending on the analyses necessary, there might be one or more appendices with analyses. A risk matrix reflecting the initial and predicted residual risks should also be included.

d. Glossary. Include any acronyms and definitions for any terms you listed in the Safety Case.

Figure D-1. Acceptable Hazard Analysis Tools and Techniques

This chart from the ATO Safety Management System Manual, available on the Internet, displays acceptable hazard analysis tools for developing safety cases.

Air Traffic Organization Safety Management System Manual - Version 2.1

Table 3.1: Selection of Hazard Identification and Analysis Tools and Techniques

Tool or Technique	Summary Description	Page in Appendix G
Preliminary Hazard Analysis (PHA)	The PHA provides an initial overview of the hazards present in the overall flow of the operation. It provides a hazard assessment that is broad, but usually not deep.	G-1
Operational Safety Assessment (OSA)	The OSA is a development tool based on the assessment of hazard severity. It establishes how safety requirements are to be allocated between air and ground components and how performance and interoperability requirements might be influenced.	G-3
Comparative Safety Assessment (CSA)	The CSA provides management with a listing of all of the hazards associated with a change, along with a risk assessment for each alternative hazard combination that is considered. It is used to rank the options for decision-making purposes. The CSA's broad scope is an excellent way to identify issues that may require more detailed hazard identification tools.	G-5
Fault Hazard Analysis (FHA)	The FHA is a deductive method of analysis that personnel can use exclusively as a qualitative analysis or, if desired, can expand to a quantitative one. The FHA requires a detailed investigation of the subsystems to determine component hazard modes, causes of these hazards, and resultant effects on the subsystem and its operation.	G-8
Failure Mode and Effect Analysis (FMEA)	The FMEA determines the results or effects of sub-element failures on a system operation and classifies each potential failure according to its severity.	G-9
Failure Modes, Effects, and Criticality Analysis (FMECA)	The FMECA is an essential function in design from concept through development. To be effective, the FMECA is iterative to correspond with the nature of the design process itself. The FMECA identifies component and sub-system failure modes, including the impact of human error; evaluates the results of the failure modes; determines rates and probability; and demonstrates compliance with safety requirements.	G-9
What-If Analysis	The What-If Analysis methodology identifies hazards, hazardous situations, or specific accident events that could produce an undesirable consequence. One can use the What-If Analysis as a brainstorming method.	G-10
Scenario Analysis	The Scenario Analysis identifies and corrects potentially hazardous situations by postulating accident scenarios in cases where it is credible and physically logical.	G-12
Change Analysis	The Change Analysis analyzes the hazard implications of either planned or incremental changes (e.g., operation, equipment, or procedure).	G-13
Cause-Consequence Analysis	The Cause-Consequence Analysis combines the bottom-up and top-down analysis techniques of Event Trees and Fault Trees. The result is the development of potential complex accident scenarios.	G-15

Figure D-1. Acceptable Hazard Analysis Tools and Techniques, continued

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Tool or Technique	Summary Description	Page in Appendix G
Hazard and Operability Tool (HAZOP)	A group uses the HAZOP to analyze hazards of completely new operations and to review the significance of all of the ways that a process element can malfunction or be incorrectly operated. The technique is essentially a structured brainstorming using specific guide words.	G-17
Interface Analysis	One uses the Interface Analysis to discover the hazardous linkages between interfacing systems.	G-18
Accident/Incident Analysis	The Accident/Incident Analysis uses data on recorded hazardous events. One groups these events in various ways according to a pre-established criterion, usually a common cause or outcome. One then identifies the groupings as hazards.	G-19
Job Safety Analysis (JSA)	One uses this technique to assess in detail the safety considerations in a single job or task..	G-20
Energy Trace and Barrier Analysis (ETBA)	The ETBA is highly structured. It documents all energy sources in system. One identifies the energy sources as hazards. One identifies the barrier between the energy sources and the operators, maintainers, and other systems as mitigations.	G-21
Fault Tree Analysis (FTA)	An FTA is a graphical design technique that can provide an alternative to block diagrams. It is a top-down, deductive approach structured in terms of events. One models faults in terms of failures, anomalies, malfunctions, and human errors.	G-22
Management Oversight and Risk Tree (MORT)	One uses the MORT technique to systematically analyze hazards to examine and determine detailed information about the process and accident contributors.	G-24
Human Error Analysis (HEA)	HEA, in a system context, involves assessing each human-machine interface point, decision, or action for the potential for human error to adversely impact system performance or safety of the system and its users. There are a variety of methodologies for conducting these analyses.	G-26
Job Task Analyses (JTA)	The foundation of the performance of HEA is a task analysis, which describes each human task/sub-task within a system in terms of the perceptual (information intake), cognitive (information processing and decision making), and manual (motor) behaviors required of an operator, maintainer, or support person. It should also identify the skills and information required to complete the tasks; equipment requirements; the task setting; time and accuracy requirements; and the probable human errors and consequences of these errors. There are several tools and techniques for performing task analyses, depending on the level of analysis needed.	G-28

APPENDIX E. CONTINGENCY PLANNING LIMITATIONS

1. Point Identification. The proponent must submit contingency plans that address emergency recovery or flight termination of the unmanned aircraft (UA) in the event of unrecoverable system failure. These procedures will normally include Lost Link Points (LLP), Divert/Contingency Points (DCP) and Flight Termination Points (FTP) for each operation. LLPs and DCPs must be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart (or similar format). FTPs or other accepted contingency planning measures must also be submitted in Lat/Long format along with a graphic representation plotted on an aviation sectional chart, or other graphic representation acceptable to the FAA. The FAA accepts the LLPs, DCPs, FTPs, and other contingency planning measures submitted by the proponent, but does not approve them. When conditions preclude the use of FTPs, the proponent must submit other contingency planning options for consideration and acceptance. At least one LLP, DCP, and FTP (or an acceptable alternative contingency planning measure) is required for each operation. The proponent must furnish this data with the initial Certification of Waiver or Authorization (COA) application. Any subsequent changes or modifications to this data must be provided to the Unmanned Aircraft Systems (UAS) Integration Office (AFS-80) for review and consideration no later than 30 days prior to proposed flight operations.

2. Risk Mitigation Plans. For all operations, the proponent must develop detailed plans to mitigate the risk of collision with other aircraft and the risk posed to persons and property on the ground in the event the UAS experiences a lost link, needs to divert, or the flight needs to be terminated. The proponent must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, Navigational Aids (NAVAIDS), and congested areas. In the event of a contingency divert or flight termination, the use of a chase aircraft is preferred when the UAS is operated outside of Restricted or Warning Areas. If time permits, the proponent should make every attempt to utilize a chase aircraft to monitor the aircraft to a DCP or to the FTP. In the event of a contingency divert or flight termination, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

a. LLP Procedures.

(1) LLPs are defined as a point, or sequence of points, where the aircraft will proceed and hold at a specified altitude, for a specified period of time, in the event the command and control link to the aircraft is lost. The aircraft will autonomously hold, or loiter, at the LLP until the communication link with the aircraft is restored or the specified time elapses. If the time period elapses, the aircraft may autoland, proceed to another LLP in an attempt to regain the communication link, or proceed to an FTP for flight termination. LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established or fuel exhaustion occurs.

(2) For areas where multiple or concurrent UAS operations are authorized in the same operational area, a segregation plan must be in place in the event of a simultaneous lost link scenario. The deconfliction plan may include altitude offsets and horizontal separation by using independent LLPs whenever possible.

b. DCP Procedures.

(1) A DCP is defined as an alternate landing/recovery site to be used in the event of an abnormal condition that requires a precautionary landing. Each DCP must incorporate the means of communication with air traffic control (ATC) throughout the descent and landing (unless otherwise specified in the Special Provisions) as well as a plan for ground operations and securing/parking the aircraft on the ground. This includes the availability of control stations (CS) capable of launch/recovery, communication equipment, and an adequate power source to operate all required equipment.

(2) For local operations, the DCP specified will normally be the airport/facility used for launch and recovery; however, the proponent may specify additional DCPs as alternates.

(3) For transit and/or mission operations that are being conducted in Class A airspace or Class E airspace above flight level (FL) 600, DCPs will be identified during the flight to be no further than one hour of flight time at any given time, taking into consideration altitude, winds, fuel consumption, and other factors. If it is not possible to define DCPs along the entire flight plan route, the proponent must identify qualified FTPs along the entire route and be prepared to execute flight termination at one of the specified FTPs if a return to base (RTB) is not possible.

(4) It is preferred that specified DCPs are non-joint use military airfields, other government-owned airfields, or private-use airfields. However, the proponent may designate any suitable airfield for review and consideration.

c. Flight Termination Procedures.

(1) Flight termination is the intentional and deliberate process of performing controlled flight into terrain (CFIT). Flight termination must be executed in the event that all contingencies have been exhausted and further flight of the aircraft cannot be safely achieved or other potential hazards exist that require immediate discontinuation of flight. FTPs or alternative contingency planning measures must be located within power-off glide distance of the aircraft during all phases of flight and must be submitted for review and acceptance. The proponent must ensure sufficient FTPs or other contingency plan measures are defined to accommodate flight termination at any given point along the route of flight. The location of these points is based on the assumption of an unrecoverable system failure and must take into consideration altitude, winds, and other factors.

(2) Unless otherwise authorized, FTPs must be located in sparsely populated areas. Except for on- or near-airport operations, FTPs will be located no closer than five nautical miles (NM) from any airport, heliport, airfield, NAVAID, airway, populated area, major roadway, oil rig, power plant, or any other infrastructure. For offshore locations, the proponent must refer to appropriate United States Coast Guard (USCG) charts and other publications to avoid maritime obstructions, shipping lanes, and other hazards. Populated areas are defined as those areas depicted in yellow on a Visual Flight Rules (VFR) sectional chart or as determined from other sources.

(a) It is preferred that flight termination occurs in Restricted or Warning Areas, government-owned land, or offshore locations that are restricted from routine civil use. However, the proponent may designate any suitable location for review and consideration.

(b) The proponent is required to survey all designated areas prior to their use as an FTP. All FTPs will be reviewed for suitability on a routine and periodic basis, not to exceed six months. The proponent assumes full risk and all liability associated with the selection and use of any designated FTP.

(c) It is desirable that the proponent receive prior permission from the land owner or using agency prior to designation of this area as an FTP. The proponent should clearly communicate the purpose and intent of the FTP.

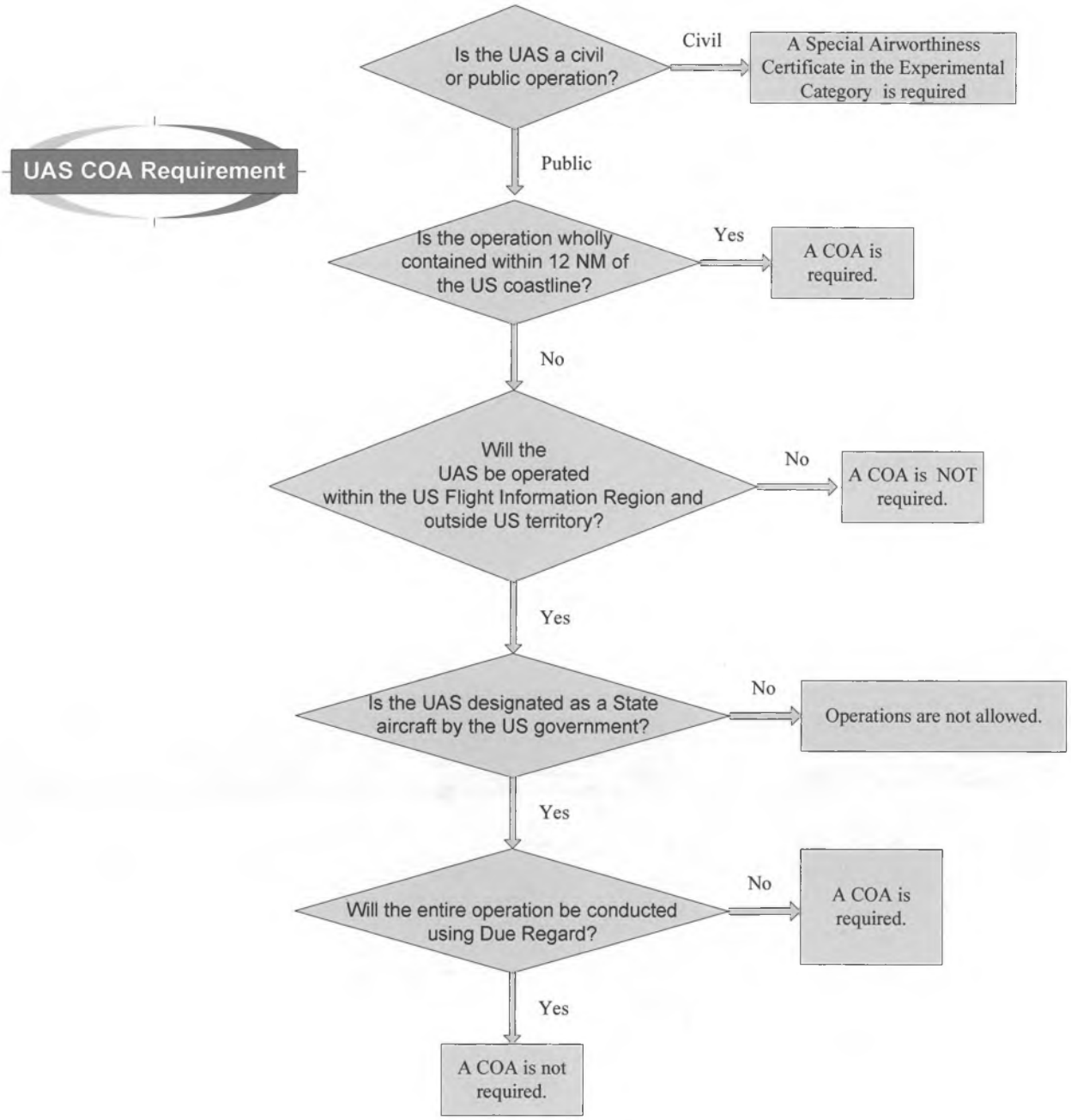
(d) For each FTP, plans must incorporate the means of communication with ATC throughout the descent as well as a plan for retrieval/recovery of the aircraft.

(e) Contingency planning must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDS, and congested areas to the maximum extent possible.

(f) In the event of a contingency divert or flight termination, if time permits, the use of a chase aircraft is preferred when the UA is operated outside of Restricted or Warning Areas.

(g) In the event of a contingency divert or flight termination or other approved contingency measures, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

APPENDIX F. UAS COA REQUIREMENT FLOWCHART



NOTICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

N JO 7210.766

Effective Date:
March 28, 2011

Cancellation Date:
March 27, 2012

SUBJ: Unmanned Aircraft Operations in the National Airspace System (NAS)

1. Purpose of This Notice. This notice provides information and interim guidance on air traffic policies and prescribes procedures for the planning, coordination, and services involving the operation of unmanned aircraft systems (UAS) in the NAS. These policies and procedures reflect current written directives and regulations and do not reflect any major changes. The intent of this notice is to consolidate all current directives and regulations into one document to assist with understanding UAS operations in the NAS.

2. Audience. This notice applies to the following Air Traffic Organization (ATO) service units: En Route and Oceanic, Terminal, Mission Support, and System Operations; the David J. Hurley Air Traffic Control System Command Center (ATCSCC); and the Flight Standards Service's divisions at Federal Aviation Administration (FAA) Washington headquarters and international field offices.

3. Where Can I Find This Notice? This notice is available on the MyFAA employee Web site at https://employees.faa.gov/tools_resources/orders_notices/ and on the air traffic publications Web site at http://www.faa.gov/air_traffic/publications.

4. Explanation of Changes. This notice is a continuation of N JO 7110.512, Unmanned Aircraft Operations in the National Airspace System, effective December 16, 2009, which was cancelled on December 15, 2010. Administrative changes (for example, website change and Air Force address) were made, and word meanings were clarified (for example, safety alerts were clarified to meet FAA Order JO 7110.65 standards). NOTAM requirements in the different classes of airspace, lost link requirements, guidance for the use of ATC visual clearances, and the requirement for the proponent to be responsible for strict compliance with the incident/accident and normal reporting provisions were added. This is to conform with the requirements in the certificate of waiver or authorization (COA) process. Also added is a clarification on the mixing of, or concurrent manned and unmanned aircraft operations in terminal airspace.

5. Action. Unmanned aircraft (UA) activities must be provided services following the policy, criteria, and procedures in this notice and other air traffic publications. When a conflict arises, supervisors must request a clarification from their respective service unit. Procedures/minima, applied jointly or otherwise, require the cooperation or concurrence of more than one facility/organization and must be documented in a letter of agreement (LOA). LOAs only supplement this notice. Any minima they specify must not be less than that specified in this notice unless appropriate military authority has authorized application of reduced separation between military aircraft. Additionally, the separation minima must not be less than authorized in the certificate of waiver or authorization (COA).

6. Certificate of Waiver or Authorization (COA). This section prescribes the policies, guidance, and procedures about COA applications for UAS operations.

a. Application Process. The ATO issues a COA to a public operator for a specific UA's activity. After a complete application is submitted, the FAA conducts a comprehensive operational and technical review. If necessary, provisions or limitations may be imposed as part of the approval to ensure the UA operates safely with other users.

b. Application Submission. Electronic applications should be submitted following the provisions provided on the following Web site:

http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/.

c. Application Information. The FAA must obtain enough information to assess the proposed operations following current standards and procedures. Because of the dynamic changes in the development of UA technologies, the applicant is responsible for adequately describing the proposed operations so an appropriate safety assessment can be conducted by the FAA. For this purpose, the following information may be required in a COA application.

(1) Organizational and operational points of contact.

(2) Operational description (for example, method of navigation, see-and-avoid).

(3) Systems description (for example, airframe, control station, communications).

(4) Airframe performance characteristics.

(5) Airworthiness.

(6) Contingency procedures (for example, lost command/control link, lost communications, and emergency).

(7) Avionics equipment.

(8) Lighting.

(9) Frequency spectrum analysis.

(10) Method of air traffic control (ATC) communications.

(11) Surveillance capability (for example, electronic and visual).

(12) System monitoring/recording capability.

(13) Flightcrew qualifications.

(14) Flight operations description (flight plan).

(15) Special circumstances.

(16) Reports of past incidents or accidents (for those applicants who have previously held a COA).

d. Emergency and Urgent Applications. The FAA must ensure procedures are available to accommodate real-time applications that will directly support emergency and law enforcement-type operations. UA operations that reduce safety must not be approved in any case.

(1) An emergency UAS COA may be considered when all of the following conditions apply:

(a) There is a situation of such distress or urgency that the possibility of loss of life is great.

(b) Manned flight is not possible or practicable due to a hazard or the operation cannot be conducted safely with manned flight, or manned assets are not available.

(c) The proposed proponent and UAS are operating under a current approved COA.

NOTE-
Requests for UAS COAs that fall outside of these perimeters must be processed through the normal online COA application process.

(2) Emergency UAS COAs will not be considered for:

(a) Demonstration flights.

(b) Flights to test capabilities.

(c) Training.

(d) Flights in Class B airspace.

(e) Flights over populated areas.

7. Operations.

a. Types and Authority. Current FAA policy for UAS operations is that no person may operate a UAS in the NAS without specific authority.

(1) Public.

(a) FAA policy restricts COAs to public operations as defined in title 14, Code of Federal Regulations (CFR), Part 1, Definitions & Abbreviations.

(b) For UAS operating as public aircraft, the authority is the COA.

(2) Civil.

(a) Civil applicants must apply for a Special Airworthiness Certificate–Experimental Category.

(b) For UAS operating as civil aircraft, the authority is special airworthiness certificates.

(3) Hobbyist.

(a) Hobbyists should follow the guidance contained in Advisory Circular (AC) 91-57.

(b) For model aircraft, the authority is AC 91-57.

NOTE-
The FAA recognizes that people and companies other than modelers might be flying UAS with the mistaken understanding they are legally operating under the authority of AC 91–57. AC 91–57 only applies to modelers and specifically excludes its use by persons or companies for business purposes.

b. Operations. UAS operations should normally be conducted in the following areas:

(1) Within active restricted areas.

(2) Within active warning areas.

(3) Within active prohibited areas, when authorized.

NOTE-

1. *Procedures for nonjoint-use DOD airfield operations will be specified by the DOD and listed in the COA.*

2. *For those operations that cannot be conducted for private recreational use or cannot be contained wholly within active restricted areas or warning areas, the UAS operations must be conducted following procedures outlined in the issued COA or Special Airworthiness Certificate-Experimental Category.*

c. General Procedures. UAS operating outside of restricted areas and warning areas must comply with the following:

(1) At least 60 business days before the proposed start of UAS operations, the proponent must submit an application for a COA, using the online application system at:

http://oeusers.faa.gov/oeaaa/Welcome.jsp.

NOTE-

1. *Approvals for UAS operations require the proponent to provide the UAS with a method that provides an equivalent level of safety comparable to see-and-avoid requirements for manned aircraft. Methods to consider include, but are not limited to, radar observations, forward- or side-looking cameras, electronic detection systems, visual observation from one or more ground sites, monitoring by patrol or chase aircraft, or a combination thereof.*

2. *Risk mitigations that would depend on the establishment of new types and categories of airspace are not considered acceptable. The NAS is established and configured through a rigorous regulatory process. Risk mitigations that result in the prohibition of the public's right to transit airspace will not be considered.*

(2) COAs must have a termination date not more than 1 year from the effective date unless renewed or revalidated. The COA expires on the stated termination date unless sooner surrendered by the proponent or revoked by the issuing agency.

(3) UAs may be equipped with standard aircraft anticollision or navigation lights following criteria in 14 CFR, section 23.1401. If installed, these lights must be operating during all phases of flight to enhance flight safety.

(4) UAs required to be equipped with an altitude encoding transponder must meet the specifications of 14 CFR, section 91.215. If equipped, the transponder must be set to operate on a code assigned by ATC. Unless the use of a specific, special-use code is authorized, the UAS pilot-in-command must have the capability to reset the transponder code while the UA is airborne. If the transponder becomes inoperative, the mission may be canceled and/or recalled at the discretion of the affected service area or air traffic facility.

(5) The proponent and/or its representatives must be responsible at all times for collision avoidance maneuvers with nonparticipating aviation activities and the safety of persons or property on the surface.

(6) The proponent and/or its representatives are responsible for strict compliance with the Incident/Accident and Normal Reporting Provisions contained in the Special Provisions section of each COA. Further guidance can be found in FAA Order JO 7210.3, Facility Management, Chapter 18, Waivers, Authorizations, and Exemptions. The Certificate of Waiver or Authorization, FAA Form 7711-1, provides additional clarity regarding the strict observance of the terms and conditions set forth in the COA.

8. Procedures. UAS operations may occur within Class A, C, D, E, and/or G airspace. Current FAA policy does not allow UAS operations in Class B airspace; however, the FAA will consider exceptional circumstances. Nighttime operations, for all classes of terminal airspace, may be authorized if the proponent requests approval and a safety analysis for such operation is approved by the FAA.

a. Terminal.

(1) Class C airspace is to be used on a case-by-case basis only. When operating in Class C airspace, UA operators must comply with the following FAA requirements:

(a) Strict compliance with the provisions of the COA is required.

(b) Lost link procedures must be clearly defined. Lost link procedures will be pre-coordinated with the appropriate ATC facility and included in the COA. At a minimum, they will include: lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points in the event recovery of the UAS is not feasible.

(c) In the event of lost link, the UA must squawk code 7600.

(d) Direct two-way radio communications with ATC and the UA pilot is required at all times.

(e) Compliance with ATC instructions for arrivals, departures, operations within, and through flight is required.

(f) Pilots/observers must have an appropriate FAA medical certificate or military/agency equivalent.

NOTE-
Pilots may not perform concurrent observer duties.

(g) Pilots must not conduct concurrent or simultaneous UAS operations in the presence of manned aircraft unless approved segregation procedures are written in a letter of agreement with the affected ATC facility and included in the COA.

(h) Use of visual separation by the UA pilot is not authorized.

(i) UA pilots and observers must be responsible for only one UA at a time.

(j) UA operations must not impede, delay, or divert manned operations (for example, excessive departure/arrival delays).

(k) UA operations must not be conducted over populated areas.

(l) All UA operations must be conducted during daylight hours unless authorized in the COA.

(m) Safety alerts will be issued in accordance with FAA Order JO 7110.65, paragraph 2-1-6.

(n) All operations must be conducted under visual meteorological conditions (VMC).

(o) Special VFR procedures are not authorized.

(p) A certified operating mode C/S transponder must be used.

(q) Compliance with mitigations identified in the FAA-approved safety analysis.

(r) A NOTAM issued by the proponent.

(2) UA operators using Class D airspace or operating with a control tower in Class E or G airspace must comply with the following FAA requirements:

NOTE-
All categories of Department of Defense (DOD) UAS operations that have a DOD Memorandum of Agreement (MOA) Class D COA will be conducted wholly within Class D airspace that has an associated DOD-controlled, non-joint-use airfield and must follow uniform air traffic control procedures at all locations. These procedures were developed in coordination with the FAA before implementation and a COA issued to the appropriate DOD air traffic facility.

(a) Strict compliance with the provisions of the COA is required.

(b) Lost link procedures must be clearly defined. Lost link procedures will be pre-coordinated with the appropriate ATC facility and included in the COA. At a minimum, they will include: lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points in the event recovery of the UAS is not feasible.

(c) In the event of lost link, the UA must squawk code 7600, if transponder equipped.

(d) Direct two-way radio communications with ATC and the UA pilot is required at all times.

(e) Compliance with all ATC instructions is required.

(f) Dedicated ground/chase aircraft observers are required for all UA flights.

NOTE-
Pilot may not perform concurrent observer duties.

(g) Pilots/observers must have an appropriate FAA medical certificate or military/agency equivalent.

(h) Pilots must not conduct concurrent or simultaneous UAS operations in the presence of manned aircraft unless approved segregation procedures are written in a Letter of Agreement with the affected ATC facility and included in the COA.

(i) Use of visual separation by the UA pilot is not authorized.

(j) UA pilots and observers must be responsible for only one UA at a time.

(k) UA operations must not impede, delay, or divert manned operations (for example, excessive departure/arrival delays).

(l) UA operations must not be conducted over populated areas.

(m) All UA operations must be conducted during daylight hours unless authorized in the COA.

(n) All UA operations must be conducted under VMC.

(o) Special VFR procedures are not authorized.

(p) A NOTAM issued by the proponent.

(3) UA operators using Class E and G airspace must comply with the following FAA requirements:

NOTE-
DOD UAS that have been authorized by the Class G section of the DOD/FAA MOA must remain within clear visual range of the pilot or a certified observer in ready contact with the pilot to ensure separation from other aircraft.

(a) Strict compliance with the provisions of the COA or DOD MOA is required.

(b) Lost link procedures must be clearly defined. Lost link procedures will be pre-coordinated with the appropriate ATC facility and included in the COA. At a minimum, they will include: lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points in the event recovery of the UAS is not feasible.

(c) In the event of lost link, the UA must squawk code 7600, if transponder equipped.

(d) Maintain direct two-way radio communication with ATC, when required in the COA.

(e) Compliance with all ATC instructions, if issued, is required.

(f) Dedicated ground/chase aircraft observers are required for all UA flights.

NOTE-
Pilot may not perform concurrent observer duties.

(g) Pilots/observers must have an appropriate FAA medical certificate or military/agency equivalent.

(h) Pilots must not conduct concurrent or simultaneous UAS operations in the presence of manned aircraft unless approved segregation procedures are written in a Letter of Agreement with the affected ATC facility and included in the COA.

(i) In the airport traffic pattern, the UA pilot is not authorized to use visual separation.

(j) UA pilots and observers must be responsible for only one UA at a time.

(k) UA operations must not have an adverse impact on manned operations (for example, excessive departure/arrival delays).

(l) UA operations must not be conducted over populated areas.

(m) All UA operations must be conducted during daylight hours unless authorized in the COA.

(n) Safety alerts will be issued in accordance with FAA Order JO 7110.65, paragraph 2-1-6.

(o) Additional services will be provided as workload and other conditions permit.

(p) All operations must be conducted in VMC.

(q) A NOTAM issued by the proponent.

b. En Route/Terminal Radar Approach Control (TRACON). UA flights in en route and TRACON airspace must be divided into two segments:

(1) Flight below flight level (FL) 180, including Class E and G airspace without a control tower, must comply with the following FAA regulations:

(a) Strict compliance with the provisions of the COA is required.

(b) Lost link procedures must be clearly defined.

(c) In the event of lost link, the UA must squawk code 7600, if transponder equipped.

(d) Direct two-way communications with the UA pilot is required at all times, unless not required in the COA.

(e) Compliance with all ATC instructions is required.

(f) Observers are required. Depending on the altitude of the UA operation, ground observers may be used.

(g) Chase aircraft acting as observers may be required.

(h) A dedicated chase pilot is required when specified.

(i) A dedicated observer is required when specified.

NOTE-
Pilot may not perform concurrent observer duties.

(j) Pilots/observers must have an appropriate FAA medical certificate or military/agency equivalent.

(k) In the airport traffic pattern, the UA pilot is not authorized to use visual separation, accept a clearance for a visual approach, or accept clearance to follow another aircraft.

(l) UA operations must not be conducted over populated areas.

(m) If installed, lights must be operational; night operations must have operational lights including anticollision and navigation lights, at a minimum.

(n) Safety alerts will be issued in accordance with FAA Order JO 7110.65, paragraph 2-1-6.

(o) All operations must be conducted in VMC.

(p) Operations may be conducted on an IFR flight plan or VFR.

(q) If operating IFR, a flight plan must be filed and followed once clearance is received.

(r) An operating mode C/S transponder must be used unless exempted by the COA.

(s) The COA may limit the number of UAs operating in a specific area.

(t) Operations in military operating areas and restricted areas require approval from the using agency.

(u) A NOTAM issued by the proponent.

(2) Flight above 18,000 feet MSL to FL 600, Class A airspace:

(a) The UA pilot must have direct two-way communications with each air traffic controller working the aircraft.

(b) Pilots/observers must have an appropriate FAA medical certificate or military/agency equivalent.

(c) Standard IFR separation will be applied unless noted in the COA.

(d) UA operations must not impede, delay, or divert manned operations.

(e) UA operations must not be conducted over populated areas.

(f) Safety alerts will be issued in accordance with FAA Order JO 7110.65, paragraph 2-1-6.

(g) All operations will be conducted on an IFR flight plan.

(h) An operating mode C/S transponder must be used.

(i) The UA should operate below or above reduced vertical separation minimum (RVSM) altitudes unless it is RVSM-certified. Requests for military non-RVSM-equipped UA in RVSM airspace remains at the discretion of each air traffic controller.

(j) Descent below 18,000 feet MSL in Class D, E, and/or G airspace without visual observers is not authorized.

(k) The pilot must be qualified for manned IFR flight.

(l) Whenever possible, the UA must enter Class A airspace from active restricted airspace. If restricted airspace is not available, a chase aircraft with a dedicated observer must be used until the UA has reached Class A airspace.

(m) Lost link procedures must be clearly defined. Lost link procedures will be pre-coordinated with the appropriate ATC facility and included in the COA. At a minimum, they will include: lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points in the event recovery of the UAS is not feasible.

NOTE-
In all classes of airspace, a COA is required for UA flights outside of active restricted or warning areas. The COA will contain additional requirements and compliance is mandatory.

c. Military Operations Interface Offices.

If military operations or facilities are involved, prior coordination by the following appropriate headquarters is required for subsequent interface with FAA. (See FAA Order JO 7110.65, TBL 1-1-3.)

Military Operations Interface Offices

Branch	Address
U.S. Navy / U.S. Marine Corps	Department of the Navy Chief of Naval Operations N8853 2000 Navy Pentagon Washington, DC 20350-2000
U.S. Air Force	HQ AFFSA/A3A Bldg 4 Room 240 6500 S. MacArthur Blvd Oklahoma City, OK 73169 Email: hqaffsa.a3a@tinker.af.mil
U.S. Army	Headquarters USAASA 9325 Gunston Road, Suite N319 Fort Belvoir, VA 22060-5582

9. Distribution. This notice is distributed to the following ATO service units: En Route and Oceanic, Terminal, Mission Support, and System Operations; the ATO Office of Safety; the David J. Hurley ATCSCC; and the Flight Standards Service's divisions at FAA Washington headquarters and international field offices.

10. Background. During the past few years, UA technology has been developing rapidly, driving a profound increase in requested operations in the NAS. Traditionally, UA operations have been conducted by the DOD or other Government agencies within restricted and warning areas. In recent years, the combined increase in requests by Government agencies has tripled, and forecasts suggest the increase will continue for the next 4 years. This notice incorporates information from other publications and serves as a compilation of air traffic topics relating to unmanned aircraft. In many cases, the information contained in this notice is complemented by guidance and directives from the Unmanned Aircraft Program Office under Aviation Safety and other regulations.

11. Authority to Change this Notice. The contents of this notice will be periodically reviewed and updated as required. Exceptional or unusual requirements may dictate procedural deviations or supplementary procedures to this notice. If there are suggestions for revision or any procedural deviation that alters the level, quality, or degree of service, obtain approval from the Vice President, Mission Support Services, Attention: Airspace Services.

12. Definitions.

a. Airworthiness – the condition in which the UAS conforms to its type certification (or military equivalent) and is in condition for safe operation.

b. Altitude –

(1) Mean sea level, unless otherwise specified.

(2) Flight level when followed by "FL."

(3) Above ground level when followed by "AGL."

c. ATC Communications – the voice or data relay of instructions or information between the UAS pilot and the air traffic controller and other NAS users, normally conducted by radio.

d. Autonomous – not controlled by others or by outside forces; independent judgment.

e. Autonomy – the quality of being autonomous; self-determination.

f. Catastrophic – the loss of the UA, other aircraft and/or loss of life.

g. Certificate of Waiver or Authorization (COA) – an FAA grant for a specific UA operation.

h. Civil Aircraft – means aircraft other than public aircraft.

i. Command/Control Link – the systems supporting the exchange of information between the ground control station and the airframe of the flight control systems.

j. Communication Link – the systems supporting the communication between the pilot and ATC, other aircraft, observers, or NAS users.

k. Direct Visual Control – the means by which the UA is controlled and the pilot/observer exercises see-and-avoid responsibilities.

l. Equivalent Level of Safety – an evaluation of a system and/or operation to determine the acceptable risk to people and property.

m. Ground Control Station – the location and equipment used by a pilot.

n. Hobby – model aircraft used for sport and recreation only.

o. Latency – the time incurred between two particular interfaces (for example, data link/communications).

p. Lost Link – loss of command and control link between control station and aircraft. There are two types of link.

(1) Up link – transmits command instructions to the aircraft, and

(2) Down link – transmits the status of the aircraft and provides situational awareness to the pilot.

q. Observer – ground-based personnel or observers within a chase aircraft.

r. Proponent – the person or organization responsible for the COA and operation of the UA.

s. Public Aircraft – aircraft operations that are inherently governmental as defined in 14 CFR, Part 1, Definitions and Abbreviations, Section 1.1, General definitions.

t. Segregation – setting apart from other activities. Segregation is not synonymous with required ATC separation standards. Therefore, segregation does not prescribe or mandate criteria such as vertical, lateral, or longitudinal distances.

u. Unmanned Aircraft (UA) – an aircraft operated without the possibility of direct human intervention from within or on the aircraft.

v. Unmanned Aircraft System (UAS) – airframe, ground control station, command and control links, and crewmembers.

13. Word usage.

a. *May* (need not be followed by a verb) means a procedure is optional.

b. *Must* (followed by a verb or the use of an appropriate action verb in the imperative sense) means a procedure is mandatory.

c. *Should* (followed by a verb) means a procedure is recommended.

d. *Will* (followed by a verb) indicates futurity; not a requirement for application of a procedure.

e. Singular words include the plural and plural words include the singular.

14. Related Publications.

a. Title 14, Code of Federal Regulations, part 91

b. FAA Order JO 7110.65, Air Traffic Control

c. FAA Order JO 7210.3, Facility Operation and Administration

d. FAA Order JO 7610.4, Special Operations

e. Obstruction/Evaluation/Airport/Airspace/Analysis (OEAAA), COA online

f. RTCA Special Committee SC-203 documents

g. Unmanned Aircraft Program Office Interim Operational Approval Guidance 08-01

h. Safety Management System Manual

i. FAA Order 1100.161, Air Traffic Safety Oversight

Elizabeth L. Ray
Vice President, Mission Support Services
Air Traffic Organization

2/18/11
Date Signed

Unmanned Aircraft System Operations
Industry "Code of Conduct"

The emergence of unmanned aircraft systems (UAS) as a resource for a wide variety of public and private applications quite possibly represents one of the most significant advancements to aviation, the scientific community, and public service since the beginning of flight. Rapid advancements in the technology have presented unique challenges and opportunities to the growing UAS industry and to those who support it. The nature of UAS and the environments which they operate, when not managed properly, can and will create issues that need to be addressed. The future of UAS will be linked to the responsible and safe use of these systems. Our industry has an obligation to conduct our operations in a safe manner that minimizes risk and instills confidence in our systems.

For this reason, the Association for Unmanned Vehicle Systems International (AUVSI), offers this Code of Conduct on behalf of the UAS industry for UAS operation. This code is intended to provide our members, and those who design, test, and operate UAS for public and civil use, a set of guidelines and recommendations for safe, non-intrusive operations. Acceptance and adherence to this code will contribute to safety and professionalism and will accelerate public confidence in these systems.

The code is built on three specific themes: Safety, Professionalism, and Respect. Each theme and its associated recommendations represent a "common sense" approach to UAS operations and address many of the concerns expressed by the public and regulators. This code is meant to provide UAS industry manufacturers and users a convenient checklist for operations and a means to demonstrate their obligation to supporting the growth of our industry in a safe and responsible manner. By adopting this Code, UAS industry manufacturers and users commit to the following:

Safety

- We will not operate UAS in a manner that presents undue risk to persons or property on the surface or in the air.
- We will ensure UAS will be piloted by individuals who are properly trained and competent to operate the vehicle or its systems.
- We will ensure UAS flights will be conducted only after a thorough assessment of risks associated with the activity. This risks assessment will include, but is not limited to:
- Weather conditions relative to the performance capability of the system
- Identification of normally anticipated failure modes (lost link, power plant failures, loss of control, etc) and consequences of the failures
- Crew fitness for flight operations
- Overlying airspace, compliance with aviation regulations as appropriate to the operation, and off-nominal procedures
- Communication, command, control, and payload frequency spectrum requirements
- Reliability, performance, and airworthiness to established standards

Professionalism

- We will comply with all federal, state, and local laws, ordinances, covenants, and restrictions as they relate to UAS operations.
- We will operate our systems as responsible members of the aviation community.
- We will be responsive to the needs of the public.
- We will cooperate fully with federal, state, and local authorities in response to emergency deployments, mishap investigations, and media relations.
- We will establish contingency plans for all anticipated off-nominal events and share them openly with all appropriate authorities.

Respect

- We will respect the rights of other users of the airspace.
- We will respect the privacy of individuals.
- We will respect the concerns of the public as they relate to unmanned aircraft operations.
- We will support improving public awareness and education on the operation of UAS.

As an industry, it is incumbent upon us to hold ourselves and each other to a high professional and ethical standard. As with any revolutionary technology, there will be mishaps and abuses; however, in order to operate safely and gain public acceptance and trust, we should all act in accordance with these guiding themes and do so in an open and transparent manner. We hope the entire UAS industry will join AUVSI in

adopting this industry Code of Conduct.

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AVIATION COMMITTEE

Recommended Guidelines for the use of Unmanned Aircraft

BACKGROUND:

Rapid advances in technology have led to the development and increased use of unmanned aircraft. That technology is now making its way into the hands of law enforcement officers nationwide.

We also live in a culture that is extremely sensitive to the idea of preventing unnecessary government intrusion into any facet of our lives. Personal rights are cherished and legally protected by the Constitution. Despite their proven effectiveness, concerns about privacy threaten to overshadow the benefits this technology promises to bring to public safety. From enhanced officer safety by exposing unseen dangers, to finding those most vulnerable who may have wandered away from their caregivers, the potential benefits are irrefutable. However, privacy concerns are an issue that must be dealt with effectively if a law enforcement agency expects the public to support the use of UA by their police.

The Aviation Committee has been involved in the development of unmanned aircraft policy and regulations for several years. The Committee recommends the following guidelines for use by any law enforcement agency contemplating the use of unmanned aircraft.

DEFINITIONS:

1. **Model Aircraft** - A remote controlled aircraft used by hobbyists, which is manufactured and operated for the purposes of sport, recreation and/or competition.
2. **Unmanned Aircraft (UA)** – An aircraft that is intended to navigate in the air without an on-board pilot. Also called Remote Piloted Aircraft and "drones."
3. **UA Flight Crewmember** - A pilot, visual observer, payload operator or other person assigned duties for a UA for the purpose of flight.
4. **Unmanned Aircraft Pilot** - A person exercising control over an unmanned aircraft during flight.

COMMUNITY ENGAGEMENT:

1. Law enforcement agencies desiring to use UA should first determine how they will use this technology, including the costs and benefits to be gained.
2. The agency should then engage their community early in the planning process, including their governing body and civil liberties advocates.
3. The agency should assure the community that it values the protections provided citizens by the U.S. Constitution. Further, that the agency will operate the aircraft in full compliance with the mandates of the Constitution, federal, state and local law governing search and seizure.
4. The community should be provided an opportunity to review and comment on agency procedures as they are being drafted. Where appropriate, recommendations should be considered for adoption in the policy.
5. As with the community, the news media should be brought into the process early in its development.

SYSTEM REQUIREMENTS:

1. The UA should have the ability to capture flight time by individual flight and cumulative over a period of time. The ability to reset the flight time counter should be restricted to a supervisor or administrator.
2. The aircraft itself should be painted in a high visibility paint scheme. This will facilitate line of sight control by the aircraft pilot and allow persons on the ground to monitor the location of the aircraft. This recommendation recognizes that in some cases where officer safety is a concern, such as high risk warrant service, high visibility may not be optimal. However, most situations of this type are conducted covertly and at night. Further, given the ability to observe a large area from an aerial vantage point, it may not be necessary to fly the aircraft directly over the target location.
3. Equipping the aircraft with weapons of any type is strongly discouraged. Given the current state of the technology, the ability to effectively deploy weapons from a small UA is doubtful. Further, public acceptance of airborne use of force is likewise doubtful and could result in unnecessary community resistance to the program.
4. The use of model aircraft, modified with cameras, or other sensors, is discouraged due to concerns over reliability and safety.

OPERATIONAL PROCEDURES:

1. UA operations require a Certificate of Authorization (COA) from the Federal Aviation Administration (FAA). A law enforcement agency contemplating the use of UA should contact the FAA early in the planning process to determine the requirements for obtaining a COA.
2. UA will only be operated by personnel, both pilots and crew members, who have been trained and certified in the operation of the system. All agency personnel with UA responsibilities, including command officers, will be provided training in the policies and procedures governing their use.
3. All flights will be approved by a supervisor and must be for a legitimate public safety mission, training, or demonstration purposes.
4. All flights will be documented on a form designed for that purpose and all flight time shall be accounted for on the form. The reason for the flight and name of the supervisor approving will also be documented.
5. An authorized supervisor/administrator will audit flight documentation at regular intervals. The results of the audit will be documented. Any changes to the flight time counter will be documented.
6. Unauthorized use of a UA will result in strict accountability.
7. Except for those instances where officer safety could be jeopardized, the agency should consider using a "Reverse 911" telephone system to alert those living and working in the vicinity of aircraft operations (if such a system is available). If such a system is not available, the use of patrol car public address systems should be considered. This will not only provide a level of safety should the aircraft make an uncontrolled landing, but citizens may also be able to assist with the incident.
8. Where there are specific and articulable grounds to believe that the UA will collect evidence of criminal wrongdoing and if the UA will intrude upon reasonable expectations of privacy, the agency will secure a search warrant prior to conducting the flight.

IMAGE RETENTION:

1. Unless required as evidence of a crime, as part of an on-going investigation, for training, or required by law, images captured by a UA should not be retained by the agency.
2. Unless exempt by law, retained images should be open for public inspection.

Association News

AUVSI Study Finds Unmanned Aircraft Industry Poised to Create 70,000 New Jobs in the U.S. in Three Years
New Study Finds Enormous Job Creation Potential Following Integration of Unmanned Aircraft into the National Airspace
12 March 2013

Today, AUVSI unveiled a new study, which finds that the unmanned aircraft industry is poised to create more than 70,000 new American jobs in the first three years following the integration of unmanned aircraft systems (UAS) into U.S. national airspace system (NAS). Integration is scheduled to take place in 2015. Beyond the first three years, the study projects that more than 100,000 new jobs will be created by 2025.

"This is an incredibly exciting time for an industry developing technology that will benefit society, as well as the economy," said Michael Toscano, president & CEO of AUVSI. "In recent years, unmanned aircraft technology has grown remarkably and is already proving useful in a range of domestic applications. Integrating UAS into the national airspace will lead to new and expanded uses, which means the creation of quality, high-paying American jobs."

Specifically, the study finds:

• In the first three years following integration into the NAS, more than 70,000 new jobs will be created.

• In the first three years following integration, the total economic impact stemming from the integration is projected to surpass $13.6 billion and will grow sustainably for the foreseeable future, cumulating in more than $82.1 billion in impact between 2015 and 2025. Economic impact includes the monies that flow to manufacturers and suppliers from the sale of new products as well as the taxes and monies that flow into communities and support the local businesses.

• The study projects integration will lead to 103,776 new jobs nationally by 2025. Many of these jobs are portable and will gravitate toward states with favorable regulatory structures and infrastructure. Future events – such as the establishment of FAA Test Sites – will ultimately determine where many of these new jobs will flow.

• Additional economic benefit will be seen through tax revenue to the states, which will total more than $482 million in the first decade following the integration.

• Every year that integration is delayed, the United States loses more than $10 billion in potential economic impact. This translates to a loss of $27.6 million per day that UAS are not integrated into the NAS.

The complete study, including state-by-state breakdowns of economic impact projections, is available at http://www.auvsi.org/econreport.

"While we project more than 100,000 new jobs by 2025, states that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not," wrote the report's author, Darryl Jenkins, a past professor at George Washington University and Embry Riddle Aeronautical University.

Nationally, the precision agriculture industry is expected to be the largest market for UAS technology, the AUVSI study finds. UAS will help farmers monitor crops and distribute pesticides, which could not only help improve efficiency, but also reduce the total amount of pesticides sprayed, saving money and reducing environmental impact. The public safety sector is another area that will benefit from the tremendous potential for UAS technology. UAS have the capability to help police and firefighters— who put themselves into harm's way every day to protect the communities they serve — do their job safely and efficiently.

The report was commissioned by AUVSI and developed by Jenkins, an aviation industry economist with more than 30 years of experience. Mr. Jenkins is the author of the Handbook of Airline Economics and previously served as the director of the Aviation Institute at George Washington University in Washington, D.C.

AUVSI Joins New Coalition to Promote Innovation, Jobs and Safety
Virginia Poised to Attract FAA Test Site
4 March 2013

The Virginia Technology Alliance for Public Safety (VATAPS) announced its official launch as a grassroots coalition promoting the economic development and public safety benefits of new technology in the field of Unmanned Aircraft Systems (UAS). The organization will highlight new jobs and investments associated with encouraging responsible research, development and testing of UAS in the Commonwealth.

"This is an opportunity to bring jobs, innovation and more technology to Virginia at a time when the federal government is cutting other programs," says Michael Toscano, AUVSI president & CEO and member of the alliance. "These are good paying jobs that will save lives, save money as well as spawn research programs at Virginia's colleges and universities." A soon to be released study conducted by AUVSI indicates Virginia could see 2,380 new jobs and $460 million in economic investment if the state embraces programs to research, develop and test UAS. The study indicates many of those jobs would pay starting salaries in the $55,000 range.

The Federal Aviation Administration (FAA) has announced plans to designate six test sites for development of UAS. Virginia is currently pursuing an FAA designation as part of a coalition lead by Virginia Tech.

The formation of VATAPS follows the passage of legislation by the Virginia General Assembly in the form of House Bill 2012 (HB2012) and Senate Bill 1331 (SB 1331), which place a two year-moratorium on the use of UAS. The legislation allows an exception for search and rescue operations, but fails to recognize other public safety applications and embrace the economic benefits of promoting responsible UAS- related research and development in the state.

"The advantages and uses of unmanned aircraft systems for public safety are greatly misunderstood and often falsely associated with military drones," says

Robert Fitzgerald, president of Bosh Global Services in Newport News and member of the alliance. "We are developing small, lightweight UAS that can aid in assessing natural disasters, fires, hazardous spills and other dangerous situations remotely without putting additional lives at risk."

"The safety of public officers in Virginia and across the country is of paramount importance. There are examples where officers have been endangered but could have been protected by the use of UAVs," says John Jones, executive director of the Virginia Sheriffs Association and member of the alliance. "Any Virginia law on UAVs needs to address existing emergency situations and other non-emergency applications. It is imperative that Governor Bob McDonnell take a very close look at this issue and its implications before he agrees to sign the bill into law."

Toscano adds, "The six FAA test sites for unmanned aircraft are expected to be an economic windfall for the states that are selected. But states that are advancing overly-restrictive legislation to limit the use of this technology are hurting their chances of attracting high-quality jobs. There is no reason we cannot responsibly advance this technology while simultaneously ensuring Americans' rights are protected. We would encourage officials in all states, and especially those seeking test sites, to work collaboratively to ensure that legislation doesn't undermine the job creation potential of unmanned aircraft or their state's ability to compete for a test site."

Charter members of VATAPS include aeronautics technology companies along with public safety and law enforcement agencies. VATAPS plans to launch an educational awareness and public information campaign as it recruits additional members.

AUVSI Statement on FAA's Request for Proposals to Receive an FAA UAS Test Site
14 February 2013

Today, AUVSI President & CEO Michael Toscano released the following statement on the Federal Aviation Administration's (FAA) request for proposals to develop and test unmanned aircraft systems (UAS) at six sites around the country:

"Today's announcement by the FAA is an important milestone on the path toward unlocking the potential of unmanned aircraft, and creating thousands of American jobs. Whether it is helping search and rescue teams, assisting in disaster response, or aiding scientific research, unmanned aircraft extend the human reach and allow us to accomplish dangerous and difficult tasks safely and efficiently.

"States across the country have been eager to receive this FAA designation because they recognize the incredible economic and job creation potential it would bring with it. While we would prefer the FAA not limit the number of test sites, we applaud the agency for finally taking this important step, which will help create jobs and ensure the U.S. remains a global leader in aviation innovation."

The FAA's announcement, which can be found here announcement, is part of the process to integrate UAS into the National Airspace System by 2015 as required by the FAA Modernization and Reform Act, which was signed into law on 14 Feb. 2012. AUVSI does not endorse any individual test site proposal.

With the demand for UAS on the rise, the industry recently released a Code of Conduct for UAS manufacturers and operators to ensure the safe, professional and respectful use of unmanned aircraft. The International Association of Chiefs of Police also released a set of guidelines last year for the use of unmanned aircraft, which addressed issues such as search warrants and image retention, and encouraged community engagement.

AUVSI Chairman Cautions Va. Governor on Pending UAS Moratorium Legislation
8 February 2013

AUVSI Chairman Peter Bale wrote a letter to Virginia Gov. Bob McDonnell regarding pending legislation that would impose a moratorium on the use of unmanned aerial vehicles by public agencies in Virginia. In the letter, Bale writes how the proposed moratorium will not only deny public safety officers the use of potentially life-saving technology, but also hurt Virginia's economy and potentially impede scientific endeavors at Virginia universities. Read the text of the letter is below.

Dear Governor McDonnell,

I would like to express serious concern with two pieces of pending legislation, Virginia House Bill 2012 and Virginia Senate Bill 1331, which would impose a two-year moratorium on the use of unmanned aerial systems (UAS) by police and government agencies in Virginia. As Chairman of the Association for Unmanned Vehicle Systems International (AUVSI), the world's largest non-profit organization devoted exclusively to advancing unmanned systems, I believe this proposed moratorium will not only hinder the ability of UAS to assist police, firefighters and other first responders in keeping Virginia communities safe, but also jeopardize current and future manufacturing jobs in the Commonwealth in the rapidly growing unmanned systems sector.

As you are well aware, public safety agencies see tremendous benefits in using UAS. They have the capability to help police and firefighters, who put themselves into harm's way every day in order to protect the communities they serve, do their job safely and efficiently. A UAS flying over a structure fire can provide firefighters with critical situational awareness, while reducing the danger to which they are exposed. A UAS flying over a wooded area can help police searching for a missing child quickly, when time is of the essence. And in times of tight budgets, UAS can provide the same capability of a manned helicopter at a fraction of the operational cost, saving taxpayer dollars.

However, the proposed moratorium would hinder these public safety agencies from using UAS.

I am also greatly concerned about the impact of this legislation on Virginia's economy. A forthcoming study commissioned by my organization projects that in the first three years following the integration of UAS into the national airspace, Virginia stands to gain 2380 new jobs and more than $460 million in economic impact.

Additionally, as you know, Virginia is interested in joining Maryland and New Jersey in putting forth a joint-bid for one of six test sites designated by the Federal Aviation Administration for the development of UAS. These test sites would most certainly be job creators and bring economic activity to the Commonwealth. However, if the moratorium were to become law, the plan for a test site, and the economic benefit that would come with it, will most certainly be in jeopardy.

Not only would future job prospects dim, but current businesses and those they employ would be at risk. More than 50 companies that manufacture UAS have a footprint in Virginia. A moratorium would create an unfriendly environment for these companies, which as a result might look to take their business, as well as jobs, elsewhere.

If the moratorium passes, scientific research could join public safety as a casualty. Right now, students at Virginia Tech are using UAS to research the spread of disease among plants and animals. Students at the University of Virginia are using 3D-printing to create an inexpensive UAS that could be quickly produced and deployed to respond to emergencies. These and other research pursuits by public institutions could be curbed by a moratorium.

As Governor, you have been an outstanding advocate for the potential of UAS. We greatly appreciate your support for the advancement of UAS technology as a tool to save time, save money and even save lives. We ask that you do everything you can to oppose this moratorium, which will hinder a remarkable technology and everyone who might one day be helped by it.

Sincerely,
Peter Bale
Chairman
Association for Unmanned Vehicle Systems International

AUVSI Congratulates Michael Huerta on his FAA Administrator Confirmation
3 January 2013

AUVSI President & CEO Michael Toscano today congratulated Michael Huerta on his confirmation as the administrator of the Federal Aviation Administration (FAA).

"For more than a year, Michael Huerta has led the FAA admirably as acting administrator, and we are pleased to see Congress make his appointment official," Toscano said. "These next several years are important ones for the FAA, as the agency moves forward with the integration of unmanned aerial systems (UAS) into the National Airspace System (NAS) and continues to develop the NextGen air traffic control system."

Toscano said, "This is a critical time for the FAA and the aerospace industry, and it is important that the FAA have a permanent leader to advance these priorities, especially the integration of UAS. This technology holds tremendous potential to save money, save time and, most importantly, save lives. Strong

and clear leadership is needed to make sure that the process stays on track, and Huerta's confirmation is a step in the right direction."

"We look forward to working with Administrator Huerta in the coming months and years to advance these innovations in a safe manner, in keeping with the FAA's primary mission. We are confident that under Administrator Huerta's leadership, the FAA will continue to ensure that the United States aerospace industry stays at the forefront of aviation safety and technological advances," Toscano said.

AUVSI to FAA: Focus on your Mission, Proceed with UAS Integration
28 November 2011

Selection of six UAS test sites more than three months delayed...and counting

AUVSI Chairman of the Board Peter Bale and President & CEO Michael Toscano today requested the Federal Aviation Administration (FAA) focus on its commitment to innovative partnerships and proceed with the integration of unmanned aerial systems (UAS) into the National Airspace System (NAS). The selection of six UAS test sites has been delayed by more than three months so far, despite a congressionally mandated timetable for the site selection process and overall integration.
Recently, the FAA has begun citing privacy issues as a reason for delaying UAS integration. However, the primary mission of the FAA is safety. The establishment of UAS test sites will help the FAA establish safety criteria for UAS, which is a completely separate issue from privacy concerns. Yet, in a letter to Rep. Howard McKeon (R-Calif.) earlier this month, Acting FAA Admistrator Michael Huerta wrote that the FAA must fulfill its obligations in a manner that, among other goals, "addresses privacy issues."

AUVSI Chairman of the Board Peter Bale and President & CEO Michael Toscano today released the following statement:

"Unmanned Aerial Systems (UAS) hold tremendous potential to keep the public safe, create lasting jobs, boost local economies and further advance the U.S. as a leader in technology and innovation. That's why, in February of this year, Congress required the FAA to safely integrate UAS into the U.S. airspace by September 2015.

"Congress had the foresight to lay out a multi-year timetable for the integration of UAS, so all stakeholders would have time to work collaboratively to advance this technology in a safe and responsible manner. The FAA should adhere to the will of Congress as well as focus on the agency's stated mission of providing 'the safest, most efficient aerospace system in the world.'

"AUVSI and its members are committed to working with all stakeholders to ensure privacy concerns are addressed while advancing this beneficial technology, and work is ongoing in this area. To date, AUVSI has met with a nearly a dozen privacy and civil liberties organizations, in addition to over 100 congressional offices, and AUVSI recently adopted an industry code of conduct that addresses privacy.

"There is also already a growing consensus among law enforcement agencies about the proper use of UAS. The International Association of Chiefs of Police (IACP) adopted UAS guidelines that have won praise from the ACLU. Three other law enforcement associations subsequently endorsed the IACP guidelines.

"As an industry, we support a continued, civil dialogue on privacy, but any such conversations should take place concurrent with the integration. The selection process for the six test sites are a separate issue and should be treated as such. Meanwhile, the FAA should adhere to its mission and do what it does best – focus on the safety of the U.S. airspace – while other, more appropriate institutions consider privacy issues.

"We request the FAA to immediately announce its UAS test site selection process to move UAS integration forward without further delay."

- Link to the Congressional Unmanned Systems Caucus Letter
- Link to AUVSI's previous letter to the FAA on the site selection delay

AUVSI Launches New Industry Career Center
19 November 2012

AUVSI launched a new industry Career Center today. AUVSI's Career Center is the leading employment resource for job-seekers and employers in the unmanned systems industry. Browse job listings or post a position today!

AUVSI Corporate Members can post unlimited jobs in the new career center for free!

AUVSI Launches Public Education Website to Highlight Benefits of Unmanned Systems
2 November 2012

Today AUVSI launched a public education website, www.increasinghumanpotential.org, to highlight the valuable and endless benefits of all unmanned systems and robotics.

The website shows how the unmanned systems and robotics industry literally increases human potential by working for the human in dull, dirty, dangerous and difficult tasks.

The site promotes the use of unmanned systems and robotics in the following categories:

By Land, Air and Sea
Jobs and Economy
Enhancing Public Safety
Mitigating and Monitoring Disasters
Helping the Environment
Fostering Education and Learning
Increasing Efficiency in Agriculture
FAA Flight Restrictions

Visit www.increasinghumanpotential.org today to learn more about the endless applications of unmanned systems and robotics.

AUVSI's Executive Vice President Gretchen West Testifies at Rep. Poe's Field Hearing on Privacy, Spoofing
25 October 2012

AUVSI's Executive Vice President Gretchen West testified at Rep. Ted Poe's (R-Texas) field hearing at Rice University on UAS privacy issues and spoofing.

Read West's opening statement:

Congressman Poe, I want to thank you, and the rest of the members for the opportunity to participate in today's forum on unmanned aircraft systems (UAS). I also want to thank Rice University for hosting this event, and congratulate President Leebron for his school's prowess in last year's NASA design showcase. In this prestigious event, Rice students won top awards for designing and building unmanned aircraft systems; this is one example of significant contributions American universities are making to the dynamic global aerospace industry.

There is a lot I would like to say about the tremendous potential of this technology, but before I do, let me first say a few words about the Association for Unmanned Vehicle Systems International – or AUVSI.

AUVSI is the world's largest non-profit organization devoted exclusively to advancing the unmanned systems and robotics community. We have more than 6,300 members in the United States, including 225 here in Texas, such as BAE Systems, Lockheed Martin, L-3 Communications, Raytheon and Rockwell Collins. Many other members are small businesses that support and supply this high-tech industry.

For years, AUVSI has been a leading advocate for the safe integration of unmanned aircraft into the United States National Airspace System. That's why we were delighted earlier this year when Congress recognized what those of us in the industry have known for a long time – that unmanned aircraft bring a host of positive benefits for our society and hold the remarkable potential to create jobs.

Whether it is helping search and rescue teams find a lost child, providing agricultural benefits or helping to fight wildfires, the applications of unmanned aircraft in the United States are virtually limitless. The benefits of UAS aren't just theoretical, however; the technology is already demonstrating its value in the United States, and its value to Texas. Let me provide just a few examples:

• U.S. Customs and Border Protection (CBP) currently uses unmanned aircraft to monitor the U.S. border, including the 1,241 mile border that Texas shares with Mexico. According to the CBP, unmanned aircraft in 2011 assisted with the seizure of thousands of pounds of narcotics and the apprehension of dozens of individuals taking part in illegal activities along the border.

• Texas is home to some of the world's largest energy companies, and several – including Shell, BP and ConocoPhillips – want to use UAS to more cost-effectively monitor critical energy infrastructure.

• Around June of each year, Texas and the Gulf Coast brace for hurricane season. Now, researchers at NASA are flying unmanned aircraft into and above hurricanes, something which is often too dangerous or difficult for manned aviation, to study how these storms form and develop to better predict hurricane tracks and make earlier evacuation decisions. As a result of UAS, Texas residents along the Gulf Coast will be much safer in the years to come.

These are just a few examples of the real-world applications of UAS. And there are many, many more.

In addition to the societal benefits of unmanned aircraft, the expansion of this technology will help drive economic growth in Texas and around the country. A 2010 study by our organization found that the integration of UAS into national airspace could add at least 23,000 new jobs by 2025, translating into roughly $107 million in wages each year.

The state of Texas, with an already thriving aerospace industry, is well positioned to reap these economic benefits. Texas has the human capital, with more than 200,000 aerospace and aviation industry workers currently employed at 1,665 companies. Meanwhile, the state is already hard at work attracting new aerospace jobs and investment including jobs in unmanned systems. The Texas Enterprise Fund, spearheaded by Gov. Rick Perry, has infused more than $44 million into aerospace-related projects since the fund was established in 2003.

As this technology advances, we are also mindful that unmanned aircraft must be operated in a safe and responsible manner. Safety has always been a top priority for our industry. In fact, safety is also one of three main pillars of the industry's new Code of Conduct, which was published this summer. We are in regular contact with the Federal Aviation Administration (FAA) and we have met with, and continue to maintain an open dialogue with, representatives from the pilot community, air traffic controllers and others with an interest in aviation safety.

We also steadfastly support Americans' right to privacy. And just like other new technologies such as cell phones, GPS and even social networking websites like "Facebook," a reasonable conversation about the implications of a new technology is entirely appropriate. That is why AUVSI has fostered a dialogue with privacy advocates and civil liberties organizations to discuss how we can ensure Americans' rights are protected as the use of this technology advances. In July, AUVSI endorsed federal privacy legislation that reaffirms citizens' Fourth Amendment rights with regard to the use of UAS. Our Code of Conduct also articulates our commitment to respecting individuals' privacy.

As we embark on this discussion of law enforcement's use of unmanned aircraft, it is important to emphasize that law enforcement already uses existing and developing technologies on manned aircraft. Unmanned aircraft simply offer a new platform for these technologies. I would also like to take a minute to recognize and applaud the proactive steps law enforcement officials have taken to ensure the safe and responsible use of UAS. Notably, the International Association of Chiefs of Police (IACP) last summer released its own detailed guidelines for UAS operations, which were quickly adopted by several other law enforcement organizations. The guidelines – which address privacy, the use of warrants and data retention – were not only praised by our industry, but the ACLU as well.

Law enforcement entities are already demonstrating a commitment to safety and privacy. Here again, Texas is leading the way.

Less than 300 miles from where we sit today, the Arlington Texas Police Department is developing what could one day be the model for law enforcement UAS programs across the country. The department has created a comprehensive framework for UAS operations that includes pre-flight checklists, flight and maintenance logs, training protocols and standard operating procedures for all UAS flights. Arlington plans to use UAS to survey multi-car crashes on interstate highways, to reduce the time officers spend roadside, cut down on pollution and clear congestion more quickly.

Clearly, we are just beginning to realize and unlock the tremendous potential of this technology. Unmanned aircraft extend our human potential and allow us to execute dangerous or difficult tasks safely and efficiently, saving time, saving money and, most importantly, saving lives.

As an industry, we believe all stakeholders can work together to advance this technology in a thoughtful way that recognizes the benefits and creates jobs while protecting Americans' safety, as well as their individual rights to privacy.

Thank you, and I look forward to your questions.

AUVSI Welcomes Formation of Senate Unmanned Aerial Systems Caucus
28 September 2012

Sens. Inhofe, Manchin Form Bipartisan Caucus to Educate Senators about the Potential Applications of Unmanned Systems

AUVSI welcomed the announcement from Capitol Hill that Sens. Jim Inhofe (R-Okla.) and Joe Manchin (D-W.Va.) formed the Senate Unmanned Aerial Systems Caucus. The mission of the bipartisan caucus will be to educate senators and staffers on the capabilities of unmanned systems and work closely together to best shape the unmanned systems policymaking process.

"I would like to commend Senators Inhofe and Manchin for their leadership and commitment in establishing the caucus, which will enable AUVSI to work with the Senate and stakeholders on the important issues that face the unmanned systems community as the expanded use of the technology transitions to the civil and commercial markets," said AUVSI President & CEO Michael Toscano. "It is our hope to establish the same open dialogue with the Senate caucus as we have for the past three years with the House Unmanned Systems Caucus."

Unmanned systems extend human potential, allowing us to execute dangerous or difficult tasks safely and efficiently. Whether bolstering search and rescue efforts; studying and aiding in natural and man-made disasters; or supporting security missions and protecting the environment, unmanned systems are capable of saving time, saving money and, more importantly, saving lives.

"I am enthusiastic about the announcement that Senator Manchin (D-W.V.) and I were able to introduce and will co-chair the Senate Unmanned Aerial Systems Caucus," said Sen. Inhofe. "The caucus will help educate senators and staff on the importance of all unmanned systems, including air, land and sea-based platforms. Federal policies and legislation relating to unmanned systems are still in its infancy and concerns of the platforms need to be addressed. This caucus will help develop and direct responsible policy to best serve the interests of U.S. national defense and emergency response, and work to address any concerns from senators, staff and their constituents. I hope that all of our colleagues in the Senate will join and participate in this bipartisan caucus."

Over the next decade, there will be an exponential growth in unmanned systems technology and operations. Congress will play a critical role in writing and passing laws that will set policy, direct oversight and provide direction for unmanned systems integration, development and utilization. The Senate Unmanned Aerial Systems Caucus will serve as a venue to discuss issues.

"The increased use of unmanned aerial systems carries great potential – and great risk," Sen. Manchin said. "It's important for all of us to understand how we can use this advancing technology to strengthen our national security and improve our ability to respond in case of natural or man-made disasters, while at the same time ensuring the privacy of all of our law-abiding American citizens. I am so appreciative of Senator Inhofe's work on this issue, and I look forward to working together in a bipartisan way to keep our colleagues updated on the emerging policy issues involving this technology."

AUVSI Holds Largest Gathering of Unmanned Systems, Robotics Technology in the World
20 August 2012

The Association for Unmanned Vehicle Systems International turned the Mandalay Bay Convention Center into a robotics playground 6-9 August, when it brought together the largest display of unmanned systems and robotics technology in the world.

With more than 550 exhibitors and 7,400 attendees, AUVSI's Unmanned Systems North America 2012 highlighted the future of unmanned systems in military, civilian and commercial applications.

Highlights from the conference include affirmation for unmanned systems in life saving applications in the military; a commitment to integrate unmanned systems into the U.S. National Airspace System; and a pledge from the industry to work with government, civil liberties groups and others to ensure integration is done safely with respect to privacy.

Day one of the convention opened with Federal Aviation Administration (FAA) Acting Administrator Michael Huerta highlighting the progress his agency has made in working to integrate unmanned air vehicles into the national airspace.

Part of the framework to integrate UAS is moving ahead, he said, with the FAA due to soon ask for proposals to manage the upcoming six test sites still currently under selection.

"We need to make sure we use these sites to obtain the very best data that we possibly can," he said.

The agency has also streamlined its certificate of authorization process, with the average non-emergency COA approval down to 60 days, and the FAA now provides two-year authorizations instead of one. This expedited process has been possible due to an internal reorganization that moved all the FAA's unmanned work into its new Unmanned Aviation Systems Integration Office.

Though the agency has come a long way, Huerta said it still has more to go.

"We need to change the way we do business as well," he said.

Huerta highlighted three core areas the FAA needs to work on: make the airspace system smarter and safer, bring technology benefits to the users, and task employees to think creatively and innovatively in a tight budget.

"There's a lot of work that needs to be done to move integration for all UAS forward, but I'm very, very optimistic that we will get there."

Day two kicked off with an affirmation of the life saving capabilities of unmanned systems when Navy Seal Lt. Cmdr Rorke Denver addressed attendees.

Denver has seen action in the Middle East, Africa and Latin America, and has made use of unmanned aircraft and unmanned underwater vehicles.

"The fact of the matter is ... I have been a benefactor from the technologies and the things that have been developed" by the people in the room, he said.

He has thrown a Raven into the air, similar to a scene in the movie, and "I've had ScanEagle, Tiger Shark, all kinds of Predators above my head helping leverage those technologies in a way that protected my guys, it made us win on the battlefield when we might not have otherwise."

He said he also made use of an unmanned underwater vehicle off the coast of Monrovia.

"We're in there with these lead lines and slates doing this classical SEAL UDT mission and this EMD guy comes walking up" with a vehicle that looks like a torpedo.

It was an unmanned underwater vehicle, "somebody probably made it in here," he said. "You throw this thing in the water and it's got side-scan radar ... an hour later it pops onto the surface, we plug it into a laptop and up pops a map" and the team was able to plot its path.

"Just remarkable technology," he said.

Chairman's Address

Finally, AUVSI Chairman of the Board Peter Bale promised attendees that the industry will, in time, figure out how to make these advances and respect all values.

"I don't want to look back on the process of figuring this out and have regrets that we learned lessons with blood or scandal that could have been avoided," Bale said. "The technology has arrived and is ready. That means it is time to figure out the public safety and civil rights issues."

Bale went on to say, "The FAA test ranges and the window until September of 2015 represent our chance to get this right on the front end. None of us, in or out of government, are quite sure how this process will unfold but I am pledging this organization's support and asking for your personal and professional assistance in answering these questions.

"Parallel with the FAA test range process that figures out the flight safety procedures and standards, I want to ask the law enforcement, criminal justice and civil rights communities to use these three years to help sort out the civil rights issues. I am pledging myself and this organization to engage in a serious dialogue with any and all concerned.

"Politics does not have to be zero sum. This is not a choice between embracing technology or respecting deeply cherished values — we can do both. I look forward to the process and let's get it right. There is too much at stake not to."

SAVE THE DATE: AUVSI's Unmanned Systems 2013 will be held in Washington, DC at the Walter E. Washington Convention Center, 12-15 August 2013.

AUVSI Applauds Police Chiefs for Adopting Guidelines for the Safe and Responsible Use of Unmanned Aircraft
16 August 2012

Today, AUVSI applauded the International Association of Chiefs of Police (IACP) for adopting guidelines for the use of unmanned aircraft systems (UAS). The guidelines provide law enforcement agencies an outline of how to use UAS safely and responsibly, and with respect to individuals' privacy. The adoption of the IACP guidelines follows the recent adoption of AUVSI's "Code of Conduct" for those who design, test and operate UAS.

"We applaud the IACP for putting forward these guidelines as part of law enforcement's simultaneous commitment to protect communities, as well as the rights of the members of those communities," said Michael Toscano, president and CEO of AUVSI. "Unmanned aircraft could help law enforcement agencies with missions such as search and rescue or crime scene photography, often at a lower cost than manned aircraft. The more the law enforcement community, privacy advocates, government and other stakeholders work together to address issues such as privacy, the faster we can unlock the incredible potential of unmanned aircraft to help save time, save money and most importantly, save lives."

The IACP guidelines, which can be found here, cover community engagement, system requirements, operational procedures and image retention. They direct law enforcement agencies to engage with the community, specifically their governing body and civil liberties advocates, about how UAS will be used and protections put in place to uphold citizens' rights. The guidelines also encourage notifying those living and working in the vicinity of aircraft operations, when possible. The guidelines call for a transparent implementation process for agencies desiring UAS, including a period of public comment.

The guidelines include specific steps law enforcement should take to respect the privacy of individuals:
• Where there are specific and articulable grounds to believe that the (unmanned aircraft) will collect evidence of criminal wrongdoing and if the (unmanned aircraft) will intrude upon reasonable expectations of privacy, the agency will secure a search warrant prior to conducting the flight.
• Unless required as evidence of a crime, as part of an on-going investigation, for training, or required by law, images captured by a UAS should not be retained by the agency.
• Unless exempt by law, retained images should be open for public inspection.

A poll conducted earlier this year by Monmouth University found strong public support for law enforcement's use of UAS in search and rescue missions, tracking runaway criminals, protecting U.S. borders and controlling illegal immigration. Currently, however, fewer than 3% of law enforcement units have aviation assets because of the high operating costs of manned aircraft. UAS provide a cost-effective alternative. The Sheriff's Office in Mesa County, Colo., operates an unmanned aircraft at the cost of $3.36 per hour, compared to $250 to $600 per hour for a manned aircraft. The purchase price of a UAS is also significantly less than a manned aircraft, costing about the price of a patrol car with standard police gear. The vast majority of UAS currently flying in the U.S. are small models that weigh less than 25 lbs and can fit in the trunk of a car.

Read more about how law enforcement agencies around the country are using UAS:
• The New Eye in the Sky over Mesa County – 9News, Denver
• Arlington PD Testing Unmanned Aircraft – KXAS, Dallas
• Drones tested as tools for police and firefighters – *Los Angeles Times*

AUVSI Announces Newly Elected Board of Directors
31 July 2012

AUVSI announces its newly elected leaders on its Board of Directors.

Officers elected for the 2012-2013 term are Peter Bale, chairman; John Lademan, executive vice chairman; Ralph Alderson, first vice chairman and Joe Brannan, treasurer. Additionally, John Lambert continues as immediate past chairman for this term.

Newly elected to the AUVSI Board of Directors:
Jason Grabinsky
Heather Griffith
Steve Pennington
Chad Partridge
Dave Seagle
Michelle Kalphat

Continuing AUVSI Board of Directors:
Virginia Young
Grant Begley
Matt England
Gene Fraser
Stephen Newton
David Place
Peter Smith
Tim Heely
Neil Hunter
Rick Lynch
Mark Patterson

"These officers and directors represent a wide range of companies and institutions in the global unmanned systems and robotics community, bringing expertise in technology, applications and markets related to this rapidly emerging industry," said AUVSI Chairman of Board of Directors Peter Bale. "We congratulate those elected and look forward to their service on the board."

The new term of office for the board of directors starts at AUVSI's Unmanned Systems North America 2012 in Las Vegas, 6-9 August, where more than 8,000 attendees from 40 countries will see 550+ exhibits and participate in 100+ educational sessions, showcasing the present and future capabilities of unmanned systems and robotics technology.

Unmanned Aircraft Industry Backs Privacy Legislation
By Melanie Hinton
19 July 2012

Today, the Association for Unmanned Vehicle Systems International (AUVSI) announced support for legislation to reaffirm individuals' Constitutional protections against unreasonable searches. An amendment included in the Department of Defense Appropriations bill, introduced by Rep. Frank LoBiondo, R-N.J., only allows funding for the operation of UAS "in accordance" with the Fourth Amendment.

"The unmanned aircraft systems industry strongly supports Rep. LoBiondo's amendment included in the Defense Appropriations bill, which reaffirms Americans' Constitutional rights. Unmanned aircraft can help our police, fire fighters and first responders save time, save money and most importantly, save lives, while fully respecting Americans' rights to privacy. This amendment is right inline with our commitment to the safe and responsible integration of unmanned aircraft into our skies," said Michael Toscano, president & CEO of AUVSI.

Earlier this year, Congress passed, and the president signed into law, legislation requiring the Federal Aviation Administration to plan for the integration of unmanned aircraft into the National Airspace System by 2015. Since then, AUVSI has met with a variety of stakeholders, including nearly a dozen privacy advocates and civil rights groups, to listen to their concerns and begin working toward solutions.

The industry's backing of the privacy legislation is just the latest example of its commitment to the safe and responsible integration of UAS into the National Airspace System. The industry recently released a Code of Conduct for UAS manufacturers and operators to ensure the safe, professional and respectful use of unmanned aircraft. The Code of Conduct set forth guidelines to provide AUVSI members - and those who design, test and operate UAS for public and civil use - with recommendations for their safe, non-intrusive operation, including respect for the privacy of individuals.

"Like with any merging technology, it is important that a commitment to safety, professionalism and respect is part of the foundation of its use. The Code of Conduct reflects how the rights of individuals and the safety of all users of civil airspace are our top priority as we work to unlock the incredible potential this technology holds," Toscano said.

AUVSI Submits Testimony for Congressional Subcommittee Hearing on Using UAS in the Homeland
18 July 2012
On 18 July, AUVSI released prepared testimony from Michael Toscano for the House Homeland Security – Subcommittee on Oversight, Investigations and Management hearing, "Using Unmanned Aerial Systems Within the Homeland: Security Game Changer? " scheduled for Thursday, 19 July at 9:30 a.m.

In the testimony, Mr. Toscano discusses the many potential uses for unmanned aircraft systems (UAS), and the industry's efforts to ensure a safe and responsible integration of UAS into the national airspace. The testimony lays out the UAS industry's commitment to safety, highlighted by the industry's recently released "Code of Conduct," as well as the technological advancements to help ensure their safe operation.

AUVSI Releases "Code of Conduct" for Unmanned Aircraft Systems Operations
Promotes Safe, Responsible Use as Integration into Airspace Proceeds
02 July 2012
AUVSI published the "Unmanned Aircraft System Operations Industry Code of Conduct" www.auvsi.org/conduct, a set of guidelines to provide AUVSI members – and those who design, test and operate UAS for public and civil use – with recommendations for their safe, non-intrusive operation.

Central to the "Code of Conduct" is the need for "safety, professionalism and respect" in all uses of UAS. This code is meant to provide UAS industry manufacturers and users a convenient checklist for operations and a means to demonstrate their obligation to supporting the growth of the industry in a safe and responsible manner.

"The emergence of unmanned aircraft systems represents one of the most significant advancements to aviation, the scientific community, and public service since the beginning of flight," said Michael Toscano, President and CEO of AUVSI. "With a commitment to safety, professionalism and respect, we can ensure unmanned aircraft are integrated responsibly into civil airspace."

The guidelines recommend when and by whom UAS should be flown, to minimize risk. They commit to complying with all federal, state and local laws and cooperating with authorities at all levels. The guidelines also commit to respecting other users of the airspace, the privacy of individuals, the concerns of the public and improving public awareness of UAS.

"By proactively adhering to these guidelines, we want to demonstrate how the rights of individuals and the safety of all users of civil airspace are our top priority, as we work to unlock the incredible potential this technology holds," Toscano said.

The FAA Modernization and Reform Act signed into law on February 14, 2012, included a provision requiring the FAA to safely integrate UAS into the national airspace. The law created a number of deadlines for the FAA to meet on its way to the safe integration of UAS by September 2015.

Unmanned aircraft systems extend human potential, allowing individuals to execute dangerous and often difficult tasks safely and efficiently. Whether it is aiding search and rescue efforts, navigating through airspace too hazardous for manned vehicles, or furthering scientific research, UAS are capable of saving time, saving money and most importantly, saving lives.

To view the Code of Conduct, visit www.auvsi.org/conduct.

AUVSI Rejects Calls for Unlawful Destruction of Unmanned Aerial Systems
18 May 2012
Today, the Association for Unmanned Vehicle Systems International (AUVSI) released the following statement from President and CEO Michael Toscano in response to recent depictions in the media that put the unlawful destruction of unmanned aerial systems in a positive light:

"To advocate for people to shoot down any object from U.S. airspace is irresponsible, dangerous and unlawful. Unmanned aerial systems are being designed to serve the public good, such as helping search and rescue officers find missing children, monitor weather and wildlife, provide disaster relief and respond to emergencies, as they did in the Fukushima nuclear crisis in Japan last year. The myriad of important uses will be imperiled if they become targets. Meanwhile, the suggestion that Americans take up arms against unmanned aircraft also endangers citizens on the ground.

"AUVSI welcomes civil discussions about privacy and the proper uses of unmanned aircraft, but it cannot and does not condone violence against technology intended to keep citizens safe while saving taxpayer dollars."

Syndicated columnist Charles Krauthammer recently stated that unmanned aircraft should be banned entirely in the United States, and said that "I would predict — I'm not encouraging, but I would predict, the first guy who uses a Second Amendment weapon to bring down a drone that's hovering over his house is gonna be a folk hero in this country."

The NBC television show "Harry's Law" also recently portrayed its main character shooting down a "drone" in just such a situation.

Under New Leadership, FAA's Unmanned Aircraft Systems Integration Office Meets Its Deadline
by Timothy Adelman, Aviation Attorney
14 May 2012

The FAA's Unmanned Aircraft Systems Integration Office (formally the UAPO) and the Department of Justice's National Institute of Justice's Aviation Technology Program (NIJ) have worked diligently over the past 18 months to identify the hurdles to public safety unmanned aircraft operations in the National Airspace System (NAS) and to provide solutions to those hurdles. With the help of the Congressional Unmanned Systems Caucus, chaired by Reps. Buck McKeon (R-Calif.) and Henry Cuellar (D-Texas), the FAA's Reauthorization Bill provided language for a roadmap to lessen the hurdles associated with the deployment of small unmanned aircraft systems (sUAS) by public safety.

When the FAA's Reauthorization Bill was signed into law by President Obama on 14 February 2012, the FAA was faced with a deadline to enter into agreements with appropriate government agencies to simplify the process for issuing Certificates of Waiver or Authorization (COAs) to operate sUAS public aircraft. While the UAS Integration Office had already been working on a solution in advance of the Bill, the 90-day deadline turned up the heat to get the solution completed. Under its new leadership by James Williams, head of the FAA's Unmanned Aircraft Systems Integration Office and in direct coordination with NIJ, the FAA has developed a streamlined COA process for public safety.

With more than 18,000 domestic law enforcement agencies in the United States and many more public safety agencies, including fire service and emergency response teams, the potential demand for aviation assets is high. Through various studies over the years, there are less than 400 law enforcement aviation units. In other words, less than 3% of all law enforcement organizations have aviation assets to support their daily operations. Why so few? Largely because of the cost and complexity of operating manned aircraft.

In 2007 the Bureau of Justice Statistics published a report that examined the use of aviation assets in large law enforcement organizations (100 officers or more). They identified 201 aviation units operating in 46 states. Those units spend more than $300 million in one year on aircraft purchases, leasing, financing, maintenance and fuel, an average of $1.5 million per aviation unit. While almost all law enforcement agencies would benefit from aviation units, not many can afford them.

Unmanned Aircraft Systems (UAS) provide an affordable solution to those agencies that need "eyes in the sky" but don't have the budget or for those agencies that need to supplement their current aviation units with more cost effective aircraft for specific missions. In December 2009, NIJ hosted a conference for all public safety agencies interested or currently using UAS. During that conference, the agencies identified the anticipated scenarios for which UAS could provide vital support: tactical teams, forensics, fire safety, high-risk warrants, marijuana eradication, photographing critical infrastructure, corrections, traffic for ingress/egress under special conditions, payload detection of HazMat, aid in evacuation after natural disasters, critical incidents, and post-event forensics.

Most domestic public safety agencies are looking for small UAS (sUAS) to provide immediate eyes in the sky in response to a defined incident. The anticipated use of sUAS does not include routine patrol, which would require flight for extended distances over an extended time period. Operations would occur within "defined incident perimeter" in close proximity to the individual controlling the aircraft on the ground and most operations would be for a relatively short duration, i.e. less than an hour. Therefore, the FAA's UAS Integration Office in collaboration with NIJ designed a solution that would permit the operation of sUAS in a less restrictive manner than current FAA policy.

While the COA process will continue, many of its barriers will be reduced. COAs will be available for operations within a defined incident perimeter throughout an agency's jurisdiction. There will be no need to obtain an emergency COA for a specific mission. As long as the agency operates within its COA, it can fly when it wants and where it wants. COAs will require line of sight operations under 400' AGL during VFR conditions. The COA will permit certain operations within Class C, D, E and G airspace. In addition, and with certain restrictions, agencies can get a COA that would involve operations within 5nm of an airport.

The FAA's UAS Integration Office and NIJ will develop a knowledge base exam for those operators that do not have an FAA issued airman certificate. This exam will help agencies demonstrate an adequate level of airman knowledge to ensure the safe operation of UAS, a tremendous asset for individual agencies risk management programs. The COA process will also provide a sample Safety Risk Analysis Plan ("SRAP") to help the agency identify its areas of risk and ensure safe operating procedures.

The FAA is working to streamline the current online application to lessen the burden on agencies applying for COAs and to help expedite review. The COA process currently requires a lot of technical detail on the aircraft and equipment. The FAA, through its work with NIJ, will develop a master list of sUAS that an agency can use to simply select the aircraft with appropriate equipment. Manufacturers will be able to have their aircraft included in this master list through an independent assessment process.

With model standard operating procedures, SRAP, operating limitations and training curriculum, agencies will have an easier time applying for COAs. The streamlined process will eliminate the need to recreate the wheel and simply provide agencies with best practices for sUAS operations.

The news for public safety agencies and manufacturers is good. The FAA was once considered a major hurdle for public safety operations. While I still hear agencies and manufacturers claim that the barrier to sUAS operations is the FAA, that is no longer an accurate statement. The FAA has already issued operational COAs for specific jurisdictions to a number of agencies. Building upon that experience and through discussions with NIJ and public safety officers, the FAA created the new COA process to help reduce the administrative burden for agencies while at the same time ensure adequate safety.

While the new "Common Strategy" which streamlines the COA process has been agreed upon, there remains an ongoing implementation process. A few of these implementation steps include:

- Creating an online knowledge exam for operators.
- Creating a sample SRAP for agencies to use when applying for a COA.
- Revising the on-line COA application website to incorporate the streamlined process.
- Educating manufacturers and end-users on the new process.

The FAA, DOJ and DHS Science and Technology Directorate are working together to host a multiday sUAS focused conference that will include both educational seminars and live sUAS demonstrations by active law enforcement sUAS units. This conference will mark the kickoff for the new "Common Strategy" and it's streamlined COA process. Attendees will have an opportunity to hear from the FAA, DHS S&T and DOJ regarding sUAS operations. Seminars will include information about the new streamlined process, best practices for operating sUAS in a public safety mission, examples of how to develop your own SRAP, and much more. The conference is anticipated to occur in the middle of September. Stayed tuned for more information about dates and locations.

Having had a chance to participate in many of the discussions with the FAA and NIJ about the new streamlined COA process and having had the chance to discuss operations with many public safety entities, I am confident that the "Common Strategy" will be a significant step forward in the employment of sUAS by public safety agencies. There appears to be a fundamental shift in the FAA's perception of public safety operations. Initially, the FAA feared operations by public safety agencies that did not have adequate aviation knowledge, thereby creating a risk in the National Airspace System. Now, the FAA is focused on providing the tools necessary to help those public safety agencies conduct safe operations in the National Airspace System. Many of the new requirements in the streamlined COA process will help agencies identify the risk of operations and implement proper mitigating steps to limit those risks which seems to be in

alignment with the FAA's desire to introduce Safety Management Systems concepts. In the end, the goal is to increase our public safety agencies' effectiveness through technology without unnecessarily increasing the risk to persons or property.

The Case for Driverless Cars
10 May 2012

AUVSI recently released a new white paper: The Case for Driverless Cars.

Driverless cars have been a dream for drivers around the world since the invention of the automobile more than 100 years ago, but have yet to be realized on a mass scale. Recent demonstrations and competitions, utilizing corporate and government investments, have shown that driverless car technology is maturing to the point where such vehicles may be commercially viable within a decade.

A variety of non-technical issues remain in order to field driverless cars. Legal, liability, regulatory, culture, and privacy concerns all need to be addressed for consumers to be able to use, and desire to use, driverless cars.

The paper goes into detail in these issues, the potential American consumer market, and technical aspects of driverless cars. The paper is written for people without a strong background in driverless cars looking for more information and is a good background for people interested in the Driverless Car Summit.

AUVSI Presses DOT to Release Small UAS Proposed Rule
4 May 2012

On 4 May, AUVSI President & CEO Michael Toscano sent a letter to U.S. Secretary of Transportation Ray LaHood asking him to expedite the publication of the small unmanned aircraft system (UAS) notice of proposed rulemaking.

The Federal Aviation Administration (FAA) has been examining the issue of allowing small UAS to fly in the airspace since 2008, when it formed an aviation rulemaking committee (ARC) to examine the issue. Although the ARC issued recommendations in 2009, the FAA has not yet released a proposed rule for public comment on how it will safely allow small UAS to fly in the civil airspace.

Congress, in the FAA Modernization and Reform Act of 2012 - which was passed into law on 14 February - requires the secretary of Transportation to publish a final rule on allowing small UAS to fly in the airspace by mid-2014, with the safe integration of all civil UAS by 30 Sept. 2015.

"The UAS industry believes the pending rule is urgently needed and will provide meaningful guidance to manufacturers and end users for design, construction and operation of small UAS to safely operate and deliver crucial services to law enforcement, agriculture and other sectors of the American economy." said Toscano in a letter to Secretary LaHood. "UAS will be the next big revolution in aviation; however, before this industry can really take off, we need rules from the FAA on how to safely operate alongside manned aircraft."

AUVSI continues to actively engage with members of Congress, federal regulators, aviation stakeholders, potential users, and privacy groups to help educate about the importance of unmanned systems.

THE ECONOMIC IMPACT

OF UNMANNED AIRCRAFT SYSTEMS INTEGRATION IN THE UNITED STATES

MARCH 2013

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

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About the Authors

Darryl Jenkins, author of "The Handbook of Airline Economics," is an airline analyst with more than 30 years of experience in the aviation industry. Jenkins also served as director of the Aviation Institute at George Washington University for more than 15 years. As an independent aviation consultant, Jenkins has worked for the majority of the world's top 50 airlines. In addition, he has consulted for the FAA, DOT, NTSB and other U.S. government agencies as well as many foreign countries. Jenkins also is the author of several aviation books and is a regular commentator for major media including ABC, CBS, NBC, MSNBC, CNN, FOX and major print publications. Jenkins was a member of the Executive Committee of the White House Conference on Aviation Safety and Security.

Dr. Bijan Vasigh is professor of economics and finance in the Department of Business Administration at Embry-Riddle Aeronautical University in Daytona Beach, Florida, and a managing director at Aviation Consulting Group LLC. Vasigh received a Ph.D. in economics from the State University of New York in 1984, and he has written and published many articles concerning the aviation industry. The articles have been published in numerous academic journals such as the "Handbook of Airline Economics," "Journal of Economics and Finance," "Journal of Transportation Management," "Transportation Quarterly," "Airport Business," "Journal of Business and Economics" and "Journal of Travel Research." He was a consultant with the International Civil Aviation Organization and provided assistance on the evolution of aeronautical charge structure for the Brazilian Institute of Civil Aviation. He is a member of the editorial board of "Journal of Air Transport Management," the "Southwest Journal of Pure and Applied Mathematics" and "Journal of Air Transportation World Wide." He is currently a member of the international faculty at the IATA Learning Center, where he is faculty leader of the Airline Finance and Accounting Management division.

Executive Summary

The purpose of this research is to document the economic benefits to the United States (U.S.) once Unmanned Aircraft Systems (UAS) are integrated into in the National Airspace System (NAS).

In 2012, the federal government tasked the Federal Aviation Administration (FAA) to determine how to integrate UAS into the NAS. In this research, we estimate the economic impact of this integration. In the event that these regulations are delayed or not enacted, this study also estimates the jobs and financial opportunity lost to the economy because of this inaction.

While there are multiple uses for UAS in the NAS, this research concludes that **precision agriculture** and **public safety** are the most promising commercial and civil markets. These two markets are thought to comprise **approximately 90%** of the known potential markets for UAS.

We conclude the following:

1. The economic impact of the integration of UAS into the NAS will total more than $13.6 billion (Table 19) in the first three years of integration and will grow sustainably for the foreseeable future, cumulating to more than $82.1 billion between 2015 and 2025 (Table 1);
2. Integration into the NAS will create more than 34,000 manufacturing jobs (Table 18) and more than 70,000 new jobs in the first three years (Table 19);
3. By 2025, total job creation is estimated at 103,776 (Table 1);
4. The manufacturing jobs created will be high paying ($40,000) and require technical baccalaureate degrees;
5. Tax revenue to the states will total more than $482 million in the first 11 years following integration (2015-2025); and
6. Every year that integration is delayed, the United States loses more than **$10 billion** in potential economic impact. This translates to a loss of **$27.6 million per day that UAS are not integrated into the NAS.**

Utility of UAS

The main inhibitor of U.S. commercial and civil development of the UAS is the lack of a regulatory structure. Because of current airspace restrictions, non-defense use of UAS has been extremely limited. However, the combination of greater flexibility, lower capital and lower operating costs could allow UAS to be a transformative technology in fields as diverse as urban infrastructure management, farming, and oil and gas exploration to name a few.

Present-day UAS have longer operational duration and require less maintenance than earlier models. In addition, they can be operated remotely using more fuel efficient technologies. These aircraft can be deployed in a number of different terrains and may be less dependent on prepared runways. Some argue the use of UAS in the future will be a more responsible approach to certain airspace operations from an environmental, ecological and human risk perspective.

UAS are already being used in a variety of applications, and many more areas will benefit by their use, such as[1]:

- **Wildfire mapping[2];**
- **Agricultural monitoring;**
- **Disaster management;**
- **Thermal infrared power line surveys;**
- **Law enforcement;**
- **Telecommunication;**
- **Weather monitoring;**
- **Aerial imaging/mapping;**
- **Television news coverage, sporting events, moviemaking[3];**
- **Environmental monitoring;**
- **Oil and gas exploration; and**
- **Freight transport.**

Applicable Markets

There are a number of different markets in which UAS can be used. This research is concentrated on the two markets, commercial and civil, with the largest potential. A third category (Other) summarizes all other markets:

1. Precision agriculture;
2. Public safety; and
3. Other.

> While we project more than 100,000 new jobs by 2025, states that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not.

Public safety officials include police officers and professional firefighters in the U.S., as well as a variety of professional and volunteer emergency medical service providers who protect the public from events that pose significant danger, including natural disasters, man-made disasters and crimes.

Precision agriculture refers to two segments of the farm market: remote sensing and precision application. A variety of remote sensors are being used to scan plants for health problems, record growth rates and hydration, and locate disease outbreaks. Such sensors can be attached to ground vehicles, aerial vehicles and even aerospace satellites. Precision application, a practice especially useful for crop farmers and horticulturists, utilizes effective and efficient spray techniques to more selectively cover plants and fields. This allows farmers to provide only the needed pesticide or nutrient to each plant, reducing the total amount sprayed, and thus saving money and reducing environmental impacts.

As listed above, a large number of other markets will also use UAS once the airspace is integrated. We believe the impact of these other markets will be at least the size of the impact from public safety use.

[1]Market Intel Group (MiG), November, 2010
[2]Predators improve wildfire mapping: Tests under way to use unmanned aircraft for civilian purposes, Tribune Business News, August 26, 2007
[3]Honeywell International Inc 2004-2012

With sensible regulations in place, we foresee few limitations to rapid growth in these industries. These products use off-the-shelf technology and thus impose few problems to rapidly ramping up production. The inputs (i.e., parts) to the UAS can be purchased from more than 100 different suppliers; therefore, prices will be stable and competitive. The inputs to the UAS can all be purchased within the U.S., although these products can be imported from any number of foreign countries without the need of an import license. UAS have a durable life span of approximately 11 years and are relatively easy to maintain. The manufacture of these products requires technical skills equivalent to a baccalaureate degree. Therefore, there will always be a plentiful market of job applicants willing to enter this market. In summary, there are no production problems on the horizon that will impact the manufacturing and output of this product. Most of the barriers of potential usage are governmental and regulatory. For this study, we assume necessary airspace integration in 2015, on par with current legislation.

Covering and justifying the cost of UAS is straightforward. In the precision agriculture market, the average price of the UAS is a fraction of the cost of a manned aircraft, such as a helicopter or crop duster, without any of the safety hazards. For public safety, the price of the product is approximately the price of a police squad car equipped with standard gear. It is also operated at a fraction of the cost of a manned aircraft, such as a helicopter, reducing the strain on agency budgets as well as the risk of bodily harm to the users in many difficult and dangerous situations. Therefore, the cost-benefit ratios of using UAS can be easily understood.

Economic Benefit

The economic benefits to the country are enormous and were estimated as follows. First, we forecast the number of sales in the three market categories. Next, we forecast the supplies needed to manufacture these products. Using estimated costs for labor, we forecast the number of direct jobs created. Using these factors, we forecast the tax revenue to the states.

In addition to direct jobs created by the manufacturing process, there is an additional economic benefit. The new jobs created and the income generated will be spread to local communities. As new jobs are created, additional money is spent at the local level, creating additional demand for local services which, in turn, creates even more jobs (i.e., grocery clerks, barbers, school teachers, home builders, etc.). These indirect and induced jobs are forecast and included in the total jobs created.

The economic benefits to individual states will not be evenly distributed. The following 10 states are predicted to see the most gains in terms of job creation and additional revenue as production of UAS increase, totaling more than $82 billion in economic impact from 2015-2025 (Table 1).

In rank order they are:

1) California
2) Washington
3) Texas
4) Florida
5) Arizona
6) Connecticut
7) Kansas
8) Virginia
9) New York
10) Pennsylvania

It is important to note that the projections contained in this report are based on the current airspace activity and infrastructure in a given state. As a result, states with an already thriving aerospace industry are projected to reap the most economic gains. However, a variety of factors—state laws, tax incentives, regulations, the establishment of test sites and the adoption of UAS technology by end users—will ultimately determine where jobs flow.

By 2025, we estimate more than 100,000 new jobs will be created nationally. For the purposes of this report, we base the 2025 state economic projections on the current aerospace employment in the states. We also presume that none of the states have enacted restrictive legislation or regulations that would limit the expansion of the technology. These landscapes will likely shift, however, as states work to attract UAS jobs in the years following integration. Future state laws and regulations could also cause some states to lose jobs while others stand to gain jobs. In conclusion, while we project more than 100,000 new jobs by 2025, states that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not.

The trend in total spending, total economic impact and total employment impact was investigated for 2015 through 2025. The total spending in UAS development and total economic and employment impacts are expected to increase significantly in the next five years. This study demonstrates the significant contribution of UAS development and integration in the nation's airspace to the economic growth and job creation in the aerospace industry and to the social and economic progress of the citizens in the U.S. See Table 1 for the results of the total impact of UAS integration in the United States.

TO READ THE FULL REPORT ONLINE, VISIT http://www.auvsi.org/econreport

Table 1: Total Economic Impact of UAS Integration in the United States						
	2015 - 2017			2015-2025		
State	Economic Impact $(M)	Taxes ($M)	Jobs Created	Economic Impact ($M)	Taxes ($M)	Jobs Created
Alabama	$294	$2.43	1,510	$1,765	$14.60	2,231
Alaska	$19	$0.00	95	$112	$0.00	141
Arizona	$561	$2.59	2,883	$3,371	$15.55	4,260
Arkansas	$80	$0.94	411	$481	$5.63	608
California	$2,390	$13.64	12,292	$14,372	$82.03	18,161
Colorado	$232	$1.79	1,191	$1,392	$10.76	1,760
Connecticut	$538	$4.32	2,764	$3,232	$25.97	4,084
Delaware	$17	$0.16	88	$103	$0.97	131
Florida	$632	$0.00	3,251	$3,801	$0.00	4,803
Georgia	$379	$3.72	1,949	$2,279	$22.34	2,880
Hawaii	$32	$0.39	166	$194	$2.35	245
Idaho	$29	$0.36	149	$174	$2.16	220
Illinois	$204	$1.71	1,049	$1,226	$10.30	1,549
Indiana	$208	$1.18	1,067	$1,248	$7.12	1,577
Iowa	$159	$0.92	817	$956	$5.53	1,208
Kansas	$489	$4.84	2,515	$2,941	$29.13	3,716
Kentucky	$89	$0.90	459	$537	$5.41	678
Louisiana	$213	$1.44	1,097	$1,282	$8.67	1,620
Maine	$107	$1.26	548	$641	$7.56	810
Maryland	$335	$2.64	1,725	$2,017	$15.85	2,549
Massachusetts	$386	$3.36	1,985	$2,321	$20.22	2,933
Michigan	$188	$1.37	965	$1,128	$8.26	1,426
Minnesota	$142	$1.68	730	$853	$10.08	1,078
Mississippi	$162	$1.10	832	$973	$6.60	1,230
Missouri	$260	$1.73	1,338	$1,565	$10.37	1,978
Montana	$14	$0.15	74	$86	$0.91	109
Nebraska	$25	$0.22	128	$149	$1.30	189
Nevada	$38	$0.00	196	$229	$0.00	290
New Hampshire	$85	$0.00	439	$514	$0.00	649
New Jersey	$263	$3.24	1,353	$1,582	$19.50	1,999
New Mexico	$101	$0.73	518	$606	$4.41	765
New York	$443	$4.66	2,276	$2,661	$28.05	3,363
North Carolina	$153	$1.79	785	$918	$10.75	1,160
North Dakota	$14	$0.07	71	$83	$0.40	105
Ohio	$359	$2.43	1,844	$2,156	$14.60	2,725
Oklahoma	$106	$0.93	545	$637	$5.61	805
Oregon	$81	$0.41	416	$486	$2.47	614
Pennsylvania	$393	$2.02	2,021	$2,363	$12.12	2,986
Rhode Island	$42	$0.38	217	$253	$2.28	320
South Carolina	$99	$1.16	507	$593	$6.99	749
South Dakota	$9	$0.00	48	$56	$0.00	71
Tennessee	$112	$0.00	578	$675	$0.00	853
Texas	$1,087	$0.00	5,588	$6,533	$0.00	8,256
Utah	$143	$1.21	735	$859	$7.26	1,085
Vermont	$36	$0.47	184	$215	$2.81	271
Virginia	$463	$4.47	2,380	$2,783	$26.86	3,517
Washington	$1,312	$0.00	6,746	$7,888	$0.00	9,967
West Virginia	$47	$0.47	240	$280	$2.83	354
Wisconsin	$88	$0.96	450	$527	$5.76	665
Wyoming	$5	$0.00	24	$28	$0.00	36
Total	$13,657	$80.22	70,240	$82,124	$482.39	103,776

Forecast

In this chapter, we describe the methodology for the forecasts we used as inputs to the economic benefits section. In accomplishing this task, we were fortunate to obtain and use comparable product sales from other countries. In making the forecasts, we relied on four different methods:

1) Comparable sales from other countries;
2) Survey results;
3) Land ratios; and
4) A literature search on rates of adoption of new technology.

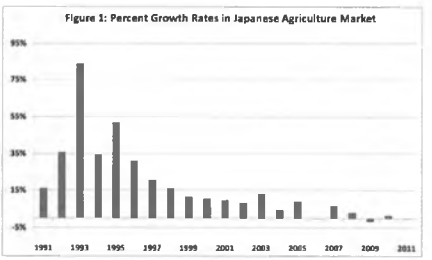
The four different methodologies yielded similar results and provide confidence in our final results.

Throughout this study, we use the following terms. When we use the term output, we are referring to the UAS. The inputs to the UAS are the parts and labor that go into making these products. In turn, the parts that go into the inputs we refer to as derived demand.

As part of this section, we provide a detailed discussion of the factors that may make our forecasts inaccurate and their potential impact. Our forecasts are for an 11-year period. That unit of measurement was chosen as that is the expected life of a UAS. We did not include maintenance, training or other revenue streams, which makes our overall estimates conservative. In addition, there are multiple options on sales including leasing the equipment and having third-party providers as an outsourced service, all of which add to our conservative estimates.

Sales in Foreign Countries

Other countries have already adopted UAS technology from a zero base (i.e., first year of adoption). By now, these technologies have been operational for more than two decades. The growth curve is found to be logistic with a rapid beginning and then a leveling off of the market (Figure 1). The issue is not whether these products will be adopted once the airspace is integrated, but at what rate(s). The experience in Japan started out at rates of growth in excess of 20% annually. This was from no unmanned vehicles in 1990 (i.e., the zero base), where neither the companies nor the consumers had previous experience with this technology (see Appendix A for detailed data).



As is readily apparent, the growth rates in the early years in Japan were very high. The question of interest is: How fast will growth occur in the U.S.? We chose a short time period for growth in the U.S. (doubling the first year, 50% growth the next year and thereafter a 5% growth rate). Our justification is as follows. First, there is considerable experience with these products. American farmers are not starting out from a zero-knowledge base as did Japan. Second, UAS are not sold in the U.S. domestic market only because FAA regulations prohibit them in the nation's airspace. It is noted that the dampening of the Japanese growth curve happened within six years. The literature review found higher initial rates of product acceptance than the previous Japanese experience and lower leveling off of rates.

Adoption Rates of New Technology

There are many factors that influence the rate at which new technologies are adopted and diffused into a society. We found considerable literature on this topic. The conclusion from the brief search we conducted is that new technologies are either accepted or rejected quickly. There is already a trade association that is doing outreach to the primary targets and showing products in their trade show(s). Because there is previous experience in this field, we reject the notion that these products will not be adopted. However, it is suggested that a follow up to this study be conducted on adoption of new technology. There is considerable literature on this topic, which needs to be investigated, and will help develop further adoption strategies.

Methodology

We performed three separate forecasts for this study:

1) The estimated number of sales by state;
2) The estimated sales by state for the inputs to the final product; and
3) The estimated sales by state for the derived demand for the final products.

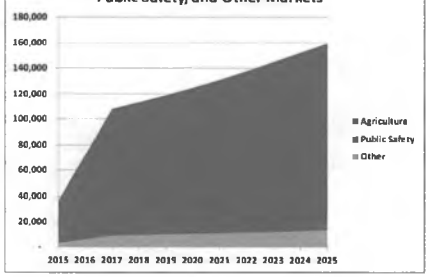
To complete these forecasts, we developed a telephone survey and pilot-tested it on five participants to refine our survey questions. We next conducted 30 telephone interviews with industry experts. An industry expert was defined as a person with more than three years of practical and relevant experience. Each interview lasted about 30 minutes. The participants were guaranteed confidentiality so we cannot divulge the individual results. However, we were able to obtain a reasonable estimate on what the group as a whole felt was the size of the market and the cost structure. Because there was considerable variance in these estimates, we ignored the outliers and calculated the average cost structure. We estimate that approximately 60% of the overall cost of a UAS is parts with an average annual labor cost of $37,000. In this report, we use $40,000 and hold it at a constant cost, as we do with the parts numbers. Thus the results can be interpreted as constant dollars over the entire term, as we are not forecasting the inflation rate. As for profitability, we consider this a competitive industry with a normal rate of return.

We found that almost all respondents considered agriculture to be far and above the largest market given that the public safety market is limited by the number of first-response teams. We next looked at some simple ratios between UAS sales in Japan and the amount of arable farmland and imputed these ratios to the United States. The survey results indicated an agricultural market of approximately 150,000 unit sales per year at maturity (i.e., 2020), and the Japanese land ratio indicated a market size of 165,000 unit sales per year. For the purposes of this forecast, we used 100,000 unit sales per year as a conservative benchmark. See Figure 2 for total expected sales for 2015-2025. Actual sales could be a multiple of this estimate.

As to the public safety market, the consensus was that the agriculture market will be at least 10 times the public safety market. Our follow-up task to the questionnaire was to find the number of first-response domestic teams and survey a small number of this group. We found their purchase issues to be minimal. They simply have a budget given to them by the local governmental unit that oversees them, and they work within it. Purchases of this size are not uncommon and public safety officials have all of the appearances of being early adopters, especially when safety is involved.

During the survey interviews, we discovered that there were unlimited uses of UAS. For example, many respondents discussed the potential uses of UAS for real estate purposes or for examining oil pipelines. In the case of oil pipelines, the consensus of the experts was that the total annual sale was approximately 1,000 units. For real estate personnel, there was not a consensus. From the surveys and follow-up calls with other professionals, we estimate that the aggregate size for other sales was approximately 10% of the total. In reality, this figure is a lower boundary and should be interpreted as at least 10% of the total. Depending on the promotions to this segment, the final price and, most importantly, the federal regulations, this segment could be significantly larger. We estimate the lower boundary at 10% to be conservative.

Figure 2: Annual UAS Sales for Agriculture, Public Safety, and Other Markets



In making the first round of forecasts, we tried several different methods but ultimately used a ratio of the number of direct aerospace and defense (A&D) industry employees in each state[4] to the total number of direct A&D industry employees in the U.S. For example, Alabama has an estimated 23,090 direct A&D industry employees out of a total of 1,040,796 direct A&D employees in the U.S., or 2.22% of the total. So we took the total forecast of agriculture sales and multiplied by 2.22% for Alabama. See Table 2 for a complete list of states and their estimated manufacturing distribution.

For the inputs, we find no constraints. There are plenty of manufacturers of these parts; they are off-the-shelf and require little lead time. If one supply line goes down, there are multiple sources as backups. For the input forecast, we relied on the size of the aerospace labor force in each state as the metric. These numbers were obtained from a Deloitte report, commissioned by the Aerospace Industries Association, titled "The Aerospace and Defense Industry in the U.S.: A Financial and Economic Impact Study"[5]. In this forecast, we also looked at employment and taxes. Using the estimated labor dollar amount, we simply divided by 40,000 to find the number of jobs. Subtracting adjacent years yields the number of new jobs created. We used marginal state tax rates for the $40,000 income range, the assumption being that states will hold this rate constant over time.

Table 2: Estimated Manufacturing Distribution

State	Manufacturing Distribution	State	Manufacturing Distribution
Alabama	2.22%	Montana	0.11%
Alaska	0.15%	Nebraska	0.19%
Arizona	4.10%	Nevada	0.30%
Arkansas	0.61%	New Hampshire	0.67%
California	15.58%	New Jersey	1.99%
Colorado	1.77%	New Mexico	0.78%
Connecticut	3.95%	New York	3.30%
Delaware	0.13%	North Carolina	1.17%
Florida	4.74%	North Dakota	0.11%
Georgia	2.83%	Ohio	2.71%
Hawaii	0.25%	Oklahoma	0.81%
Idaho	0.22%	Oregon	0.63%
Illinois	1.56%	Pennsylvania	3.00%
Indiana	1.59%	Rhode Island	0.32%
Iowa	1.24%	South Carolina	0.76%
Kansas	3.54%	South Dakota	0.07%
Kentucky	0.69%	Tennessee	0.81%
Louisiana	1.65%	Texas	8.43%
Maine	0.82%	Utah	1.10%
Maryland	2.53%	Vermont	0.27%
Massachusetts	2.90%	Virginia	3.55%
Michigan	1.44%	Washington	9.02%
Minnesota	1.09%	West Virginia	0.36%
Mississippi	1.25%	Wisconsin	0.67%
Missouri	1.97%	Wyoming	0.04%

4Deloitte, The Aerospace and Defense Industry in the U.S., A financial and economic impact study, March, 2012
5http://www.deloitte.com/view/en_US/us/Industries/Aerospace-Defense-Manufacturing/b4c8ae98118f5310VgnVCM3000001c56f00aRCRD.htm

Necessary Conditions for the Forecasts

We now turn our attention to the conditions that must happen to validate this forecast:

1) The FAA must develop new regulations integrating UAS into the nation's airspace;
2) Job growth distribution will mimic current aerospace manufacturing employment;
3) Creative destruction of existing jobs will have a net-zero impact;
4) There must be sufficient capital available to smaller manufacturing companies;
5) There must be financing available to UAS purchasers;
6) There must be insurance to cover liabilities;
7) Gross Domestic Product (GDP) needs to grow at least 3% annually over the designated time period;
8) The adoption rate(s) of this product in the U.S. will mimic Japan; and
9) Other unforeseen factors.

The FAA Must Develop New Regulations Integrating UAS into the Nation's Airspace

Perhaps the single most important aspect of this forecast is that the FAA develops new guidelines allowing the integration of UAS in the nation's airspace. In the absence of these guidelines, this report is simply the opportunity cost to the economy (new jobs, tax revenue, etc.) of a good idea that was hindered due to government interference or inaction. The FAA regulatory process, like all government entities, is slow and unpredictable.

Job Growth Distribution Will Mimic Current Aerospace Manufacturing Employment

The employment growth described in this report is all new employment, that is, jobs that do not currently exist. To project the statewide distribution of this employment, we used current aerospace manufacturing employment. However, there are many external factors that will affect this distribution that are impossible to predict in this report. These include, among other things, tax incentives, test sites and where new product development will actually occur.

Creative Destruction of Existing Jobs Will Have a Net Zero Impact

As UAS are introduced, some uses will replace existing capabilities, because there are efficiencies to be gained by using a UAS versus a traditional capability. As such, there is likely to be some job destruction from UAS. However, UAS will still need many similar capabilities to manned systems including training, maintenance and pilots. Any jobs that will be made immaterial by UAS will be transitioned to regular UAS operations. Because of the efficient use of UAS, there will be job creation in other areas. For instance, a farmer that saves money because he or she can use less pesticide since UAS can provide precision application will spend less money on pesticides and less on taxes due to pesticide use. That money back into the farmer's pocket will provide economic impact to the U.S. that is not calculated in this report. To simplify, we generalize that there will be a net-zero impact of job creation in the application of these systems. A detailed analysis of this potential job creation is recommended for further research.

There Must be Sufficient Capital Available to Smaller Manufacturing Companies

One of the biggest problems with growing companies is their access to capital. As companies grow, their need for capital to buy new equipment, hire additional personnel, rent extra space and all of the other requirements are seldom met from working capital. The need for short-term working capital to accommodate growth can stymie any otherwise well thought out business plan.

There Must be Financing Available to UAS Purchasers

While the costs of these purchases are not the same as other farm equipment, they are seldom made as a cash purchase. Farm implements, such as tractors, are usually bought with company financing as they do not have serial numbers like cars. Banks may finance a tractor, but usually at a higher interest rate with the credit worthiness of the person as the collateral. This means that the industry or consortia of companies will need to be created for these purchases. There is probably less of a need for these arrangements for public safety, but they are only a shadow market compared to the agriculture market. It is clear that offering financing from a small company standpoint, outside of normal banking realms, is impossible and impractical at this time. This may be one of the most important factors outside of regulation reform to move this industry forward.

Insurance to Cover Liabilities Must be Supplied

One of the many great unknowns about the infant commercial UAS industry is its product liability exposure. Suppose a UAS used by a public safety agency malfunctions and crashes into a building. The assumption is that this event is covered by the local government's umbrella insurance policy. What if this happens elsewhere? Perhaps the thrust of this argument is that the industry as a whole needs to start collecting relevant data in this realm. A Google search on this topic turned up little information, as governments use UAS mainly for wartime purposes. However, anything mechanical can malfunction, and a UAS is no exception. There will be issues of proper maintenance and liability, as there always are with aircraft of any type, in addition to workmen's compensation and other potential problems. The long-term issue is the need for industry-wide data collection.

GDP Needs to Grow at Least 3% Annually Over the Designated Time Period

All studies of this nature require GDP assumptions. The typical scenario is that over a longer time period, the economy will grow at 3% per year. This is our assumption as well. Our forecast is that with new and improved products, they will grow at a slightly higher rate.

There may be several problems with this assumption. First, the current economic stagnation may persist. If so, this may favor sunken capital over new capital. Thus, we may see growth, but at a much later date, and significantly slower growth thereafter. If this happens, it has the potential to make our forecast inaccurate.

The Adoption Rate(s) of this Product in the U.S. Will Mimic Japan

Consumers in different countries or even different segments of the same country can react differently to the same product offering. Our assumption is that consumers in both countries will react similarly.

Other Unforeseen Factors

Any researcher knows that economic analysis and forecasts may not include hundreds of unforeseen events that impact economic estimates that were not taken into account. Any of these may materially affect our forecast.

Discussion of Forecast Results

In this section, we will discuss the forecast results for the year 2015, which is the first forecast year. Table 3 shows the rank ordering of UAS manufacturing by state for agriculture uses in 2015, and Table 4 shows it for public safety. Other markets besides agriculture and public safety are estimated to have the same total economic impact as the public safety market, so in the following we only show the agriculture and public safety markets. Final economic impact calculations include agriculture, public safety and other markets (i.e., the public safety total economic impact multiplied by two to account for "other markets").

Table 3: 2015 Total UAS Agriculture Sales Inputs

State	Labor	Parts	Taxes	Employment
California	$65,438,414	$ 98,157,622	$2,094,029	1,636
Washington	$37,902,240	$ 56,853,360	$ -	948
Texas	$35,422,907	$ 53,134,361	$ -	886
Florida	$19,927,882	$ 29,891,823	$ -	498
Arizona	$17,225,796	$ 25,838,695	$ 396,882	431
Connecticut	$16,575,698	$ 24,863,547	$ 663,028	414
Virginia	$14,907,071	$ 22,360,607	$ 685,725	373
Kansas	$14,873,981	$ 22,310,972	$ 743,699	372
New York	$13,878,051	$ 20,817,077	$ 716,107	347
Pennsylvania	$12,598,434	$ 18,897,651	$ 309,418	315
Massachusetts	$12,175,124	$ 18,262,685	$ 516,225	304
Georgia	$11,882,156	$ 17,823,233	$ 570,343	297
Ohio	$11,362,400	$ 17,043,599	$ 372,687	284
Maryland	$10,645,314	$ 15,967,971	$ 404,522	266
Alabama	$ 9,317,676	$ 13,976,514	$ 372,707	233
New Jersey	$ 8,353,625	$ 12,530,438	$ 497,876	209
Missouri	$ 8,276,550	$ 12,414,825	$ 264,850	207
Colorado	$ 7,416,208	$ 11,124,313	$ 274,696	185
Louisiana	$ 6,918,647	$ 10,377,970	$ 221,397	173
Indiana	$ 6,686,613	$ 10,029,919	$ 181,876	167
Illinois	$ 6,571,201	$ 9,856,802	$ 262,848	164
Michigan	$ 6,060,323	$ 9,090,485	$ 210,899	152
Mississippi	$ 5,268,583	$ 7,902,874	$ 168,595	132
Iowa	$ 5,193,121	$ 7,789,682	$ 141,253	130
North Carolina	$ 4,898,943	$ 7,348,414	$ 274,341	122
Utah	$ 4,636,240	$ 6,954,360	$ 185,450	116
Minnesota	$ 4,561,989	$ 6,842,984	$ 257,296	114
Maine	$ 3,444,594	$ 5,166,891	$ 192,897	86
Oklahoma	$ 3,410,294	$ 5,115,440	$ 143,232	85
Tennessee	$ 3,390,117	$ 5,085,175	$ -	85
New Mexico	$ 3,271,880	$ 4,907,821	$ 112,553	82
South Carolina	$ 3,185,523	$ 4,778,285	$ 178,389	80
Kentucky	$ 2,877,624	$ 4,316,437	$ 138,176	72
Wisconsin	$ 2,825,568	$ 4,238,352	$ 146,930	71
New Hampshire	$ 2,817,497	$ 4,226,246	$ -	70
Oregon	$ 2,632,274	$ 3,948,411	$ 63,175	66
Arkansas	$ 2,565,690	$ 3,848,535	$ 143,679	64
West Virginia	$ 1,504,791	$ 2,257,186	$ 72,230	38
Rhode Island	$ 1,364,360	$ 2,046,539	$ 58,326	34
Nevada	$ 1,255,001	$ 1,882,501	$ -	31
Vermont	$ 1,150,888	$ 1,726,333	$ 71,815	29
Hawaii	$ 1,041,126	$ 1,561,689	$ 59,969	26
Idaho	$ 932,978	$ 1,399,467	$ 55,232	23
Nebraska	$ 807,478	$ 1,211,217	$ 33,074	20
Alaska	$ 611,763	$ 917,644	$ -	15
Delaware	$ 557,285	$ 835,928	$ 24,743	14
Montana	$ 462,857	$ 694,286	$ 23,328	12
North Dakota	$ 453,576	$ 680,364	$ 10,233	11
South Dakota	$ 305,881	$ 458,822	$ -	8
Wyoming	$ 155,765	$ 233,648	$ -	4

Table 4: 2015 Total UAS Public Safety Sales Inputs

State	Labor	Parts	Taxes	Employment
California	$ 2,804,503	$ 4,206,755	$ 89,744	70
Washington	$ 1,624,382	$ 2,436,573	$ -	41
Texas	$ 1,518,125	$ 2,277,187	$ -	38
Florida	$ 854,052	$ 1,281,078	$ -	21
Arizona	$ 738,248	$ 1,107,373	$ 17,009	18
Connecticut	$ 710,387	$ 1,065,581	$ 28,415	18
Virginia	$ 638,874	$ 958,312	$ 29,388	16
Kansas	$ 637,456	$ 956,184	$ 31,873	16
New York	$ 594,774	$ 892,160	$ 30,690	15
Pennsylvania	$ 539,933	$ 809,899	$ 13,261	13
Massachusetts	$ 521,791	$ 782,687	$ 22,124	13
Georgia	$ 509,235	$ 763,853	$ 24,443	13
Ohio	$ 486,960	$ 730,440	$ 15,972	12
Maryland	$ 456,228	$ 684,342	$ 17,337	11
Alabama	$ 399,129	$ 598,993	$ 15,973	10
New Jersey	$ 358,013	$ 537,019	$ 21,338	9
Missouri	$ 354,709	$ 532,064	$ 11,351	9
Colorado	$ 317,838	$ 476,756	$ 11,773	8
Louisiana	$ 296,513	$ 444,770	$ 9,488	7
Indiana	$ 286,569	$ 429,854	$ 7,795	7
Illinois	$ 281,623	$ 422,434	$ 11,265	7
Michigan	$ 259,728	$ 389,592	$ 9,039	6
Mississippi	$ 225,796	$ 338,695	$ 7,225	6
Iowa	$ 222,562	$ 333,844	$ 6,054	6
North Carolina	$ 209,955	$ 314,932	$ 11,757	5
Utah	$ 198,696	$ 298,044	$ 7,948	5
Minnesota	$ 195,514	$ 293,271	$ 11,027	5
Maine	$ 147,625	$ 221,438	$ 8,267	4
Oklahoma	$ 146,155	$ 219,233	$ 6,139	4
Tennessee	$ 145,291	$ 217,936	$ -	4
New Mexico	$ 140,223	$ 210,335	$ 4,824	4
South Carolina	$ 136,522	$ 204,784	$ 7,645	3
Kentucky	$ 123,327	$ 184,990	$ 5,920	3
Wisconsin	$ 121,096	$ 181,644	$ 6,297	3
New Hampshire	$ 120,750	$ 181,125	$ -	3
Oregon	$ 112,812	$ 169,218	$ 2,707	3
Arkansas	$ 109,958	$ 164,937	$ 6,158	3
West Virginia	$ 64,491	$ 96,737	$ 3,096	2
Rhode Island	$ 58,473	$ 87,709	$ 2,500	1
Nevada	$ 53,786	$ 80,679	$ -	1
Vermont	$ 49,324	$ 73,986	$ 3,078	1
Hawaii	$ 44,620	$ 66,930	$ 2,570	1
Idaho	$ 39,985	$ 59,977	$ 2,367	1
Nebraska	$ 34,606	$ 51,909	$ 1,417	1
Alaska	$ 26,218	$ 39,328	$ -	1
Delaware	$ 23,884	$ 35,825	$ 1,060	1
Montana	$ 19,837	$ 29,755	$ 1,000	0
North Dakota	$ 19,439	$ 29,158	$ 439	0
South Dakota	$ 13,109	$ 19,664	$ -	0
Wyoming	$ 6,676	$ 10,013	$ -	0

The next series of tables we refer to as derived demand. The products that are used as inputs are manufactured by other companies, and the platform manufacturer must buy inputs for their finished goods. Table 5 shows the results for the derived demand for inputs for agriculture and Table 6 for public safety.

Table 5: 2015 Total UAS Agriculture Derived Demand

State	Labor	Parts	Taxes	Employment
California	$ 39,263,049	$ 58,894,573	$ 1,256,418	982
Washington	$ 22,741,344	$ 34,112,016	$ -	569
Texas	$ 21,253,744	$ 31,880,616	$ -	531
Florida	$ 11,956,729	$ 17,935,094	$ -	299
Arizona	$ 10,335,478	$ 15,503,217	$ 238,129	258
Connecticut	$ 9,945,419	$ 14,918,128	$ 397,817	249
Virginia	$ 8,944,243	$ 13,416,364	$ 411,435	224
Kansas	$ 8,924,389	$ 13,386,583	$ 446,219	223
New York	$ 8,326,831	$ 12,490,246	$ 429,664	208
Pennsylvania	$ 7,559,061	$ 11,338,591	$ 185,651	189
Massachusetts	$ 7,305,074	$ 10,957,611	$ 309,735	183
Georgia	$ 7,129,293	$ 10,693,940	$ 342,206	178
Ohio	$ 6,817,440	$ 10,226,160	$ 223,612	170
Maryland	$ 6,387,188	$ 9,580,782	$ 242,713	160
Alabama	$ 5,590,606	$ 8,385,908	$ 223,624	140
New Jersey	$ 5,012,175	$ 7,518,263	$ 298,726	125
Missouri	$ 4,965,930	$ 7,448,895	$ 158,910	124
Colorado	$ 4,449,725	$ 6,674,588	$ 164,818	111
Louisiana	$ 4,151,188	$ 6,226,782	$ 132,838	104
Indiana	$ 4,011,968	$ 6,017,952	$ 109,126	100
Illinois	$ 3,942,721	$ 5,914,081	$ 157,709	99
Michigan	$ 3,636,194	$ 5,454,291	$ 126,540	91
Mississippi	$ 3,161,150	$ 4,741,725	$ 101,157	79
Iowa	$ 3,115,873	$ 4,673,809	$ 84,752	78
North Carolina	$ 2,939,366	$ 4,409,048	$ 164,604	73
Utah	$ 2,781,744	$ 4,172,616	$ 111,270	70
Minnesota	$ 2,737,193	$ 4,105,790	$ 154,378	68
Maine	$ 2,066,757	$ 3,100,135	$ 115,738	52
Oklahoma	$ 2,046,176	$ 3,069,264	$ 85,939	51
Tennessee	$ 2,034,070	$ 3,051,105	$ -	51
New Mexico	$ 1,963,128	$ 2,944,692	$ 67,532	49
South Carolina	$ 1,911,314	$ 2,866,971	$ 107,034	48
Kentucky	$ 1,726,575	$ 2,589,862	$ 82,876	43
Wisconsin	$ 1,695,341	$ 2,543,011	$ 88,158	42
New Hampshire	$ 1,690,498	$ 2,535,748	$ -	42
Oregon	$ 1,579,364	$ 2,369,046	$ 37,905	39
Arkansas	$ 1,539,414	$ 2,309,121	$ 86,207	38
West Virginia	$ 902,874	$ 1,354,312	$ 43,338	23
Rhode Island	$ 818,616	$ 1,227,924	$ 34,996	20
Nevada	$ 753,001	$ 1,129,501	$ -	19
Vermont	$ 690,533	$ 1,035,800	$ 43,089	17
Hawaii	$ 624,676	$ 937,014	$ 35,981	16
Idaho	$ 559,787	$ 839,680	$ 33,139	14
Nebraska	$ 484,487	$ 726,730	$ 19,845	12
Alaska	$ 367,058	$ 550,586	$ -	9
Delaware	$ 334,371	$ 501,557	$ 14,846	8
Montana	$ 277,714	$ 416,572	$ 13,997	7
North Dakota	$ 272,146	$ 408,218	$ 6,140	7
South Dakota	$ 183,529	$ 275,293	$ -	5
Wyoming	$ 93,459	$ 140,189	$ -	2

Table 6: 2015 Total UAS Public Safety Derived Demand

State	Labor	Parts	Taxes	Employment
California	$ 1,682,702	$ 2,524,053	$ 53,846	42
Washington	$ 974,629	$ 1,461,944	$ -	24
Texas	$ 910,875	$ 1,366,312	$ -	23
Florida	$ 512,431	$ 768,647	$ -	13
Arizona	$ 442,949	$ 664,424	$ 10,206	11
Connecticut	$ 426,232	$ 639,348	$ 17,049	11
Virginia	$ 383,325	$ 574,987	$ 17,633	10
Kansas	$ 382,474	$ 573,711	$ 19,124	10
New York	$ 356,864	$ 535,296	$ 18,414	9
Pennsylvania	$ 323,960	$ 485,940	$ 7,956	8
Massachusetts	$ 313,075	$ 469,612	$ 13,274	8
Georgia	$ 305,541	$ 458,312	$ 14,666	8
Ohio	$ 292,176	$ 438,264	$ 9,583	7
Maryland	$ 273,737	$ 410,605	$ 10,402	7
Alabama	$ 239,597	$ 359,396	$ 9,584	6
New Jersey	$ 214,808	$ 322,211	$ 12,803	5
Missouri	$ 212,826	$ 319,238	$ 6,810	5
Colorado	$ 190,703	$ 286,054	$ 7,064	5
Louisiana	$ 177,908	$ 266,862	$ 5,693	4
Indiana	$ 171,941	$ 257,912	$ 4,677	4
Illinois	$ 168,974	$ 253,461	$ 6,759	4
Michigan	$ 155,837	$ 233,755	$ 5,423	4
Mississippi	$ 135,478	$ 203,217	$ 4,335	3
Iowa	$ 133,537	$ 200,306	$ 3,632	3
North Carolina	$ 125,973	$ 188,959	$ 7,054	3
Utah	$ 119,218	$ 178,826	$ 4,769	3
Minnesota	$ 117,308	$ 175,962	$ 6,616	3
Maine	$ 88,575	$ 132,863	$ 4,960	2
Oklahoma	$ 87,693	$ 131,540	$ 3,683	2
Tennessee	$ 87,174	$ 130,762	$ -	2
New Mexico	$ 84,134	$ 126,201	$ 2,894	2
South Carolina	$ 81,913	$ 122,870	$ 4,587	2
Kentucky	$ 73,996	$ 110,994	$ 3,552	2
Wisconsin	$ 72,657	$ 108,986	$ 3,778	2
New Hampshire	$ 72,450	$ 108,675	$ -	2
Oregon	$ 67,687	$ 101,531	$ 1,624	2
Arkansas	$ 65,975	$ 98,962	$ 3,695	2
West Virginia	$ 38,695	$ 58,042	$ 1,857	1
Rhode Island	$ 35,084	$ 52,625	$ 1,500	1
Nevada	$ 32,271	$ 48,407	$ -	1
Vermont	$ 29,594	$ 44,391	$ 1,847	1
Hawaii	$ 26,772	$ 40,158	$ 1,542	1
Idaho	$ 23,991	$ 35,986	$ 1,420	1
Nebraska	$ 20,764	$ 31,146	$ 850	1
Alaska	$ 15,731	$ 23,597	$ -	0
Delaware	$ 14,330	$ 21,495	$ 636	0
Montana	$ 11,902	$ 17,853	$ 600	0
North Dakota	$ 11,663	$ 17,495	$ 263	0
South Dakota	$ 7,866	$ 11,798	$ -	0
Wyoming	$ 4,005	$ 6,008	$ -	0

Forecast Conclusion

In this section, we outline the assumptions and methodology used in making our forecasts. We drew on experience in Japan for comparable sales. Japan and the U.S. are both countries that readily adapt new technologies. We conclude the following:

1) If the FAA adopts new rules allowing for commercial use of UAS in the nation's airspace, these products will be received rapidly into the marketplace;

2) The doubling rate can take place over either a three-year or six-year period. With the known rates of change in newer technologies, it is likely to be a three-year scenario given the fact that the potential marketplace is well aware of the product(s) unlike the introduction in Japan; and

3) The commercial agriculture market is by far the largest segment, dwarfing all others.

Agriculture is an important product group. It has the potential for bringing a more reliable, cost-effective and safe method to domestic farmers for a variety of uses. In the event that a new set of regulations is not enacted and UAS are not integrated in the U.S. National Airspace System (NAS), this study estimates the lost jobs, lost tax revenue, and total economic loss to the states and nation. In addition, a delay in airspace integration will impact the U.S. in terms of a lag in technology development, manufacturing, job development and economic stimulus. With U.S. integration of UAS, more than 103,000 good paying jobs with benefits will be created.

While this section shows the huge potential available to the nation, the exact calculations of these benefits are laid out in the next section, where we estimate the total economic impact of NAS integration.

Economic Impact Analysis

Economic impact is based on the theory that a dollar flowing into a local economy from the outside is a benefit to the regional economy. The financial return for residents is in the form of new jobs, more earnings and new tax revenues that follow because of the initial development of a new business organization, and through new spending, in the municipality due to the operation of such a business or industry. These earnings, for instance, are generated for residents who are not directly associated with the business but who are the beneficiaries of the positive externalities that the business or industry can provide to communities.

External benefits, or positive externalities, are those returns that are generated by a business but that are not captured by the business or local region. When the employees of a company spend money at local businesses, such as restaurants, gas stations and retail stores, their spending will benefit the owners and employees of those establishments, thereby creating a positive incremental impact.

According to Davis (1990) an impact analysis is purposely designed to produce quantitative results of the effects that a certain segment of an industry has in the local economy. From an industry's standpoint, these impact studies are based on the grounds of aggregate economic growth that may be derived from additional spending by the business. The range of the impact can be limited to the city, county, state or national levels.

There are various methodologies that aid the economic valuation of specific organizations in their local economies. From the literature review, we concluded that Economic Impact Analysis (EIA) mostly relies on input-output economic models. Economists evaluate the impact that one sector has on another in terms of indirect and induced effects. The total economic impact is then the sum of the direct, indirect and induced effects.

Direct Impacts

Direct impacts are consequences of economic activities carried out by a company or organization in the economy. For example, institutions (public or private) have a direct impact on the local economy because of the activities conducted by the institution, management, employees, visitors and other related events. Employing labor, purchasing locally produced goods and services, and contracting for construction and capital improvements are all examples of activities that generate direct impacts. Some direct impacts, such as UAS, occur on site. Others, such as local production of goods and services for use at the institution, may occur off site.

Expenditures by management, owners and visitors also generate direct impacts, but only those expenditures that lead to local business activity are relevant for a regional economic assessment. For this reason, it is important to distinguish between (a) the local value-added component of expenditures and (b) the regional import component. Thus, the manufacturers of UAS expenditures on utilities, supplies, professional services, meals and entertainment generate significant economic benefits to the local and national economy. In most parts of the country, only the former component is relevant for the analysis. The following is a list of local value-added components:

- Direct Spending Effects:
  Construction, maintenance, operations
- Direct Business Cost Savings:
  Value of user benefits
- Other Business Cost Savings:
  Logistics/inventory/ processing, scale economies
- Regional Business Markets:
  Tourism, business relocation effects
- Personal Cost Savings:
  Effect on disposable income

The distinguishing feature of a direct impact is that it is an immediate consequence of the manufacturers of UAS' economic activity.

Indirect Impacts

In addition to the direct effect of an economic activity, there are also indirect effects and induced effects. Indirect impacts derive from off-site economic activities that are attributable to the business activities of the manufacturers of UAS' presence. For example, if we are looking at the job impacts of a new UAS being manufactured in Arizona, the direct effect is the number of new jobs created by the company itself. The indirect effect is the number of new jobs created at those firms that supply ancillary services for individuals who are employed at the UAS manufacturing facility and for customers of the firm. These can include, but are not limited to, hotels, restaurants and other businesses that may expand because of the presence of the UAS manufacturing facility. These suppliers and clients employ labor, purchase locally produced goods and services, and invest in capital expansion and improvements. Indirect impacts differ from direct impacts in that they originate entirely off site.

Examples of indirect impacts would be:

- Ancillary business expansion due to the UAS firm;
- New capital investment in response to the UAS firm; and
- Supplies and equipment that may be purchased because of the new business opportunities created by the UAS manufacturing facility.

Induced Impacts

Induced impacts are the result of spending of the wages and salaries of the direct and indirect employees on items such as food, housing, transportation and medical services. In other words, induced effects are the multiplier effects caused by successive rounds of spending throughout the economy as a result of the direct and indirect effects discussed above.

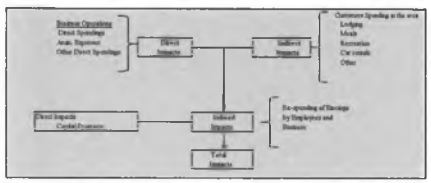
For example, most of the take-home income earned by the manufacturers of UAS employees is spent locally. Some of this spending becomes income to local businesses and their employees that provide services to the firm's employees. Then part of these second-round incomes are also spent locally and thus become income to another set of individuals. As successive rounds of spending occur, additional income is created. Although some of the induced impacts occur locally, some are felt outside the region because of the regional import components of the goods and services purchased. More economically self-sufficient regions have higher multipliers than do regions that are more dependent on regional imports, because more of the spending and respending is accomplished in the area. Similarly, two or more counties considered together as one economic region would have a higher multiplier than would each individual county.

Total Impact

The total impact is the sum of direct impacts, indirect impacts and induced impacts. Total impact is expressed in economic output, earnings or jobs.

Total Impacts = Direct Impacts + Indirect Impacts + Induced Impacts

Economic Impact Overview



Economists sometimes say that the direct economic impacts are "multiplied" through their indirect economic impacts. The ratio of the total (direct + indirect) economic impacts to the direct economic impacts is frequently referred to as the economic multiplier. The employment multiplier is the ratio of total employment to direct employment. The income multiplier is the ratio of total income to direct income created.

Multipliers are not directly observed; rather, they are inferred from an economic model. The direct measure is generally the most accurate since it can be measured more easily, but it only represents a part of the impact, so other multipliers are added to get the total. However, it should be emphasized that the sum of the multipliers is very important since these are virtually the only tools available to researchers attempting to identify the overall impact of activity within a regional economy.

Although a variety of methods can be used to generate economic multipliers, input-output (I-O) models are the most popular tool for such analysis and will be our focus. IMPLAN is a standard economic impact software package used to generate indirect, induced employment and sales estimates. IMPLAN utilizes user-supplied estimates of the direct sales and/or employment and provides associated indirect and induced effects estimates. Direct effects are the changes in the industries to which a final demand change was made; indirect effects are the changes in interindustry purchases as the response to demand of the directly affected industry; and induced effects generally reflect changes in household spending resulting from activity generated by the direct and indirect effects (MIG, p.102).

$$Multiplier = \frac{indirect\ impacts}{direct\ impacts}$$

Previous Economic Impact Studies

Conducting an economic impact study is important, because it is a useful tool to evaluate the economic impact of a business in a community in terms of jobs, income and tax revenue. Ten studies were selected from the literature to illustrate the different facets of economic impact and approaches used to assess impact. The purpose is to illustrate the range of values that may be achieved by different economic entities. The 10 examples are listed below:

- Marshall County Hospital Impact in Marshall County, Kentucky;
- Port of Baltimore impact in Maryland;
- University of Florida in Florida;
- Intel impact in Washington County;
- Intel impact in Oregon;
- Intel impact in Portland, Oregon Metro;
- Boeing impact in Arizona;
- All Acute Care Hospital Systems impact in New Hampshire;
- National Aeronautics and Space Administration (NASA) impact in Florida; and
- Nike impact in Oregon.

Methodology

The aircraft industry, undoubtedly, provides significant economic and social benefits for the regional, state and national economies. Most economic impact analyses utilize input-output models to provide detailed descriptions on how money invested in an economy travels and, through multiplier effects, creates additional employment and income. The basis of these input-output models is a summation of expenditures of the manufacturer (operations, capital and payroll) and the application of the multipliers to account for the interdependency of economic activity in a local economy (Siegfried et al., 2007). There are two well-known input-output programs: Regional Input-Output Modeling System (RIMS II) and the more advanced Impact Analysis for Planning (IMPLAN) software.

To more effectively use the multipliers for impact analysis, users must provide geographically and industrially detailed information

on the initial changes in output, earnings or employment that are associated with the project or program under study.

RIMS II was developed by the Bureau of Economic Analysis (BEA) and is based on an accounting framework called an I-O table, which shows the industrial distribution of inputs purchased and outputs sold for each industry (BEA, 2010). There are two sources for the I-O table: BEA's national I-O table, which shows the input and output structure of nearly 500 U.S. industries, and BEA's regional economic accounts, which are used to adjust the national I-O table to show a region's industrial structure and trading patterns. RIMS II has several advantages:

- Multipliers can be estimated for any region and for any industry;
- Low-cost estimates of regional multipliers because of data source accessibility are available; and
- Expensive surveys and RIMS II-based estimates are similar in magnitude.

IMPLAN is a more specialized software; it captures the actual dollar amounts of all business transactions taking place in a regional economy by utilizing Social Accounting Matrices (SAMs) accounts (IMPLAN, 2011). IMPLAN's advantages are:

- SAMs are a better measure of economic flow as they include "nonmarket" transactions (i.e., taxes and unemployment benefits);
- Multiplier Models are built directly from the region-specific SAMs, which reflect the region's unique structure;
- Trade Flows Method tracks regional purchases by estimating trade flows, allowing for more accurate capturing of indirect effects; and
- Data accessibility is cost effective and efficient.

For this study, we have utilized IMPLAN's input-output software to estimate the direct, indirect and induced effects of UAS integration in the NAS upon the local economy. The estimated economic impacts of this integration for each of the 50 states are provided in Appendix B.

Data

The most common economic measures used in economic impact analysis are:

- Employment [broken down to include full-time equivalents (FTEs)];
- Annual labor income;
- Taxes; and
- Total output or revenue.

This analysis is based on the following data provided by our own forecasts for the 50 states from 2015 through 2025:

1) Total spending by agriculture and public safety in payroll, parts, and taxes;
2) Total direct employment by agriculture and public safety; and
3) State adjustment factors.

Results

For this study, we used IMPLAN's input-output software to estimate the direct, indirect, induced and total effects of UAS integration on the economy of the state of Arizona. Because of the unique nature of manufacturing UAS and the specialized type of workers required, specific project payroll, parts, and taxes for agriculture and public safety were provided. Using the parts manufacturing distribution data in Table 7, we subtracted 4.10% (Arizona) from all values to get a distribution relative to Arizona. We then used this to modify the existing IMPLAN model for the rest of the states. Table 7 shows the adjustment factors to modify the multipliers for all states based on the Arizona multipliers that were derived from the IMPLAN's input output software.

Table 7: State Multiplier Adjustment Factors Based on State of Arizona's Multiplier

State	Abbreviation	Adjustment Factors	State	Abbreviation	Adjustment Factors
Alabama	AL	-1.88%	Montana	MT	-3.99%
Alaska	AK	-3.96%	Nebraska	NE	-3.91%
Arizona	AZ	0.00%	Nevada	NV	-3.80%
Arkansas	AR	-3.49%	New Hampshire	NH	-3.43%
California	CA	11.48%	New Jersey	NJ	-2.11%
Colorado	CO	-2.34%	New Mexico	NM	-3.32%
Connecticut	CT	-0.15%	New York	NY	-0.80%
Delaware	DE	-3.97%	North Carolina	NC	-2.93%
Florida	FL	0.64%	North Dakota	ND	-3.99%
Georgia	GA	-1.27%	Ohio	OH	-1.40%
Hawaii	HI	-3.85%	Oklahoma	OK	-3.29%
Idaho	ID	-3.88%	Oregon	OR	-3.47%
Illinois	IL	-2.54%	Pennsylvania	PA	-1.10%
Indiana	IN	-2.51%	Rhode Island	RI	-3.78%
Iowa	IA	-2.86%	South Carolina	SC	-3.34%
Kansas	KS	-0.56%	South Dakota	SD	-4.03%
Kentucky	KY	-3.42%	Tennessee	TN	-3.29%
Louisiana	LA	-2.45%	Texas	TX	4.33%
Maine	ME	-3.28%	Utah	UT	-3.00%
Maryland	MD	-1.57%	Vermont	VT	-3.83%
Massachusetts	MA	-1.20%	Virginia	VA	-0.55%
Michigan	MI	-2.66%	Washington	WA	4.92%
Minnesota	MN	-3.02%	West Virginia	WV	-3.74%
Mississippi	MS	-2.85%	Wisconsin	WI	-3.43%
Missouri	MO	-3.13%	Wyoming	WY	-4.06%

Total Economic and Employment Impacts of Agriculture Spending

Table 8 presents the estimated total economic and employment impacts of agriculture spending in all 50 states in 2015. The total economic impact in all 50 states is $2,096.5 million with total job creation of 21,565. The state with the largest economic and employment impacts is California with a total economic impact of about $366.9 million and creation of 3,774 new jobs. Following California are Washington, Texas, Florida and Arizona. The state with the least economic and employment impacts is Wyoming with an estimated $723,647 and creation of seven new jobs.

The average economic and employment impacts of agriculture spending per state are $41,929,742 and creation of 431 new jobs. The standard deviation of economic and employment impacts of agriculture spending are $61,565,404 and 633 new jobs. The large standard deviation indicates the wide variability (spread) of economic and employment impacts among states.

Table 8: 2015 Total Economic & Employment Impacts of Agriculture Spending

State	Direct Spending				State total multipliers	Total Economic Impact	Total Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	$8,371,270	$13,975,214	$372,707	$22,689,897	1.9043	[illegible]	[illegible]
Alaska	$611,783	$917,644	$0	$1,529,428	1.8623	$2,848,213	28
Arizona	$17,225,796	$25,838,695	$396,882	$43,461,373	1.9800	$86,053,515	885
Arkansas	$2,565,890	$3,848,835	$143,679	$6,557,904	1.8718	$12,275,085	126
California	$65,438,414	$98,157,622	$2,094,029	$165,690,065	2.2143	$366,887,512	3,774
Colorado	$7,416,208	$11,124,313	$274,696	$18,815,217	1.8893	$35,547,590	366
Connecticut	$16,575,698	$24,863,547	$663,028	$42,102,272	1.9598	$82,512,034	849
Delaware	$557,295	$835,939	$24,743	$1,417,968	1.8594	$2,636,547	27
Florida	$19,927,882	$29,891,823	$0	$49,819,705	1.9477	$97,033,640	999
Georgia	$11,882,156	$17,823,233	$570,343	$30,275,732	1.9218	$58,177,847	599
Hawaii	$1,041,120	$1,561,680	$59,969	$2,662,784	1.8604	$4,953,944	51
Idaho	$952,678	$1,399,467	$65,232	$2,387,679	1.8602	$4,441,568	46
Illinois	$6,671,201	$9,956,802	$262,848	$16,890,851	1.8750	$31,296,340	322
Indiana	$6,686,613	$10,029,919	$181,876	$16,898,408	1.8850	$31,853,499	328
Iowa	$5,193,121	$7,789,682	$141,253	$13,124,056	1.8589	$24,396,329	251
Kansas	$14,873,981	$22,310,972	$743,699	$37,928,652	1.9792	$75,068,387	772
Kentucky	$2,877,624	$4,316,437	$138,126	$7,332,187	1.8681	$13,697,259	141
Louisiana	$6,918,647	$10,377,970	$221,397	$17,518,014	1.8684	$32,730,067	337
Maine	$3,444,594	$5,166,891	$192,897	$8,804,383	1.8584	$16,362,068	168
Maryland	$10,945,314	$15,987,971	$404,522	$27,017,806	1.9061	$51,498,641	530
Massachusetts	$12,175,124	$18,262,685	$516,225	$30,954,034	1.9142	$59,252,215	609
Michigan	$6,080,323	$9,090,485	$210,898	$15,381,707	1.8748	$28,800,128	296
Minnesota	$4,581,589	$6,842,984	$257,296	$11,682,269	1.8677	$21,781,820	224
Mississippi	$5,268,580	$7,902,874	$168,595	$13,340,052	1.8621	$24,840,611	256
Missouri	$8,279,550	$12,414,825	$264,850	$20,958,224	1.9064	$39,950,946	411
Montana	$462,857	$694,286	$23,328	$1,180,471	1.8589	$2,194,379	23
Nebraska	$807,479	$1,211,217	$33,074	$2,051,770	1.8600	$3,816,291	39
Nevada	$1,255,001	$1,882,501	$0	$3,137,502	1.8666	$5,856,442	60
New Hampshire	$2,817,497	$4,226,246	$0	$7,043,743	1.8612	$13,109,815	135
New Jersey	$8,353,625	$12,530,438	$497,876	$21,381,940	1.8883	$40,375,617	415
New Mexico	$3,271,880	$4,907,821	$112,553	$8,292,254	1.8642	$15,458,419	159
New York	$13,878,061	$20,817,077	$716,107	$35,411,256	1.9184	$67,932,913	699
North Carolina	$4,898,943	$7,348,414	$274,541	$12,521,898	1.8711	$23,429,348	241
North Dakota	$453,576	$680,364	$10,233	$1,144,173	1.8585	$2,126,445	22
Ohio	$11,382,400	$17,043,589	$372,687	$28,778,686	1.9129	$55,050,748	566
Oklahoma	$3,410,294	$5,115,440	$143,232	$8,668,966	1.8753	$16,256,913	167
Oregon	$2,632,274	$3,948,411	$63,175	$6,643,859	1.8685	$12,414,050	128
Pennsylvania	$12,598,434	$18,897,651	$309,418	$31,805,503	1.8984	$60,315,964	620
Rhode Island	$1,364,360	$2,046,539	$58,326	$3,469,225	1.8658	$6,465,042	67
South Carolina	$3,185,523	$4,778,285	$178,388	$8,142,196	1.8585	$15,132,275	156
South Dakota	$305,881	$458,822	$0	$764,703	1.8673	$1,427,930	15
Tennessee	$3,390,117	$5,085,175	$0	$8,475,292	2.0342	$17,240,439	177
Texas	$35,422,907	$53,134,361	$0	$88,557,268	1.8834	$166,786,758	1,716
Utah	$4,636,340	$6,954,510	$185,450	$11,776,049	1.8619	$21,925,627	226
Vermont	$1,160,488	$1,730,333	$71,815	$2,949,036	1.8578	$5,478,720	56
Virginia	$14,907,071	$22,360,607	$695,725	$37,963,403	1.8720	$71,048,771	731
Washington	$37,902,340	$56,853,360	$0	$94,755,601	2.1250	$201,355,651	2,071
West Virginia	$1,504,791	$2,257,186	$72,230	$3,834,206	1.8662	$7,155,396	74
Wisconsin	$2,825,569	$4,238,352	$146,930	$7,210,850	1.8642	$13,442,406	138
Wyoming	$155,765	$233,648	$0	$389,413	1.8583	$723,647	7
TOTAL	$420,000,000	$630,000,000	[illegible]	[illegible]		$2,096,487,[illegible]	21,565
Average						$41,929,742	431
STD						$61,565,404	633

Total Economic and Employment Impacts of Public Safety and Other Spending

Table 9 presents the estimated total economic and employment impacts in 2015 of public safety spending in all 50 states. Since the total spending for "other markets" is considered equivalent to the public safety estimates, these data are not repeated. The total economic impact of the public safety market in all 50 states is approximately $89.8 million with creation of 924 new jobs. As with agriculture spending, the state with the largest economic and employment impacts is California with a total of more than $15.7 million and creation of 162 new jobs. This is followed in descending order by the states of Washington, Texas, Florida and Arizona. The state of Wyoming has the least economic and employment impacts with $31,013 and no new jobs created.

The average economic and employment impacts of public safety spending per state are $1,796,989 and creation of 18 new jobs. The standard deviation of economic and employment impacts of public safety spending is $2,638,517 and creation of 27 new jobs. The large standard deviation again indicates the wide variability among states.

Table 9: 2015 Total Economic & Employment Impacts of Public Safety Spending

State	Direct Spending				State Total Multipliers	Total Economic Impact	Total Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	$399,329	$598,993	$15,973	$1,014,295	1.9043	$1,931,523	20
Alaska	$26,218	$39,328	$0	$65,546	1.8623	$122,068	1
Arizona	$734,248	$1,107,373	$17,009	$1,852,630	1.9800	$3,668,008	38
Arkansas	$109,958	$164,937	$6,158	$281,053	1.8718	$526,075	5
California	$2,804,503	$4,206,755	$89,744	$7,101,003	2.2143	$15,723,751	162
Colorado	$317,838	$476,756	$11,773	$806,368	1.8893	$1,523,468	16
Connecticut	$710,387	$1,065,581	$28,415	$1,804,383	1.9598	$3,536,230	36
Delaware	$23,884	$35,825	$1,060	$60,770	1.8594	$112,995	1
Florida	$854,052	$1,281,078	$0	$2,135,130	1.9477	$4,158,560	43
Georgia	$509,235	$763,853	$24,443	$1,297,531	1.9218	$2,493,338	26
Hawaii	$44,620	$66,930	$2,570	$114,119	1.8604	$212,308	2
Idaho	$39,965	$59,977	$2,367	$102,329	1.8602	$190,353	2
Illinois	$281,623	$422,434	$11,265	$715,322	1.8750	$1,341,229	14
Indiana	$286,569	$429,854	$7,795	$724,217	1.8850	$1,365,150	14
Iowa	$222,562	$333,844	$6,054	$562,460	1.8589	$1,045,556	11
Kansas	$637,456	$956,184	$31,873	$1,625,514	1.9792	$3,217,217	33
Kentucky	$123,327	$184,990	$5,920	$314,237	1.8681	$587,025	6
Louisiana	$296,513	$444,770	$9,488	$750,772	1.8684	$1,402,742	14
Maine	$147,625	$221,438	$8,267	$377,331	1.8584	$701,231	7
Maryland	$456,228	$684,342	$17,337	$1,157,908	1.9061	$2,207,085	23
Massachusetts	$521,791	$782,687	$22,124	$1,326,601	1.9142	$2,539,381	26
Michigan	$259,728	$389,592	$9,039	$658,359	1.8748	$1,234,291	13
Minnesota	$195,514	$293,271	$11,027	$499,812	1.8677	$933,488	10
Mississippi	$225,798	$338,695	$7,225	$571,717	1.8621	$1,064,580	11
Missouri	$354,709	$532,064	$11,351	$898,124	1.9064	$1,712,183	18
Montana	$19,837	$29,755	$1,000	$50,592	1.8589	$94,045	1
Nebraska	$34,606	$51,909	$1,417	$87,933	1.8600	$163,555	2
Nevada	$53,786	$80,679	$0	$134,464	1.8666	$250,991	3
New Hampshire	$120,750	$181,125	$0	$301,875	1.8612	$561,849	6
New Jersey	$358,013	$537,019	$21,338	$916,369	1.8883	$1,730,379	18
New Mexico	$140,223	$210,335	$4,824	$355,382	1.8642	$662,504	7
New York	$594,774	$892,160	$30,690	$1,517,624	1.9184	$2,911,411	30
North Carolina	$209,955	$314,932	$11,757	$536,644	1.8711	$1,004,115	10
North Dakota	$19,439	$29,159	$439	$49,036	1.8585	$91,133	1
Ohio	$486,960	$730,440	$15,972	$1,233,372	1.9129	$2,359,318	24
Oklahoma	$146,155	$219,233	$6,139	$371,527	1.8753	$696,725	7
Oregon	$112,812	$169,218	$2,707	$284,737	1.8685	$532,031	5
Pennsylvania	$539,933	$809,899	$13,261	$1,363,093	1.8984	$2,584,970	27
Rhode Island	$58,473	$87,709	$2,500	$148,681	1.8658	$277,112	3
South Carolina	$136,522	$204,784	$7,645	$348,951	1.8585	$648,526	7
South Dakota	$13,109	$19,664	$0	$32,773	1.8673	$61,197	1
Tennessee	$145,291	$217,936	$0	$363,227	2.0342	$738,879	8
Texas	$1,518,125	$2,277,187	$0	$3,795,311	1.8834	$7,148,090	74
Utah	$198,698	$298,044	$7,948	$504,688	1.8619	$939,676	10
Vermont	$49,324	$73,986	$3,078	$126,387	1.8578	$234,802	2
Virginia	$638,874	$958,312	$29,388	$1,626,574	1.8720	$3,044,847	31
Washington	$1,624,382	$2,436,573	$0	$4,060,954	2.1250	$8,629,528	89
West Virginia	$64,491	$96,737	$3,096	$164,323	1.8662	$306,660	3
Wisconsin	$121,096	$181,644	$6,297	$309,036	1.8642	$576,106	6
Wyoming	$6,676	$10,013	$0	$16,689	1.8583	$31,013	0
TOTAL	$18,000,000	$27,000,000	$527,772	$45,527,772		$89,849,448	924
Average						$1,796,989	18
STD						$2,638,517	27
Max						$15,723,751	162
Min						$31,013	0

Total Economic and Employment Impacts of Agriculture, Public Safety and Other Spending

Table 10 presents the estimated total economic and employment impacts of agriculture, public safety and other spending in 2015 all 50 states. The total economic impact of these markets in all 50 states is more than $2,276 million with total job creation of 23,413. The state with the largest economic and employment impact is California with a total of more than $398.3 million and creation of 4,097 new jobs. Following California in descending rank order are Washington, Texas, Florida and Arizona. In addition, the order of job creation was similar to estimated total economic impact. Wyoming has the least economic and employment impacts with $785,674 and eight new jobs created.

The average economic and employment impacts of agriculture, public safety and other spending per state are approximately $45.5 million and creation of 468 new jobs. The standard deviation of economic and employment impacts is approximately $66.8 million and 688 new jobs created. As with agriculture, public safety and other state estimates, there is a wide variability of economic and employment impacts and job creation among states.

Table 10: 2015 Total Economic & Employment Impacts of Agriculture, Public Safety and Other Spending

State	Direct Spending				State Total Multiplier	Total Economic Impact	Total Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	$10,176,334	$15,174,501	$404,553	[illegible]	[illegible]	[illegible]	[illegible]
Alaska	$664,106	$996,299	$0	$1,660,405	1.8623	$3,092,349	32
Arizona	$18,702,260	$28,053,440	$430,901	$47,186,634	1.9800	$93,429,535	961
Arkansas	$2,785,606	$4,178,410	$155,994	$7,120,010	1.8718	$13,327,235	137
California	$71,047,421	$106,571,132	$2,273,517	$179,892,071	2.2143	$398,335,013	4,097
Colorado	$8,051,883	$12,077,825	$298,242	$20,427,950	1.8893	$38,594,526	397
Connecticut	$17,996,472	$26,994,708	$719,859	$45,711,039	1.9598	$89,584,494	921
Delaware	$605,052	$907,578	$26,864	$1,539,495	1.8594	$2,862,537	29
Florida	$21,635,686	$32,453,979	$0	$54,089,966	1.9477	$105,351,026	1,084
Georgia	$12,900,626	$19,350,939	$619,230	$32,870,795	1.9216	$63,164,520	650
Hawaii	$1,130,366	$1,695,548	$65,109	$2,891,023	1.8604	$5,378,459	55
Idaho	$1,012,848	$1,519,422	$59,967	$2,592,338	1.8602	$4,822,263	50
Illinois	$7,134,447	$10,701,671	$285,378	$18,121,496	1.8750	$33,977,804	350
Indiana	$7,259,751	$10,889,627	$197,465	$18,346,843	1.8890	$34,583,799	356
Iowa	$5,638,246	$8,457,369	$153,360	$14,248,976	1.8589	$26,487,421	272
Kansas	$16,148,884	$24,223,341	$807,445	$41,179,679	1.9792	$81,502,821	838
Kentucky	$3,124,278	$4,686,417	$149,965	$7,960,660	1.8681	$14,871,309	153
Louisiana	$7,511,674	$11,267,511	$240,374	$19,019,558	1.8684	$35,536,142	366
Maine	$3,739,845	$5,609,768	$209,431	$9,559,045	1.8584	$17,764,528	183
Maryland	$11,557,769	$17,336,654	$439,196	$29,333,618	1.9061	$55,912,610	575
Massachusetts	$13,218,706	$19,828,059	$560,473	$33,607,237	1.9142	$64,330,974	662
Michigan	$8,579,779	$9,869,669	$228,976	$18,678,425	1.8748	$31,268,710	322
Minnesota	$4,963,017	$7,429,525	$279,350	$12,661,892	1.8677	$23,648,616	243
Mississippi	$5,720,176	$8,580,264	$183,046	$14,483,485	1.8621	$26,969,697	277
Missouri	$8,985,968	$13,478,953	$287,551	$22,752,472	1.9064	$43,375,313	446
Montana	$502,531	$753,796	$25,328	$1,281,654	1.8589	$2,382,467	25
Nebraska	$876,691	$1,315,038	$35,909	$2,227,638	1.8600	$4,143,402	43
Nevada	$1,362,572	$2,043,859	$0	$3,406,431	1.8666	$6,358,445	65
New Hampshire	$3,058,997	$4,588,496	$0	$7,647,493	1.8612	$14,233,514	146
New Jersey	$9,069,851	$13,604,476	$540,551	$23,214,878	1.8883	$43,836,276	451
New Mexico	$3,552,327	$5,328,491	$122,200	$9,003,018	1.8642	$16,783,427	173
New York	$15,067,596	$22,601,397	$777,488	$38,446,484	1.9184	$73,755,734	759
North Carolina	$5,318,852	$7,978,276	$297,856	$13,594,986	1.8711	$25,437,578	262
North Dakota	$492,454	$738,681	$11,110	$1,242,244	1.8585	$2,308,711	24
Ohio	$12,336,320	$18,504,479	$404,631	$31,245,430	1.9129	$59,769,363	615
Oklahoma	$3,702,605	$5,553,907	$155,508	$9,412,021	1.8753	$17,650,363	182
Oregon	$2,857,897	$4,286,846	$68,590	$7,213,333	1.8685	$13,478,112	139
Pennsylvania	$13,678,300	$20,517,450	$335,939	$34,531,689	1.8964	$65,485,895	674
Rhode Island	$1,481,305	$2,221,957	$63,326	$3,766,588	1.8638	$7,020,166	72
South Carolina	$3,458,569	$5,187,852	$193,680	$8,840,100	1.8585	$16,429,327	169
South Dakota	$332,100	$498,149	$0	$830,249	1.8673	$1,550,324	16
Tennessee	$3,680,698	$5,521,047	$0	$9,201,746	2.0342	$18,718,191	193
Texas	$38,459,156	$57,688,734	$0	$96,147,891	1.8834	$181,084,837	1,863
Utah	$5,033,632	$7,550,448	$201,346	$12,785,425	1.8019	$23,805,163	245
Vermont	$1,249,536	$1,874,304	$77,971	$3,201,811	1.8579	$5,948,324	61
Virginia	$16,184,620	$24,277,230	$744,502	$41,206,552	1.8720	$77,138,665	793
Washington	$41,151,004	$61,726,505	$0	$102,877,509	2.1250	$218,614,707	2,249
West Virginia	$1,633,773	$2,450,659	$78,421	$4,162,853	1.8662	$7,768,718	80
Wisconsin	$3,067,760	$4,601,640	$159,524	$7,828,923	1.8642	$14,594,678	150
Wyoming	$169,117	$253,675	$0	$422,792	1.8583	$785,674	8
TOTAL	[illegible]	[illegible]	$13,370,225	[illegible]		$2,276,166,015	23,413
Average						$45,523,720	468
STD						$66,842,438	688
MAX						$398,335,013	4,097
MIN						$785,674	8

Total Economic and Employment Impacts of Agriculture Direct Spending

Tables 11, 12 and 13 show the 2015 direct, indirect and induced impacts respectively, of agriculture spending. Table 11 presents the total economic and employment impacts of direct agriculture spending in all 50 states. The nationwide total economic impact is an estimated $1,058,841,630 with about 11,094 newly created jobs. The largest economic and employment impacts of direct agriculture spending is in California with total economic impact of more than $185,307,769 and creation of 1,942 new jobs. As before, the order of job creation was similar to overall economic impact. The state with least economic and employment impacts is Wyoming with $365,503 and four newly created jobs.

The average economic and employment impacts of direct agriculture spending per state are approximately $21,176,833 and an estimated 222 new jobs. The standard deviation of economic and employment impacts of direct agriculture spending is approximately $31,094,684 and new job creation of 326. This again reflects the wide spread of economic and employment impacts among states.

Table 11: 2015 Direct Economic & Employment Impacts of Agriculture Spending

State	Direct Spending				State Direct Multiplier	Direct Economic Impact	Direct Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alaska	$611,763	$917,644	$0	$1,529,406	0.9405	$1,438,407	15
Arizona	$17,225,796	$25,838,695	$396,882	$43,461,373	1	$43,461,373	455
Arkansas	$2,565,690	$3,848,535	$143,679	$6,557,904	0.9453	$6,199,187	65
California	$65,438,414	$98,157,622	$2,094,029	$165,690,065	1.1184	$185,307,769	1942
Colorado	$7,416,208	$11,124,313	$274,696	$18,815,217	0.9542	$17,953,480	188
Connecticut	$16,575,698	$24,863,547	$663,028	$42,102,272	0.9898	$41,672,829	437
Delaware	$567,285	$835,928	$24,743	$1,417,956	0.9391	$1,331,602	14
Florida	$19,927,682	$29,891,823	$0	$49,819,705	0.9837	$49,007,644	513
Georgia	$11,882,156	$17,823,233	$570,343	$30,275,732	0.9705	$29,382,598	308
Hawaii	$1,041,126	$1,561,689	$59,969	$2,662,784	0.9396	$2,501,952	26
Idaho	$932,976	$1,399,467	$55,232	$2,387,678	0.9396	$2,243,223	24
Illinois	$6,571,201	$9,856,802	$262,848	$16,690,851	0.947	$15,806,238	166
Indiana	$6,686,613	$10,029,919	$181,876	$16,898,408	0.952	$16,087,285	169
Iowa	$5,193,121	$7,789,682	$141,253	$13,124,056	0.9388	$12,320,864	129
Kansas	$14,873,981	$22,310,972	$743,699	$37,928,652	0.9996	$37,913,480	397
Kentucky	$2,877,624	$4,316,437	$138,126	$7,332,187	0.9435	$6,917,916	72
Louisiana	$6,918,647	$10,377,970	$221,397	$17,518,014	0.9436	$16,529,998	173
Maine	$3,444,594	$5,166,891	$192,897	$8,804,383	0.9388	$8,263,794	87
Maryland	$10,645,314	$15,967,971	$404,522	$27,017,806	0.9627	$26,010,042	273
Massachusetts	$12,175,124	$18,262,685	$516,225	$30,954,034	0.9668	$29,926,360	314
Michigan	$6,060,323	$9,090,485	$210,899	$15,361,707	0.9468	$14,544,404	152
Minnesota	$4,561,969	$6,842,984	$257,296	$11,662,269	0.9433	$11,001,018	115
Mississippi	$5,268,583	$7,902,874	$168,595	$13,340,052	0.9405	$12,546,319	131
Missouri	$8,276,550	$12,414,825	$264,850	$20,956,224	0.9628	$20,176,053	211
Montana	$462,857	$694,286	$23,328	$1,180,471	0.9368	$1,108,226	12
Nebraska	$807,478	$1,211,217	$33,074	$2,051,770	0.9394	$1,927,432	20
Nevada	$1,255,001	$1,882,501	$0	$3,137,502	0.9427	$2,957,724	31
New Hampshire	$2,817,497	$4,226,246	$0	$7,043,743	0.94	$6,621,119	69
New Jersey	$8,353,625	$12,530,438	$497,876	$21,381,940	0.9537	$20,391,956	214
New Mexico	$3,271,880	$4,907,821	$112,553	$8,292,254	0.9415	$7,807,157	82
New York	$13,878,051	$20,817,077	$716,107	$35,411,235	0.9688	$34,309,946	359
North Carolina	$4,898,943	$7,348,414	$274,341	$12,521,698	0.945	$11,833,004	124
North Dakota	$453,576	$680,364	$10,233	$1,144,172	0.9386	$1,073,920	11
Ohio	$11,362,400	$17,043,599	$372,687	$28,778,686	0.9661	$27,803,088	291
Oklahoma	$3,410,294	$5,115,440	$143,232	$8,668,966	0.9471	$8,210,378	86
Oregon	$2,632,274	$3,948,411	$63,175	$6,643,859	0.9437	$6,269,810	66
Pennsylvania	$12,598,434	$18,897,651	$309,418	$31,805,503	0.9578	$30,463,311	319
Rhode Island	$1,364,380	$2,046,539	$58,326	$3,469,225	0.9413	$3,265,562	34
South Carolina	$3,185,523	$4,778,285	$178,389	$8,142,198	0.9386	$7,642,267	80
South Dakota	$305,881	$458,822	$0	$764,703	0.9431	$721,192	8
Tennessee	$3,390,117	$5,085,175	$0	$8,475,292	1.0274	$8,707,515	91
Texas	$35,422,907	$53,134,361	$0	$88,557,268	0.9512	$84,235,673	883
Utah	$4,636,240	$6,954,360	$185,450	$11,776,049	0.9403	$11,073,019	116
Vermont	$1,150,888	$1,726,333	$71,815	$2,949,036	0.9383	$2,767,081	29
Virginia	$14,907,071	$22,360,607	$685,725	$37,953,403	0.9455	$35,884,943	376
Washington	$37,902,240	$56,853,360	$0	$94,755,601	1.0732	$101,691,710	1065
West Virginia	$1,504,791	$2,257,186	$72,230	$3,834,206	0.9425	$3,613,739	38
Wisconsin	$2,825,568	$4,238,352	$146,930	$7,210,850	0.9415	$6,789,015	71
Wyoming	$155,765	$233,648	$0	$389,413	0.9386	$365,503	4
TOTAL	$420,000,000	$630,000,000	$12,314,681	$1,062,314,681		$1,058,841,630	11,094
Average						$21,176,833	222
STD						$31,094,684	326

Total Economic and Employment Impacts of Agriculture Indirect Spending

The total economic and employment impact of indirect agriculture spending in all 50 states is shown in Table 12. The nationwide total economic impact is approximately $487,060,836, with an estimated 5,103 new jobs. The largest economic and employment impacts of indirect agriculture spending is in the state of California with a total economic impact of approximately $85,230,970 and creation of 893 new jobs. The order of job creation was similar to overall economic impact. Wyoming has the least economic and employment impact with $168,110 and creation of two new jobs.

The average economic and employment impacts of indirect agriculture spending per state are $9,741,217 and creation of 102 jobs. The standard deviation of economic and employment impacts of indirect agriculture spending is $14,302,673 and job creation of 150. The large standard deviation indicates the wide variability of economic and employment impacts among states.

Table 12: 2015 Indirect Economic & Employment Impacts of Agriculture Spending

State	Direct Spending				State Indirect	Indirect Economic Impact	Indirect Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alaska	$611,763	$917,644	$0	$1,529,406	0.4327	$661,774	7
Arizona	$17,225,796	$25,838,695	$396,882	$43,461,373	0.46	$19,992,232	209
Arkansas	$2,565,690	$3,848,535	$143,679	$6,557,904	0.4349	$2,852,032	30
California	$65,438,414	$98,157,622	$2,094,029	$165,690,065	0.5144	$85,230,970	893
Colorado	$7,416,208	$11,124,313	$274,696	$18,815,217	0.4389	$8,257,999	87
Connecticut	$16,575,698	$24,863,547	$663,028	$42,102,272	0.4553	$19,169,165	201
Delaware	$567,285	$835,928	$24,743	$1,417,956	0.432	$612,557	6
Florida	$19,927,682	$29,891,823	$0	$49,819,705	0.4525	$22,543,417	236
Georgia	$11,882,156	$17,823,233	$570,343	$30,275,732	0.4464	$13,515,067	142
Hawaii	$1,041,126	$1,561,689	$59,969	$2,662,784	0.4322	$1,150,855	12
Idaho	$932,976	$1,399,467	$55,232	$2,387,678	0.4322	$1,031,954	11
Illinois	$6,571,201	$9,856,802	$262,848	$16,690,851	0.4356	$7,270,535	76
Indiana	$6,686,613	$10,029,919	$181,876	$16,898,408	0.4379	$7,399,813	78
Iowa	$5,193,121	$7,789,682	$141,253	$13,124,056	0.4319	$5,668,260	59
Kansas	$14,873,981	$22,310,972	$743,699	$37,928,652	0.4598	$17,438,594	183
Kentucky	$2,877,624	$4,316,437	$138,126	$7,332,187	0.434	$3,182,169	33
Louisiana	$6,918,647	$10,377,970	$221,397	$17,518,014	0.4341	$7,604,570	80
Maine	$3,444,594	$5,166,891	$192,897	$8,804,383	0.4317	$3,800,852	40
Maryland	$10,645,314	$15,967,971	$404,522	$27,017,806	0.4428	$11,963,485	125
Massachusetts	$12,175,124	$18,262,685	$516,225	$30,954,034	0.4447	$13,765,258	144
Michigan	$6,060,323	$9,090,485	$210,899	$15,361,707	0.4356	$6,691,560	70
Minnesota	$4,561,969	$6,842,984	$257,296	$11,662,269	0.4339	$5,060,254	53
Mississippi	$5,268,583	$7,902,874	$168,595	$13,340,052	0.4326	$5,770,906	60
Missouri	$8,276,550	$12,414,825	$264,850	$20,956,224	0.4429	$9,281,512	97
Montana	$462,857	$694,286	$23,328	$1,180,471	0.4319	$509,846	5
Nebraska	$807,478	$1,211,217	$33,074	$2,051,770	0.4321	$886,570	9
Nevada	$1,255,001	$1,882,501	$0	$3,137,502	0.4337	$1,360,735	14
New Hampshire	$2,817,497	$4,226,246	$0	$7,043,743	0.4324	$3,045,715	32
New Jersey	$8,353,625	$12,530,438	$497,876	$21,381,940	0.4387	$9,380,257	98
New Mexico	$3,271,880	$4,907,821	$112,553	$8,292,254	0.4331	$3,591,375	38
New York	$13,878,051	$20,817,077	$716,107	$35,411,235	0.4457	$15,782,787	165
North Carolina	$4,898,943	$7,348,414	$274,341	$12,521,698	0.4347	$5,443,182	57
North Dakota	$453,576	$680,364	$10,233	$1,144,172	0.4318	$494,054	5
Ohio	$11,362,400	$17,043,599	$372,687	$28,778,686	0.4444	$12,789,248	134
Oklahoma	$3,410,294	$5,115,440	$143,232	$8,668,966	0.4357	$3,777,069	40
Oregon	$2,632,274	$3,948,411	$63,175	$6,643,859	0.4341	$2,884,099	30
Pennsylvania	$12,598,434	$18,897,651	$309,418	$31,805,503	0.4406	$14,013,505	147
Rhode Island	$1,364,380	$2,046,539	$58,326	$3,469,225	0.433	$1,502,175	16
South Carolina	$3,185,523	$4,778,285	$178,389	$8,142,198	0.4318	$3,515,801	37
South Dakota	$305,881	$458,822	$0	$764,703	0.4338	$331,728	3
Tennessee	$3,390,117	$5,085,175	$0	$8,475,292	0.4726	$4,005,423	42
Texas	$35,422,907	$53,134,361	$0	$88,557,268	0.4376	$38,752,680	406
Utah	$4,636,240	$6,954,360	$185,450	$11,776,049	0.4326	$5,094,319	53
Vermont	$1,150,888	$1,726,333	$71,815	$2,949,036	0.4316	$1,272,804	13
Virginia	$14,907,071	$22,360,607	$685,725	$37,953,403	0.4349	$16,505,935	173
Washington	$37,902,240	$56,853,360	$0	$94,755,601	0.4937	$46,780,640	490
West Virginia	$1,504,791	$2,257,186	$72,230	$3,834,206	0.4336	$1,662,512	17
Wisconsin	$2,825,568	$4,238,352	$146,930	$7,210,850	0.4331	$3,123,019	33
Wyoming	$155,765	$233,648	$0	$389,413	0.4317	$168,110	2
TOTAL	$420,000,000	$630,000,000	$12,314,681	$1,062,314,681		$487,060,836	5,103
Average						$9,741,217	102
STD						$14,302,673	150

Total Economic and Employment Impacts of Agriculture Induced Spending

Table 13 presents the total economic and employment impacts of induced agriculture spending in 2015 in all 50 states. The estimated nationwide total economic impact is $550,584,654 with the creation of 5,770 new jobs. The largest economic and employment impacts of induced agriculture spending is in the state of California with a total economic impact of approximately $96,348,773 and creation of 1,010 new jobs. The order of job creation was similar to economic impact. The state of Wyoming has the least amount economic and employment impact with $190,034 and the creation of two new jobs. The average economic and employment impacts of induced agricultural spending per state are an estimated 11,011,693 and creation of 115 jobs. The standard deviation of economic and employment impacts of induced agriculture spending is approximately $16,168,047 and 169 jobs. There is wide variability in economic and employment impacts among states as is evidenced by the large standard deviation.

Table 13: 2015 Induced Economic & Employment Impacts of Agriculture Spending

State	Direct Spending				State Induced Multipliers	Induced Economic Impact	Induced Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alaska	$611,763	$917,644	$0	$1,529,406	0.4891	$748,033	8
Arizona	$17,225,798	$25,838,885	$388,682	$43,461,373	0.52	$22,599,914	237
Arkansas	$2,565,690	$3,848,535	$143,679	$6,557,904	0.4916	$3,223,868	34
California	$65,438,414	$98,157,622	$2,094,029	$165,690,065	0.5815	$96,348,773	1,010
Colorado	$7,416,208	$11,124,313	$274,696	$18,815,217	0.4962	$9,336,111	98
Connecticut	$16,575,698	$24,863,547	$663,028	$42,102,272	0.5147	$21,670,040	227
Delaware	$567,285	$835,928	$24,743	$1,417,956	0.4883	$692,388	7
Florida	$19,927,882	$29,891,823	$0	$49,819,705	0.5115	$25,482,779	267
Georgia	$11,882,156	$17,823,233	$570,345	$30,275,732	0.5047	$15,280,162	160
Hawaii	$1,041,129	$1,561,689	$59,969	$2,662,784	0.4886	$1,301,036	14
Idaho	$932,978	$1,399,467	$55,232	$2,387,678	0.4885	$1,166,381	12
Illinois	$6,571,201	$9,856,807	$262,845	$16,690,851	0.4924	$8,218,575	86
Indiana	$6,686,613	$10,029,919	$181,876	$16,898,408	0.4951	$8,366,402	88
Iowa	$5,193,121	$7,789,682	$141,253	$13,124,056	0.4882	$6,407,164	67
Kansas	$14,873,981	$22,310,972	$743,699	$37,928,652	0.5198	$19,715,313	207
Kentucky	$2,877,624	$4,316,437	$138,126	$7,332,187	0.4906	$3,597,171	38
Louisiana	$6,918,647	$10,377,970	$221,397	$17,518,014	0.4907	$8,596,089	90
Maine	$3,444,594	$5,166,891	$192,897	$8,804,383	0.4881	$4,297,419	45
Maryland	$10,645,314	$15,967,971	$404,522	$27,017,806	0.5006	$13,525,114	142
Massachusetts	$12,175,124	$18,262,685	$516,225	$30,954,034	0.5027	$15,560,593	163
Michigan	$6,060,323	$9,090,485	$210,898	$15,361,707	0.4924	$7,564,104	79
Minnesota	$4,561,989	$6,842,984	$257,296	$11,662,269	0.4905	$5,720,343	60
Mississippi	$5,268,583	$7,902,874	$168,595	$13,340,052	0.489	$6,523,285	68
Missouri	$8,276,550	$12,414,825	$264,850	$20,956,224	0.5007	$10,492,761	110
Montana	$462,857	$694,286	$23,328	$1,180,471	0.4882	$576,306	6
Nebraska	$807,478	$1,211,217	$33,074	$2,051,770	0.4885	$1,002,289	11
Nevada	$1,255,001	$1,882,501	$0	$3,137,502	0.4902	$1,538,004	16
New Hampshire	$2,817,497	$4,226,246	$0	$7,043,743	0.4888	$3,442,982	36
New Jersey	$8,353,625	$12,530,438	$497,876	$21,381,940	0.4959	$10,603,304	111
New Mexico	$3,271,880	$4,907,821	$112,553	$8,292,254	0.4896	$4,059,887	43
New York	$13,878,051	$20,817,077	$716,107	$35,411,235	0.5038	$17,840,180	187
North Carolina	$4,898,943	$7,348,414	$274,341	$12,521,698	0.4914	$6,153,162	64
North Dakota	$453,578	$680,364	$10,233	$1,144,172	0.4881	$558,471	6
Ohio	$11,362,400	$17,043,599	$372,687	$28,778,686	0.5024	$14,458,412	152
Oklahoma	$3,410,294	$5,115,440	$143,232	$8,668,966	0.4925	$4,269,466	45
Oregon	$2,632,274	$3,948,411	$63,175	$6,643,859	0.4907	$3,260,142	34
Pennsylvania	$12,598,434	$18,897,651	$309,418	$31,805,503	0.498	$15,838,141	166
Rhode Island	$1,364,360	$2,046,539	$58,326	$3,469,225	0.4895	$1,698,186	18
South Carolina	$3,185,523	$4,778,285	$178,389	$8,142,198	0.4881	$3,974,207	42
South Dakota	$305,881	$458,822	$0	$764,702	0.4904	$375,010	4
Tennessee	$3,390,117	$5,085,176	$0	$8,475,292	0.5342	$4,527,501	47
Texas	$35,422,907	$53,134,361	$0	$88,557,268	0.4946	$43,800,425	459
Utah	$4,636,240	$6,954,360	$185,450	$11,776,049	0.489	$5,758,488	60
Vermont	$1,150,888	$1,726,333	$71,815	$2,949,036	0.4879	$1,438,835	15
Virginia	$14,907,071	$22,360,607	$685,725	$37,953,403	0.4916	$18,657,893	196
Washington	$37,902,240	$56,853,360	$0	$94,755,601	0.5581	$52,883,101	554
West Virginia	$1,504,791	$2,257,186	$72,230	$3,834,206	0.4901	$1,879,145	20
Wisconsin	$2,829,568	$4,238,352	$146,930	$7,210,850	0.4898	$3,530,432	37
Wyoming	$155,795	$233,648	$0	$389,413	0.488	$190,034	2
TOTAL	$420,000,000	$630,000,000	[illegible]	[illegible]		$550,584,654	5,770
Average						$11,011,693	115
STD						$16,168,047	169

Total Economic and Employment Impacts of Public Safety and Other Direct Spending

Tables 14, 15, and 16 show the 2015 direct, indirect, and induced impacts respectively, of public safety spending. Since the impacts to "other" markets are equivalent to public safety, that data is not presented. Table 14 presents the total economic and employment impacts of direct public safety spending in all 50 states. The total economic impact is approximately $45,378,927 with a total job creation of 475. The largest economic and employment impacts of direct public safety spending is in the state of California with a total economic impact of $7,941,762 and creation of 83 new jobs. The state of Wyoming has the least economic and employment impacts among public safety direct spending with $15,664 and no new jobs created. The average economic and employment impacts of direct public safety spending per state are approximately $907,579 and creation of 10 new jobs. The standard deviation of economic and employment impacts of direct public safety spending are approximately $1,332,629 and new job creation of 14. The large standard deviation again indicates the variability of economic and employment impacts of direct public safety spending among states.

Table 14: 2015 Direct Economic & Employment Impacts of Public Safety Spending

State	Direct Spending				State Direct Multipliers	Direct Economic Impact	Direct Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	$398,329	$598,993	$15,973	$1,014,296	0.9618	$975,550	10
Alaska	$26,218	$39,328	$0	$65,546	0.9405	$61,646	1
Arizona	$738,248	$1,107,373	$17,009	$1,862,630	1	$1,862,630	20
Arkansas	$109,958	$164,937	$8,158	$281,053	0.9453	$265,679	3
California	$2,804,503	$4,208,755	$89,744	$7,101,003	1.1184	$7,941,762	83
Colorado	$317,838	$476,756	$11,773	$806,366	0.9542	$769,435	8
Connecticut	$710,387	$1,065,581	$28,415	$1,804,383	0.9898	$1,785,978	19
Delaware	$23,884	$35,825	$1,060	$60,770	0.9391	$57,069	1
Florida	$854,052	$1,281,078	$0	$2,135,130	0.9837	$2,100,328	22
Georgia	$509,235	$763,853	$24,443	$1,297,531	0.9705	$1,259,254	13
Hawaii	$44,620	$66,930	$2,570	$114,119	0.9396	$107,227	1
Idaho	$39,985	$59,977	$2,367	$102,329	0.9395	$96,138	1
Illinois	$281,623	$422,434	$11,265	$715,322	0.947	$677,410	7
Indiana	$288,569	$429,854	$7,795	$724,217	0.952	$689,455	7
Iowa	$222,562	$333,844	$6,054	$562,460	0.9388	$528,037	6
Kansas	$637,456	$956,184	$31,873	$1,625,514	0.9998	$1,624,863	17
Kentucky	$123,327	$184,990	$5,920	$314,237	0.9435	$296,482	3
Louisiana	$296,513	$444,770	$9,488	$750,772	0.9436	$708,428	7
Maine	$147,625	$221,438	$8,267	$377,331	0.9386	$354,163	4
Maryland	$456,228	$684,342	$17,337	$1,157,906	0.9627	$1,114,716	12
Massachusetts	$521,791	$782,687	$22,124	$1,326,601	0.9668	$1,282,558	13
Michigan	$259,728	$389,592	$9,039	$658,359	0.9468	$623,334	7
Minnesota	$195,514	$293,271	$11,027	$499,812	0.9433	$471,472	5
Mississippi	$225,798	$338,695	$7,225	$571,717	0.9405	$537,699	6
Missouri	$354,709	$532,064	$11,351	$898,124	0.9828	$884,714	9
Montana	$19,837	$29,755	$1,000	$50,592	0.9388	$47,495	0
Nebraska	$34,606	$51,909	$1,417	$87,933	0.9394	$82,604	1
Nevada	$53,786	$80,679	$0	$134,464	0.9427	$126,760	1
New Hampshire	$120,750	$181,125	$0	$301,875	0.94	$283,762	3
New Jersey	$358,013	$537,019	$21,338	$916,369	0.9537	$873,941	9
New Mexico	$140,223	$210,335	$4,824	$355,382	0.9415	$334,592	4
New York	$594,774	$892,160	$30,690	$1,517,624	0.9689	$1,470,426	15
North Carolina	$208,955	$314,932	$11,757	$535,644	0.945	$507,129	5
North Dakota	$19,439	$29,158	$439	$49,036	0.9386	$46,025	0
Ohio	$486,980	$730,440	$15,972	$1,233,372	0.9661	$1,191,561	12
Oklahoma	$146,155	$219,233	$6,139	$371,527	0.9471	$351,873	4
Oregon	$112,812	$169,218	$2,707	$284,737	0.9437	$268,706	3
Pennsylvania	$539,933	$809,899	$13,261	$1,363,093	0.9578	$1,305,570	14
Rhode Island	$58,473	$87,709	$2,500	$148,681	0.9413	$139,954	1
South Carolina	$136,522	$204,784	$7,645	$348,951	0.9388	$327,526	3
South Dakota	$13,109	$19,664	$0	$32,773	0.9431	$30,908	0
Tennessee	$145,291	$217,936	$0	$363,227	1.0274	$373,179	4
Texas	$1,518,125	$2,277,187	$0	$3,795,311	0.9512	$3,610,100	38
Utah	$198,698	$298,044	$7,948	$504,688	0.9403	$474,558	5
Vermont	$49,324	$73,986	$3,078	$126,387	0.9383	$118,589	1
Virginia	$638,874	$958,312	$29,388	$1,626,574	0.9455	$1,537,926	16
Washington	$1,624,382	$2,436,573	$0	$4,060,954	1.0732	$4,358,216	46
West Virginia	$64,491	$96,737	$3,096	$164,323	0.9425	$154,875	2
Wisconsin	$121,096	$181,644	$6,297	$309,036	0.9415	$290,958	3
Wyoming	$6,676	$10,013	$0	$16,689	0.9386	$15,664	0
TOTAL	$18,000,000	$27,000,000	$527,772	$45,527,772		$45,378,927	475
Average						$907,579	10
STD						$1,332,629	14
MAX						$7,941,762	83
MIN						$15,664	0

Total Economic and Employment Impacts of Public Safety and Other Indirect Spending

The total economic and employment impact of indirect public safety spending in 2015 in all 50 states is shown in Table 15. The nationwide total economic impact is approximately $20,874,036 creation of an estimated 219 new jobs. The largest economic and employment impacts of indirect public safety spending is in the state of California with total economic impact of more than $3,652,756 and creation of 38 new jobs. Wyoming has the least economic and employment impacts with $7,205 and no new jobs created.

The economic and employment impacts of indirect public safety spending per state averages approximately $417,481 and creation of four new jobs. The standard deviation of economic and employment impacts of indirect public safety spending are $612,972 creation of six new jobs. As with public safety direct spending, there is a wide variability of economic and employment impacts among the states.

Table 15: 2015 Indirect Economic & Employment Impacts of Public Safety Spending

State	Direct Spending				State Indirect Multipliers	Indirect Economic Impact	Indirect Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	$398,329	$598,993	$15,973	$1,014,296	0.4424	$448,724	5
Alaska	$26,218	$39,328	$0	$65,546	0.4327	$28,362	0
Arizona	$738,248	$1,107,373	$17,009	$1,862,630	0.46	$856,810	9
Arkansas	$109,958	$164,937	$8,158	$281,053	0.4349	$122,230	1
California	$2,804,503	$4,208,755	$89,744	$7,101,003	0.5144	$3,652,756	38
Colorado	$317,838	$476,756	$11,773	$806,366	0.4389	$353,914	4
Connecticut	$710,387	$1,065,581	$28,415	$1,804,383	0.4553	$821,536	9
Delaware	$23,884	$35,825	$1,060	$60,770	0.432	$26,252	0
Florida	$854,052	$1,281,078	$0	$2,135,130	0.4525	$966,146	10
Georgia	$509,235	$763,853	$24,443	$1,297,531	0.4464	$579,218	6
Hawaii	$44,620	$66,930	$2,570	$114,119	0.4322	$49,322	1
Idaho	$39,985	$59,977	$2,367	$102,329	0.4322	$44,227	0
Illinois	$281,623	$422,434	$11,265	$715,322	0.4356	$311,594	3
Indiana	$288,569	$429,854	$7,795	$724,217	0.4379	$317,135	3
Iowa	$222,562	$333,844	$6,054	$562,460	0.4319	$242,926	3
Kansas	$637,456	$956,184	$31,873	$1,625,514	0.4598	$747,411	8
Kentucky	$123,327	$184,990	$5,920	$314,237	0.434	$136,379	1
Louisiana	$296,513	$444,770	$9,488	$750,772	0.4341	$325,910	3
Maine	$147,625	$221,438	$8,267	$377,331	0.4317	$162,894	2
Maryland	$456,228	$684,342	$17,337	$1,157,906	0.4428	$512,721	5
Massachusetts	$521,791	$782,687	$22,124	$1,326,601	0.4447	$589,940	6
Michigan	$259,728	$389,592	$9,039	$658,359	0.4356	$286,781	3
Minnesota	$195,514	$293,271	$11,027	$499,812	0.4339	$216,868	2
Mississippi	$225,798	$338,695	$7,225	$571,717	0.4326	$247,325	3
Missouri	$354,709	$532,064	$11,351	$898,124	0.4429	$397,779	4
Montana	$19,837	$29,755	$1,000	$50,592	0.4319	$21,851	0
Nebraska	$34,606	$51,909	$1,417	$87,933	0.4321	$37,996	0
Nevada	$53,786	$80,679	$0	$134,464	0.4337	$58,317	1
New Hampshire	$120,750	$181,125	$0	$301,875	0.4324	$130,531	1
New Jersey	$358,013	$537,019	$21,338	$916,369	0.4387	$402,011	4
New Mexico	$140,223	$210,336	$4,824	$355,382	0.4331	$153,916	2
New York	$594,774	$892,160	$30,690	$1,517,624	0.4457	$676,405	7
North Carolina	$208,955	$314,932	$11,757	$536,644	0.4347	$233,279	2
North Dakota	$19,439	$29,158	$439	$49,036	0.4318	$21,174	0
Ohio	$486,980	$730,440	$15,972	$1,233,372	0.4444	$548,111	6
Oklahoma	$146,155	$219,233	$6,139	$371,527	0.4357	$161,874	2
Oregon	$112,812	$169,218	$2,707	$284,737	0.4341	$123,604	1
Pennsylvania	$539,933	$809,899	$13,261	$1,363,093	0.4406	$600,579	6
Rhode Island	$58,473	$87,709	$2,500	$148,681	0.433	$64,379	1
South Carolina	$136,522	$204,784	$7,645	$348,951	0.4318	$150,677	2
South Dakota	$13,109	$19,664	$0	$32,773	0.4338	$14,217	0
Tennessee	$145,291	$217,936	$0	$363,227	0.4726	$171,661	2
Texas	$1,518,125	$2,277,187	$0	$3,795,311	0.4376	$1,660,828	17
Utah	$198,696	$298,044	$7,948	$504,688	0.4326	$218,328	2
Vermont	$49,324	$73,986	$3,078	$126,387	0.4316	$54,549	1
Virginia	$638,874	$958,312	$29,388	$1,626,574	0.4349	$707,397	7
Washington	$1,624,382	$2,436,573	$0	$4,060,954	0.4937	$2,004,893	21
West Virginia	$64,491	$96,737	$3,096	$164,323	0.4336	$71,251	1
Wisconsin	$121,096	$181,644	$6,297	$309,036	0.4331	$133,844	1
Wyoming	$6,676	$10,013	$0	$16,689	0.4317	$7,205	0
TOTAL	$18,000,000	$27,000,000	$527,772	$45,527,772		$20,874,036	219
Average						$417,481	4
STD						$612,972	6
MAX						$3,652,756	38
MIN						$7,205	0

Total Economic and Employment Impacts of Public Safety and Other Induced Spending

Table 16 presents the total economic and employment impacts of induced public safety spending in 2015 in all 50 states. The total economic impact is estimated to be $23,596,485 with total new job creation of 247. The largest economic and employment impacts of induced public safety spending is in the state of California with a total economic impact of approximately $4,129,233 and creation of 43 new jobs. Following California are the states of Washington, Texas, Florida and Arizona. The order of job creation was similar to economic impact. The state with least economic and employment impacts is Wyoming with $8,144 and no new jobs created.

The average economic and employment impacts of induced public safety spending per state are an estimated $471,930 and creation of five jobs. The standard deviation of economic and employment impacts of induced public safety spending are approximately $692,916 and creation of seven new jobs. The large standard deviation indicates the wide variability of economic and employment impacts among states.

Table 16: 2015 Induced Economic & Employment Impacts of Public Safety Spending

State	Direct Spending				State Induced Multipliers	Induced Economic Impact	Induced Employment Impact
	Payroll	Parts	Taxes	Total			
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3
Alaska	$26,218	$39,328	$0	$65,546	0.4891	$32,059	0
Arizona	$738,248	$1,107,373	$17,009	$1,862,630	0.52	$968,568	10
Arkansas	$109,958	$164,937	$6,158	$281,053	0.4916	$138,166	1
California	$2,804,603	$4,206,756	$89,744	$7,101,003	0.5815	$4,129,233	43
Colorado	$317,838	$476,756	$11,773	$806,366	0.4962	$400,119	4
Connecticut	$710,387	$1,065,581	$28,415	$1,804,383	0.5147	$928,716	10
Delaware	$23,884	$35,826	$1,060	$60,770	0.4883	$29,674	0
Florida	$854,052	$1,281,078	$0	$2,135,130	0.5115	$1,092,119	11
Georgia	$509,235	$763,853	$24,443	$1,297,531	0.5047	$654,864	7
Hawaii	$44,620	$66,930	$2,570	$114,119	0.4886	$55,758	1
Idaho	$39,985	$59,977	$2,367	$102,329	0.4885	$49,988	1
Illinois	$281,623	$422,434	$11,265	$715,322	0.4924	$352,225	4
Indiana	$286,569	$429,854	$7,795	$724,217	0.4951	$358,560	4
Iowa	$222,562	$333,844	$6,054	$562,460	0.4882	$274,593	3
Kansas	$637,456	$956,184	$31,873	$1,625,514	0.5198	$844,942	9
Kentucky	$123,327	$184,990	$5,920	$314,237	0.4906	$154,164	2
Louisiana	$296,513	$444,770	$9,488	$750,772	0.4907	$368,404	4
Maine	$147,625	$221,438	$8,267	$377,331	0.4881	$184,175	2
Maryland	$456,228	$684,342	$17,337	$1,157,906	0.5006	$579,648	6
Massachusetts	$521,791	$782,687	$22,124	$1,326,601	0.5027	$666,883	7
Michigan	$259,728	$389,592	$9,039	$658,359	0.4924	$324,176	3
Minnesota	$195,514	$293,271	$11,027	$499,812	0.4905	$245,158	3
Mississippi	$225,796	$338,695	$7,225	$571,717	0.489	$279,569	3
Missouri	$354,709	$532,064	$11,351	$898,124	0.5007	$449,691	5
Montana	$19,637	$29,756	$1,000	$50,592	0.4882	$24,699	0
Nebraska	$34,606	$51,909	$1,417	$87,933	0.4885	$42,955	0
Nevada	$53,786	$80,679	$0	$134,464	0.4902	$65,914	1
New Hampshire	$120,750	$181,125	$0	$301,875	0.4888	$147,556	2
New Jersey	$358,013	$537,019	$21,338	$916,369	0.4959	$454,427	5
New Mexico	$140,223	$210,335	$4,824	$355,382	0.4896	$173,995	2
New York	$594,774	$892,160	$30,690	$1,517,624	0.5038	$764,579	8
North Carolina	$209,955	$314,932	$11,757	$536,644	0.4914	$263,707	3
North Dakota	$19,439	$29,158	$439	$49,036	0.4881	$23,934	0
Ohio	$486,960	$730,440	$15,972	$1,233,372	0.5024	$619,646	6
Oklahoma	$146,155	$219,233	$6,139	$371,527	0.4925	$182,977	2
Oregon	$112,812	$169,218	$2,707	$284,737	0.4907	$139,720	1
Pennsylvania	$539,933	$809,899	$13,261	$1,363,093	0.498	$678,820	7
Rhode Island	$58,473	$87,709	$2,500	$148,681	0.4895	$72,778	1
South Carolina	$136,522	$204,784	$7,645	$348,951	0.4881	$170,323	2
South Dakota	$13,109	$19,664	$0	$32,773	0.4904	$16,072	0
Tennessee	$145,291	$217,936	$0	$363,227	0.5342	$194,036	2
Texas	$1,518,125	$2,277,187	$0	$3,795,311	0.4946	$1,877,161	20
Utah	$196,696	$295,044	$7,948	$504,688	0.489	$246,792	3
Vermont	$48,324	$73,986	$3,078	$126,387	0.4879	$61,664	1
Virginia	$638,874	$958,312	$29,388	$1,626,574	0.4916	$789,624	8
Washington	$1,624,382	$2,436,573	$0	$4,060,954	0.5581	$2,266,418	24
West Virginia	$64,491	$96,737	$3,096	$164,323	0.4901	$80,535	1
Wisconsin	$121,096	$181,644	$6,297	$309,036	0.4896	$151,304	2
Wyoming	$6,676	$10,013	$0	$16,689	0.488	$8,144	0
TOTAL	$18,000,000	$27,000,000	$527,772	$45,527,772		$23,596,485	247
Average						$471,930	5
STD						$692,916	7
MAX						$4,129,233	43
MIN						$8,144	0

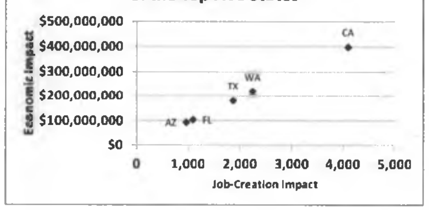
Total Economic and Employment Impacts of UAS Development in the Top Five States

A comparison of the total economic and job creation impacts of UAS integration in the U.S. in the top five states is presented in Table 17. The orders of output and job multipliers are consistent with the order of the states in terms of direct spending. California is the number one state with the highest direct spending of $179,892,071 and the highest direct employment of 2,108, which resulted in the highest contribution to total economic impact of approximately $398,335,013 and total new job creation impact of approximately 4,097. In addition, California has the highest multipliers for job and output creation. Figure 2 graphically shows the total economic and job creation impacts of the top five states in the U.S.

Table 17: 2015 Total Economic and Employment Impacts of UAS Development in the Top Five States

State	Direct Jobs	Total Job Creation Impact	Job multiplier	Direct spending	Total Economic Impact	Output multiplier
California	2108	4,097	1.94	179,892,071	398,335,013	2.21
Washington	1157	2,249	1.94	102,877,509	218,614,707	2.13
Texas	958	1,863	1.94	96,147,891	181,084,937	1.88
Florida	557	1,084	1.94	54,089,966	105,351,026	1.95
Arizona	494	961	1.94	47,186,634	93,429,535	1.98

Figure 2: 2015 Economic and Job Impacts of the Top Five States



Total Economic and Employment Impacts of UAS Development in the United States From 2015-2025

UAS integration into the NAS will have tremendous economic and job creation impacts on the aerospace industry and aid in driving economic development in many states across the country. In today's economic environment, job creation will continue to be extremely important for the aerospace industry and the U.S. economy. Note that the economic impact of UAS integration will not stop with the primary UAS market. Similar to other industries, job growth will stretch into many additional sectors, and the economic growth in the aerospace industry will support the growth in many other businesses across multiple U.S. industries, including the hospitality and entertainment industries.

The total direct spending in UAS development and the total economic and employment impacts are expected to increase significantly in the next 11 years from 2015 through 2025, as seen in Table 18. The expected total direct spending in UAS development in 2015 is an estimated $1,153,370,225. This amount is expected to increase by 100% in 2016 to approximately $2,306,740,450. In 2017, total direct spending is expected to increase by 50% to an estimated $3,460,110,675. This rate of growth is expected to decrease in 2018 to approximately 5% with total spending of $3,633,116,209 and to level off at 5% between 2019 and 2025, with total spending in 2025 of 5,112,159,353.

Table 18: Direct Spending and Employment In The U.S. from 2015-2025

Year	Total Direct Spending		Total Direct Employment	Percent Change Over Previous Year
2015	$	1,153,370,225	11,400	
2016	$	2,306,740,450	22,800	100%
2017	$	3,460,110,675	34,200	50%
2018	$	3,633,116,209	35,910	5%
2019	$	3,814,772,019	37,706	5%
2020	$	4,005,510,620	39,591	5%
2021	$	4,205,786,151	41,570	5%
2022	$	4,416,075,459	43,649	5%
2023	$	4,636,879,232	45,831	5%
2024	$	4,868,723,193	48,123	5%
2025	$	5,112,159,353	50,529	5%

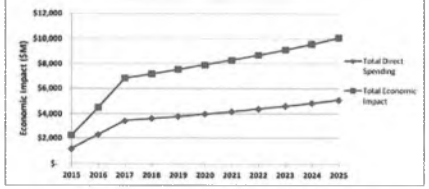
The expected total economic and employment impacts in the U.S. for UAS integration for the 11-year period from 2015 through 2025 is shown in Table 19. In 2015, the expected total economic and employment impacts are estimated to be $2,276,186,016 with creation of 23,413 jobs. These amounts are expected to increase by 100% in 2016 (from 2015) to approximately $4,552,372,033 in economic impact and job creation of 46,826. In 2017, the economic and employment impacts are expected to increase by approximately 50% to $6,828,558,049 and 70,240 jobs. This rate of growth is expected to decrease in 2018 to approximately 5% and level off at 5% through 2025. By 2025, the expected total economic impact is estimated to be $10,088,890,263 and total employment impact 103,776.

Table 19: Economic & Employment Impacts in The U.S. from 2015-2025

Year	Total Direct Spending	Total Economic Impact	Total Employment Impact	Percent Change Over Previous Year
2015	$1,153,370,225	$ 2,276,186,016	23,413	
2016	$2,306,740,450	$ 4,552,372,033	46,826	100%
2017	$3,460,110,675	$ 6,828,558,049	70,240	50%
2018	$3,633,116,209	$ 7,169,985,952	73,752	5%
2019	$3,814,772,019	$ 7,528,485,249	77,439	5%
2020	$4,005,510,620	$ 7,904,909,512	81,311	5%
2021	$4,205,786,151	$ 8,300,154,987	85,377	5%
2022	$4,416,075,459	$ 8,715,162,737	89,645	5%
2023	$4,636,879,232	$ 9,150,920,874	94,128	5%
2024	$4,868,723,193	$ 9,608,466,917	98,834	5%
2025	$5,112,159,353	$10,088,890,263	103,776	5%

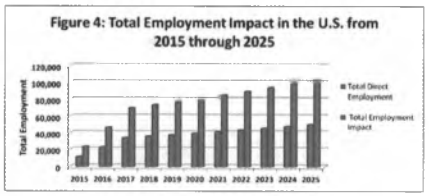
Figure 3 graphically compares total spending and economic impacts from 2015 to 2025. There are high growth rates for both spending and total economic impact in the first three years (2015-2017) but both spending and total economic impact growth are expected to decrease to 5% in 2018 and level off at 5% through 2025.

Figure 3: Total Spending and Economic Impact in the U.S. from 2015 - 2025



Direct employment and total employment impact from 2015 to 2025 are compared in Figure 4. There are high growth rates for both direct and total employment impacts in the first three years (2015-2017) to approximately 100% and 50% in 2016 and 2017, respectively. The growth rate of both direct employment and total employment impacts are expected to decrease to 5% in 2018 and level off at 5% through 2025.

Figure 4: Total Employment Impact in the U.S. from 2015 through 2025



Conclusion

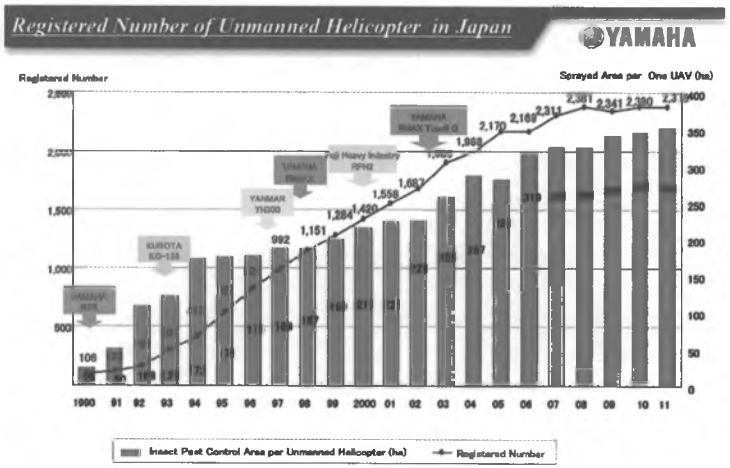
UAS integration into the NAS is expected to have enormous economic and job creation impacts in the United States. These impacts have been demonstrated to be due to direct, indirect and induced effects of total spending in UAS development. The results of these economic impacts are as follows:

During the 11-year period 2015-2025:

- UAS integration is expected to contribute $82.1 billion to the nation's economy by agriculture, public safety and other activities;
- 103,776 new jobs will be created, with 844,741 job years worked over the time period;
- UAS integration is expected to contribute $75.6 billion economic impact by agriculture, $3.2 billion by public safety and $3.2 billion by other activities;
- The manufacturing jobs created will be high paying ($40,000) and require technical baccalaureate degrees; and
- In the first three years, U.S. airspace integration will create more than 34,000 manufacturing jobs and more than 70,000 new jobs.

This study demonstrates the significant contribution of UAS integration to the economic growth and job creation in the aerospace industry and to the social and economic progress of the citizens in the United States.

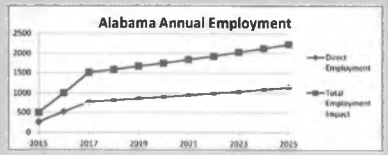
Appendix A

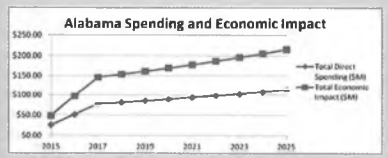


Sato, Akira (2011, October). Civil UAV Applications in Japan and Related Safety & Certification. Presented at the 1st Annual Agricultural UAS Conference: Precision Agriculture, Atlanta, GA.

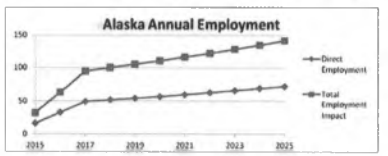
Appendix B
State Level Detailed Economic Impact

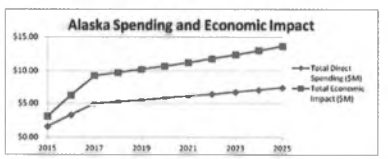
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	259	503	$25.70	$48.83	$404.65	
2016	518	1007	$51.39	$97.86	$809.31	100%
2017	777	1510	$77.09	$146.80	$1,213.96	50%
2018	816	1585	$80.94	$154.14	$1,274.66	5%
2019	856	1665	$84.99	$161.84	$1,338.39	5%
2020	899	1748	$89.24	$169.93	$1,405.31	5%
2021	944	1835	$93.70	$178.43	$1,475.58	5%
2022	991	1927	$98.38	$187.35	$1,549.35	5%
2023	1041	2023	$103.30	$196.72	$1,626.82	5%
2024	1093	2125	$108.47	$206.56	$1,708.16	5%
2025	1148	2231	$113.89	$216.88	$1,793.57	5%



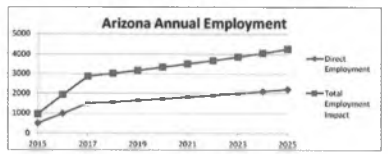


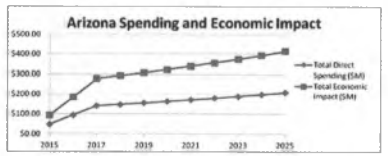
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	16	32	$1.66	$3.09	$0.00	
2016	33	64	$3.32	$6.18	$0.00	100%
2017	49	95	$4.98	$9.28	$0.00	50%
2018	52	100	$5.23	$9.74	$0.00	5%
2019	54	105	$5.49	$10.23	$0.00	5%
2020	57	110	$5.77	$10.74	$0.00	5%
2021	60	116	$6.06	$11.28	$0.00	5%
2022	63	122	$6.36	$11.84	$0.00	5%
2023	66	128	$6.68	$12.43	$0.00	5%
2024	69	134	$7.01	$13.05	$0.00	5%
2025	73	141	$7.36	$13.71	$0.00	5%



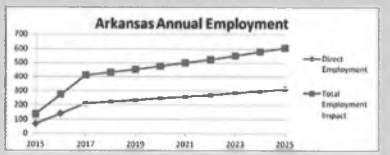


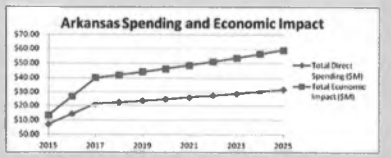
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	494	961	$47.19	$93.43	$430.90	
2016	989	1922	$94.37	$186.86	$861.80	100%
2017	1483	2883	$141.56	$280.29	$1,292.70	50%
2018	1557	3027	$148.64	$294.30	$1,357.34	5%
2019	1635	3179	$156.07	$309.02	$1,425.20	5%
2020	1717	3338	$163.87	$324.47	$1,496.46	5%
2021	1803	3504	$172.07	$340.69	$1,571.29	5%
2022	1893	3680	$180.67	$357.73	$1,649.85	5%
2023	1988	3864	$189.70	$375.61	$1,732.34	5%
2024	2087	4057	$199.19	$394.39	$1,818.96	5%
2025	2191	4260	$209.15	$414.11	$1,909.91	5%



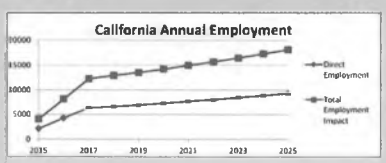


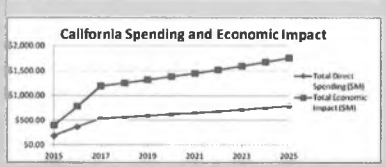
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	71	137	$7.12	$13.33	$155.99	
2016	141	274	$14.24	$26.65	$311.99	100%
2017	212	411	$21.36	$39.98	$467.98	50%
2018	222	432	$22.43	$41.98	$491.38	5%
2019	233	453	$23.55	$44.08	$515.95	5%
2020	245	476	$24.73	$46.28	$541.75	5%
2021	257	500	$25.96	$48.60	$568.83	5%
2022	270	525	$27.26	$51.03	$597.28	5%
2023	284	551	$28.62	$53.58	$627.14	5%
2024	298	579	$30.06	$56.26	$658.50	5%
2025	313	608	$31.56	$59.07	$691.42	5%



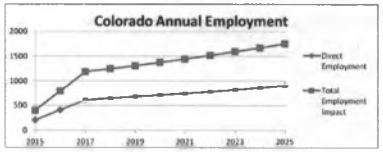


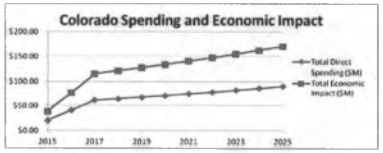
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	2108	4097	$179.89	$398.34	$2,273.52	
2016	4216	8195	$359.78	$796.67	$4,547.03	100%
2017	6324	12292	$539.68	$1,195.01	$6,820.55	50%
2018	6640	12907	$566.66	$1,254.76	$7,161.58	5%
2019	6972	13552	$594.99	$1,317.49	$7,519.66	5%
2020	7321	14230	$624.74	$1,383.37	$7,895.64	5%
2021	7687	14941	$655.98	$1,452.54	$8,290.42	5%
2022	8071	15688	$688.78	$1,525.18	$8,704.95	5%
2023	8475	16472	$723.22	$1,601.42	$9,140.19	5%
2024	8898	17296	$759.38	$1,681.49	$9,597.20	5%
2025	9343	18161	$797.35	$1,765.57	$10,077.08	5%



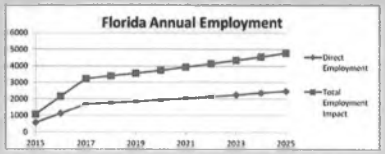


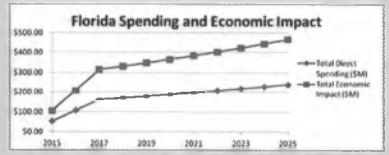
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	204	397	$20.43	$38.59	$298.24	
2016	408	794	$40.86	$77.19	$596.48	100%
2017	613	1191	$61.28	$115.78	$894.73	50%
2018	643	1251	$64.35	$121.57	$939.46	5%
2019	675	1313	$67.57	$127.65	$986.43	5%
2020	709	1379	$70.94	$134.03	$1,035.76	5%
2021	745	1448	$74.49	$140.74	$1,087.54	5%
2022	782	1520	$78.22	$147.77	$1,141.92	5%
2023	821	1596	$82.13	$155.16	$1,199.02	5%
2024	862	1676	$86.23	$162.92	$1,258.97	5%
2025	905	1760	$90.54	$171.07	$1,321.92	5%



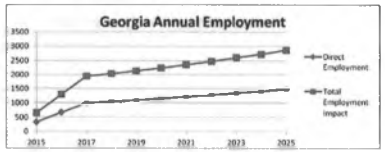


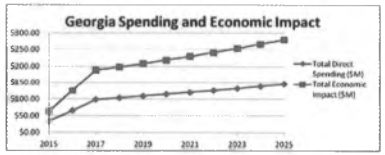
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	557	1084	$54.09	$105.35	$0.00	
2016	1115	2167	$108.18	$210.70	$0.00	100%
2017	1672	3251	$162.27	$316.05	$0.00	50%
2018	1756	3414	$170.38	$331.86	$0.00	5%
2019	1844	3584	$178.90	$348.45	$0.00	5%
2020	1936	3763	$187.85	$365.87	$0.00	5%
2021	2033	3952	$197.24	$384.16	$0.00	5%
2022	2135	4149	$207.10	$403.37	$0.00	5%
2023	2241	4357	$217.46	$423.54	$0.00	5%
2024	2353	4574	$228.33	$444.72	$0.00	5%
2025	2471	4803	$239.75	$466.95	$0.00	5%



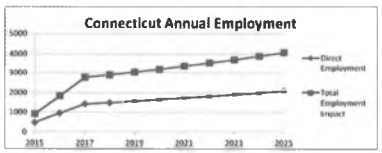


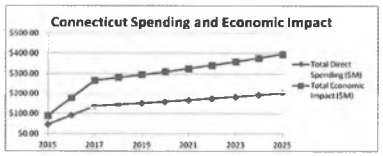
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	334	650	$32.87	$63.16	$619.23	
2016	668	1299	$65.74	$126.33	$1,238.46	100%
2017	1003	1949	$98.61	$189.49	$1,857.69	50%
2018	1053	2047	$103.54	$198.97	$1,950.57	5%
2019	1106	2149	$108.72	$208.92	$2,048.10	5%
2020	1161	2256	$114.16	$219.36	$2,150.51	5%
2021	1219	2369	$119.86	$230.33	$2,258.03	5%
2022	1280	2488	$125.86	$241.85	$2,370.94	5%
2023	1344	2612	$132.15	$253.94	$2,489.48	5%
2024	1411	2743	$138.76	$266.64	$2,613.96	5%
2025	1481	2880	$145.70	$279.97	$2,744.65	5%



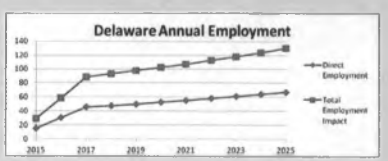


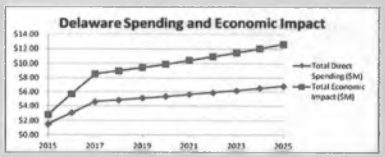
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	474	921	$45.71	$89.56	$719.86	
2016	948	1843	$91.42	$179.17	$1,439.72	100%
2017	1422	2764	$137.13	$268.75	$2,159.58	50%
2018	1493	2903	$143.99	$282.19	$2,267.56	5%
2019	1568	3048	$151.19	$296.30	$2,380.93	5%
2020	1646	3200	$158.75	$311.12	$2,499.98	5%
2021	1729	3360	$166.69	$326.67	$2,624.98	5%
2022	1815	3528	$175.02	$343.01	$2,756.23	5%
2023	1906	3705	$183.77	$360.16	$2,894.04	5%
2024	2001	3890	$192.96	$378.16	$3,038.74	5%
2025	2101	4084	$202.61	$397.07	$3,190.68	5%



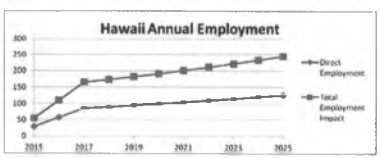


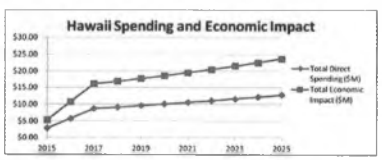
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	15	29	$1.54	$2.86	$26.88	
2016	30	59	$3.08	$5.73	$53.73	100%
2017	45	88	$4.62	$8.59	$80.59	50%
2018	48	93	$4.85	$8.02	$84.62	5%
2019	50	97	$5.09	$9.47	$88.85	5%
2020	53	102	$5.35	$9.94	$93.30	5%
2021	55	107	$5.61	$10.44	$97.96	5%
2022	58	113	$5.89	$10.96	$102.86	5%
2023	61	118	$6.19	$11.51	$108.00	5%
2024	64	124	$6.50	$12.08	$113.40	5%
2025	67	131	$6.82	$12.69	$119.07	5%



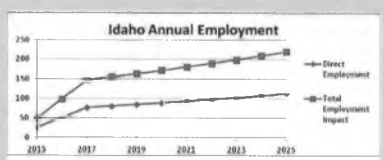


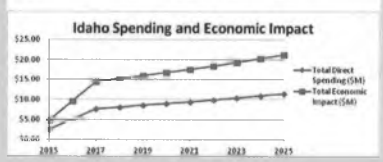
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	28	55	$2.89	$5.38	$65.11	
2016	57	111	$5.78	$10.76	$130.22	100%
2017	85	166	$8.67	$16.14	$195.33	50%
2018	90	174	$9.11	$16.94	$205.09	5%
2019	94	183	$9.56	$17.79	$215.35	5%
2020	99	192	$10.04	$18.68	$226.12	5%
2021	104	202	$10.54	$19.61	$237.42	5%
2022	109	212	$11.07	$20.59	$249.29	5%
2023	114	222	$11.62	$21.62	$261.76	5%
2024	120	234	$12.20	$22.70	$274.84	5%
2025	126	245	$12.81	$23.84	$288.59	5%



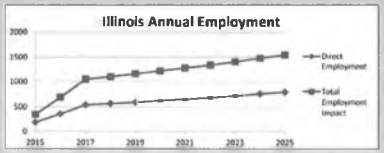


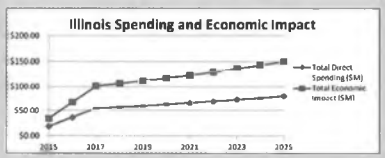
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	26	50	$2.59	$4.82	$59.97	
2016	51	99	$5.18	$9.64	$119.93	100%
2017	77	145	$7.78	$14.47	$179.90	50%
2018	80	156	$8.17	$15.19	$188.88	5%
2019	84	164	$8.57	$15.95	$198.34	5%
2020	89	172	$9.00	$16.75	$208.26	5%
2021	93	181	$9.45	$17.58	$218.67	5%
2022	98	190	$9.93	$18.46	$229.60	5%
2023	103	199	$10.42	$19.39	$241.08	5%
2024	108	209	$10.94	$20.36	$253.14	5%
2025	113	220	$11.49	$21.37	$265.79	5%



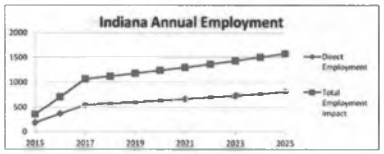


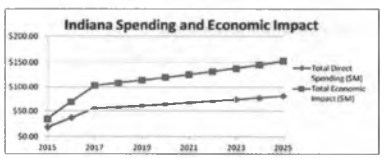
Illinois Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	180	350	$18.12	$33.98	$285.38	
2016	360	699	$36.24	$67.96	$570.76	100%
2017	539	1049	$54.36	$101.93	$856.13	50%
2018	566	1101	$57.08	$107.03	$898.94	5%
2019	595	1156	$59.94	$112.38	$943.89	5%
2020	624	1214	$62.93	$118.00	$991.08	5%
2021	656	1274	$66.08	$123.90	$1,040.64	5%
2022	688	1338	$69.38	$130.10	$1,092.67	5%
2023	723	1405	$72.85	$136.60	$1,147.30	5%
2024	759	1475	$76.50	$143.43	$1,204.67	5%
2025	797	1549	$80.32	$150.60	$1,264.90	5%



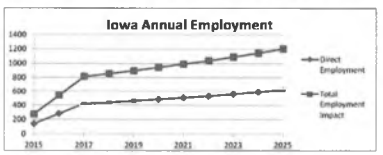


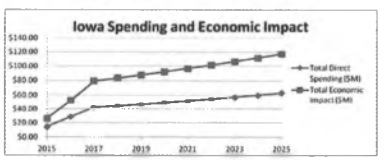
Indiana Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	183	356	$18.35	$34.58	$197.47	
2016	366	711	$36.69	$69.17	$394.93	100%
2017	549	1067	$55.04	$103.75	$592.40	50%
2018	576	1121	$57.79	$108.94	$622.02	5%
2019	605	1177	$60.68	$114.39	$653.12	5%
2020	636	1235	$63.72	$120.11	$685.77	5%
2021	667	1297	$66.90	$126.11	$720.06	5%
2022	701	1362	$70.25	$132.42	$756.06	5%
2023	736	1430	$73.76	$139.04	$793.87	5%
2024	773	1502	$77.45	$145.99	$833.56	5%
2025	811	1577	$81.32	$153.29	$875.24	5%



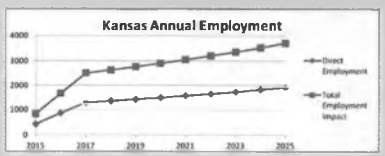


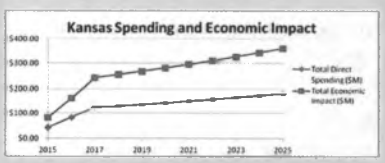
Iowa Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	140	272	$14.25	$26.49	$153.36	
2016	280	545	$28.50	$52.97	$306.72	100%
2017	420	817	$42.75	$79.46	$460.08	50%
2018	441	858	$44.88	$83.44	$483.08	5%
2019	464	901	$47.13	$87.61	$507.24	5%
2020	487	946	$49.48	$91.99	$532.60	5%
2021	511	994	$51.96	$96.59	$559.23	5%
2022	537	1043	$54.56	$101.42	$587.19	5%
2023	563	1095	$57.28	$106.49	$616.55	5%
2024	592	1150	$60.15	$111.81	$647.38	5%
2025	621	1208	$63.16	$117.40	$679.75	5%



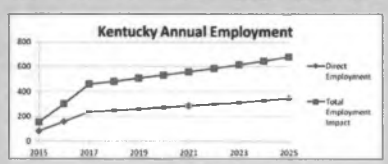


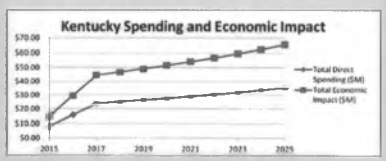
Kansas Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	431	838	$41.18	$81.50	$807.44	
2016	863	1677	$82.36	$163.01	$1,614.89	100%
2017	1294	2515	$123.54	$244.51	$2,422.33	50%
2018	1359	2641	$129.72	$256.73	$2,543.45	5%
2019	1426	2773	$136.20	$269.57	$2,670.62	5%
2020	1498	2911	$143.01	$283.05	$2,804.15	5%
2021	1573	3057	$150.16	$297.20	$2,944.36	5%
2022	1651	3210	$157.67	$312.06	$3,091.58	5%
2023	1734	3370	$165.55	$327.66	$3,246.16	5%
2024	1821	3539	$173.83	$344.05	$3,408.47	5%
2025	1912	3716	$182.52	$361.25	$3,578.89	5%



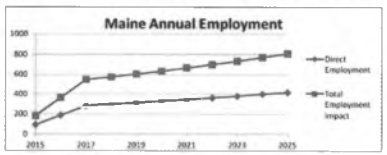


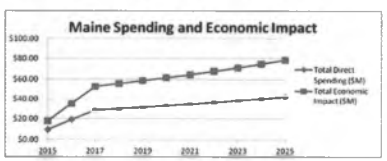
Kentucky Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	79	153	$7.96	$14.87	$149.97	
2016	157	306	$15.92	$29.74	$299.93	100%
2017	236	459	$23.88	$44.61	$449.90	50%
2018	248	482	$25.08	$46.84	$472.39	5%
2019	260	506	$26.33	$49.19	$496.01	5%
2020	273	531	$27.65	$51.65	$520.81	5%
2021	287	558	$29.03	$54.23	$546.85	5%
2022	301	586	$30.48	$56.94	$574.19	5%
2023	316	615	$32.00	$59.79	$602.90	5%
2024	332	646	$33.60	$62.78	$633.05	5%
2025	349	678	$35.28	$65.92	$664.70	5%



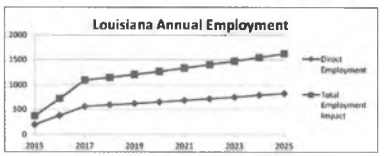


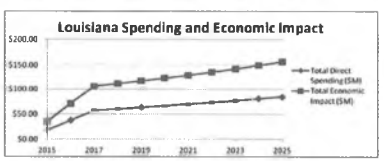
Maine Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	94	183	$9.56	$17.76	$209.43	
2016	188	365	$19.12	$35.53	$418.86	100%
2017	282	548	$28.68	$53.29	$628.29	50%
2018	296	576	$30.11	$55.96	$659.71	5%
2019	311	604	$31.62	$58.76	$692.69	5%
2020	326	635	$33.20	$61.69	$727.33	5%
2021	343	666	$34.86	$64.78	$763.70	5%
2022	360	700	$36.60	$68.02	$801.88	5%
2023	378	735	$38.43	$71.42	$841.97	5%
2024	397	771	$40.35	$74.99	$884.07	5%
2025	417	810	$42.37	$78.74	$928.28	5%



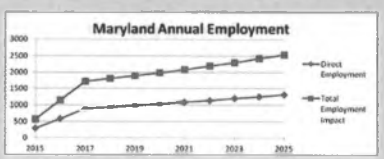


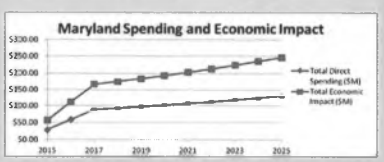
Louisiana Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	188	366	$19.02	$35.54	$240.37	
2016	376	731	$38.04	$71.07	$480.75	100%
2017	564	1097	$57.06	$106.61	$721.12	50%
2018	592	1151	$59.91	$111.94	$757.18	5%
2019	622	1209	$62.91	$117.54	$795.04	5%
2020	653	1269	$66.05	$123.41	$834.79	5%
2021	686	1333	$69.36	$129.58	$876.53	5%
2022	720	1400	$72.82	$136.06	$920.35	5%
2023	756	1470	$76.46	$142.87	$966.37	5%
2024	794	1543	$80.29	$150.01	$1,014.69	5%
2025	833	1620	$84.30	$157.51	$1,065.42	5%



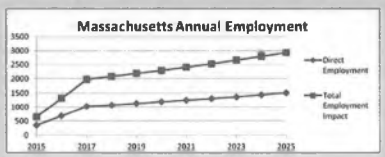


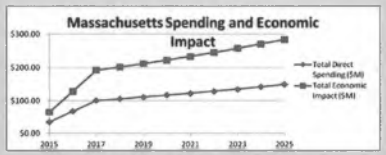
Maryland Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	296	575	$29.33	$55.91	$439.20	
2016	592	1150	$58.67	$111.83	$878.39	100%
2017	888	1725	$88.00	$167.74	$1,317.59	50%
2018	932	1812	$92.40	$176.13	$1,383.46	5%
2019	979	1902	$97.02	$184.93	$1,452.64	5%
2020	1028	1997	$101.87	$194.18	$1,525.27	5%
2021	1079	2097	$106.97	$203.89	$1,601.53	5%
2022	1133	2202	$112.31	$214.08	$1,681.61	5%
2023	1190	2312	$117.93	$224.79	$1,765.69	5%
2024	1249	2428	$123.83	$236.02	$1,853.98	5%
2025	1311	2549	$130.02	$247.83	$1,946.67	5%



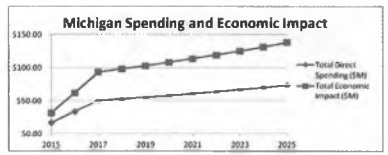


Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	340	662	$33.61	$64.33	$560.47	
2016	681	1323	$67.21	$128.66	$1,120.95	100%
2017	1021	1985	$100.82	$192.99	$1,681.42	50%
2018	1072	2084	$105.86	$202.64	$1,765.49	5%
2019	1126	2189	$111.16	$212.77	$1,853.76	5%
2020	1182	2298	$116.71	$223.41	$1,946.45	5%
2021	1241	2413	$122.55	$234.58	$2,043.78	5%
2022	1303	2534	$128.68	$246.31	$2,145.96	5%
2023	1369	2660	$135.11	$258.63	$2,253.26	5%
2024	1437	2793	$141.87	$271.56	$2,365.93	5%
2025	1509	2933	$148.96	$285.14	$2,484.22	5%

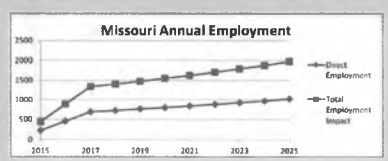


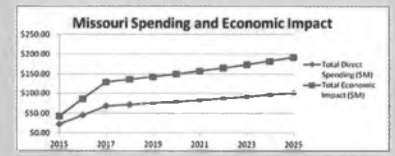


Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	185	322	$16.68	$31.27	$228.98	
2016	331	643	$33.36	$62.54	$457.95	100%
2017	496	965	$50.04	$93.81	$686.93	50%
2018	521	1013	$52.54	$98.50	$721.28	5%
2019	547	1064	$55.16	$103.42	$757.34	5%
2020	575	1117	$57.92	$108.59	$795.21	5%
2021	603	1173	$60.82	$114.02	$834.97	5%
2022	633	1231	$63.86	$119.72	$876.71	5%
2023	665	1293	$67.05	$125.71	$920.55	5%
2024	698	1358	$70.40	$131.99	$966.58	5%
2025	733	1426	$73.92	$138.59	$1,014.91	5%

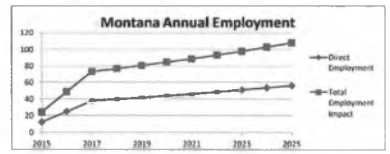


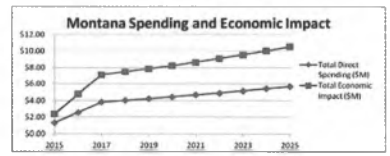
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	230	446	$22.75	$43.38	$287.55	
2016	459	892	$45.50	$86.75	$575.10	100%
2017	689	1338	$68.26	$130.13	$862.65	50%
2018	723	1405	$71.67	$136.63	$905.79	5%
2019	759	1476	$75.25	$143.46	$951.07	5%
2020	797	1549	$79.02	$150.64	$998.63	5%
2021	837	1627	$82.97	$158.17	$1,048.56	5%
2022	879	1708	$87.12	$166.08	$1,100.99	5%
2023	923	1794	$91.47	$174.38	$1,156.04	5%
2024	969	1883	$96.05	$183.10	$1,213.84	5%
2025	1017	1978	$100.85	$192.26	$1,274.53	5%



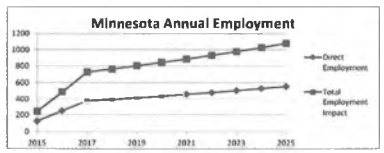


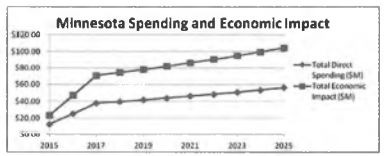
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	13	25	$1.28	$2.38	$25.33	
2016	25	49	$2.56	$4.76	$50.66	100%
2017	38	74	$3.84	$7.15	$75.98	50%
2018	40	77	$4.04	$7.50	$79.78	5%
2019	42	81	$4.24	$7.88	$83.77	5%
2020	44	85	$4.45	$8.27	$87.96	5%
2021	46	89	$4.67	$8.69	$92.36	5%
2022	48	94	$4.91	$9.12	$96.98	5%
2023	51	99	$5.15	$9.58	$101.82	5%
2024	53	103	$5.41	$10.06	$106.92	5%
2025	56	109	$5.68	$10.56	$112.26	5%



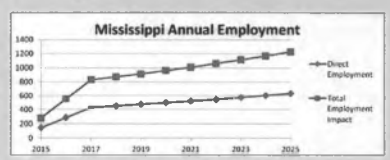


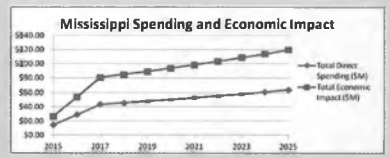
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	125	243	$12.66	$23.65	$279.35	
2016	250	487	$25.32	$47.30	$558.70	100%
2017	375	730	$37.99	$70.95	$838.05	50%
2018	394	766	$39.88	$74.49	$879.95	5%
2019	414	805	$41.88	$78.22	$923.95	5%
2020	435	845	$43.97	$82.13	$970.15	5%
2021	456	887	$46.17	$86.24	$1,018.66	5%
2022	479	931	$48.48	$90.55	$1,069.59	5%
2023	503	978	$50.90	$95.07	$1,123.07	5%
2024	528	1027	$53.45	$99.83	$1,179.22	5%
2025	555	1078	$56.12	$104.82	$1,238.18	5%



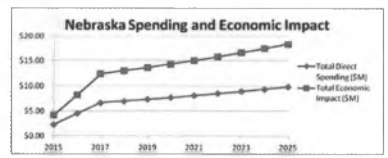


Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	143	277	$14.48	$26.97	$183.05	
2016	285	555	$28.97	$53.94	$366.09	100%
2017	428	832	$43.45	$80.91	$549.14	50%
2018	450	874	$45.62	$84.95	$576.59	5%
2019	472	918	$47.90	$89.20	$605.42	5%
2020	496	963	$50.30	$93.66	$635.69	5%
2021	520	1012	$52.81	$98.35	$667.48	5%
2022	546	1062	$55.48	$103.28	$700.85	5%
2023	574	1115	$58.23	$108.43	$735.90	5%
2024	602	1171	$61.14	$113.85	$772.69	5%
2025	633	1230	$64.20	$119.54	$811.33	5%

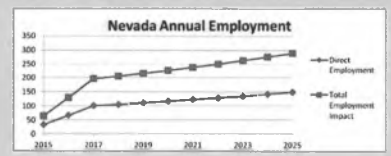


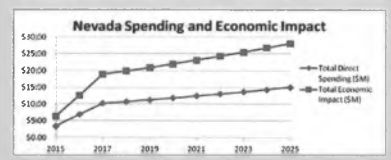


Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	22	43	$2.23	$4.14	$35.91	
2016	44	85	$4.46	$8.29	$71.82	100%
2017	66	128	$6.68	$12.43	$107.73	50%
2018	69	134	$7.02	$13.05	$113.11	5%
2019	73	141	$7.37	$13.70	$118.77	5%
2020	76	148	$7.74	$14.39	$124.71	5%
2021	80	155	$8.12	$15.11	$130.94	5%
2022	84	163	$8.53	$15.86	$137.49	5%
2023	88	171	$8.96	$16.66	$144.37	5%
2024	93	180	$9.40	$17.49	$151.58	5%
2025	97	189	$9.87	$18.37	$159.16	5%

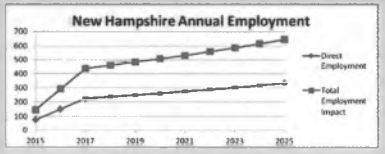


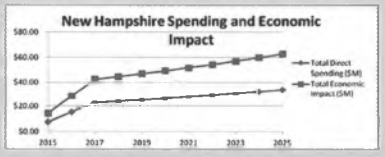
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	34	65	$3.41	$6.38	$0.00	
2016	67	131	$6.81	$12.72	$0.00	100%
2017	101	196	$10.22	$19.08	$0.00	50%
2018	106	206	$10.73	$20.03	$0.00	5%
2019	111	216	$11.27	$21.03	$0.00	5%
2020	117	227	$11.83	$22.08	$0.00	5%
2021	123	238	$12.42	$23.19	$0.00	5%
2022	129	250	$13.04	$24.35	$0.00	5%
2023	135	263	$13.69	$25.56	$0.00	5%
2024	142	276	$14.38	$26.84	$0.00	5%
2025	149	290	$15.10	$28.18	$0.00	5%



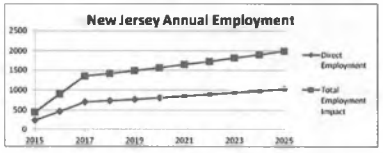


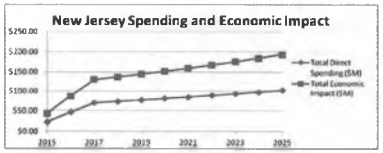
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	75	146	$7.65	$14.23	$0.00	
2016	151	293	$15.29	$28.47	$0.00	100%
2017	226	439	$22.94	$42.70	$0.00	50%
2018	237	461	$24.09	$44.84	$0.00	5%
2019	249	484	$25.29	$47.08	$0.00	5%
2020	262	508	$26.56	$49.43	$0.00	5%
2021	275	534	$27.89	$51.90	$0.00	5%
2022	288	561	$29.28	$54.50	$0.00	5%
2023	303	589	$30.75	$57.22	$0.00	5%
2024	318	618	$32.28	$60.08	$0.00	5%
2025	334	649	$33.90	$63.09	$0.00	5%



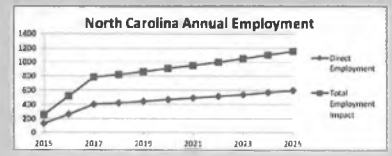


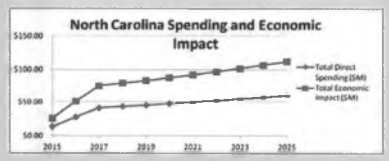
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	232	451	$23.21	$43.84	$540.55	
2016	464	902	$46.43	$87.67	$1,081.10	100%
2017	696	1353	$69.64	$131.51	$1,621.65	50%
2018	731	1420	$73.13	$138.08	$1,702.74	5%
2019	767	1491	$76.78	$144.99	$1,787.87	5%
2020	806	1566	$80.62	$152.24	$1,877.27	5%
2021	846	1644	$84.65	$159.85	$1,971.13	5%
2022	888	1726	$88.89	$167.84	$2,069.68	5%
2023	933	1813	$93.33	$176.23	$2,173.17	5%
2024	978	1903	$98.00	$185.05	$2,281.83	5%
2025	1028	1998	$102.90	$194.30	$2,395.92	5%



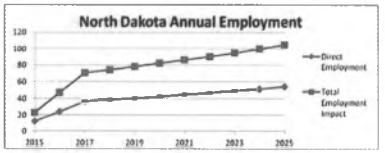


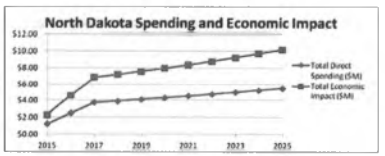
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	135	262	$13.58	$25.44	$297.86	
2016	269	523	$27.19	$50.88	$595.71	100%
2017	404	785	$40.78	$76.31	$893.57	50%
2018	424	824	$42.82	$80.13	$938.25	5%
2019	445	865	$44.97	$84.13	$985.16	5%
2020	467	909	$47.21	$88.34	$1,034.42	5%
2021	491	954	$49.57	$92.76	$1,086.14	5%
2022	515	1002	$52.05	$97.40	$1,140.44	5%
2023	541	1052	$54.66	$102.27	$1,197.47	5%
2024	568	1105	$57.39	$107.38	$1,257.34	5%
2025	597	1160	$60.26	$112.75	$1,320.21	5%



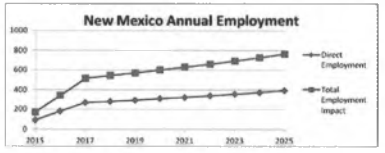


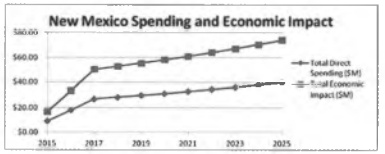
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	12	24	$1.24	$2.31	$11.11	
2016	24	47	$2.48	$4.62	$22.22	100%
2017	37	71	$3.73	$6.93	$33.33	50%
2018	38	75	$3.91	$7.27	$35.00	5%
2019	40	79	$4.11	$7.64	$36.75	5%
2020	42	82	$4.31	$8.02	$38.58	5%
2021	45	87	$4.53	$8.42	$40.51	5%
2022	47	91	$4.76	$8.84	$42.54	5%
2023	49	95	$4.99	$9.28	$44.66	5%
2024	52	100	$5.24	$9.75	$46.90	5%
2025	54	105	$5.51	$10.23	$49.24	5%



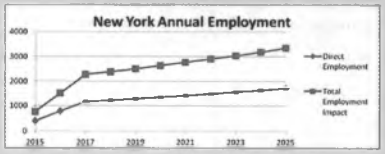


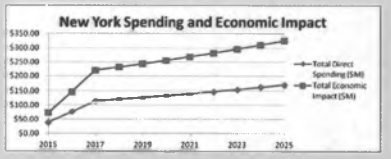
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	88	173	$9.00	$16.78	$122.20	
2016	178	345	$18.01	$33.57	$244.40	100%
2017	266	518	$27.01	$50.35	$366.60	50%
2018	280	544	$28.36	$52.87	$384.93	5%
2019	294	571	$29.78	$55.51	$404.18	5%
2020	308	600	$31.27	$58.29	$424.39	5%
2021	324	630	$32.83	$61.20	$445.60	5%
2022	340	661	$34.47	$64.26	$467.89	5%
2023	357	694	$36.19	$67.47	$491.28	5%
2024	375	729	$38.00	$70.85	$515.84	5%
2025	394	765	$39.90	$74.39	$541.64	5%



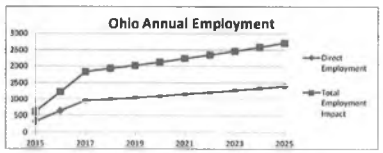


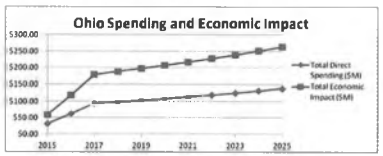
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	390	759	$38.45	$73.76	$777.48	
2016	781	1517	$76.88	$147.51	$1,554.98	100%
2017	1171	2276	$115.34	$221.27	$2,332.46	50%
2018	1229	2390	$121.11	$232.33	$2,449.09	5%
2019	1291	2509	$127.16	$243.95	$2,571.54	5%
2020	1355	2635	$133.52	$256.14	$2,700.12	5%
2021	1423	2768	$140.20	$268.95	$2,835.12	5%
2022	1494	2905	$147.21	$282.40	$2,976.88	5%
2023	1569	3050	$154.57	$296.52	$3,125.73	5%
2024	1648	3203	$162.29	$311.35	$3,282.01	5%
2025	1730	3363	$170.41	$326.91	$3,446.11	5%



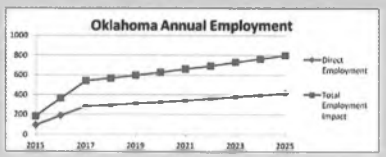


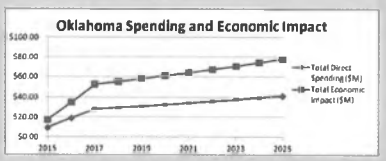
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	316	615	$31.25	$59.77	$404.63	
2016	633	1230	$62.49	$119.54	$809.26	100%
2017	949	1844	$93.74	$179.31	$1,213.89	50%
2018	996	1937	$98.42	$188.27	$1,274.59	5%
2019	1046	2033	$103.34	$197.69	$1,338.32	5%
2020	1098	2135	$108.51	$207.57	$1,405.23	5%
2021	1153	2242	$113.94	$217.95	$1,475.50	5%
2022	1211	2354	$119.63	$228.85	$1,549.27	5%
2023	1272	2472	$125.62	$240.29	$1,626.73	5%
2024	1335	2595	$131.90	$252.30	$1,708.07	5%
2025	1402	2725	$138.49	$264.92	$1,793.47	5%





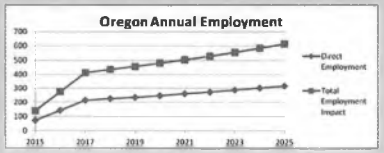
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	93	182	$9.41	$17.65	$155.51	
2016	187	383	$18.82	$35.30	$311.02	100%
2017	280	545	$28.24	$52.95	$466.53	50%
2018	294	572	$29.65	$55.60	$489.85	5%
2019	309	600	$31.13	$58.38	$514.35	5%
2020	324	631	$32.69	$61.30	$540.08	5%
2021	341	662	$34.32	$64.36	$567.07	5%
2022	358	695	$36.04	$67.58	$595.42	5%
2023	375	730	$37.84	$70.96	$625.19	5%
2024	394	766	$39.73	$74.51	$656.45	5%
2025	414	805	$41.72	$78.23	$689.27	5%

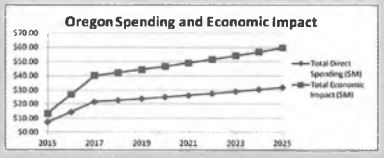




Oregon Economic Impact

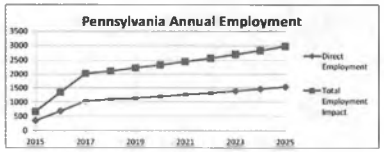
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	71	139	$7.21	$13.48	$68.59	
2016	143	277	$14.43	$26.96	$137.18	100%
2017	214	416	$21.64	$40.43	$205.77	50%
2018	225	437	$22.72	$42.46	$216.06	5%
2019	236	459	$23.86	$44.58	$226.86	5%
2020	248	481	$25.05	$46.81	$238.20	5%
2021	260	506	$26.30	$49.15	$250.11	5%
2022	273	531	$27.62	$51.61	$262.62	5%
2023	287	557	$29.00	$54.19	$275.75	5%
2024	301	585	$30.45	$56.90	$289.54	5%
2025	316	614	$31.97	$59.74	$304.01	5%

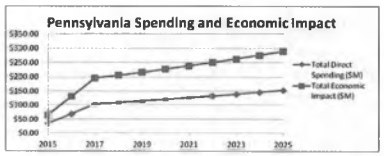




Pennsylvania Economic Impact

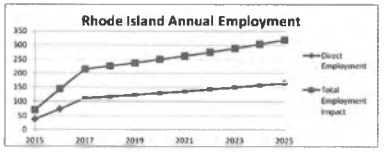
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	347	674	$34.53	$65.49	$335.94	
2016	693	1347	$69.06	$130.97	$671.88	100%
2017	1040	2021	$103.60	$196.46	$1,007.82	50%
2018	1092	2122	$108.77	$206.28	$1,058.21	5%
2019	1146	2228	$114.21	$216.59	$1,111.12	5%
2020	1203	2339	$119.92	$227.42	$1,166.67	5%
2021	1264	2456	$125.92	$238.80	$1,225.01	5%
2022	1327	2579	$132.22	$250.74	$1,286.26	5%
2023	1393	2708	$138.83	$263.27	$1,350.57	5%
2024	1463	2843	$145.77	$276.44	$1,418.10	5%
2025	1536	2986	$153.08	$290.26	$1,489.00	5%

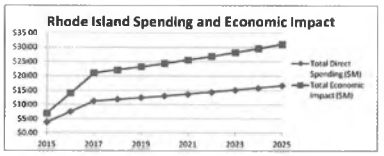




Rhode Island Economic Impact

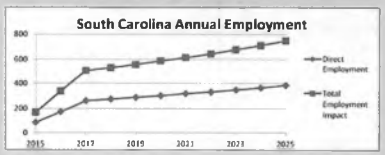
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	37	72	$3.77	$7.02	$63.33	
2016	74	144	$7.53	$14.04	$126.65	100%
2017	111	217	$11.30	$21.06	$189.98	50%
2018	117	227	$11.86	$22.11	$199.48	5%
2019	123	239	$12.46	$23.22	$209.45	5%
2020	129	251	$13.08	$24.38	$219.92	5%
2021	135	263	$13.73	$25.60	$230.92	5%
2022	142	276	$14.42	$26.88	$242.46	5%
2023	149	290	$15.14	$28.22	$254.59	5%
2024	157	305	$15.90	$29.63	$267.32	5%
2025	165	320	$16.69	$31.12	$280.68	5%

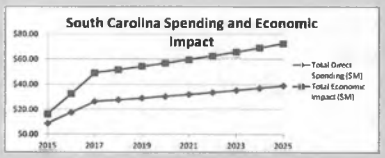




South Carolina Economic Impact

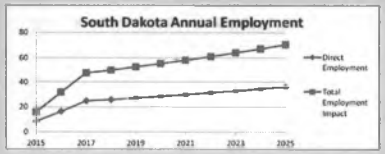
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	87	169	$8.84	$16.43	$193.68	
2016	174	338	$17.68	$32.86	$387.36	100%
2017	261	507	$26.52	$49.29	$581.04	50%
2018	274	532	$27.85	$51.75	$610.09	5%
2019	288	559	$29.24	$54.34	$640.60	5%
2020	302	587	$30.70	$57.06	$672.63	5%
2021	317	616	$32.24	$59.91	$706.26	5%
2022	333	647	$33.85	$62.91	$741.57	5%
2023	350	679	$35.54	$66.05	$778.65	5%
2024	367	713	$37.32	$69.35	$817.58	5%
2025	385	749	$39.18	$72.82	$858.46	5%

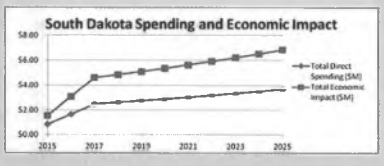




South Dakota Economic Impact

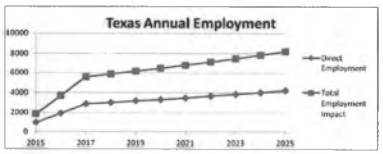
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	8	16	$0.83	$1.55	$0.00	
2016	16	32	$1.66	$3.10	$0.00	100%
2017	25	48	$2.49	$4.65	$0.00	50%
2018	26	50	$2.62	$4.88	$0.00	5%
2019	27	53	$2.75	$5.13	$0.00	5%
2020	28	55	$2.88	$5.38	$0.00	5%
2021	30	58	$3.03	$5.65	$0.00	5%
2022	31	61	$3.18	$5.94	$0.00	5%
2023	33	64	$3.34	$6.23	$0.00	5%
2024	35	67	$3.50	$6.54	$0.00	5%
2025	36	71	$3.68	$6.87	$0.00	5%

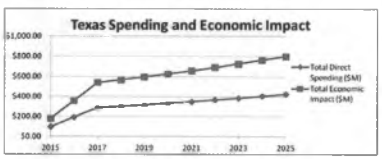




Texas Economic Impact

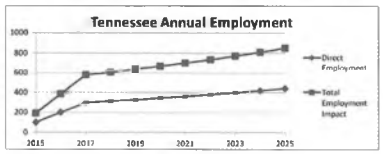
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	958	1863	$96.15	$181.08	$0.00	
2016	1916	3725	$192.30	$362.17	$0.00	100%
2017	2875	5588	$288.44	$543.25	$0.00	50%
2018	3018	5867	$302.87	$570.42	$0.00	5%
2019	3169	6161	$318.01	$598.94	$0.00	5%
2020	3328	6469	$333.91	$628.89	$0.00	5%
2021	3494	6792	$350.61	$660.33	$0.00	5%
2022	3669	7132	$368.14	$693.35	$0.00	5%
2023	3852	7488	$386.54	$728.01	$0.00	5%
2024	4045	7863	$405.87	$764.41	$0.00	5%
2025	4247	8256	$426.16	$802.63	$0.00	5%

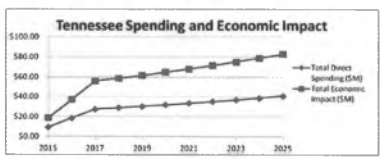




Tennessee Economic Impact

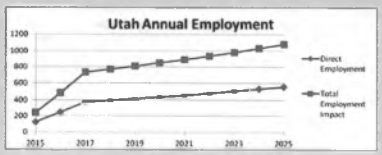
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	99	193	$9.20	$18.72	$0.00	
2016	198	385	$18.40	$37.44	$0.00	100%
2017	297	578	$27.61	$56.15	$0.00	50%
2018	312	606	$28.99	$58.96	$0.00	5%
2019	328	637	$30.43	$61.91	$0.00	5%
2020	344	669	$31.96	$65.01	$0.00	5%
2021	361	702	$33.55	$68.26	$0.00	5%
2022	379	737	$35.23	$71.67	$0.00	5%
2023	398	774	$36.99	$75.25	$0.00	5%
2024	418	813	$38.84	$79.02	$0.00	5%
2025	439	853	$40.79	$82.97	$0.00	5%

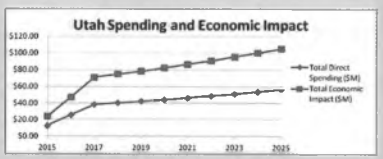




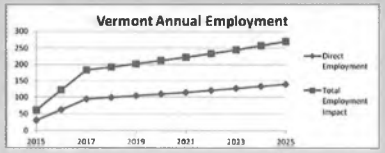
Utah Economic Impact

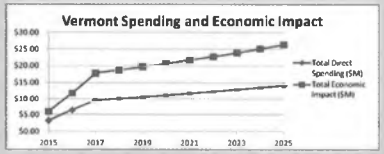
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	126	245	$12.79	$23.61	$201.35	
2016	252	490	$25.57	$47.61	$402.69	100%
2017	378	735	$38.36	$71.42	$604.04	50%
2018	397	771	$40.27	$74.99	$634.24	5%
2019	417	810	$42.28	$78.74	$665.95	5%
2020	437	850	$44.40	$82.67	$698.25	5%
2021	459	893	$46.62	$86.81	$734.21	5%
2022	482	938	$48.95	$91.15	$770.92	5%
2023	506	984	$51.40	$95.70	$809.47	5%
2024	532	1034	$53.97	$100.49	$849.94	5%
2025	558	1085	$56.67	$105.51	$892.44	5%



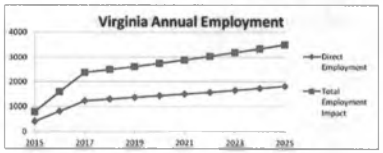


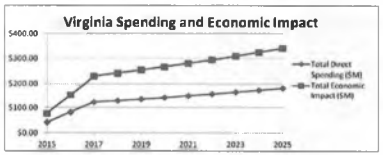
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	31	61	$3.20	$5.95	$77.97	
2016	63	122	$6.40	$11.90	$155.94	100%
2017	94	184	$9.61	$17.84	$233.91	50%
2018	99	193	$10.09	$18.74	$245.61	5%
2019	104	202	$10.59	$19.67	$257.89	5%
2020	109	212	$11.12	$20.66	$270.78	5%
2021	115	223	$11.68	$21.69	$284.32	5%
2022	121	234	$12.26	$22.78	$298.54	5%
2023	127	246	$12.87	$23.91	$313.47	5%
2024	133	258	$13.52	$25.11	$329.14	5%
2025	140	271	$14.19	$26.37	$345.60	5%



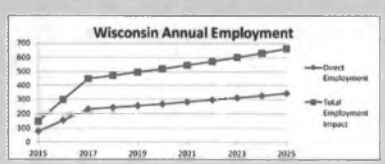


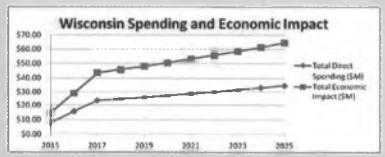
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	408	793	$41.21	$77.14	$744.50	
2016	816	1587	$82.41	$154.28	$1,489.00	100%
2017	1225	2380	$123.62	$231.42	$2,233.51	50%
2018	1286	2499	$129.80	$242.99	$2,345.18	5%
2019	1350	2624	$136.29	$255.14	$2,462.44	5%
2020	1418	2756	$143.11	$267.89	$2,585.56	5%
2021	1489	2893	$150.26	$281.29	$2,714.84	5%
2022	1563	3038	$157.77	$295.35	$2,850.58	5%
2023	1641	3190	$165.66	$310.12	$2,993.11	5%
2024	1723	3349	$173.95	$325.63	$3,142.77	5%
2025	1809	3517	$182.64	$341.91	$3,299.90	5%



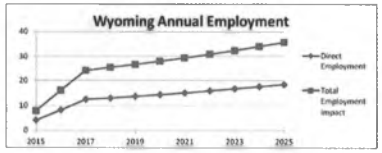


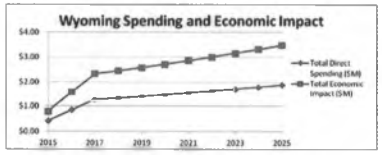
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	77	150	$7.83	$14.59	$159.52	
2016	154	300	$15.66	$29.19	$319.05	100%
2017	232	450	$23.49	$43.78	$478.57	50%
2018	243	473	$24.66	$45.97	$502.50	5%
2019	255	497	$25.89	$48.27	$527.62	5%
2020	268	521	$27.19	$50.69	$554.01	5%
2021	282	547	$28.55	$53.22	$581.71	5%
2022	296	575	$29.98	$55.88	$610.79	5%
2023	310	604	$31.47	$58.67	$641.33	5%
2024	326	634	$33.05	$61.61	$673.40	5%
2025	342	665	$34.70	$64.69	$707.07	5%





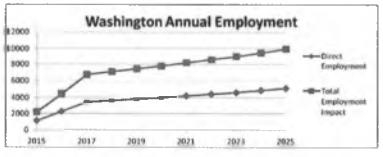
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	4	8	$0.42	$0.79	$0.00	
2016	8	16	$0.85	$1.57	$0.00	100%
2017	12	24	$1.27	$2.36	$0.00	50%
2018	13	25	$1.33	$2.47	$0.00	5%
2019	14	27	$1.40	$2.60	$0.00	5%
2020	14	28	$1.47	$2.73	$0.00	5%
2021	15	29	$1.54	$2.86	$0.00	5%
2022	16	31	$1.62	$3.01	$0.00	5%
2023	17	32	$1.70	$3.16	$0.00	5%
2024	18	34	$1.78	$3.32	$0.00	5%
2025	18	36	$1.87	$3.48	$0.00	5%

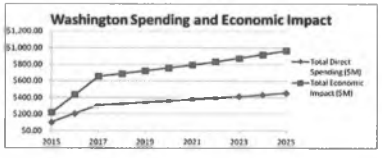




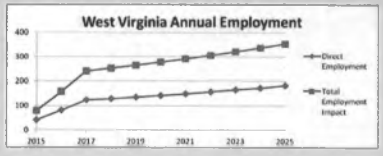
** Some states have zero tax revenue, because those states do not have a state income tax.

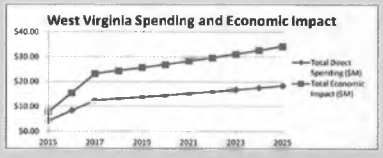
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	1157	2249	$102.88	$218.61	$0.00	
2016	2314	4497	$205.76	$437.23	$0.00	100%
2017	3470	6746	$308.63	$655.84	$0.00	50%
2018	3644	7083	$324.06	$688.64	$0.00	5%
2019	3826	7438	$340.27	$723.07	$0.00	5%
2020	4017	7809	$357.28	$759.22	$0.00	5%
2021	4218	8200	$375.14	$797.18	$0.00	5%
2022	4429	8610	$393.90	$837.04	$0.00	5%
2023	4651	9040	$413.60	$878.89	$0.00	5%
2024	4883	9492	$434.28	$922.84	$0.00	5%
2025	5127	9967	$455.99	$968.98	$0.00	5%





Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	41	80	$4.16	$7.77	$78.42	
2016	82	160	$8.33	$15.54	$156.84	100%
2017	123	240	$12.49	$23.31	$235.26	50%
2018	129	252	$13.11	$24.47	$247.03	5%
2019	136	264	$13.77	$25.70	$259.38	5%
2020	143	278	$14.46	$26.98	$272.35	5%
2021	150	291	$15.18	$28.33	$285.96	5%
2022	157	306	$15.94	$29.75	$300.26	5%
2023	165	321	$16.74	$31.23	$315.28	5%
2024	174	337	$17.57	$32.79	$331.04	5%
2025	182	354	$18.45	$34.43	$347.59	5%





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AUVSI FAST FACTS

MISSION

The mission of AUVSI is to advance the unmanned systems and robotics community through education, advocacy and leadership.

MEMBERS

AUVSI represents more than 7,000 individual members and more than 600 corporate members from 60+ allied countries involved in the fields of government, industry and academia. AUVSI members work in the defense, civil and commercial markets.

AUVSI ACTIVITIES

EVENTS

- **AUVSI's Unmanned Systems Conference and Exhibition** – More than 8,000 attendees and 600+ exhibitors from more than 40 countries and an average annual growth rate of 20% make this the leading event for the global unmanned systems and robotics marketplace. www.auvsishow.org
- **AUVSI's Unmanned Systems Program Review** – Providing the latest information on government and industry programs for ground, air and maritime systems, this annual event is one of the most important to the unmanned systems community. This is one event where business happens.
- **Networking Events** – AUVSI hosts meetings and events worldwide, providing education and networking opportunities for key industry leaders, including AUVSI's Driverless Car Summit.

ADVOCACY

AUVSI works with its membership to shape policy by advocating on behalf of the unmanned systems industry, monitoring legislation and assessing the impact of the industry. AUVSI plays a key role in addressing critical industry issues, such as National Airspace Access, Frequency Spectrum (GPS), NextGen/SESAR, Coalition Building and First Responder Grants. AUVSI works to influence legislation, including the FAA Reauthorization, Transportation Bill, DOD Reauthorization and Homeland Security Reauthorization.

EDUCATION CAMPAIGN

AUVSI is working hard to change the public perception of the unmanned systems and robotics industry through promotion of our members and the endless applications and benefits of their systems. Part of this campaign includes a public website: www.increasinghumanpotential.org.

PUBLICATIONS

- **Print** - *Unmanned Systems* magazine – A monthly magazine providing current industry news, trends and emerging developments; *Unmanned Systems: Mission Critical* – A quarterly supplement dedicated to unmanned systems sectors that, once tapped, will change the way the world works.
- **Electronic** – *AUVSI's Unmanned Systems eBrief* – A weekly electronic newsletter that includes the latest global industry and association news and information; Flight Unmanned – A biweekly electronic publication of the association for AUVSI members.

ONLINE CAREER CENTER

A leading resource for job-seekers and employers in the unmanned systems and robotics market.

KNOWLEDGE RESOURCES

Through its knowledge services AUVSI promotes vision, intellectual leadership and education in unmanned systems. AUVSI's Knowledge Vault provides AUVSI members a one-stop shop for all AUVSI event proceedings and publications.

AUVSI FOUNDATION

The AUVSI Foundation is a tax-exempt 501(c)3 public charity established to support educational initiatives such as AUVSI's Youth Education Program, discussion groups, forums and other programs. The foundation has provided more than $500,000 to educational programs worldwide. Each year, the AUVSI Foundation hosts and sponsors competitions to challenge students to design, build and deploy autonomous air, ground and maritime systems.

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AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

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Unmanned Aircraft System Operations

Industry "Code of Conduct"

The emergence of unmanned aircraft systems (UAS) as a resource for a wide variety of public and private applications quite possibly represents one of the most significant advancements to aviation, the scientific community, and public service since the beginning of flight. Rapid advancements in the technology have presented unique challenges and opportunities to the growing UAS industry and to those who support it. The nature of UAS and the environments which they operate, when not managed properly, can and will create issues that need to be addressed. The future of UAS will be linked to the responsible and safe use of these systems. Our industry has an obligation to conduct our operations in a safe manner that minimizes risk and instills confidence in our systems.

For this reason, the Association for Unmanned Vehicle Systems International (AUVSI), offers this Code of Conduct on behalf of the UAS industry for UAS operation. This code is intended to provide our members, and those who design, test, and operate UAS for public and civil use, a set of guidelines and recommendations for safe, non-intrusive operations. Acceptance and adherence to this code will contribute to safety and professionalism and will accelerate public confidence in these systems.

The code is built on three specific themes: Safety, Professionalism, and Respect. Each theme and its associated recommendations represent a "common sense" approach to UAS operations and address many of the concerns expressed by the public and regulators. This code is meant to provide UAS industry manufacturers and users a convenient checklist for operations and a means to demonstrate their obligation to supporting the growth of our industry in a safe and responsible manner. By adopting this Code, UAS industry manufacturers and users commit to the following:

Safety

- We will not operate UAS in a manner that presents undue risk to persons or property on the surface or in the air.
- We will ensure UAS will be piloted by individuals who are properly trained and competent to operate the vehicle or its systems.
- We will ensure UAS flights will be conducted only after a thorough assessment of risks associated with the activity. This risks assessment will include, but is not limited to:
    - Weather conditions relative to the performance capability of the system

- Identification of normally anticipated failure modes (lost link, power plant failures, loss of control, etc) and consequences of the failures
- Crew fitness for flight operations
- Overlying airspace, compliance with aviation regulations as appropriate to the operation, and off-nominal procedures
- Communication, command, control, and payload frequency spectrum requirements
- Reliability, performance, and airworthiness to established standards

Professionalism

- We will comply with all federal, state, and local laws, ordinances, covenants, and restrictions as they relate to UAS operations.
- We will operate our systems as responsible members of the aviation community.
- We will be responsive to the needs of the public.
- We will cooperate fully with federal, state, and local authorities in response to emergency deployments, mishap investigations, and media relations.
- We will establish contingency plans for all anticipated off-nominal events and share them openly with all appropriate authorities.

Respect

- We will respect the rights of other users of the airspace.
- We will respect the privacy of individuals.
- We will respect the concerns of the public as they relate to unmanned aircraft operations.
- We will support improving public awareness and education on the operation of UAS.

As an industry, it is incumbent upon us to hold ourselves and each other to a high professional and ethical standard. As with any revolutionary technology, there will be mishaps and abuses; however, in order to operate safely and gain public acceptance and trust, we should all act in accordance with these guiding themes and do so in an open and transparent manner. We hope the entire UAS industry will join AUVSI in adopting this industry Code of Conduct.

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AUVSI PRIVACY RIGHTS STATEMENT

AUVSI Statement on U.S. Constitutional Privacy Rights

The Association for Unmanned Vehicle Systems International (AUVSI) supports the expanded use of unmanned systems, and believes unmanned systems can be used lawfully and responsibly to avoid infringing upon Constitutional rights protecting privacy. AUVSI encourages an open dialogue at the national, state, and local level with all parties, including the police, citizens and advocacy groups, to address the concerns about the use of unmanned systems.

Summary

Unmanned systems, in particular, unmanned aircraft systems (UAS), are a tool to do tasks that are too difficult, dangerous, dull, or expensive for manned aviation. An unmanned aircraft is simply a vehicle on which to house and use some sort of system payload, such as a camera.

Although the use of the system payload onboard an unmanned aircraft defines its purpose, differentiating it from hobby or model aircraft, the system payload itself is not a new technology. Manned aircraft have been using cameras and sensors for decades.

AUVSI believes there is already a robust legal framework to allow unmanned systems to operate without infringing upon Constitutional rights protecting privacy. As with any new technology, there exists the possibility of abuse (i.e. computers, the internet, cell phones, GPS, satellites, etc.); however, used properly, in accordance with established rules and precedent, unmanned systems have the potential to greatly enhance public safety while also allowing for an entirely new industry to be formed.

Non-Military Applications

There are currently dozens of non-military uses of unmanned systems, including the use for law enforcement, firefighting, border surveillance, disaster surveillance, aerial photography, wildlife monitoring, agriculture applications, news coverage, mapping and more. The field of unmanned systems is changing rapidly, and it is likely that we have not fully comprehended all of the potential uses for unmanned systems. One thing is clear however, unmanned systems are here to stay.

Public Safety Use

Air support is an invaluable tool for public safety agencies, and the increased use of public UAS will undoubtedly save lives.

The objective of public UAS technology is to give an incident commander (whether it be police, fire, search and rescue, disaster response, or the military) access to the aerial imagery and other pertinent data necessary to efficiently and effectively bring an event to a successful conclusion. The end result is increased public safety.

The relatively small size and low cost of UAS will allow most, if not all, local public safety departments the ability to access aerial imagery. Law enforcement and first responders want to use small UAS (weighing less than 55 pounds) to give them situational awareness. These systems are very different than their larger military cousins (which can weigh tens of thousands of pounds and carry weapons) which many people picture when they think of an unmanned aircraft.

Rather than spending millions of dollars on manned helicopters and aviation units, law enforcement can use a small UAS to gain a lot of the same benefit of a manned aviation asset at a fraction of the cost. Although still expensive, small UAS will cost about the same as a police cruiser.

According to the U.S. Federal Bureau of Investigation, there are approximately 18,000 local police and sheriff departments in the United States; however, according to the Airborne Law Enforcement Association, less than 300 currently have aviation units (either fixed wing or rotary wing). According to the U.S. Fire Administration, there are approximately 30,000 fire departments in the United States; however, there are less than a dozen municipal or county fire aviation units. Because UAS are typically cheaper than manned assets, and because they can operate in dangerous environments, where manned aviation might not be feasible, UAS can provide great value to those agencies that want air assets, but cannot afford them.

In 2009, according to the National Fire Protection Association, there were more than 362,000 home fires. According to the National Interagency Fire Center, between 1 January 2010 and 4 October 2010, there were more than 57,000 wildfires, which burned nearly 3 million acres. In 2009, fires took more lives than all other natural disasters combined, with approximately 3,000 individuals and 90 firefighters dying as a result.

Some of the potential uses of UAS in firefighting include: persistent aerial surveillance, mapping, chemical sniffing, hot spot detection, designating water or suppressant drop areas, providing communication relays, search and rescue, medical evacuation, resupply, and weather monitoring. For law enforcement, UAS uses include aerial surveillance, suspect tracking, crash/crime scene photography, incident scene management, threat assessment of inaccessible areas, and emergency broadcast messaging.

Situational awareness is crucial for first responders and public safety agencies, and oftentimes, the best way to get situational information is from above. The development and use of UAS has the potential to increase public safety by allowing most, if not all, public safety agencies to acquire aerial surveillance equipment.

An Open and Transparent Discussion

Throughout the years, law enforcement agencies have proven their ability to use new technologies, even technologies with the capability to invade privacy, and use them in a safe and appropriate manner to increase public safety while still ensuring privacy protection. A few examples include manned helicopters, thermal imaging cameras, wire surveillance, GPS tracking, vast online databases, and CCTVs.

Law enforcement is able to ensure privacy rights are protected by adopting policies and procedures that govern their use. They can provide training, and they can hold people accountable if there is inappropriate behavior. They are also ultimately accountable to local elected officials and the community. AUVSI believes the easiest way to gain public support for UAS is to be forthright and open, and to invite a public discussion about the use of new technologies. Agencies that want to use UAS technology are encouraged to work with their communities to address any *reasonable* concerns and to tailor their policies and procedures to address them.

AUVSI plans on working with other law enforcement associations, such as the International Association of Chiefs of Police, the Airborne Law Enforcement Association, and the National Sheriff's Association to draft a model policy for the use of UAS by law enforcement agencies across the United States.

Existing Legal Framework

The Fourth Amendment of the U.S. Constitution prohibits unreasonable searches and seizures and requires search warrants to be based upon probable cause. The U.S. Supreme Court has interpreted the law and issued rulings that restrict the actions of police and their use of technology of all types. Courts, including the U.S. Supreme Court, have repeatedly held that airborne technology cannot be used to invade Constitutionally protected areas.

So far, in determining what is a Constitutionally protected area, the U.S. Supreme Court has distinguished between three types of areas: businesses, open fields, and homes. The Court has held that the expectation of privacy outside a home or outside a business is less than that for inside a residence.

In *Kyllo v. United States*, a case involving the use of thermal imaging by police, the U.S. Supreme Court held that all details, with respect to a home, are "intimate details" and that the use of "sense-enhancing technology" to gather information about a home, in this case forward-looking infrared imaging, is considered a search and cannot be done without a warrant. In the words of the court, "we think that obtaining by sense-enhancing technology any information regarding the interior of the home that could not otherwise have been obtained without physical intrusion into a constitutionally protected area ... constitutes a search." In other words, the court prohibits the use of airborne technology to invade Constitutionally protected areas without a

search warrant.

However, the Court has a differing view on the reasonable expectation of privacy in outdoor business property, and open fields and curtilage surrounding a residence, when observations can be made from a place where the observer has a legal right to be and the item or area is in "plain view".

In *Dow Chemical Company v. United States*, another case involving the airborne use of thermal imaging, the Court held that a Fourth Amendment protection does not include the open area of an industrial complex where there was no legitimate demand for privacy. The Court compared the aerial observations of the business with the lawful observations made over an "open field", where an individual also does not have a legitimate expectation of privacy.

With regards to the "open fields" doctrine, in *California v. Ciraolo*, the U.S. Supreme Court held that the police did not have to obtain a search warrant when observing a person's backyard or curtilage from an airplane more than 1,000 feet in altitude, and the Court went further in *Florida v. Riley*, when it held that police officers do not need a search warrant when flying a helicopter above 400 feet in altitude.

These cases can serve as the template for how law enforcement should use UAS. Because most small UAS will likely only be allowed to operate at or below 400 feet in altitude, it is likely that law enforcement will have to obtain a search warrant when using a UAS, absent exigent circumstances.

UAS Integration into the National Airspace

The Federal Aviation Administration's (FAA) mission is to "provide the safest, most efficient aerospace system in the world." The FAA's task for unmanned aircraft is coming up with the rules and regulations allowing for the safe operation and integration of UAS in the national airspace system. The UAS industry has, and will continue, to work with the FAA and other aviation stakeholders on establishing appropriate aviation safety standards.

That being said, the FAA should not be in the position to approve or deny a UAS operation based upon anything other than the safety of the airspace. Therefore, it would be inappropriate for the FAA to restrict UAS access based on anything other than aviation safety or airworthiness. Manned aviation does not need prior authorization to fly, and neither should UAS once safety standards are established and met.

On 14 February 2012, Congress passed an FAA bill into law, which requires the FAA to integrate all UAS by 30 September 2015. The bill mandates that small UAS (weighing less than 55 pounds) be integrated earlier, by the spring of 2014. The bill also instructs the FAA to expedite the access for public safety operators, and calls for the FAA to allow the use of very small UAS, weighing less than 4.4 pounds, by public safety agencies, by the middle of March 2012.

Conclusion

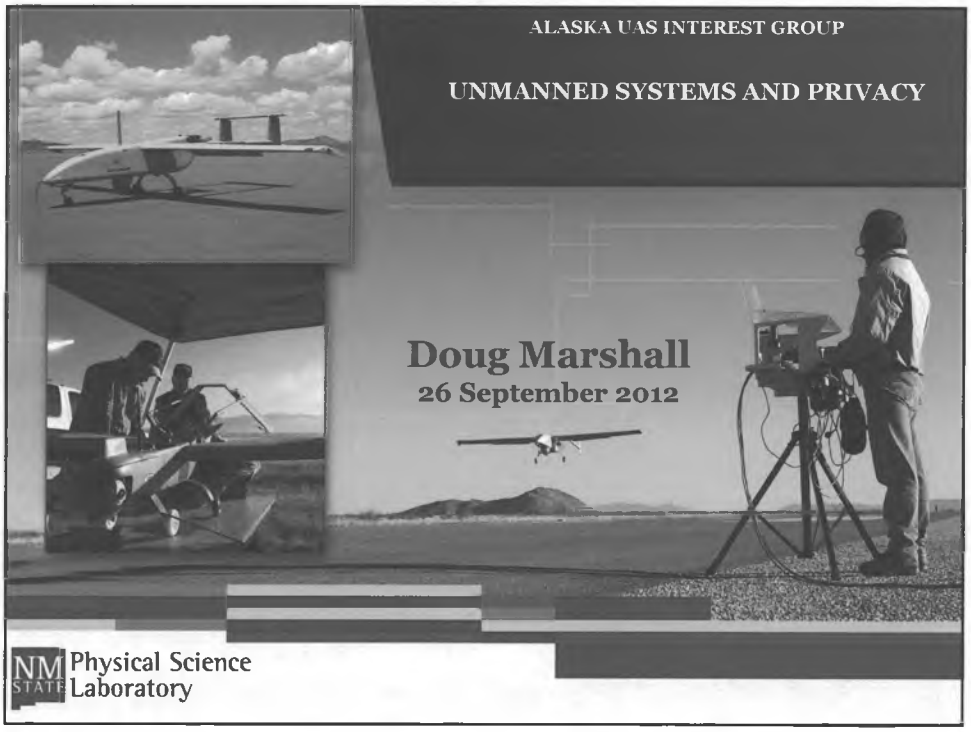
Unmanned aircraft systems will be the next major revolution in the aerospace industry, and UAS will likely change the way we think about aviation. AUVSI, as the industry's representative,

plans on playing a constructive role to ensure UAS are operated safely in the airspace and in a way that does not infringe upon Constitutionally protected privacy.

AUVSI welcomes feedback or suggestions at advocacy@auvsi.org.

###

The Association for Unmanned Vehicle Systems International (AUVSI) - the world's largest non-profit organization dedicated to the advancement of unmanned systems – represents more than 7,000 members from 55 allied countries and 2,500 organizations involved in the fields of government, industry and academia.



Privacy Cases

Key words and phrases:

- "Fourth Amendment"
- "Curtilage"
- "Reasonable/subjective Expectations of Privacy"
- "Constitutionally Protected Area"
- "Plain View"
- "Open Fields"
- "Intimate Details"
- "General Public Use"
- "Eavesdropping"
- "Routine flights on public airways"

Katz v. United States
389 U.S. 347 (1967)

- Listening device on a phone booth
- "Eavesdropping"
- "Fourth Amendment search occurs when the government violates a subjective expectation of privacy that society recognizes as reasonable"
- "These considerations do not vanish when the search in question is transferred from the setting of a home, an office, or a hotel room to that of a telephone booth. Wherever a man may be, he is entitled to know that he will remain free from unreasonable searches and seizures."

California v. Ciraolo
476 U.S. 207 (1986)

- Ciraolo grew marijuana plants in back yard
- Shielded from view by two fences
- Based on anonymous tip Santa Clara police flew over in private aircraft at 1,000 ft. and photographed house
- On evidence of naked eye observation, search warrant issued
- "The Fourth Amendment simply does not require the police traveling in the public airways at this altitude to obtain a warrant in order to observe what is visible to the naked eye."
- Reversed CA SCt's grant of motion to suppress.

Dow Chemical Company v. United States

476 U.S. 227 (1986)

- Environmental Protection Agency's aerial observation of Dow's plant complex
- EPA hired commercial aerial photographer, using a standard floor-mounted, precision aerial mapping camera, to take photographs of the facility from altitudes of 12,000, 3,000, and 1,200 feet.
- At all times the aircraft was lawfully within navigable airspace
- Held EPA's aerial photography of petitioner's 2,000-acre plant complex without a warrant was not a search under the Fourth Amendment
- Not "industrial curtilage", but an "open field"

Florida v. Riley

488 U.S. 445 (1989)

- Rural property, growing marijuana
- Unable to see inside a greenhouse behind Riley's mobile home
- Circled with helicopter at 400 ft., saw through two missing panels
- Held that police officials do not need a warrant to observe an individual's property from public airspace
- Any member of the public could legally have been flying over Riley's property in a helicopter at the altitude of 400 feet and could have observed Riley's greenhouse. The police officer did no more.
- Helicopter did not interfere with the normal use of the property (noise, dust, wind, etc.)
- Brennan's dissent worth reading w/ reference to UAS

Kyllo v. United States

533 U.S. 27 (2001)

- Use of a thermal imaging device from a public vantage point by agent of DOI to monitor the radiation of heat from person's home was a search within the meaning of the 4th Amendment and thus required a search warrant.
- The Agema 210 "is a non-intrusive device which emits no rays or beams and shows a crude visual image of the heat being radiated from the outside of the house"
- Because police did not have a warrant, the conviction for possession of marijuana was reversed.
- The question is what limits there are upon this power of technology to shrink the realm of guaranteed privacy.
- "....at the mercy of advancing technology – including imaging technology that could discern all human activity in the home."

U.S. v. Jones

- GPS tracking device attached to vehicle
- 4th Amendment violation because no warrant
- Justice Scalia stated that extended electronic surveillance "without an accompanying trespass" may be unconstitutional.
- Justice Alito: "…the use of longer term GPS monitoring in investigations of most offenses impinges on expectations of privacy.
- Could apply to UAS technology

GAO Report ("Not Ready for Prime Time")

- A June 2012 poll by Monmouth University found that 42 percent of Americans would be "very concerned" about their privacy if law enforcement started using drones, and just 15 percent said they wouldn't be concerned at all.
- "Many stakeholders believe that there should be federal regulations … to specifically protect the privacy of individuals," the report says. But "it is not clear what entity should be responsible for addressing privacy concerns across the federal government"

A gross invasion of privacy?

Does she lose her right to privacy because she is a "public figure"?

Backup Slides

Privacy and Public Policy Concerns for the UAS Owner/Operator

What types of current legal safeguards exist to protect us from misuse of UAS?

Privacy and Public Policy Concerns for the UAS Owner/Operator

- **Is there a right to privacy in the U.S.?**
- **If so, how could a UA operator violate that right?**
- **If a violation, what are the victim's remedies?**
- **How can the operator avoid liability and/or prosecution?**
- **How does the mandate to "do no harm" fit in?**

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Louis Brandeis/Samuel Warren and the "right to be let alone" (1890-Harvard Law Review)
- Dean Prosser' s four privacy tort claims (1960-Prosser, The Law of Torts)
- The Impact of the Internet

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Unguarded (or indiscreet) moments between friends can be captured in pictures and be instantly available across the world in digital form.
- A computer can identify the faces in each picture to create a searchable database - a fully indexed catalog of life, captured in still frames.
- The technology is here.

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Facial recognition search engines
- This technology creates an automatic, searchable pictorial documentary of one's life
- Flickr and Shutterfly were created to help anyone with a camera share pictures over the Internet.
- Flickr alone now catalogues over 325 million digital photos.

Privacy and Public Policy Concerns for the UAS Owner/Operator

- The new facial recognition systems (Polar Rose, Riva, Google Picasa, Facebook) make it possible for computers to tag photos with names even if the uploader and the subject are complete strangers
- For several reasons, existing privacy law may be ill-suited for this new technology

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Traditional tort law does not recognize invasions of privacy that occur in public, such as the taking of a photo in any public location.
- The few "public invasions" that do constitute torts involve celebrities or other individuals who have commercial interests in their likenesses.
- Courts have severely limited privacy protections to ensure that privacy claims do not limit the free flow of ideas.

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Dean Prosser's torts:
  - Intrusion upon seclusion
  - Public disclosure
  - False light
  - Misappropriation (the right of publicity)

Privacy and Public Policy Concerns for the UAS Owner/Operator

- "Intrusion upon seclusion" is an intrusion into "a private place or matter as to which a person would have a reasonable expectation of privacy.
- "Public disclosure" punishes those who reveal private information "that would be objectionable to a reasonable person of ordinary sensibilities."
- "False light" makes liable someone who falsely claims another person made certain statements or actions

Privacy and Public Policy Concerns for the UAS Owner/Operator

- These three torts probably don't apply to those photos taken in public spaces and then uploaded to the Internet.
- The fact that an image is snapped at a party, a restaurant, a park, or a bar would doom the claim.
- The torts do "not apply to matters which occur in a public place or a place otherwise open to the public eye."
- Intrusion upon seclusion" is an intrusion into "a private place or matter as to which a person would have a reasonable expectation of privacy

Privacy and Public Policy Concerns for the UAS Owner/Operator

The UAS problem is with images taken of people who are in situations where they have a reasonable expectation of privacy:

- Their own property
- In the wilderness
- On a boat
- Use your imagination...

Privacy and Public Policy Concerns for the UAS Owner/Operator

Misappropriation (the right of publicity)

- Only applies to those whose names and faces are well recognized
- Have commercial value that could be exploited
- Celebrities, usually
- A small UA that just happens to get an image of a famous person sun bathing on a "deserted" beach

Privacy and Public Policy Concerns for the UAS Owner/Operator

- When the lives of ordinary citizens are suddenly searchable, private or indiscreet moments can become lasting reminders open to the entire world
- The ability to keep parts of our lives private is central to our individual uniqueness

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Possible privacy scenarios :
  - Aerial photography
  - Remote sensing that records images
  - Surveillance activities over public (and private) land
  - Scientific payload with imaging capability
  - Scientific payload on a CBP or DoD UAS in a joint use arrangement

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Other issues:
  - Who owns the images?
  - Who is liable in case of "inadvertent" capture of images that somehow result in harm to the person depicted?
  - How to ensure security of data capture?
  - In joint-use situations, what are obligations/duties of operator, pilot, contractor to share digital data that may show criminal behavior?
  - What if a sensor operator puts an image or video on the Internet?

Privacy and Public Policy Concerns for the UAS Owner/Operator

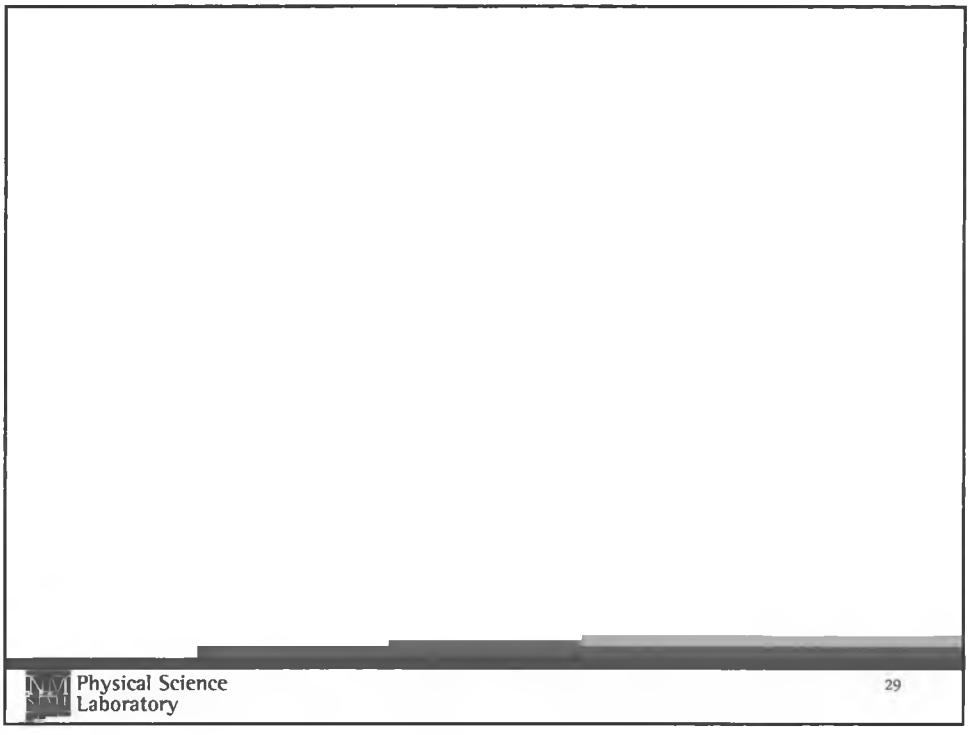
- Other issues:
  - If the potential for misuse of imaging is real, how to ensure that the system or operator "does no harm"?
  - For joint scientific, DHS/CBP and DoD operations, if law enforcement captures data on a science pod, can the data be legally used in prosecution?
  - Can owner/operator be civilly liable for turning over images or data to law enforcement?

Privacy and Public Policy Concerns for the UAS Owner/Operator

- In the law, there is the concept of "foreseeability"
- If it can happen, it probably will
- Possible solutions:
  - Courts or legislatures can expand "privacy" into public places
  - Legislative Intervention
    - Government regulation may be preferable to tort litigation in this circumstance

Privacy and Public Policy Concerns for the UAS Owner/Operator

- Some objections to any legislative intervention:
  - concern for the First Amendment
  - a desire for full information
  - faith in the market
  - anxiety about government interference with emerging technology
- Caveat-there is no good precedent for any of this....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