SMART Fire Fighting:
The Use of Unmanned Aircraft Systems in the Fire Service

2015

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Abstract

The Unmanned Aircraft System (UAS) is going to change how we view the fire or accident scene today. It provides the ability to get a complete overview of a scene and can even provide different views that we normally can’t get such as thermal images. UASs will be able to help us in many of the functions we do today, such as scene size up, ongoing situational awareness, search and rescue, investigations, pre-planning and training. UASs will also come with their challenges such as determining how they will be used, handling the cost and operations, and dealing with federal regulations. However, even with the challenges, the value that the UAS brings will forever change the value and service we provide to the public.

The fire service has had the same mission from day one, save life and property. As we have gained experience in this mission, we have continued to introduce technologies that aided us in that mission. From the very first hand squirts to the pumpers and hose line we use today. From the pry bar to the Halligan bar to the extrication tools we use. The advancement of technology has aided us in almost every way. The introduction of the thermal imaging camera allowed us to see where we couldn’t before. Today, the introduction of the Unmanned Aerial Systems has the opportunity to allow us to take a new leap in improving not only our tactics on the fire ground, but also how we learn and train as a whole.
This White Paper has been prepared for fire departments considering the purchase and use of an Unmanned Aerial Vehicle (UAV)/Unmanned Aircraft System (UAS). Its purpose is to provide guidance from fire service leaders on developing policies, procedures and guidelines for the use of these tools and an overview of the current regulations, best practices and purchasing considerations involved in a public agency’s use of a UAV/UAS.

While the intent of this paper is to provide the most current and relevant information regarding the purchasing and use of an UAS, it is understood that technology is ever-changing and, therefore, information regarding the capabilities, use and regulation of UAS is ever-evolving. For this reason, a section of this paper has been dedicated to resources, including other White Papers, websites and filesthat will aid the reader in obtaining the most current information.

The UAS, which is often and mistakenly referred to as a drone, has been around since the middle 19th century when the Austrian’s used unmanned balloons to bomb the Italian City of Venice [1]. World War I and World War II saw very crude types of unmanned aircraft that were used as decoys or training devices. It wouldn’t be until the cold war, when we would first start seeing the types of UASs that are in use today. The military use of the UAS has unfortunately given the technology a negative image as a videogame-esque killing technology. We can thank the media for helping to sensationalize this impression. [2]

In the mid-2000’s GPS and flight stabilization technologies were getting small enough to put into small radio controlled aircraft. This would lead to a new evolution of model aircraft that no longer needed highly skilled pilots to control. Instead you could point and click and the aircraft would do what you wanted without having to truly “pilot” the aircraft. Once cameras were added to them, people found them as great and easy ways of getting amazing aerial shots that they could never get before. Unfortunately, the technology is ahead of regulation and many consumer UAV have been getting to close to aircraft, airports and other assemblies of people where a falling UAV could cause serious harm. There is also considerable concern for privacy; much like when the camera was added to the cell phone. The addition of a camera to a UAV means that the world got a little less private. Hopefully though, through sensible regulation and once the “honeymoon” of the drone has calmed down a bit, society will begin to accept them as a part of everyday life… just like the camera phone.

The UAS is composed of two core parts. The UAV or Unmanned Aerial Vehicle and the Ground Control Station. The UAV is the actual vehicle that is flown, while the Ground Control Station gives the pilot the necessary controls to fly the UAV, as well as the necessary telemetry from the UAV, so that the pilot can navigate through the environment. The most typical telemetry is a video image showing the direction in which the UAV is pointing/heading.

There are two typical types of UAV. One is fixed-wing and the other is rotary-wing. The fixed-wing is much like an airplane. It needs to continue moving in order to stay in the air. These types of aircraft are ideal when a lot of ground needs to be covered in a short amount of time, such as in a search and rescue mission. The rotary-wing aircraft uses effectively one or more rotors that produce lift for the aircraft. An UAV is typically found in configurations of 4, 6 or 8 rotors. These types of aircraft are great for hovering and allowing the pilot to inspect a particular location such as a fire scene. There is also a new type of
hybrid aircraft that is both a rotary- and fixed-wing. This type of aircraft can lift off vertically and convert into a fixed-wing aircraft once in the air. This has the benefits of both a fixed-and rotary-wing aircraft.

What makes the UAS so compelling is its relative simplicity in use. You can just move the stick in a direction and the UAV moves proportionately in that direction. The pilot doesn’t have to worry about counteracting wind or other aerodynamic principles because the UAV has a computer and sensors that stabilize the aircraft. The most commonly used sensors are the GPS (Global Positioning System), IMU (Inertial Measurement Unit) and the Accelerometers. Together they keep the UAV positioned exactly where the pilot wants it.

Being able to fly a UAV around isn’t the real value. The real value is in the remote sensing technology and payload capabilities. The most basic remote sensor is the camera. Being able to take videos and pictures of a fire scene from an aerial prospective will be a game changer for the fire service. However, it doesn’t stop there. Thermal imaging cameras are also being fitted onto the UAV as well as multi-spectral cameras. There are even a few manufactures developing LIDAR for the UAV for scene reconstruction purposes. While multi-spectral cameras are proving useful in the agriculture industry, they currently don’t have any specific value for the fire service.

When it comes to payloads, most smaller UAVs cannot carry much more than a pound without impacting the flight characteristics of the aircraft. Therefore, the options are currently limited. Nonetheless, there are specific scenarios that are useful, such as delivering a two-way radio or cell phone to a victim in a remote area or a lightweight inflatable water rescue device to a victim stranded in the water.

In the process of gathering information for this White Paper, gaps were identified between the information and technology that is currently available and the recognized needs of the emergency services community. These gaps are listed below:

- The FAA needs to better define pilot training requirements for public agencies to operate an UAS under a Certificate of Authorization (COA)
- The determination of best practices associated with deployment of an UAS still needs to be studied as this technology expands into emergency services agencies
- Lack of (and/or cost of) intrinsically-safe options
- Inability to decontaminate the UAS without causing damage to the system
- Lack of (and/or cost of) all-weather options
- Flight stability in extreme weather
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 Aerial Vehicle (UAV)** - An aircraft that is intended to navigate in the air without an on-board pilot. Also called **Remote Piloted Aircraft, Robotic Aircraft** or **drone**.

3. **Unmanned Aerial Vehicle Pilot** - A person exercising control over an unmanned aerial vehicle during flight. Also called the **Pilot in Command (PIC)**.

4. **Unmanned Aerial Vehicle Flight Crewmember** - A pilot, visual observer (VO), payload operator or other person assigned duties for a UAV for the purpose of flight.

5. **Unmanned Aircraft Systems (UAS)** - An all encompassing description that encapsulates the aircraft or UAV, the ground-based controller, and the systems of communications connecting the two.

6. **Pilot in Command (PIC)** – The pilot responsible for the UAS flight operation. This person may be in charge and physical control of the UAVs flight controls via the Ground Control Unit

7. **Visual Observer (VO) or Visual Forward Observer (VFO)** - A person or persons with the assigned duties to maintain visual contact with the UAV via **Visual Line of Sight (VLOS)**
IAFC Position: Use of Unmanned Aerial Vehicles in Public Safety Emergency Response

Today’s advances in aerial technology have led to the development and increased use of unmanned aerial vehicles (UAV) for observation and tactical planning. This technology is now available for use in the emergency response field to put “eyes on target” without endangering the lives of responders. However, we live in a culture that is sensitive to the idea of preventing unnecessary government intrusion into any facet of our lives. Personal rights are cherished and legally protected by the United States Constitution. Despite the proven effectiveness of unmanned aerial vehicles, public safety use of this technology should be balanced against privacy concerns which may be voiced by private citizens. From enhanced remote monitoring of hazardous incidents so emergency response personnel are not exposed to unseen dangers, to search and rescue efforts and structure and wildland fire events, the potential benefits are irrefutable. However, privacy concerns are a challenge that must be addressed effectively if public safety agencies expect citizens to support the use of unmanned aerial vehicles by their emergency response personnel.

The International Association of Fire Chiefs (IAFC) constantly seeks to enhance safety, operations, command and fiscal efficiencies of emergency incidents. The use of unmanned aerial vehicles is a viable option for emergency personnel to quickly and safely gather essential incident intelligence for the use of tactical planning and observation of executed plans.

Unmanned aerial vehicles can be safely launched, in accordance with Federal Communications Commission regulations, by qualified field personnel in a timely manner during all types of events and emergency incidents. The unmanned aircraft can be equipped with thermal imaging or infrared capabilities, greatly improving chances of identifying “hot spots,” fire fronts and other vital fire behavior information. Once launched, the aircraft can fly on automated flight patterns and transmit valuable "real-time" data back to incident command and emergency operations centers. This data can assist the Incident Commander with decision making by detailing the current status of the incident, where potential expansion may occur, public and property value risks and may offer intelligence that allows for cost effective mitigation options.

The intelligence data provided by unmanned aerial vehicles is cost effective, efficient and avoids subjecting emergency response personnel to hazardous environments. With available Internet connectivity, the data can be delivered through secure and encrypted channels to command staff. This "real-time" data will greatly improve situational awareness that provides for better decision making during dynamic incidents.

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 Aerial Vehicle (UAV)** – An aircraft that is intended to navigate in the air without an on-board pilot. Also called Remote Piloted Aircraft, Robotic Aircraft or drone.
3. **Unmanned Aerial Vehicle Pilot** – A person exercising control over an unmanned aerial vehicle during flight.

4. **Unmanned Aerial Vehicle Flight Crewmember** – A pilot, visual observer, payload operator or other person assigned duties for a UAV for the purpose of flight.

**Initial Community Engagement:**

1. Emergency response agencies desiring to use UAVs 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 U.S. 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.

**System Requirements:**

The UAV should have the ability to capture flight time (manual or automated) 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.

The UAV 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.

**Operational Procedures:**

The Federal Aviation Administration (FAA) offers a Fact Sheet on Unmanned Aircraft Systems which should be reviewed and provides direct contact information for further inquiries.

1. UAV operations require a Certificate of Authorization (COA) from the FAA. An emergency response agency contemplating the use of UAVs should contact the FAA early in the planning process to determine the requirements for obtaining a COA.

2. UAVs 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 UAV responsibilities, including command officers, will be provided training in the policies and
procedures governing their use. The agency using the UAVs assumes all liability associated with its operations.

3. All flights will be approved by an operating agency’s supervisor and must be for a legitimate public safety mission, training, or demonstration purpose.

4. All flights will be documented on a form designed for that purpose and all flight times shall be accounted for on the form. The reason for the flight and name of the supervisor approving it 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 UAV will result in strict accountability.

7. Except for those instances where emergency personnel’s safety could be jeopardized, the agency should consider using a type of “reverse 911” telephone system, if available, to alert those living and working in the vicinity of UAV operations. If such a system is not available, the use of emergency apparatus public address systems should be considered. This will provide a level of safety should the aircraft make an uncontrolled landing.

8. Where there are specific and articulable grounds to believe that the UAV will collect evidence that will facilitate a criminal investigation or sound argument that the UAV will intrude upon reasonable expectations of privacy, the agency should coordinate with law enforcement to secure a search warrant prior to conducting the over-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 UAV should not be retained by the agency.

2. Unless exempt by law, retained images should be open for public inspection.

SUBMITTED BY: International Association of Fire Chiefs

ADOPTED BY: The IAFC Board of Directors on January 23, 2014

(Taken From IAFC Website)
UAS Uses in Fire and Rescue Operations

With the UAS being so new to the emergency services community, everyone seems to think they need one. However, it is necessary first to understand how an UAS can be useful to the fire service and the costs and resources required to fly and maintain them.

In determining how the UAS can be useful to the fire service, it is necessary to break down specific tasks and determine how remote sensing or light payload delivery could be useful. The following sections look at scene size up, situational awareness, search and rescue, scene investigation, pre-planning and training as the various functions were the UAS can provide value.

Scene Size Up

Getting as much information as possible in the first few minutes is always critical for determining the best strategies and tactics to employ. The most common approach to size-up consists of a 360-degree observation of the scene, which is great, but it is routinely accomplished from the ground. The ability to get an aerial view of a scene can bring a new perspective, new information and possibly change the strategies and tactics chosen. For instance, heavy smoke from a structure fire makes it difficult to completely see the entire building due to the smoke obscuring the view of the person conducting the size-up. It could be quite possible that the roof had already collapsed and the units would not know that until a team tries to make entry. An UAV could provide an aerial view that would allow the Incident Commander to better determine the overall condition of the structure.

The most challenging obstacle in using an UAS for size-up is the amount of time it takes to deploy the unit. The initial size-up of a scene is done within minutes of arrival. Most UASs cannot be easily deployed in mere seconds and would require a dedicated pilot. For most departments this would be impractical, unless the scene involved a large area such as a natural disaster or hazardous materials spill, where access may be limited. Odds are that this will be addressed over time with completely autonomous UAVs. In this case, the UAV takes off from the top of the vehicle and performs an aerial size-up without any intervention from a pilot. However, technology and regulations are not yet available for this capability.

Situational Awareness

Situational Awareness is another task for which the UAS is well suited. The UAS can give the Incident Commander a different perspective of the scene. Regardless of what type of incident the agency is mitigating…a structure or brush fire, hazardous materials spill, vehicle accident, or natural disaster…this additional view and added intelligence is invaluable. This is especially true when multiple remote sensors, such a camera and TIC, can be leveraged. Being able to see possible areas of fire extension from the air can give Incident Commanders valuable information on how to manage tactics to better handle the situation and keep firefighters out of harm’s way. For example, a TIC on a UAV could be aimed the roof of a structure with fire in the space between the ceiling and the roof. The images captured and transmitted to the Ground Control Unit and Incident Command Post could identify fire progression and flow path or the effectiveness of suppression efforts. Situational awareness is likely to be one of the most valuable uses for a UAS for fire operations.
Search and Rescue

The fire service routinely thinks of search and rescue as a combined task. However, for an UAS, it should be broken down into two separate tasks.

Search. With remote sensing technologies available, such as cameras and TICs, an UAS can be a sought after tools for search operations. UAVs are typically less expensive than manned aircraft and are quicker and easier to deploy. Maintenance costs are routinely far less for an UAS than its manned counterparts. An UAV is capable of flying into tighter spaces and can do so more safely. UASs are being used in the wilderness to find lost hikers and after disasters and to help find victims in a disaster area. As the physical and technological capabilities of UASs are ever-changing, there are some exciting opportunities for the use of UAVs in searching for victims. A consumer/commercial UAS manufacturer named DJI, Ford Motor Company and the United Nations Development Programme have partnered to create a Developer Challenge. The Developer Challenge asks software developers around the world to come up with a solution to allow an UAV to search and identify potential victims in a disaster area, transmit this information to an Incident Commander and return to its launch vehicle, completely autonomously. [3] This challenge could very well be the prelude of technology that will help public safety agencies to quickly identify victims and prioritize resources.

Rescue. With rescue, an UAV can provide not only situational awareness for rescuers, but some models can deliver payloads to a victim. Possibilities include the delivery of a two-way radio or cell phone, water, food, or first aid supplies to help stabilize a victim until rescuers can reach them.

Water Rescue

Water Rescue is a very practical scenario for an UAS, because an UAV can quickly reach a victim with very little setup time and can deploy a lightweight inflatable flotation device to the victim with tethered rope line that goes back to shore. Keenan Newton, from the Lynwood Fire Department (Lynwood, IL), has been working on the feasibility of using an consumer UAV to take an inflatable floatation device over the water (such as a Mustang Rescue Stick [4]) and put it within the victim’s reach. On contact with water, the floatation device automatically inflates. Rescuers then can then pull the victim to shore. Initial testing has shown that the floatation device can be in the victim’s hands in less than 2½ minutes from the time the rescuer arrives on scene.

Scene Investigation

Scene investigation, while being more of a law enforcement and fire investigation task, is another scenario well suited for UASs. UAVs can be programmed via a simple user interface (UI) to methodically fly over a scene, or around it, and take images at specific intervals. These images can later be taken and processed with special software that can stitch the images together and provide three dimensional models and orthomosaic images of a scene. With this data, information such as measurements of distance and volume can be taken, as well as having a visual view of the scene from any angle.
Pre-Planning

Much like scene investigation, three dimensional models and orthomosaic images can be very useful for pre-planning purposes. Having this imagery can help Incident Commanders identify potential hazards before getting to the scene as well as during fire ground operations.

Training

Training is another valuable use for an UAS. It can take video and still images of training activities than be replayed later; either for debriefing purposes or for making reusable training content.

UAS Operations Models

Taking the time to think of how an agency will use an UAS will help determine the features required for an UAS platform. An agency should also take a look at various operating models to determine which may be the best for them. It is likely that an UAS will not be used as much as a pumper or ambulance, so looking at an inter-agency or outsource model might be more cost effective for some agencies.

Intra-Agency

For larger agencies, it will probably make sense to operate an UAS team internally. A decision to host an intra-agency UAS unit should be based on a determination of call volume and call types where an UAS would provide beneficial services. Additionally, an agency should identify the specifications for the UAS needed by their jurisdiction and the costs associated with purchasing and maintaining the equipment and necessary training of flight crews.

Inter-Agency

For smaller agencies with a lower frequency of call types to utilize an UAS, sharing UAS resources among several departments and/or disciplines may prove to be the best justification. Having to fund an UAS internally could be a daunting venture with today’s ever tightening budgets. For example, a Mutual Aid Box Alarm System (MABAS) division may want to provide UAS support for its member agencies. The MABAS division could purchase two units to support the multiple towns and provide the necessary redundancy of equipment. The overall initial cost, with a TIC, would be approximately $80,000. However, that cost divided across 20 member agencies would only equate to $4,000 per agency.

Outsourced Services

Another option is to outsource the service by hiring a private contractor that has the equipment and skilled pilots to perform the tasks. As many fire departments contract ambulance transportation services, a similar model with UASs could be beneficial. This would mean giving up some control by the fire department, but it could prove to be more cost effective in the long run for a public safety agency.
Privacy Issues

According to Charles Werner, a Firehouse Magazine contributing editor, “Many localities prohibit the use of drones due to concerns about inappropriate use and the invasion of privacy. About a year ago, the Charlottesville City Council enacted a two-year moratorium on drones to allow time for some of these issues to be addressed. While it is clear that UAVs offer great value to the fire service, it is imperative that every fire department that seeks to use a drone understands the requirements (legal, operational, safety and liability) and commitment (training, operational readiness, policies and procedures) that will be needed to implement a successful UAV program.[5]

The Costs of UASs

Funding of the UAS program is one of the most important factors to consider when planning to begin an UAS team for any jurisdiction. The initial funding could be made possible through grants, private donors and/or the fire department budget. The department will need to decide how many UASs to purchase and how many crewmembers will be needed. These crew members will all require initial training and certification, as well as an adequate location to practice flying. (Gym, field, pasture, building, etc.) Assistant Chief Richard Davis, of the Austin Fire Department Red Team, recommends having a minimum of two members per UAS, but four team members would be optimal. Each team would consist of one pilot, one spotter and two backup team members. Firefighter Coitt Kessler, also of the Austin Fire Department Red Team, recommends that for every UAS you purchase that you also purchase a backup. A backup unit is needed in case the initial UAS is damaged and/or in need of repair. Ongoing funding would be required for continued training, certifications, replacement equipment and repairs.

The cost of an UAS and maintenance of an UAS program, while cheaper than manned aircraft, is still going to be a significant cost. While most consumer or commercial UAS are around $2,000 to $10,000 in cost, high-end UASs - specifically made for public safety - can cost $20,000 to $100,000. After the initial investment, training costs have to be factored in as well as maintenance and parts. For maintenance purposes alone, an agency should factor at least 50% of the initial cost of the UAS, annually. Accidents will happen, and parts or possibly the whole UAS, will have to be replaced. Training can also be significant, as it can take weeks to be proficient with the device, and it will be necessary for there to be continuing education to keep the skills of the pilot(s) proficient. Adding a thermal imaging camera to the payload can cost $10,000 to $20,000. Software and hardware for creating pre-plans or 3D models for investigations cost up to $10,000.

Case Study Examples

The use of UASs is still new and the use of UASs in law enforcement is facing more scrutiny due to privacy concerns. Sharing a fire departments UAS with your local law enforcement who may not have a UAS should only be considered with a strict policy on its use, in order to make sure federal and state laws regarding privacy are not violated. Many states are now enacting laws requiring the use of a search warrant when utilizing UASs in law enforcement activities if any surveillance is involved.
In 2011, a Predator drone was used to assist an arrest in North Dakota.[14]

In February 2013, Seattle mayor Michael McGinn ordered the Seattle Police Department to abandon plans to use UAVs after objections from residents.[15] Two DraganflyerX6 craft had been purchased with a federal grant and the police had been granted FAA approval though they had not started using them.[15] The vehicles were to be returned to the manufacturer.[15] Seattle Police Department had announced in October 2012 that they were drafting a policy and they were one of the first police forces in the United States to receive approval from the federal government to use UAVs.[16] Opponents of the program included the Washington chapter of the ACLU.[15] The ACLU has also been concerned with privacy over drones that the Los Angeles Police Department had acquired.[17]

UAVs can be powerful surveillance tools by carrying camera systems capable of license plate scanning and thermal imaging as well as radio equipment and other sensors.[18] The Electronic Frontier Foundation filed a Freedom of Information Act request on 10 January 2012 against the Federal Aviation Administration.[19] As a result of the request, the FAA released a list of the names of all public and private entities that have applied for authorizations to fly UAVs domestically.[20] Some of these government licenses belong to the U.S. Customs and Border Protection, a component of the Department of Homeland Security. UAVs have been used by U.S. Customs and Border Protection to patrol United States borders since 2005, and the agency currently owns 10 UAVs with plans to use armed drones.[21]

A May 2012 report issued by the DHS Inspector General found that CBP "needs to improve planning of its unmanned aircraft systems program to address its level of operation, program funding, and resource requirements, along with stakeholder needs".[22] Also, despite the Bureau’s limited mission to safeguard the borders, the Bureau often flies missions for the FBI, the Department of Defense, NOAA, local law enforcement, and other agencies. In December 2011, the CBP made headlines when reporters discovered that the agency’s UAVs were being used to assist local law enforcement in relation to cattle raiding in North Dakota without receiving prior approval from the FAA or any other agency.[23]

Individuals in the United States have few legal privacy protections from aerial surveillance conducted through UAVs. In Florida v. Riley,[1] the United States Supreme Court held that individuals do not have the right to privacy from police observation from public airspace. The weakness of legal protection from UAV surveillance have led to calls from civil liberties advocacy groups for the U.S. government to issue laws and regulations that establish both privacy protections and greater transparency regarding the use of UAVs to gather information about individuals.[25] As an example, the American Civil Liberties Union (ACLU) has warned of a "nightmare scenario" in the future where the police might be able, with computer technology, to combine mobile phone tracking with video data and build up a database of people's routine daily movements.[3]
• On 24 February 2012, the Electronic Privacy Information Center, joined by
over 100 organizations, experts, and members of the public, submitted a
petition to the FAA requesting a public rule-making on the privacy impact of
UAV use in U.S. airspace.\[26\] In June 2012, Senator Rand Paul and
Representative Austin Scott both introduced legislation that would require law
enforcement to obtain a warrant before using a UAV to conduct surveillance
of criminal activities.\[27\] EPIC has stated that transparency and accountability
must be built into the FAA's system of UAV/UAS/RPV regulation in order to
provide basic protections to the public.\[28\]

• While Congress rapidly moves ahead to authorize further use of domestic
UAVs, many remain skeptical regarding privacy concerns.\[2\] Some privacy
scholars argue that the domestic use of UAVs for surveillance will ultimately
benefit privacy by encouraging society to demand greater privacy rights.

Associated today with the theatre of war, the widespread
domestic use of drones for surveillance seems inevitable.
Existing privacy law will not stand in its way. It may be
tempting to conclude on this basis that drones will further
erode our individual and collective privacy. Yet the opposite
may happen. Drones may help restore our mental model of a
privacy violation. They could be just the visceral jolt society
needs to drag privacy law into the twenty-first century.

— M. Ryan Calo\[29\]

• FBI Director Robert Mueller testified before the Senate Judiciary Committee
on 19 June 2013 that the FBI owns and uses UAVs for the purposes of
"surveillance".\[30\]

• In 2014, the California State Senate passed rules imposing strict regulations
on how law enforcement and other government agencies can use drones. The
legislation would require law enforcement agencies to obtain a warrant before
using an unmanned aircraft, or drone, except in emergencies.\[31\]

(Taken from Wikipedia – Use of UAVs in Law Enforcement)
Regulatory Requirements

The FAA currently has issued special orders requiring UAVs to apply for and obtain special airworthiness certificates for the UAV to be valid to operate in flight operations. When purchasing an UAS an agency should work with the manufacture/distributor to apply for and obtain a special airworthiness certificate for the UAV being purchased.

U.S Department of Transportation Federal Aviation Administration

Order 8130.34C
08/02/2013

Subject:

Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft

This order establishes procedures for issuing special airworthiness certificates in the experimental category or special flight permits to unmanned aircraft systems (UAS), optionally piloted aircraft (OPA), and aircraft intended to be flown as either a UAS or an OPA, under the designation “OPA/UAS.” The procedures in this order apply to Federal Aviation Administration (FAA) manufacturing aviation safety inspectors (ASI), to FAA airworthiness ASIs, and to private persons or organizations delegated authority to issue special flight permits for production flight testing new production aircraft.

(Taken from FAA Website)
As noted in the below regulation UAVs used by public agencies are required to register and the FAA continues to work on regulations regarding the registration of UAVs by private users.

DEPARTMENT OF TRANSPORTATION - Office of the Secretary Federal Aviation Administration
14 CFR Chapter I - [Docket No. FAA–2015–4378]

Clarification of the Applicability of Aircraft Registration Requirements for Unmanned Aircraft Systems (UAS) and Request for Information Regarding Electronic Registration for UAS

Federal law requires that a person may only operate an aircraft when it is registered with the FAA. 49 U.S.C. 44101(a).1 “Aircraft” is defined as “any contrivance invented, used, or designed to navigate, or fly in, the air.” 2 49 U.S.C. 40102(a)(6). In 2012, Congress confirmed that UAS, including those used for recreation or hobby purposes, are aircraft consistent with the statutory definition set forth in 49 U.S.C. 40102(a)(6). See Public Law 112–95, sec. 331(8), 336 (defining an unmanned aircraft as “an aircraft that is that is operated without the possibility of direct human intervention from within or on the aircraft,” and model aircraft as “an unmanned aircraft that is capable of sustained flight in the atmosphere, flown within visual line of sight of the person operating the aircraft, and flown for hobby or recreational purposes”); see also Administrator v. Pirker, NTSB Order No. EA–5730, at 12 (Nov. 17, 2014) (affirming that the statutory definition of aircraft is clear and unambiguous and “includes any air aircraft, manned or unmanned, large or small.”).

Requiring registration of all UAS, including those operated for hobby or recreation, embraces and applies the Academy of Model Aeronautics’ (AMA)’s policy of identification to UAS operators who may not be modelers registered with the AMA. Additionally, it would ensure consistency with other UAS operations currently required to be registered, such as public aircraft, those operated under exemptions, and certificated aircraft, as well as those operations contemplated in the small UAS NPRM.

(Taken from FAA Website)
Federal Register
Vol. 80 Wednesday,
No. 241 December 16, 2015
Part VI
Department of Transportation Federal Aviation Administration
14 CFR Parts 1, 45, 47, et al.
Registration and Marking Requirements for Small Unmanned Aircraft; Final Rule

Part 45: Under part 45 of Title 14

CFR, aircraft must display the unique registration number that corresponds with the number on the registration certificate. Part 45 prescribes the requirements for identification of U.S. registered aircraft and the display of the registration number. The number must generally be: (1) Painted on the aircraft or affixed to the aircraft by some other permanent means; (2) have no ornamentation; (3) contrast in color with the background; and (4) be legible. See 14 CFR 45.21(c). Currently, small unmanned aircraft authorized to operate in the NAS under an exemption issued pursuant to the authority in section 333 of the FAA Modernization and Reform Act of 2012 must register in accordance with the paper-based process in 14 CFR part 47. Owners of unmanned aircraft with special airworthiness certificates and unmanned aircraft used by governmental entities in public aircraft operations also register via the part 47 registration process. Accordingly, consistent with existing statutory requirements for registration, the IFR will not apply to small unmanned aircraft of the armed forces of the United States. 49 U.S.C. 44101(b)(2). Small unmanned aircraft used in non-military public aircraft operations are subject to the registration requirements of 49 U.S.C. 44101 and as such, must complete the registration process provided in part 47. These aircraft may also be registered in accordance with the part 48 process that will be available for aircraft used for other than model aircraft operations in the spring of 2016.

(Taken from FAA Website)
Aircraft registration Requirements:

PART 48—REGISTRATION AND MARKING REQUIREMENTS FOR SMALL UNMANNED AIRCRAFT

AUTHORITY: 49 U.S.C. 106(f), 106(g), 40101, 40103, 40113-40114, 41703, 44101-44103, 44105-44106, 44110-44113, 45302, 45305, 46104, 46301, 46306.

SOURCE: Doc. No. FAA-2015-7396; Amdt. No. 48-1; 80 FR 78645, Dec. 16, 2015, unless otherwise noted.

Subpart A - General

§48.1 Applicability.

(a) This part provides registration and identification requirements for small unmanned aircraft that are part of a small unmanned aircraft system as defined in §1.1 of this chapter.

(b) Small unmanned aircraft eligible for registration in the United States must be registered and identified in accordance with either:

(1) The registration and identification requirements in this part; or

(2) The registration requirements in part 47 and the identification and registration marking requirements in subparts A and C of part 45.

(c) Small unmanned aircraft intended to be operated outside of the territorial airspace of the United States, or registered through a trust or voting trust, must be registered in accordance with subparts A and B of part 47 and satisfy the identification and registration marking requirements of subparts A and C of part 45.

§48.5 Compliance dates.

(a) Small unmanned aircraft used exclusively as model aircraft. For small unmanned aircraft operated by the current owner prior to December 21, 2015, compliance with the requirements of this part or part 47 is required no later than February 19, 2016. For all other small unmanned aircraft, compliance with this part is required prior to operation of the small unmanned aircraft.

(b) Small unmanned aircraft used as other than model aircraft. Small unmanned aircraft owners authorized to conduct operations other than model aircraft operations must register the small unmanned aircraft in accordance with part 47 of this chapter. Beginning March 31, 2016, small unmanned aircraft operated as other than model aircraft may complete aircraft registration in accordance with this part.

§48.10 Definitions.
For purposes of this part, the following definitions apply:

*Citizen of the United States or U.S. citizen* means one of the following:

1. An individual who is a citizen of the United States or one of its possessions.

2. A partnership each of whose partners is an individual who is a citizen of the United States.

3. A corporation or association organized under the laws of the United States or a State, the District of Columbia, or a territory or possession of the United States, of which the president and at least two-thirds of the board of directors and other managing officers are citizens of the United States, which is under the actual control of citizens of the United States, and in which at least 75 percent of the voting interest is owned or controlled by persons that are citizens of the United States.

*Registry* means the FAA, Civil Aviation Registry, Aircraft Registration Branch.

*Resident alien* means an individual citizen of a foreign country lawfully admitted for permanent residence in the United States as an immigrant in conformity with the regulations of the Department of Homeland Security (8 CFR Chapter 1).

§48.15 Requirement to register.

No person may operate a small unmanned aircraft that is eligible for registration under 49 U.S.C. 44101-44103 unless one of the following criteria has been satisfied:

(a) The owner has registered and marked the aircraft in accordance with this part;

(b) The aircraft weighs 0.55 pounds or less on takeoff, including everything that is on board or otherwise attached to the aircraft; or

(c) The aircraft is an aircraft of the Armed Forces of the United States.

§48.20 Eligibility for registration.

A small unmanned aircraft may be registered under 49 U.S.C. 44103 and under this part only when the aircraft is not registered under the laws of a foreign country and is—

(a) Owned by a U.S. citizen;

(b) Owned by an individual citizen of a foreign country lawfully admitted for permanent residence in the United States;

(c) Owned by a corporation not a citizen of the United States when the corporation is organized and doing business under the laws of the United States or a State within
the United States, and the aircraft is based and primarily used in the United States; or

(d) An aircraft of—

(1) The United States Government; or

(2) A State, the District of Columbia, a territory or possession of the United States, or a political subdivision of a State, territory, or possession.

§48.25 Applicants.

(a) To register a small unmanned aircraft in the United States under this part, a person must provide the information required by §48.100 to the Registry in the form and manner prescribed by the Administrator. Upon submission of this information, the FAA issues a Certificate of Aircraft Registration to that person.

(b) A small unmanned aircraft must be registered by its owner using the legal name of its owner, unless the owner is less than 13 years of age. If the owner is less than 13 years of age, then the small unmanned aircraft must be registered by a person who is at least 13 years of age.

(c) In accordance with 49 U.S.C. 44103(c), registration is not evidence of aircraft ownership in any proceeding in which ownership of an unmanned aircraft by a particular person is in issue.

(d) In this part, “owner” includes a buyer in possession, a bailee, a lessee of a small unmanned aircraft under a contract of conditional sale, and the assignee of that person.

§48.30 Fees.

(a) The fee for issuing or renewing a Certificate of Aircraft Registration for aircraft registered in accordance with §48.100(a) is $5.00 per aircraft.

(b) The fee for issuing or renewing a Certificate of Aircraft Registration for aircraft registered in accordance with §48.100(b) is $5.00 per certificate.

(c) Each application for and renewal of a Certificate of Aircraft Registration must be accompanied by the fee described in paragraphs (a) and (b), as applicable, paid to the Federal Aviation Administration through the web-based aircraft registration system, or in another manner if prescribed by the Administrator.

Subpart B—Certificates of Aircraft Registration for Small Unmanned Aircraft
§48.100 Application.

(a) Required information: Persons intending to use the small unmanned aircraft as other than a model aircraft. Each applicant for a Certificate of Aircraft Registration issued under this part must submit all of the following information to the Registry:

1. Applicant name and, for an applicant other than an individual, the name of the authorized representative applying for a Certificate of Aircraft Registration.

2. Applicant's physical address and, for an applicant other than an individual, the physical address for the authorized representative. If the applicant or authorized representative does not receive mail at their physical address, a mailing address must also be provided.

3. Applicant's email address or, for applicants other than individuals, the email address of the authorized representative.

4. The aircraft manufacturer and model name.

5. The aircraft serial number, if available.

6. Other information as required by the Administrator.

(b) Required information: Individuals intending to use the small unmanned aircraft exclusively as a model aircraft. Each applicant for a Certificate of Aircraft Registration issued under this part must submit all of the following information to the Registry:

1. Applicant name.

2. Applicant's physical address and if the applicant does not receive mail at their physical address, a mailing address must also be provided.

3. Applicant's email address.

4. Other information as required by the Administrator.

(c) Provision of information. The information identified in paragraphs (a) and (b) of this section must be submitted to the Registry through the Web-based small unmanned aircraft registration system in a form and manner prescribed by the Administrator.

(d) Issuance of Certificate of Aircraft registration. The FAA will issue a Certificate of Aircraft Registration upon completion of the application requirements provided in paragraph (a) or (b) of this section as applicable.

§48.105 Requirement to maintain current information.
(a) The holder of a Certificate of Aircraft Registration must ensure that the information provided under §48.100 remains accurate.

(b) The holder of a Certificate of Aircraft Registration must update the information using the web-based small unmanned aircraft registration system within 14 calendar days of the following:

1. A change in the information provided under §48.100.
2. When aircraft registration requires cancellation for any reason including sale or transfer, destruction, or export.

§48.110 Registration: Persons intending to use small unmanned aircraft for purposes other than as model aircraft.

(a) Certificate of Aircraft Registration. A Certificate of Aircraft Registration issued in accordance with §48.100 for aircraft used for purposes other than as model aircraft constitutes registration only for the small unmanned aircraft identified on the application.

(b) Effective date of registration. An aircraft is registered when the applicant receives a Certificate of Aircraft Registration for the specific aircraft. The effective date of registration is shown by the date of issue on the Certificate of Aircraft Registration issued for the aircraft.

(c) Registration renewal. A Certificate of Aircraft registration issued under this part expires 3 years after the date of issue unless it is renewed.

1. The holder of a Certificate of Aircraft Registration must renew the Certificate by verifying, in a form and manner prescribed by the Administrator, that the information provided in accordance with §48.100 of this subpart is accurate and if it is not, provide updated information. The verification may take place at any time within the six months preceding the month in which the Certificate of Aircraft registration expires.

2. A certificate issued under this paragraph expires three years from the expiration date of the previous certificate.

(d) Other events affecting effectiveness of Certificate. Each Certificate of Aircraft Registration issued by the FAA under this subpart is effective, unless registration has ended by reason of having been revoked, canceled, expired, or the ownership is transferred, until the date upon which one of the following events occurs:

1. Subject to the Convention on the International Recognition of Rights in Aircraft when applicable, the aircraft is registered under the laws of a foreign country.
(2) The small unmanned aircraft is totally destroyed or scrapped.

(3) The holder of the Certificate of Aircraft Registration loses U.S. citizenship.

(4) Thirty days have elapsed since the death of the holder of the Certificate of Aircraft Registration.

(5) The owner, if an individual who is not a citizen of the United States, loses status as a resident alien, unless that person becomes a citizen of the United States at the same time.

(6) The owner is a corporation other than a corporation which is a citizen of the United States and one of the following events occurs:

   (i) The corporation ceases to be lawfully organized and doing business under the laws of the United States or any State thereof; or

   (ii) The aircraft was not operated exclusively within the United States during the period of registration under this part.

§48.115 Registration: Individuals intending to use small unmanned aircraft exclusively as a model aircraft.

(a) Certificate of Aircraft Registration: A Certificate of Aircraft Registration issued in accordance with §48.100 for small unmanned aircraft used exclusively as model aircraft constitutes registration for all small unmanned aircraft used exclusively as model aircraft owned by the individual identified on the application.

(b) Effective date of registration. An aircraft is registered when the applicant receives a Certificate of Aircraft Registration. The effective date of registration is shown by the date of issue on the Certificate of Aircraft Registration issued under this part.

(c) Registration renewal. A Certificate of Aircraft registration issued under this part expires 3 years after the date of issue unless it is renewed.

(1) The holder of a Certificate of Aircraft Registration must renew the Certificate by verifying, in a form and manner prescribed by the Administrator, that the information provided in accordance with §48.100(b) and (c) of this part is accurate and if it is not, provide updated information. The verification may take place at any time within the six months preceding the month in which the Certificate of Aircraft registration expires.

(2) A certificate issued under this paragraph expires three years from the expiration date of the previous certificate.
(d) *Other events affecting effectiveness of Certificate.* Each Certificate of Aircraft Registration issued by the FAA under this part is effective, unless registration has ended by reason of having been revoked, canceled or expired, or until the date upon which one of the following events occurs:

1. The holder of the Certificate of Aircraft Registration loses U.S. citizenship.
2. Thirty days have elapsed since the death of the holder of the Certificate of Aircraft Registration.
3. The owner, if an individual who is not a citizen of the United States, loses status as a resident alien, unless that person becomes a citizen of the United States at the same time.

§48.120 Invalid registration.

The registration of a small unmanned aircraft is invalid if, at the time it is made—

(a) The aircraft is registered in a foreign country;
(b) The applicant is not the owner, except when the applicant registers on behalf of an owner who is under 13 years of age;
(c) The applicant is not eligible to submit an application under this part; or
(d) The interest of the applicant in the aircraft was created by a transaction that was not entered into in good faith, but rather was made to avoid (with or without the owner's knowledge) compliance with 49 U.S.C. 44101-44103.

§48.125 Foreign civil aircraft.

Except for corporations eligible to register under §48.20(c), the FAA will issue a recognition of ownership to persons required to comply with the provisions of this part pursuant to an authorization to operate issued under part 375 of this title. The recognition of ownership does not have the effect of U.S. aircraft registration.

Subpart C—Aircraft Marking

§48.200 General.

(a) No person may operate a small unmanned aircraft registered in accordance with this part unless the aircraft displays a unique identifier in accordance with the requirements of §48.205 of this subpart.

(b) A unique identifier is one of the following:
(1) The registration number issued to an individual or the registration number issued to
the aircraft by the Registry upon completion of the registration process provided by
this part; or

(2) If authorized by the Administrator and provided with the application for Certificate
of Aircraft Registration under §48.100 of this part, the small unmanned aircraft serial
number.

§48.205  Display and location of unique identifier.

(a) The unique identifier must be maintained in a condition that is legible.

(b) The unique identifier must be affixed to the small unmanned aircraft by any means
necessary to ensure that it will remain affixed for the duration of each operation.

(c) The unique identifier must be readily accessible and visible upon inspection of the
small unmanned aircraft. A unique identifier enclosed in a compartment is readily
accessible if it can be accessed without the use of any tool.

(Taken from FAA Website)
Below is information on the regulation regarding obtaining a Certificate of Authorization (COA). The FAA requires those using UAVs for “public agencies” obtain a COA.

Public Operations (Governmental)

Public Aircraft Operations are limited by federal statute to certain government operations within U.S. airspace. Title 49 U.S.C. § 40102(a)(41) provides the definition of “Public Aircraft” and § 40125 provides the qualifications for public aircraft status. Whether an operation qualifies as a public aircraft operation is determined on a flight-by-flight basis, under the terms of the statute. The considerations when making this determination are aircraft ownership, the operator, the purpose of the flight, and the persons on board the aircraft.

Public COAs

For public aircraft operations, the FAA issues a Certificate of Waiver or Authorization (COA) that permits public agencies and organizations to operate a particular aircraft, for a particular purpose, in a particular area. The COA allows an operator to use a defined block of airspace and includes special safety provisions unique to the proposed operation. COAs usually are issued for a specific period – up to two years in many cases.

The FAA works with these organizations to develop conditions and limitations for UAS operations to ensure they do not jeopardize the safety of other aviation operations. The objective is to issue a COA with parameters that ensure a level of safety equivalent to manned aircraft. Usually, this entails making sure that the UAS does not operate in a populated area and that the aircraft is observed, either by someone in a manned aircraft or someone on the ground to ensure separation from other aircraft in accordance with right-of-way rules. Common public uses today include law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions.

The FAA manages public aircraft COAs through its COA Online system. Before the FAA grants an agency access to COA Online, the agency (or proponent) will be asked to provide the FAA with a "declaration letter" from the city, county, or state attorney's office assuring the FAA that the proponent is recognized as a political subdivision of the government of the State under Title 49 of the United Stated Code (USC) section (§) 40102(a)(41)(c) or (d) and that the proponent will operate its unmanned aircraft in accordance with 49 USC. § 40125(b) (not for commercial purposes). An agency's accountable executive cannot self-certify their agency is a "public" agency.

Certificates of Waiver or Authorization (COA)

COA is an authorization issued by the Air Traffic Organization to a public operator for a specific UA activity. After a complete application is submitted, 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 can operate safely with other airspace
users. In most cases, FAA will provide a formal response within 60 days from the time a completed application is submitted.

To better support the needs of our customers, FAA deployed a web-based application system. The UAS COA Online System provides applicants with an electronic method of requesting a COA. Applicants will need to obtain an account in order to access the online system.

**Dear COA Holder:**

You are receiving this letter because you hold a Certificate of Authorization (COA) from the Federal Aviation Administration (FAA) to conduct Unmanned Aircraft Systems (UAS) operations in the National Airspace System (NAS). This letter provides UAS operators with information regarding the statutory requirement to register aircraft and includes details on the registration process and marking. If you need to register aircraft, you will have 45 days from the date of this letter to submit an Aircraft Registration Application to the FAA.

**Aircraft Registration Requirements**

Title 49 §§ 44101-44104 prohibit operation of unregistered aircraft and establish the requirements for aircraft registration. The regulations implementing those requirements are found in 14 CFR part 47.

Public Aircraft are not excepted from the registration requirements. Under § 47.3, aircraft owned by U.S. citizens, lawfully admitted permanent residents of the United States, and U.S. corporations are eligible for registration and operation. This includes U.S. Government, the District of Columbia, Puerto Rico, territories, or possessions of the United States and political subdivisions thereof.

No registration is required for UAS owned by the Armed Forces or under temporary ownership of the Armed Forces. 49 USC § 44101(b)(2); 14 CFR §47.3(b) (3). If temporary ownership of UAS by the Armed Forces ceases, the UAS must be registered prior to operating in the NAS.

**UAS Registration Process and Numbers**

To register UAS, you must submit an Aircraft Registration Application, AC Form 8050-1, and evidence of ownership to the Aircraft Registration Branch (AFS-750). Registration costs $5.00. Complete details for registering UAS and reserving an N-number are provided online at www.faa.gov. For your convenience, instructions and a blank registration form are attached.

**UAS Registration Marking**

UAS must be marked with their U.S. nationality and registration marks (N-Number) in accordance with 14 CFR Part 45. Most full scale UAS are able to comply with the marking requirements, including size and location of the N-Number on the aircraft. Sub-scale or small UAS, or UAS of a non-conventional shape such as a multi-rotor (quad-copter, octo-copter, etc.) or ducted fan may not be able to comply with Part 45 or the guidance in AC 45-2D.
because of size or space limitations on the aircraft. In these cases, markings may be as large as practicable, or a person may apply to the FAA for an alternative marking procedure. See 14 CFR §§ 45.22(d); 45.29(f). Alternate marking approvals may be issued to public aircraft by FAA UAS Integration Office (AFS-80).

**Instructions for Operators 2**

Effective immediately, all UAS operated under a COA, other than those excepted by 49 USC § 44101(b), must be registered and marked. For those to be operated under a new COA, the UAS must be registered and marked prior to COA application. The aircraft registration number (N-number) must be entered into the “Aircraft Registration” field, of the System Description section in COA online. If alternative markings were required, a copy of the Alternative Marking approval letter should be attached to application in the “Aircraft Registration” field. Applications for registration must be submitted for aircraft currently operating under an existing COA within 45 days of the date of this letter. COA holders will confirm their aircraft have been registered by entering the registration number, (N-number) in the Monthly Operational Report, in the block labeled, “Describe any other Operational / Coordination Issued.” Failure to comply with the registration requirements within the prescribed timeframe may result in a suspension of the COA or a delay in the renewal of the COA.

Additional questions can be directed to Ken Fugate, AFS-86, (202) 267-8259, or the Aircraft Registration Branch, AFS-750, (405) 954-3116, toll free 1-866-762-9434.

Sincerely,

James H. Williams
Manager
UAS Integration Office, AFS-80

**References**

14 CFR, Part 45 Aircraft Markings
14 CFR, Part 47 Aircraft Registration
Title 49 §44101-44104
FAA Advisory Circular 45-2D Cancelled October 2015

(Taken from AA Website)
The guidance listed below is provided by the FAA regarding the operation of an UAS. These guidelines are not currently in the regulations, however are considered for future inclusion in the FAA regulations. Those utilizing a UAS for a “public agency “should operate their UAS under these guidelines.

The guidance provides recommended requirements for the UAS observer, communications with Air Traffic Control (ATC), Air Space restrictions, pilot required certification to operate as Pilot in Command (PIC), pilot ratings, pilot currency, pilot medical certification and pilot training.

_interim operational approval guidance 08-01
unmanned aircraft systems
operations in the u. s. national airspace system
March 13, 2008

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.

8.2.14 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:** UAS 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.*

### 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:

- 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.

*(Take from FAA website)*
From FAA website complete listing of all regulations related to Unmanned Aircraft Systems (UAS) Regulations & Policies

Presidential Guidance and Laws

- Presidential Memorandum: Promoting Economic Competitiveness While Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems

- Public Law 112-95, Title III, Subtitle B – Unmanned Aircraft Systems (PDF) (FAA Modernization and Reform Act of 2012)

Title 14 Code of Federal Regulations

- Part 1, Definitions, Civil Aircraft, section 1.1

- Part 21, Certification Procedures for Products and Parts

- Part 21, Subpart H, Airworthiness Certificates, Experimental Certificates, sections 21.191 and 21.193

Notices

- Clarification of the Applicability of Aircraft Registration Requirements for Unmanned Aircraft Systems (UAS) and Request for Registration Regarding Electronic Registration for UAS

Rules

- Interpretation of the Special Rule for Model Aircraft (PDF)

Advisory Circulars

- AC 00-1.1A, Public Aircraft Operations

- AC 91-57A – Model Aircraft Operating Standards

- AC 21-12, Application for U.S. Airworthiness Certificate, FAA Form 8130-6

- AC 45-2D, Identification and Registration Marking
Policies

- **FAA Notice 7210.891, Unmanned Aircraft Operations in the National Airspace System (NAS)**

- **Notice 8900.291, Inspection and Maintenance Program Requirements for Airworthiness Certification of Unmanned Aircraft Systems Operating Under 55 Pounds**

- **Notice 8900.292, Aviation-Related Videos or Other Electronic Media on the Internet**

- **UAS Temporary Flight Restrictions (TFRs) for Sporting Events** (PDF)

- **2007 Federal Register Notice, Unmanned Aircraft Operations in the National Airspace System** (PDF)

- **Notice 8900.313 Education, Compliance, and Enforcement of Unauthorized Unmanned Aircraft Systems Operators**

- **UAS Certification Status, November 15, 2006, includes FAA focal points for UAS certification project coordination** (PDF)

- **UAS Certification Status, Optionally Piloted Aircraft and Accidents Involving UAS, August 18, 2008, Revision to AVS Policy** (PDF)

Orders

- **Order 8000.372A, UAS Designated Airworthiness Representatives (DAR) for UAS Certification at UAS Test Sites**

- **Order 1110.150, Small Unmanned Aircraft System Aviation Rulemaking Committee (ARC)**

- **Order 2150.3B, Change 6 (Compliance and Enforcement Bulletin)**

- **Order 8130.2, Airworthiness Certification of Aircraft and Related Products**

- **Order 8130.20, Registration Requirements for the Airworthiness Certification of U.S. Civil Aircraft**

- **Order 8130.34C, Airworthiness Certification of Unmanned Aircraft Systems**
• **Order 8900, Volume 16, Unmanned Aircraft Systems**

**FAA Legal Interpretations on Unmanned Aircraft Systems**

• New [Media Use of UAS](#) (PDF)

• [Clarification of June 13, 2014 Interpretation of Research Using UAS](#) (PDF)

• [Operation of UAS as Public Aircraft for Educational Purposes](#) (PDF)

• [Interpretation regarding whether certain required documents may be kept at an unmanned aircraft's control station](#) (PDF)

**Guidance**

• [State and Local Regulation of Unmanned Aircraft Systems (UAS)](#) (PDF)

• [Law Enforcement Guidance for Suspected Unauthorized UAS Operations](#) (PDF)

• [Letter to COA Holders – Statutory Requirement to Register UAS (November 5, 2014)](#) (PDF)

• [Public Guidance for Petitions for Exemption Filed under Section 333](#) (PDF)

**Forms**

• [FAA Form 8130-6, Application for U.S. Airworthiness Certificate](#) (PDF)

**Sources of Best Practices for UAS in the Fire Service**

UAS can be used as a tool to assist first responders with a diverse number of tasks. First responders are encouraged to look at these resources when developing a UAS program.

**International Association of Fire Chiefs’ Position: Use of Unmanned Aerial Vehicles in Public Safety Emergency Response**

**IAFC Position on UAV**

**Resources Including Guides and Best Practices for Small UAVs at Disasters – Center for Robot-Assisted Search and Rescue (CRASAR)**
Center for Robot-Assisted Search and Rescue

This resource emphasizes:

- Checklists
- Having a sterile cockpit to minimize distracting the pilot
- Reviewing each mission for continuous improvement
- Rest periods for pilots
- Fixed wing vs. rotary wing

The Memorial Day Floods, May 23, 2015, Wimberley, Texas: Using Unmanned Aerial Systems During a Natural Disaster in Texas by Coitt Kessler and Gene Robinson, July 15, 2015 white paper offers a number of recommendations that public agencies need to consider:

Texas Memorial Day Floods

This is an excellent white paper that describes the use of UAS during the 2015 floods in Central Texas. Recommendations coming out of this deployment include:

- Staffing a flight crew
- Establishing an Emergency Certificate of Authorization (eCOA) when deployed to assist at an incident outside the current COA
- Managing a Temporary Flight Restriction (TFR) area
- Managing communication for all air assets
- Managing communications between air assets, incident command, and search teams
- Improving communication capabilities for UAS flight crews
- Fixed wing vs. rotary wing
- Training
- Logistic considerations

The information in this paper is helpful and also provides a draft SOG for public agencies looking for a SOG.

The Practicality of Utilizing Unmanned Aerial Vehicles for Damage Assessments
Richard L. Davis
Austin Fire Department

Please see link below on this paper emphasizing a best practice utilization of UAS for damage assessments.

UVA usage at Austin Fire Department


- UAV maintenance
- Hardware
- Personnel Issues regarding maintenance

Conclusion

UASs are becoming and will continue to become an invaluable tool for the fire service. They have already demonstrated a lot of value in various pilot programs across the country. As technology improves and regulations manage their use, they will become a normalized, staple tool in fire service operations.

There are challenges that must be overcome, as with any new tool in use today. Some of the challenges include technological limitations, regulatory requirements and cost. However, with a proper plan and guidance, the UAS will be as useful as the TIC is today.
References


