Institute for Water Resources

June 2015

Unmanned Aircraft System Considerations within the U.S. Army Corps of Engineers Civil Works

2015-R-01

US Army Corps of Engineers®

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Institute for Water Resources

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Views, opinions, and/or findings contained in this report should not be construed as an official Department of the Army position, policy or decision unless so designated by other official documentation.

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UAS CONSIDERATIONS WITHIN USACE CIVIL WORKS

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Appendix A: 2013 Memorandum of Agreement Concerning the Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System

Appendix B: 2012 Memorandum – Army Directive 2012-02 (Supplemental Policy for Operations of Unmanned Aircraft Systems in the National Airspace System).

Appendix B includes:

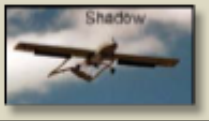
- 2009 DOD Memorandum – ATC Procedures for Department of Defense (DOD) Non-Joint-Use Airfields With Associated Class D Airspace
- Air Traffic Control Procedures for DOD Non-Joint-Use Airfields With Associated Class D Airspace, 23 January 2009
- Sample Memorandum for Class G Airspace
- DA Form 2397-U (Unmanned Aircraft System Accident Report (UASAR))

UNMANNED AIRCRAFT SYSTEMS USE WITHIN THE U.S. ARMY CORPS OF ENGINEERS CIVIL WORKS

Unmanned aircraft systems offer a plethora of potential for the U.S. Army Corps of Engineers Civil Works Program. They have been touted to track hurricanes, create 3D maps, protect wildlife, assist farmers, locate archaeological sites, improve metrology, and conduct search and rescue among other applications (Handwerk 2013, Henriques 2014). More recently, Amazon has claimed that packages will soon be delivered to your front door via a UAS once Federal Aviation Administration (FAA) regulations are lifted (Amazon 2015). Realistically, it may still be many years before packages are dropped at one's front door. Regardless, government agencies and companies alike are starting to explore these capabilities due to some relaxation of FAA restrictions beginning in 2014. This leads us to question how will this impact the Corps and what is the future of small unmanned aircraft systems within the Corps?

These small unmanned aircraft systems offer the potential for cost-effective surveys of remote and/or small areas while offering new and improved tools to collect data and aerial imagery. Additionally, images and video of infrastructure inspections are proving essential for Corps operations. The Corps' use of small systems is expanding. At least three Corps districts purchased an UAS in 2014 and more districts are planning acquisitions in 2015 and beyond. The type of UAS being used and purchased falls into Group 1 under the Department of Defense (DOD) UAS Categories (Picture 1). This means that it weighs less than 20 pounds, is hand-launched, is portable, and operates within visual site close to the ground (DOD 2011, Flynn 2015). The Corps defines an UAS as individual elements that consistent of an unmanned air vehicle (EC 1110-1-106 2015).

This paper will summarize the state of the UAS technology with a focus on DOD UAS Group 1, its current and future use in the Corps Civil Works (non-military), challenges in using an UAS, and the process for acquiring UAS services. Finally, the report concludes with recommendations for the Corps UAS program and management. The mentioned companies and products are not endorsed by the government and serve only as examples. This paper is not a substitute for official guidance, memoranda, policies, rules, law, or procedures; it has a summary and generalization of the key procedures and policies that a UAS proponent should keep in mind. The laws and regulations are changing often and it is important to look for the latest updates when pursuing UAS services.

UAS Groups	Maximum Weight (lbs) (MGTOW)	Normal Operating Altitude (ft)	Speed (kts)	Representative UAS	
Group 1	0 – 20	<1200 AGL	100	Raven (RQ-11), WASP	
Group 2	21 – 55	<3500 AGL	< 250	ScanEagle	
Group 3	< 1320	< FL 180		Shadow (RQ-7B), Tier II / STUAS	
Group 4	>1320		Any Airspeed	Fire Scout (MQ-8B, RQ-8B), Predator (MQ-1A/B), Sky Warrior ERMP (MQ-1C)	
Group 5		> FL 180		Reaper (MQ-9A), Global Hawk (RQ-4), BAMS (RQ-4N)	

Picture 1: Department of Defense UAS Groups (DOD 2011, Flynn 2015). MGTOW is the Maximum Gross Takeoff Weight. AGL is the altitude above ground level. KTS is knots.

WHAT IS AN UAS?

An unmanned aircraft system (UAS) is also known as a drone, unmanned aircraft vehicle (UAV), unpiloted air system, unmanned aerial system, unpiloted aerial vehicle, or remotely piloted aircraft (RPA). The U.S. Army refers to them as an unmanned aircraft system (UAS); therefore, this term will be used throughout this paper. An UAS is an aircraft that can be manipulated to serve a specific purpose without the use of an onboard pilot. There are a few main components to a UAS:

1. **Air Vehicle System**: this includes an airframe, power source, and flight control system.
2. **Control System(s)** to send and receive data, and control information. A remote, ground station, or laptop may also be used for this purpose.
3. **Payload**: these are the tools on board such as a camera or sensor.
4. **Software** is used to process data collected.

Picture 2: Fixed-wing UAS (Jacksonville District, USACE 2014)

Types of UAS range in battery life, fuel capacity, size, functionality, and price. Typically, flight software on a laptop is used as a ground control station for transmitting remote commands to the aircraft. The aircraft receives the signal through a transmitter and flies itself using GPS and inertial navigation systems (Flynn 2015). All are also programmed to come back to the "home" when a signal is lost or something goes wrong (Hutchinson 2015, Hendrickson 2015) to comply with DOD and FAA regulations (Flynn 2015).

There are two main types of an UAS:

- **Fixed-wing** (see Picture 2)
- **Vertical take-off and landing system** (**VTOL**), also known as rotors, or multicopters, which have many mini-blade systems to hover (see Picture 3)

Picture 3: Altavian R8400 VTOL (Jacksonville District, 2015)

Both range in size from something that fits in your hand to large fixed-wing aircrafts. More robust devices can fly in high speeds and be launched or landed on water. Many small models are launched by hand with a throwing motion. Some UAS land on their feet like most VTOLs, but the fixed-wing tend to land intact similar to an airplane landing or are designed to break apart after coming in on their bellies.

Geographical UAS coverage is determined by the intended range for observation, the power capacity, visual range, winds, aircraft speed, weather and the extent of ground stations to control the UAS and obtain data. An advanced fixed-wing UAS can fly thousands of acres per day and can operate up to about a 30 mph wind with rain; however, flying in extreme weather isn't recommended for data quality and safety. These devices typically fly between 400 to 800 feet for aerial photography within the Corps.

Picture 4: UAS Boat Launch (Jacksonville District, 2014)

The VTOLs are typically smaller and can hover closer to the ground than fixed-wing. Corps-owned VTOLs are typically used for inspections and can fly up to 500 acres per day. Unlike fixed-wing, VTOLs can hover in one place and provide higher resolution data that can create better 3D models and are more likely to carry Light Detection and Ranging (LiDAR) payloads. However, in the case of LiDAR, some smaller units may not have the power requirements to make them cost-efficient with current technology (Padgett 2015). VTOLs also don't require a flat landing strip like many fixed-wing unmanned aircraft systems.

Flying an UAS to collect data often requires several aircrew members for a successful, safe, and legal flight. Each flight is different, but most have a pilot and/or operator and observers at a minimum. The total crew size will change depending on the type of UAS, general conditions, operational plan and approvals, and data being collected. Any professional aircrew must be fully qualified, follow operational standards and regulations, and obtain approvals prior to any flights.

WHAT CAN AN UAS DO?

An UAS can do one or many things at once depending on the model. The small UAS are often limited to one function at a time due to their size and ability to carry payloads. However, their payload can often be exchanged with another payload. There are a variety of payloads that can do the following via a data connection:

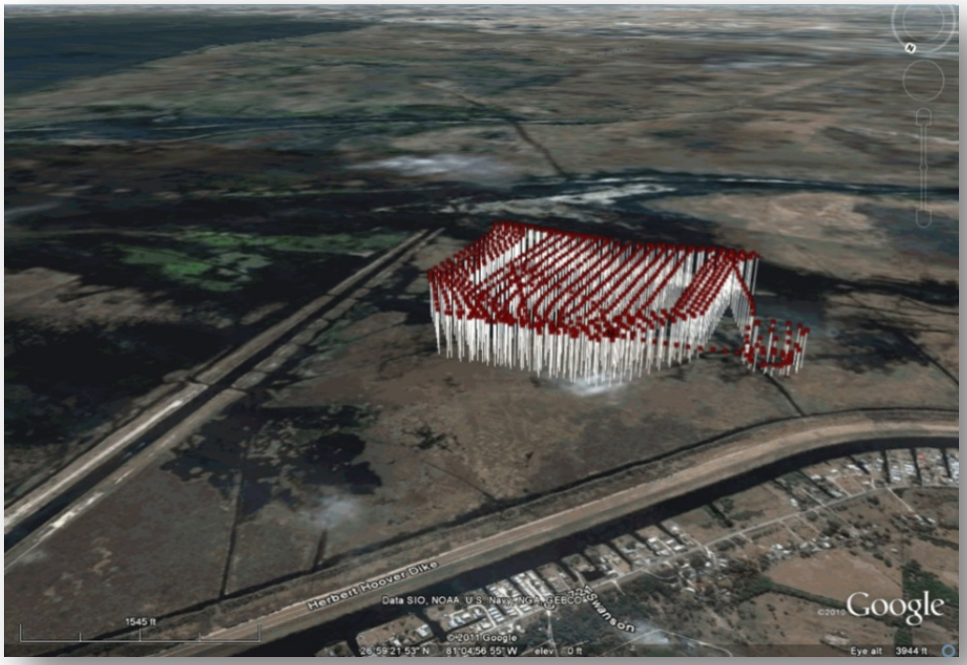
- *Aerial Photography*: Digital SLR (single-lens reflex), high resolution, geo-referenced, metric cameras, day or night use, near-infrared, and low-light
- *Video*: Electro-optical video (used to focus on a location or identify moving objects), infrared (IR), geo-referenced, high definition, continuous pan, and image stabilization
- *GPS* and geospatial data collection
- *Inertial Measurement Unit (IMU)* for an aircraft's yaw, pitch, and roll
- *LiDAR*
- *Communications* (provide communication capabilities to a location)
- *Carry and drop* items (although the FAA restricts this within the U.S.)
- Record *wind* speeds
- *Gravity* measurements
- *Collect air samples*, "sniffers" for radiological, biological, or nuclear
- *And much more*!

In discussion with several Corps users, most say that they either have or will use them primarily for aerial and infrared photography. An UAS can fly over "hard to reach" areas where flyovers or other types of surveys are too difficult or expensive. An UAS can cost-effectively reach remote or small

> "*Using an accurate, high-resolution metric camera system with a UAS, we can continue to explore the many applications and benefits of unmanned aerial technology*,"
>
> -Clint Padgett, Chief, Spatial Data Branch, USACE Mobile District. (Woolpert 2014)

locations that wouldn't be otherwise easily reached. They can go almost anywhere with the right authorizations and trained aircrew, but they are most suitable for the following conditions:

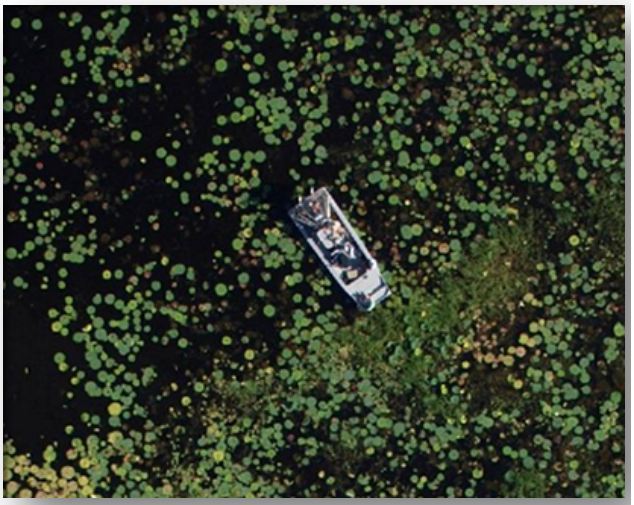
- Water-covered areas, wetlands
- Remote or small locations
- Areas of dense vegetation
- Dangerous locations, such as those caused by storms or infrastructure failures
- Infrastructure inspections
- Wildlife observations or locations with wildlife
- Situations where the need for advanced capabilities that are only provided by an UAS
- Situations where routine aerial photography is needed for a small area



Picture 5: The points represent individual images used to create a general image like a mosaic. (Jacksonville District 2014)

The quality and resolution of aerial imagery can be better than traditional imagery (such as airplane flyovers). Pictures 6 through 9 show the differences in quality (Photos are courtesy of Jacksonville District, USACE 2014).

Picture 6: Traditional Aerial Photography



Picture 7: Unmanned Aircraft Photography

Picture 8: Google Earth Image

Picture 9: UAS Image

UAS data must be transformed into meaningful data after collection. Special software and often advanced computers are used to do advanced image processing which can create 3D images, detect vegetation type, and identify changes in landscapes and more. The 3D images are created from "Red, Green, Blue" known as RGB, or Color-infrared (CIR) using LASer (LAS) and XYZ file formats during post processing. Picture 5 shows how multiple images are combined together to form 3D images. Acquiring high-tech computers with advanced software

has been challenging within the current Corps Information Technology (ACE-IT) approval process. Sometimes contractors are used to perform data rendering.

There are several software packages that are currently used. Some examples include: Agisoft PhotoScan ($179 Standard Edition or $3,499 Professional Edition, Agisoft.com 2015) or SimActive Correlator 3D. Also, specific UAS often have special software for flying or processing data, like the "senseFly Postflight Terra 3D" software that is used for the "eBee senseFly" UAS.

UAS CHALLENGES

An UAS is very powerful; however, there are some known drawbacks. Here are some that were more frequently cited by UAS users:

- Crashes and accidents can occur. This means that expensive back-up parts are necessary at best. At worst, an UAS could crash into people, property, or another plane and could cause a fatality, injuries, damage property or a plane, and/or break the system.
- Every flight requires flight planning and a qualified operator along with any permissions, waiver and/or authorizations depending on the airspace. A "licensed pilot" is often not required for most Corps applications; however, projects that require a Certificate of Authorization (COA) from the FAA because of the airspace location will need a licensed pilot. Parts will wear out through time and may be expensive to replace. Some components are made of lightweight material that is not very durable and difficult to repair.
- An UAS must be in a visual line of sight when flying, which can be challenging when surveys are over large distances. "See and avoid" is acceptable over water, but the operator cannot be the primary observer (FAA FAR Part 91.113)
- Strong winds or various weather conditions can reduce data quality and even prevent flights from occurring as planned.
- User skills may improve or degrade the data quality.
- The paperwork to operate and maintain an UAS is tedious and demanding.
- Battery and fuel size will drive the distance and duration of flights. An UAS can last from a few minutes to a few days depending on a variety of factors.
- There is still a lot of grey area in terms of laws and regulations. The FAA is in the process of writing new rules. Policies are always subject to change.
- Privacy concerns and permissions could restrict the usability or range of an UAS. Similar to current procedures, permission to enter any private property will likely be required along with any necessary permits such as a National Park Permit.

- Uses of UAS could be restricted for models that require flat landing spots. All UAS can pretty much take off from anywhere, but they all have different landing requirements. A Corps district may prefer an UAS that can land in water or hover depending on the use.
- The technology is constantly changing and systems may need to be upgraded often, which can be expensive. Training pilots is expensive to keep up with new systems and changing training requirements.

CORPS UAS USAGE

The Corps has several districts that have experience with unmanned aircraft systems. Those who have used unmanned aircraft systems for their mission have come together organically and via the Geospatial Tech Exchange to form a Corps Small UAS Community of Practice (Picture 10). The community is expanding, but currently includes districts from St. Louis (the Corps' Photogrammetric Mapping Center of Expertise), Mobile, New Orleans, and Huntington along with the Engineer Research and Development Center (ERDC). The community has a shared internal website for sharing lessons learned, templates and more. They also have held informal workshops to share lessons learned.

A new Engineer Circular (**EC 1110-1-106**), published in May 2015, formally defines a UAS Working Committee and provides guidance for the acquisition and operation of UAS by USACE districts. This committee is a subset of the Community of Practice, but also includes committee members outside of the Corps. The Corps UAS Working Committee is chaired by Corps Headquarters Engineering and Construction. James Dalton is currently the Chief of Engineering and Construction. Nancy Blyler is the designated UAS Working Committee Chair and is also the Program Manager for Enterprise GIS within the Corps. She also leads monthly Geospatial Tech Exchanges for the Corps geospatial community that occasionally features UAS technology. The UAS Working Committee includes the following participants: Engineering and Construction Division (chair), Corps Logistics (CELD), Army Program Execution Office (PEO) Aviation for Small UAS, Army Aviation Engineering Directorate (AED) for Special Projects, Corps Emergency Management (CECO-HS), Corps Jacksonville District UAS Section (CESAJ-OD-HU), and the USACE Photogrammetric Center of Expertise (CEMVS-EC-SD).

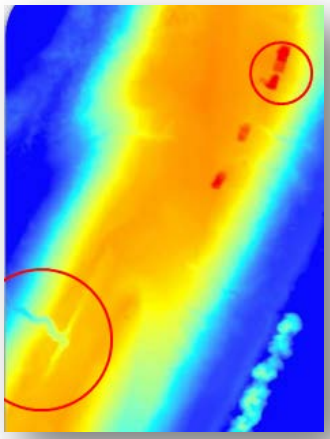
The first district to use an UAS within the Corps Civil Works was the Jacksonville District which began around 2007. Jacksonville District is also the South Atlantic Division UAS Operations Center of Expertise. They own a fixed-wing system, quad-copter VTOL for video surveillance, octo-copter VTOL for mapping, and also low-end, remote-controlled airplanes that can be found in retail stores. The Jacksonville District has used an UAS to detect infrastructure

problems along levees and dikes on Lake Okeechobee and Herbert Hover Dike, capture aerial photography, identify vegetation and erosion, and more. Like Jacksonville, other districts are also looking to investigate existing infrastructure conditions for operations and maintenance activities.

Picture 10: Corps UAS Community of Practice 2014

St. Louis recently purchased a UAS in 2014. The district is interested in using aerial imaging for emergency management and using thermal imaging to identify sand boils that could lead to a levee failure among other uses (Short 2014). Sand boils are pockets of cool water that cause seepage and failures of systems. A few examples of infrastructure inspection uses are depicted in Picture 11. The highlighted features show how infrastructure breaches or seepage may be more easily identified.

The Environmental Laboratory at the Engineer Research and Development Center (ERDC) has been exploring potential applications for the Corps using unmanned aircraft systems. They have tested them for environmental monitoring, search and rescue, surveillance, inspections and mapping. One innovative use that they are testing is the use of spot applications for herbicides and sampling in environmentally sensitive areas (ERDC 2015). Likewise, ERDC is also testing the stressors, limitations and identifying the most cost-effective UAS applications. This research will benefit both the military and civil works within the Corps.



Picture 11: Levee and Disposal Site inspections (Jacksonville District, 2014)

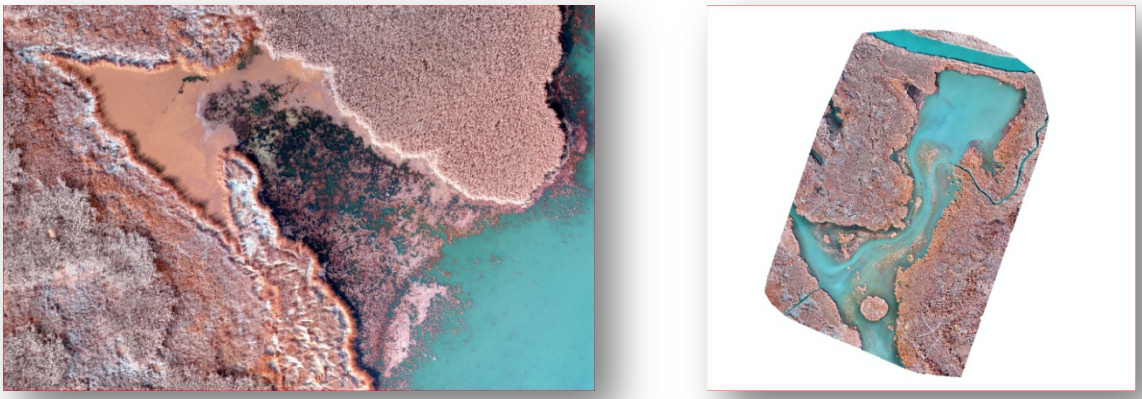
Huntington, New Orleans, Huntsville, St. Louis, the Far East District, and Engineer Research and Development Center (ERDC) within the Corps each own an UAS that does aerial photography (RGB) and infrared sensing (Picture 12). The New Orleans District purchased the "eBee senseFly," which is a lightweight, 1.5 pound UAS that could potentially fly over levees within a populated area. The UAS is mostly foam which reduces risks in the event of a crash. ERDC also uses the eBee senseFly. They pair this UAS data with data from a mobile van that holds a 30-foot LiDAR sensor to merge together the two data and fill any gaps (Massaro 2015). The DJI's Phantom, Altavian Nova, and Trimble products have also been purchased by the Corps (Blyler 2015).

The Mobile District and ERDC are the only offices that have used UAS leasing or contracting in the Corps for Civil Works. Recently, they have had a contract with Woolpert for these services. They are investigating potential uses such as locating turtle tracks leading to nesting locations along a beach or submerged aquatic vegetation (Padgett 2015).

Most recently, the New Orleans District flew over flooding in Texas as part of the large scale emergency mission (Thomas 2015).

Watch this drone flyover of the Upper Turkey Creek Basin within the Kansas City District at:
https://www.youtube.com/watch?v=zashtMqP9lE&feature=youtu.be

(USACE 2015)



Picture 12: Infrared Imagery (New Orleans District, 2014)

GOVERNMENT USE OF UAS

Several government entities are using unmanned aircraft systems for non-military operations. These systems are being used for biological research to reducing the impact of natural disasters and more. The growth and breath of applications is expanding. The Corps could potentially use similar applications for their own purposes.

The United States Geological Service (USGS) seems to have the largest breadth of applications among federal agencies that is most similar to the Corps. The USGS has used unmanned aircraft systems for "*research, monitoring environmental conditions, analyzing the impacts of climate change, responding to natural hazards, wildlife inventories, and search and rescue*," (Malykhina 2014). Switching to an UAS for collecting air quality data from traditional methods has cut costs from $30,000 per hour to $3,000 per mission. Added, the USGS has teamed up with the Bureau of Land Management (BLM) in using these systems to study hydrology, erosion, demolition, revegetation, and to find wildlife through thermal sensors (Robots.net 2012).

The National Oceanic and Atmospheric Administration (NOAA) has an Unmanned Aerial Systems Program. Their mission focuses on high-impact weather, polar and marine monitoring (NOAA 2014). NOAA routinely flies manned aircrafts into hurricanes and other bad storms to collect data; now, they can use an UAS which reduces risks to onboard pilots. However, this is just one of many purposes for NOAA's UAS use. The agency recently used a hexacopter to capture high resolution images of killer whales from about 100 feet above (Picture 13). The researchers used the images to determine the characteristics of the whale's health by their size and diet while not disturbing the species (Press 2014). NOAA also conducted a proof of concept

using an AeroVironment Puma AE (All Environment) to do fish costs of Atlantic Menhaden. The total cost was about $250,000 for equipment with real-time video, still photo capabilities, three planes, additional cameras and controls as compared to a minimum start-up cost of $500,000 for a traditional count was twice as much (Landers 2014).

Picture 13: Photos Courtesy of NOAA, Vancouver Aquarium (2014)

Furthermore, the National Aeronautics and Space Administration (NASA) used small unmanned aircraft systems for firefight surveillance. They are investigating the potential to send helicopter drones to Mars which shows the limitless potential for these systems (Griffin 2015).

Relevant examples to the Corps are using an UAS to survey cultural resources and for surveillance during flood events. An archaeologist at University of North Florida recently surveyed parts of the New Mexico desert to locate ancient religious structures using an UAS. Heat patterns helped researchers differentiate between the sands and remnants (St. Fleur 2015). Additionally, the Boulder County Emergency Operations Center in Colorado took advantage of assistance from the Falcon UAV Company when flooding occurred in 2013 (Picture 14). The UAS was the only aircraft capable of flying in the weather and was able to capture

aerial imagery for a damage assessment (Miser 2013).

Picture 14: Boulder County flood from aerial photomaps from a Falcon UAV (Schroyer 2013)

UAS REGULATIONS

Unmanned aircraft systems offer many services and potential; however, non-recreational uses are highly regulated. Unmanned aircraft systems are regulated by the Federal Aviation Administration (FAA) and are in the midst of ongoing changes to meet demands and balance safety. The operational regulations for systems less than 55 pounds are different between hobbyists, commercial users, and the Department of Defense (DOD). Unlike other agencies, the Corps is also bound by its own policies, DOD's and the Army's policies, and the procedures and regulations that were agreed upon by the Department of Defense and the FAA. The Corps must follow all policies, rules and regulations for any UAS no matter the size, cost or application[1]. The Corps cannot purchase any type of UAS without heeding official guidance. While hobbyists can fly their aircrafts within certain guidelines, this doesn't allow the Army or Corps to do the same because the Corps is subject to policy and liability issues, no matter the circumstances.

Additionally, like all UAS proponents, general laws and regulations exist that apply to all UAS users and there are more specific rules depending on the type of UAS, the user, data collected and flight purpose. Some of the more general laws and rules that apply to everyone include: not flying over protected or private property without permission, avoiding the disruption of threatened or endangered species, avoiding air traffic and keeping a safe distance away from people. The Privacy Act of 1974 is also important to consider as a safeguard to the invasion of personal privacy by Federal Agencies.

To learn more about model aircraft flying as a hobby, please consult the FAA, "What Can I Do with My Model Aircraft" at http://www.faa.gov/uas/publications/model_aircraft_operators/.

The next few sections discuss some of the more significant rules, regulations and policies by the FAA, DOD, and Army in regards to using an UAS. It is important to remember that regulations are likely to change in the future as Congress has required the FAA to write UAS regulations by September 30, 2015 (Yuhas 2014). In 2015, the FAA has proposed amendments to current regulations on small UAS use that drive commercial UAS usage. A summary can be viewed at: http://www.faa.gov/regulations_policies/rulemaking/media/021515_sUAS_Summary.pdf and details can be found at http://www.regulations.gov/#!documentDetail;D=FAA-2015-0150-0017.

[1] *Corps employees may not bring a remote-controlled aircraft or any type of aircraft from home to work for use.*

The commercial and military UAS applications apply two different processes for flight approvals. However, they share these same general steps:

1. Choose an UAS that best suits the mission needs, will likely meet all safety standards, and be found acceptable to fly.
2. Obtain some type of formal recognition or approval from an appropriate authority for the specific UAS that verifies that the UAS, the flight team, operating plan, and conditions are essentially safe. The same UAS may require multiple approvals for different operations and locations.
3. Apply for permission to fly a specific operation for that approved UAS for a specific time, location and mission. Proof of the UAS's safety and its operational plan will be provided as proof along with other information. Additional permissions to fly over certain areas may be required. Typically, some type of Certificate of Authorization (COA) from the FAA will be issued for a specific timeframe.
4. Inform all other airman and usually air traffic controllers of flight plans to fly a UAS in a specific location at a given time.
5. Ensure all approvals and permissions for the mission are in place and conduct operations within the range of approved and prescribed standards.

The next few sections will expand these steps and provide details on how these steps relate to regulations for commercial and military UAS applications.

FAA REGULATIONS

The FAA has the right to regulate the National Airspace System (NAS) which includes regulating unmanned aircraft systems (U.S. Code Title 49). A difference in regulation exists between the commercial and DOD uses. For commercial UAS services[2], the FAA first determines whether an **airworthiness certificate** is required to ensure the safe use of a UAS in the National Airspace System (NAS) of a specific type of UAS. An airworthiness certificate is used solely by the FAA for non-military purposes. The airworthiness certificate is issued by the Aircraft Certification Service (AIR) after a UAS proponent ensures that an UAS can "*be safely maintained and safely*

[2] *The Corps requires those pursuing commercial UAS services to consult the UAS Working Committee prior to acquiring services. These services may still be subject to Corps, Army and DoD procedures and rules.*

operated by fleet pilots within the described and documented operational envelope" for a UAS (FAA 8900.1 CHG 351 6/23/2014) [3]. Recent practices by the FAA suggest that they are following their proposed rules and allowing UAS usage via granting **Section 333 exemptions, Certificates of Waiver or Authorization** that will allow UAS operation for certain commercial uses.

Once some type of approval is granted to a specific UAS, the UAS operator must get a **Certification of Authorization (COA)** or **COA via notification** from the FAA. A COA via notification is a mechanism to access the NAS pursuant to a Memorandum of Agreement (MOA) between the Department of Defense and only applicable for operations by a DOD proponent. A COA via notification does not require as much paperwork and a pilot license isn't necessary. All operations are required to have a Certificate of Authorization (COA) for a specific type and concept of UAS, operator, and location (FAA 2014, Army 2012, and Short 2014).

The DOD (and therefore the Corps) doesn't use the FAA processes for an airworthiness release, Section 333 exemption, Certificate of Waiver or Authorization. UAS are considered "public use" and therefore the government accepts liability. The U.S. Code Title 10 Armed Forces, Subtitle B-Army provides the DOD authority for crew qualifications and aircraft worthiness. The Corps must obtain an **Airworthiness Release (AWR)** to satisfy the requirements of Army Regulation 70-62.

> *"Army aircraft as used herein includes all aviation material and aircraft that are Army assigned, bailed, borrowed, leased, owned or otherwise authorized for operation by Army personnel, or after modification under Army contract."*
>
> *-AR 70-62*

After receiving and AWR, the proponents then applies for a COA or COA via notifications through the DOD proponent's representative to the FAA. For the Army, the "Department of Army Regional Representative" (DARR) from the United States Army Aeronautical Services Agency (USAASA), interfaces with the FAA for access to the NAS. DOD flights over "Active Restricted Airspace owned by the Military" do not require a COA, but they do require the consent of the airspace manager for that region.

The following sections will explain this in greater detail.

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[3] *Accessed March 9, 2015. http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.16,Ch1,Sec2*

CERTIFICATE OF AUTHORIZATION (COA)

A COA allows for the operations of a pre-approved UAS in a specified location for both commercial and any Corps operations. The COA will determine when and if flights can be done and under what circumstances for a given UAS, location and operators. According to the FAA on their Public Operations website, *"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….. 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."*

The FAA often places the following restrictions on an UAS via COAs:

- Have a Pilot in Command (PIC) that has a pilot's license
- Flight only below 400 or 500 ft (AGL)
- Daytime operations in **Visual Flight Rules** (VFR) – clear of clouds and fog
- Nighttime operations are being considered on a case by case basis
- Range limited to **Visual Line-Of-Sight** (VLOS) of the UAS (typically, less than 3/4 of a mile from the operator or visual observer)
- Restrictions over the types of airspace (typically, operations within 5 nautical miles (NM) of an airport may require additional operator qualifications and operations within Class B airspace are not authorized)
- A **Notice to Airman** (**NOTAM**) must be filed with an aviation authority to alert other pilots along a flight route or at a location that could affect flight safety. This includes contacting local air traffic control authorities prior to UAS operations.
- Avoiding flights over existing infrastructure
- Securing any necessary state or local government approvals

Operators of an UAS must also meet the following requirements:

- Medical tests to ensure visual acuity (FAA Second-Class Medical Exam)
- Knowledge of airspace and FAA regulations applicable to the operation of UAS (UAS pilot must pass the FAA private pilot ground written examination or an FAA approved alternative)
- Training on the system to be flown and proficiency requirements.

These requirements are often the same for the military, but they are laid out in various official documents discussed in the next sections.

DOD, FAA AND ARMY POLICIES

The Corps is subject to Corps, Army, DOD and FAA rules, policies, and procedures to effectively use UAS services. This is in addition to standing laws and related regulations indirectly related to UAS uses. These regulations, policies, and procedures seem to be most directly applicable to DOD-owned or leased systems; however, contracting for UAS services may also be subject to these policies and procedures. This section is a brief overview of the agreements, policies and procedures in place that apply to the Corps.

There have been several **Memoranda of Agreement signed between the Department of Defense (DOD) and the Federal Aviation Administration** (FAA) in regards to unmanned aircraft systems. The most recent and superseding memo dated September 16, 2013. Appendix A contains a copy of this memo as a reference. The previous agreement was from 2007. The latest memo sets forth provisions for "*increased access for DOD unmanned aircraft system (UAS) into the National Airspace System (NAS) outside of Restricted, Warning, and Prohibited Areas through accommodation, implementation of advanced mitigations, and integration, where applicable.*" The memo assigns specific tasks and responsibilities to the DOD and FAA.

Here is a summary of some of the main points and short explanation of how this impacts the Army.

- *The DOD will certify a DOD UAS as airworthy to operate in specific segments of the airspace.*
    - Each DOD branch has a designate authority for this purpose. The Army uses the **Army Aviation Engineering Directorate (AED)** office for airworthiness evaluations. The AED issues an **Airworthiness Release (AWR)** on behalf of the Army and this recognized by the FAA**.**

- *UAS pilots and crew shall be qualified and medically certified to operate in the class of airspace in which operations will occur.*
    - The Army refers to **ALARACT (All Army Activities) 293/2010** – Notification of Changes to the Aeromedical Physical Standards of Unmanned Aviation Systems to meet this requirement in a January 13, 2014 Army Memorandum (See Appendix B).
    - The **U.S. Army Aviation Center of Excellence** at Fort Rucker, Alabama provides "Unmanned Aircraft Systems Standardization" via its **Directorate of Evaluation**

and Standardization which includes operator training and developing guidance for aircrew training through "Air Crew Training Manuals." Added, the center will inspect UAS standardization programs and flying hours.
    - Qualified operators "must comply with qualification, training, evaluation, and currency requirements of [AR 95-23]." More details and specific qualifications for UAS roles are in Army Regulation 95-23 (2010).

- *The FAA will streamline new or renewing COA applications and for COA via Notification. New COAs will be applied for at the FAA Obstruction Evaluation, Airport Analysis (OE/AAA) website at http://ioeaaa.faa.gov.*
    - Army owned or leased systems must receive a COA from the USAASA (Flynn 2015).
    - The Army also issued an Army Directive on UAS use via a memorandum and accompanying guidance on January 13, 2012 from John M. McHugh. (See Appendix B)

- *For Class D airspace, which is generally characterized as airspace above an airport upwards to 2,500 feet (AIM FAA 2014), there some specific rules:*
    - Operations will not be conducted over populated areas, unless the level of airworthiness allows.
    - Night operations are permitted if there is sufficient lighting and flight crews have been training appropriately
    - Proponent will publish **Notices to Airmen** (NOTAM) to alert non-participating aircraft between 48-72 hours in advance.
    - **Air Traffic Control** (**ATC**) Procedure for DOD Non-Joint-Use Airfields will be followed. There is a DOD Memo with the subject "ATC Procedures for Department of Defense (DOD) Non-Joint Airfields with Associated Class D Airspace" dated January 23, 2009 with more details. This memo lays out specific operation procedures such as communication checks, use of Visual Flight Rules and more. (See Appendix B)

- *For an UAS less than 20 pounds and within Class G airspace, which is uncontrolled airspace commonly found in remote locations (AIM FAA 2014). Approval for UAS flights in these areas are often easier to obtain. Specific rules in these areas include:*
    - Operations will be in the visual line of site
    - Flights over military bases, reservations, or private land must have the proper permissions

- Flights cannot occur over populated areas unless the level of airworthiness allows.
- The UAS must be at least 5 nautical miles (NM) from any airport of heliport.
- There are various flying height limitations depending on the distance from an airport. All operations between 0 and 5 NM are prohibited.
- Night operations are permitted with lighting and training requirements met

DOD GUIDANCE FOR DOMESTIC USE OF UNMANNED AIRCRAFT SYSTEMS

DOD Policy Memorandum 15-002 from the Deputy Secretary of Defense was signed on February 17, 2015 and it was titled "Guidance for the Domestic Use of Unmanned Aircraft Systems." This memo replaced an earlier memo from September 28, 2006, titled "Interim Guidance for Domestic Use of Unmanned Aircraft Systems." This current memo requires the approval by the Secretary of Defense for all domestic UAS operations unless "*specifically provided for in this policy, law, or other guidance" (DOD 2015).* This memo applies to DOD domestic UAS operations that are done for the DOD, such as DOD-contracted services, or by the DOD, such as assisting another Federal agency.

Corps UAS proponents should consult the UAS Working Committee for the latest guidance from DOD, Army and the Corps on how to comply with this memo. An updated EC 1110-1-106 is forthcoming to incorporate this memorandum and further clarify its applicability to the Corps (Dalton 2015).

The memo states under the DOD Operations heading that "*in appropriate circumstances, UAS may be used in lieu of manned aircraft for domestic mission*." Appropriate circumstances are defined as "*sustained endurance efforts are required; unmanned aircraft provide superior capabilities; or physical infrastructure limitations prohibit the use of manned rotary- or fixed-wing aircraft."* It is unclear if this section applies all DOD operations, or if it describes the circumstances that are most likely to be approved by the Secretary of Defense for specific operations.

Other key points of this memo are:

- UAS operations must be used within applicable laws, regulations, memoranda of agreement about the National Airspace System, and in consultation with the FAA.
- UAS operations **cannot conduct surveillance on U.S. persons**
- **Search and Rescue Exception**: Search and rescue missions are "*the only exception to the requirement for approval by the Secretary of Defense*" for UAS domestic operations. Commanders are **responsible for legal, intelligence, Privacy Act, and airspace issues**.

- Some **disaster response** is permitted after seeking the proper approvals and requests across the DOD and FAA.
- **DOD-Required Training and Exercises**: Prior notification and approvals are required at least 30 days in advance. Information during training and other exercises is not allowed to be collected (except to incidental) about specific U.S. persons or non-DOD property without consent. *"All UAS acquisition, collection, retention, and dissemination of information"* will follow DOD regulations and policy and will require a **proper use memorandum (PUM)**.
- General responsibilities of the various Assistant Secretaries of Defense are described as it pertains to this UAS policy.

ARMY POLICIES AND PROCEDURES

The Army has further rules and policies in regards to unmanned aircraft systems.

Army Regulation AR 95-23 (http://www.apd.army.mil/pdffiles/r95_23.pdf), "Unmanned Aircraft System Flight Regulations," is an essential document to understanding UAS usage within the Army. This regulation covers "*unmanned aircraft crewmember training, and currency requirements, and flight rules*" and references compliance with **FAA FAR Part 91** for operations in national and international airspace. The regulation cover topics on UAS management, records management, reporting flight violations, mission approvals, operations and safety including composite risk management, aircrew training, description of aircrew roles, UAS standardization program, flight procedures and rules, weight and balance, nonstandard UAS acquisition, waivers and more. This regulation must be followed unless waivers or exceptions to this regulation are approved by the Deputy Chief of Staff, G-3/5/7. As of March 2015, the Corps was pursuing a Memorandum of Agreement (MOA) with the appropriate Army departments which may clarify the Corps compliance to these regulations.

For training, the Army has several documents that must be reviewed in addition to FAA materials. This includes **Training Circulars TC 1-600** and **TC-1611**, Commander's guides and air

Army Regulations Related to UAS:

- *Training Circulars: TC 3-04-.61 (TC 1-600), TC 3-04.62 (TC 1--611)*
- *Army Regulations: AR 70-62, 95-23, 95-20, 95-2, 700-138*
- *ALARACT 293/2010*

crew training manual.

Policy and procedures are described in **Army Regulation 700-138,** Army Logistics Readiness and Sustainability, for "collecting and reporting physical conditions of Army materiel" (EC 1110-1-106 2015). This regulation ensures readiness and responsibility for equipment through reporting and feedback systems.

Added, the Army issued an Army Directive on UAS use via a memorandum and accompanying policy document dated January 13, 2012 from John M. McHugh that provides more detail (See Appendix B). This guidance covers information like arrival/departure criteria, air traffic control procedures, observers and their qualifications, weather and facility requirements, accident reporting and more.

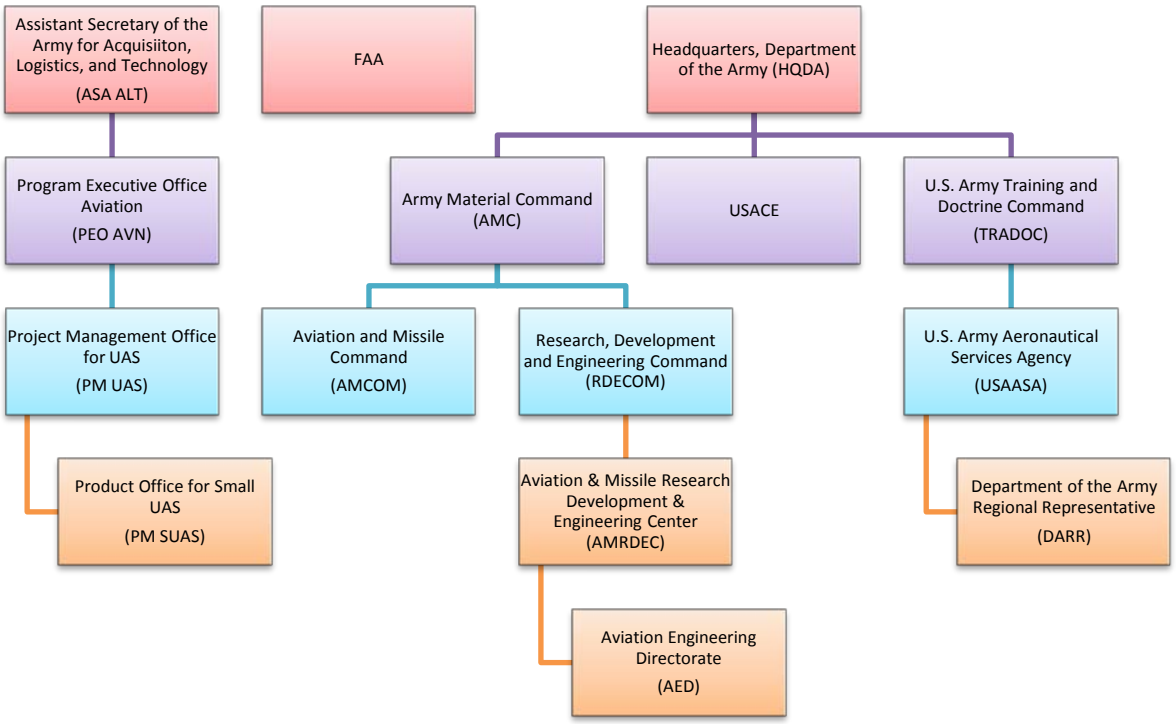
UAS services can be acquired in several ways. The Corps UAS Working Committee should be consulted first. The **Army Program Execution Office (PEO) Aviation** will likely also need to be consulted at some point. PEO Aviation is responsible for managing all current and future Army fixed wing, rotary wing, and non-tethered lighter than air platforms which would include any UAS. This includes those owned or under contract to the Army, even if operated by another government entity (Shyu 2011). Acquisition is covered in the next section of this report in detail.

After appropriately acquiring an UAS or UAS service, the Corps must ensure that their aircraft has an **Airworthiness Release (AWR)** for a specific UAS, platform configuration, operators, location, time, conditions, and purpose. After receiving an AWR, the UAS proponents will likely need to apply for a **Certificate of Authorization** (COA) or COA via notification. Finally, the UAS can be flown as approved.

KEY ARMY UAS OFFICES

Some key offices that UAS proponents will interact with are:

- **Army Aviation Engineering Directorate (AED)**: The AED issues an AWR as the designated authority from the **Army Aviation and Missile Command** (AMCOM). This responsibility is recognized by the DOD and FAA. This office interfaces with the FAA, provides standards for an AWR, and assists with updating Army regulations (ARMDEC 2015)**.**
- **Army Aeronautical Services Administration (ASA):** This office submits a COA or COA via notification to the FAA via the **Department of the Army Representative (DAR).** The DAR ensures Army requirements for airspaces are satisfied, advises Army units, and represents the Army at the FAA among other functions (USAASA 2015).
- **Army Program Execution Office (PEO) Aviation:** This office should be consulted for acquisition assistance to purchase, lease or use UAS services. PEO Aviation is responsible for life-cycle management of Army aviation platforms and equipment (PEO Aviation 2015).
- **Army Center of Aviation Excellence:** This center has many functions, but key functions relevant to an UAS are: inspecting standardization programs, flying hours, and maintenance records. The center publishes Air Crew Training Manuals for off-the-shelf and houses the **Directorate of Evaluation and Standardization** which ensures that all aircrews are training to Army standards.



Picture 15: UAS Organizational Chart (Compiled from multiple sources)[4]

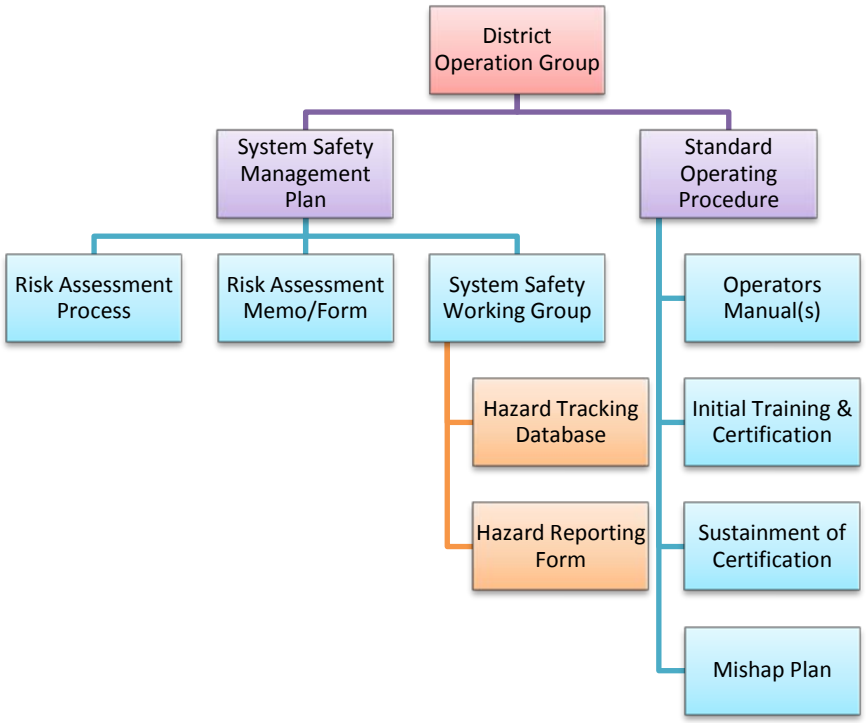
ARMY AIR WORTHINESS RELEASE (AWR)

All purchased or leased unmanned aircraft systems within the Army are required to first have an **Airworthiness Release** (AWR), which is issued by the **Army Aviation Engineering Directorate** (AED) for the Corps. This would even include an RC vehicle that can be found at an average retail store. The AWR is a statement of airworthiness as required by **Army Regulation AR 70-62** and by the FAA to fly outside of Active Restricted Airspace. It is assumed that any borrowed military aircrafts or personnel would already have completed this process for an aircraft, but this should be verified.

[4] *Compiled from the Office of the Administrative Assistant to the Secretary of the Army (http://www.oaa.army.mil/hqda.aspx), EC 1110-1-106, AMRDEC (http://www.amrdec.army.mil/amrdec/Directorates/AED.aspx), USAASA (http://www.usaasa.tradoc.army.mil/OrgChart.asp), AMC (http://www.amc.army.mil/amc/msc.html), ASAALT (http://usarmy.vo.llnwd.net/e2/c/downloads/394456.pdf), Command Profile: UAS Project Office (http://www.army.mil/article/83251/Command_Profile__Army_Unmanned_Aircraft_Systems_Project_Office/)*

An AWR authorizes "operation for a combination of a specific system type and configuration, geographically defined location(s), and the group operating the system using specific operational procedures" (EC 1110-1-106 2015). Unlike airplanes, an UAS will require multiple AWRs for each new location and operation. An AWR affirms that a UAS is suitable for operations and has best managed risk for a given operation, aircraft, and location. There are various levels of AWR that will require more or less documentation depending on the mission.

Army Regulation AR 95-23 is be helpful in understanding AWR and operational requirements. A **System Safety Management Plan** (SSMP) according to military specifications must be submitted as part of this application package. This plan also contains a description of the **System Safety Working Group** (SSWG) and a **Standard Operating Procedure** (SOP) to operate a UAS. **MIL-STD-882E** provides information for DOD Standard Practice System Safety. This plan will lay out how a risk is managed and accepted for the system, location and operation. A Composite Risk Management (CRM) form documents the risk assessment for each location (EC 1110-1-106 2015). The SOP should include checklists, Mishap Plan, Operators Manual and other documents. The overall submittal package will require all materials to be signed by a district's leadership and include standard operating procedures, training, and other information.



Picture 16: Required Structure for the SSMP, SSWG and SOP for Each District to Operate an UAS (EC 1110-1-106)

Obtaining an AWR could take as little as one month, but as long as a year. The length of time depends on the aircraft chosen, proposed aircraft operations, the experience of those submitting the paperwork, and the workload at AED. It is recommended that those pursuing UAS acquisition first investigate systems that already have an AWR first because the cost for the AWR process is reduced. EC 1110-1-106 on UAS Operations and Acquisition requires this investigation first prior to approval for any new UAS acquisitions through the Corps UAS Working Committee. The Corps UAS Working Committee and AED are good contacts to investigate existing systems with approvals. Each AWR application for a new UAS requires a standard package of documents although sometimes additional documentation may be required. The Army AED and other Corps UAS owners can help guide proponents on the documentation package and this helps expedite the process. Ideally, an Army or Corps aviation safety officer would assist the UAS proponents with this package and a senior UAS operation instructor would ensure that the crew training meets standards.

Those seeking acquisition should also be prepared to send money to the Army AED and other offices to assist them in their application and for evaluations. Some Corps districts have taken up 9 months to properly prepare, submit, and gain an AWR due to a variety of factors (Davis and Grunder 2014). The length of time depends on the type of UAS, purpose, operator and flight location. An AED representative will actually visit each District for a flight operational evaluation of the operators prior to granting an AWR (Flynn 2015).

Once an AWR is received by a Corps office, these new AWRs must be reported to the Corps UAS Working Committee to describe its location, attributes, local point of contact, and details about the AWR.

ARMY PROCESS FOR A CERTIFICATE OF AUTHORIZATION (COA)

Prior to any UAS operations, any Army owned or leased system requires a Certificate of Authorization (COA) or COA via Notification must be received from the Army Aeronautical Services Administration (Flynn 2015). The only exception to this requirement is for flights over "Active Restricted Airspace owned by the Military" which don't require a COA, but they do require the consent of the airspace manager for that region.

Corps proponents should contact the Army Department of the Army Regional Representative (DAR) within the U.S. Army Aeronautical Services (USAASA) office, so that this office can submit a COA application to the FAA on behalf of the Corps as needed (Wilhelm 2015). COA requests must be made by a GS-15 employee, a district Colonel, or higher.

A standard COA applicant must create a flight plan and conduct a safety analysis, provide a boundary map, supply proof of any special permission (such as a National Park permit), provide a copy of the AWR, have medical qualified aircrews (per ALARACT 293/2010), and be Army qualified as a UAS pilot and often hold a pilot's license. The process can take from one week to 60 days (although sometimes up to 90 days based on Corps experience).

COAs will have in special flying provisions for flying the UAS for a specific location, time and mission. Most of the requirements are listed in the sections previously.

CORPS POLICY CONSIDERATIONS

The Corps has published Engineer Circular (EC) 1110-1-106 to provide guidance on acquisition and operation of an UAS (May 2015). The EC summarizes the FAA, DOD and Army policies in regards to an UAS. The EC also requires that the UAS Working Committee approve new UAS acquisitions.

The Corps also follows Federal Geospatial Data Committee (FGDC) Standards. This is relevant for the collection and processing of UAS data. Nancy Blyler also leads the Corps Geospatial Community along with being the UAS EC proponent.

There are other indirectly related considerations within the Corps for acquiring or purchasing equipment. UAS proponents should consult their legal, contracting, information technology and others in terms of financial investment authority, related computer purchases, software approvals and more.

ACQUIRING UAS SERVICES

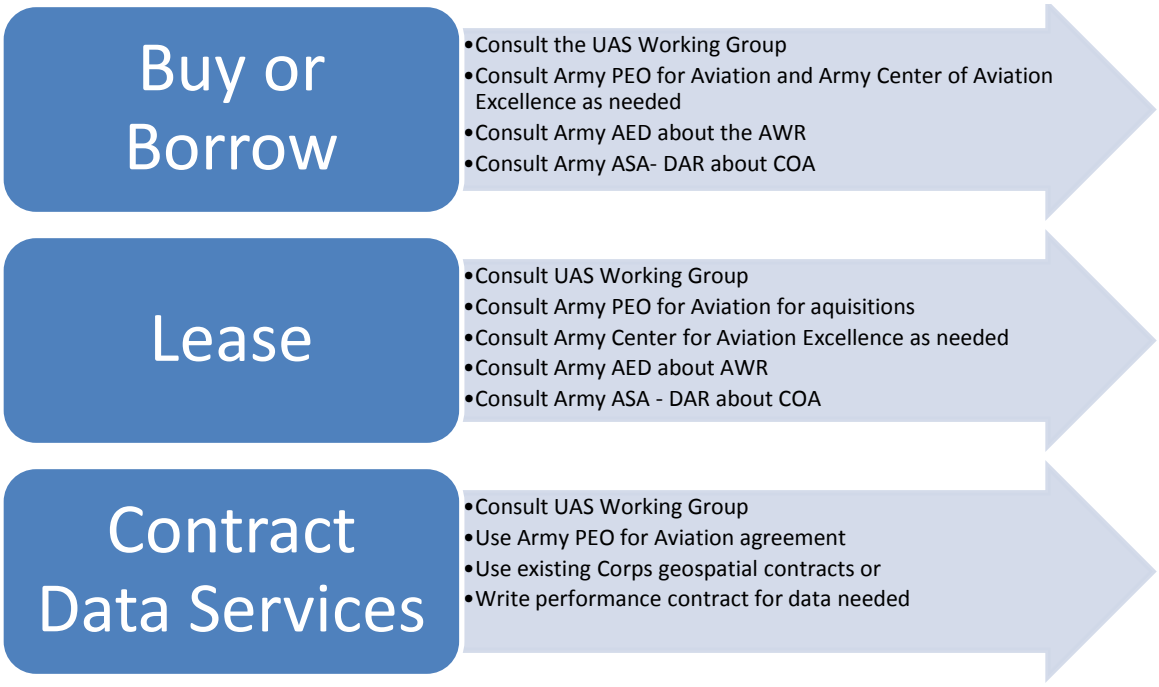
UAS services can be acquired through purchasing, leasing, contracting for services or even borrowing from other Corps districts. This must be done with consideration of the Office of Management Budget and Budget **(OMB) Circular A-126** "*before purchasing, leasing or otherwise acquiring aircraft and related services to assure that these services cannot be obtained from and operated by the private sector more cost effectively*." The purpose of this circular is "*to minimize cost and improve the management and use of government aviation resources*" (OMB 1992).

According to several Corps UAS owners, it only takes about two to three uses of a UAS before a UAS pays for itself in comparison to the cost of a traditional flyover. However, there is a large commitment to get started, trained and stay familiar with the equipment. The cost of using an UAS is entirely dependent on the type of UAS, data collected, and type of UAS purchase, lease, or agreement pursued. New leasing services may prove the most cost-effective for small

organizations that can't afford routine staff training and maintenance requirements. Up until 2014, commercial use of UAS via contracting was prohibited by the FAA, so this is a new commercial area in the U.S. market. The following sections will describe the acquisition process further.

A first step towards pursuing UAS services is to consult with the **Photogrammetric Center of Expertise (CX)** in the Corps St. Louis District to ensure that UAS services are the best fit. (It is possible that a contractor may propose using a UAS in a performance based contract. In this case, the next step would be to consult the Corps UAS Working Committee and official Army aviation offices to ensure that this can be done within policy. Corps legal advice may also be necessary as approval from the Secretary of Defense may also be needed for UAS operations (DOD 2015). Assuming that it is agreed that a UAS could best meet a district's needs, then the district should decide whether purchasing, leasing, borrowing within the Corps, borrowing from military units, or contracting for data services is appropriate. The UAS Working Committee will be able to advice the UAS proponent on this decision.

Several districts own devices and have agreements for obtaining UAS services. Districts requiring a UAS could potentially borrow the devices and expertise. Devices and any required expertise can also be leased through contracting. In addition, data collection can be contracted which in turn may require the contractor to use a UAS. Alternatively, a combination of these acquisition paths can be pursued such as leasing a payload for a borrowed UAS.



CORPS OWNERSHIP

Owning an UAS isn't as simple as ordering one online. While Corps districts may choose to purchase their own systems, it is also possible to borrow from others, or exchange payloads. Corps Districts, National Guard and other military units may be able to provide their payload, aircrafts and expertise. The Army Center of Aviation Excellence can also provide their services for UAS procedures and operations. Payloads can be interchangeable depending on the UAS; therefore, this ensures that not all UAS owners need all payload types.

Those wanting to borrow or buy a UAS or its components should first consult the UAS Working Committee, as required in EC 1110-1-106. The committee can help a Corps district that is seeking UAS services through exploring various acquisition strategies. The UAS proponent will be asked to justify their acquisition strategy with the UAS Working Committee for approval. If the committee agrees that purchasing is best, then the district will consult the Army Program Execution Office (PEO) Aviation (for UAS agreements), Army AED (AWR info), and later on Army ASA (for COA).

The purchase of equipment that already has an AWR is likely the most efficient plan if ownership is pursued. The UAS Working Committee and Army AED office can help identify these UAS that previously had an AWR or provide guidance on a new AWR application, but the AED charges a fee for their assistance.

Choosing to purchase an unmanned aircraft system can be a detailed, lengthy, and expensive process. The cost of ownership may include medical qualifications, pilot licenses, replacement parts and systems, repairs, additional payloads and training, maintenance, insurance, FAA paperwork management, advanced computers, remote attachments, and software for flying and processing data. In addition, nearly all of the experienced UAS operators consulted for this paper warned that crashes are inevitable and therefore costly replacement parts and units are necessary. Crashes could also result in legal fees and costs to repair any damage property, injuries, etc. The acquisition process and obtaining the right permission can take up to a year. Coordination with the Army Aviation Engineering Directorate (AED) is required and essential to successfully complete this process.

The prices for an unmanned aircraft system range from a few hundred dollars upwards to $300,000 for systems likely to be used within the Corps. The Corps has spent $35,000 to $150,000 for advanced systems that includes replacement parts and training. The most inexpensive type of UAS can be easily purchased at stores or online. For example, the DJI

Phantom Vision 2 is used by Jacksonville District for smaller applications and costs about $1,200. It can record video and hover around smaller areas for about 25 minutes (Hensch 2014).

The more expensive models have better reliability, functionality, flexibility and durability. The purchase of an advanced UAS typically includes training for several people on how to operate the UAS. These advanced systems start around $40,000. The battery life or fuel capacity of advanced fixed-wing systems is greater than VTOLs and can last many hours (anywhere from 2 hours to 24 hours plus). An example of a more advanced system is Altavian's F6500 which can fly up to 3,000 acres per day. The payload of this UAS enables a near-infrared filter, thermal imaging, electro-optical, images and video, GPS, and IMU. Very large and advanced systems could easily cost well beyond $150,000 and would likely be limited to military operations or special circumstances outside of Corps needs.

EXISTING ACQUISITION AGREEMENTS

The Corps currently has access to a variety of companies to acquire UAS services. However, these agreements also are always changing and can be short-term. The Army PEO Aviation has an Indefinite Delivery and Indefinite Quantity Contract (IDIQ) with various UAS companies for purchasing systems and UAS services. Currently, this IDIQ includes Altavian, AeroVironment, Elibit Systems of America, Lockheed Martin Corporation, and Innovation Automation Technologies (although subject to change in the future). They also have a services contract with BOSH Global Services for training, repair and engineering services related to small UAS (PEO Aviation 2015).

The Jacksonville District has an IDIQ contract with Altavian that has been used by other districts to purchase equipment (Hensch 2014). VDOS Global has a partnership agreement with Quantum Spatial (QSI), which has agreements with the St. Louis District (Burke 2014, Short 2015) so that their services can be accessed. Additionally, St. Louis also has an agreement with Woolpert Inc (Short 2015).

Other than purchasing an UAS, there is always a chance that other offices are upgrading equipment and may have a surplus UAS. The Army PEO Aviation would be able to help identify these opportunities to obtain an UAS via an ownership transfer. In previous years, the USGS was able to obtain UAS from the Army using this method (Wilhelm 2015). UAS vendors may also be able to provide leads on various agencies that are looking to replace existing systems.

UAS LEASING OR CONTRACTING

The FAA completely prohibited commercial use of an UAS until June 2014. Until a shift in rules, leasing was the only legal way to use commercial providers for UAS services since the government would technically own the UAS. The Mobile District among other Federal agencies has used leasing to acquire UAS services. The Mobile District contracted with Woolpert, prior to Woolpert's Section 333 Exemption, and all approvals went through official Army offices for an AWR and COA (Padgett 2015). **Army Regulation 95-20**, "Contractor's Flight and Ground Operations," establishes requirements for UAS operation involving contracted work (Army 2002). A **Government Flight Representative** (GFR) is required to assist on any contracted work.

However, the FAA began easing restrictions in June 2014 when the BP Oil Company received a Certificate of Waiver or Authorization to fly an AeroVironment UAS over Prudhoe Bay, Alaska to survey BP pipelines, roads, and equipment. This was the first allowance of a commercial UAS over U.S. soils (Chappell 2014). In September 2014, six more companies received authorizations to fly drones for closed-set filming via Section 333 by the FAA (FAA 2015). Since these initial authorizations, there have been many more to companies for real estate photography, construction, surveying, agricultural analysis, bridge inspections, roof inspections and more. More relevant to the Corps, the FAA announced on December 10, 2014 that it would allow four companies (VDOS Global, Woolpert Inc., Clayco Inc., and Trimble Navigation Limited) the ability to fly commercially for the following reasons:

- to survey land
- inspect remote oil rigs
- perform environmental and agriculture research
- assist construction projects
- collect GPS and geographical data

Additional authorizations for commercial use can be found on the Section 333 Authorization Webpage on the FAA website at:
http://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/

Per discussion with VDOS Global, this company seeks out an UAS per the needs of a client and then leases them to the client. The company provides trained pilots, the equipment, insurance, the latest technology, and maintenance to assure that data is collected as required (Burke 2015). VDOS Global received something similar to an AWR from the FAA for the Aeyron Sky Ranger and an FAA exemption for commercial flying. This means that VDOS Global, like the

other companies in the exemption, can now more easily obtain COAs for their operations and additional an airworthiness certificate for other aircrafts from the FAA (Burke 2015). Those wanting to pursue these types of UAS services should first consult with the UAS Working Committee, because these services may still require standard approvals, such as an AWR or COA, through the established Army processes (Flynn 2015 and Blyler 2015). There are multiple types of UAS contracts that could be specified by data collected, number of flights, hours, duration or other increments of service (Blyler 2015).

RECOMMENDATIONS FOR THE CORPS UAS PROGRAM AND MANAGEMENT

The application of unmanned aircraft systems within the Corps has great potential. However, the organization and management for an UAS is still new. The new Engineer Circular (EC 1110-1-106) has helped establish a formal UAS Working Committee and a process for pursuing UAS services. Furthermore, there is a broader and more informal UAS Community of Practice that has come together through peer-led workshops, webinars, and shared websites to share lessons learned and work together. However, more may need to be done to solidify the Corps' capabilities and efficiency in this burgeoning field. It is important to funnel the enthusiasm and expansion of UAS technology into a clear path with flexibility to encourage innovation in the safest and most cost-effective manner in the future.

Here are some recommendations for the future:

- **Establish USACE National Center for Small UAS Operations.** The learning curve for acquiring UAS services and coordinating approvals is steep. Centralizing activities and expertise will make UAS services more affordable across the board, create time savings, ensure safety and compliance to regulations. A national Corps center will likely open doors to more applications of UAS technology, which in turn will improve activities across the Corps. Additionally, a National Center would be able to keep up with the latest regulations, UAS trainings and technologies, and a center could provide strategic planning and coordination with the various Army offices (AED, ASA, and PEO). Additionally, the Concept of Operations (CONOP) can be explored for new system types and payloads in a coordinated fashion.
- **Improve UAS Communication:** In the course of researching this report, it became clear that the use, applications, policies, laws, guidance and other regulations regarding unmanned aircraft systems are not clear to all UAS proponents. This communication is complicated by the vast extent of policies and other documents that overlap and supersede one another across the FAA, DOD, Army and the Corps. The UAS Community of Practice and Working Committee have established routine meetings and a shared workspace as a start. This

community should outreach to other parts of the Corps, such as to the Emergency Management Program, to help identify all UAS proponents.

- **Increase UAS Visibility and UAS Working Committee within the Corps.** Increasing the visibility of UAS Working Committee and UAS Technology within the Corps will lead to efficiency gains across existing activities. Additionally, it will lead to innovation, improved analyses, and provide new risk assessment and management tools for existing infrastructure. Their functions should be widely advertised within the Corps, however, only under an organized UAS Corps umbrella. Whether it is a working group, committee, strategic plan, and/or other mechanisms, it is important to funnel the energy and excitement towards UAS into a clearly laid path to use existing systems and services or appropriately pursue different systems and services.
- **Target Specific Corps Communities for UAS Use.** There are certain communities within the Corps that are more likely to benefit than others. These include Corps offices that are doing infrastructure inspections to manage risks, emergencies management, performance or wildlife monitoring, regulatory inspections, and others. Workshops, webinars or other outreach activities that are specific to these communities could introduce them to UAS technology and the surrounding processes to use this technology effectively and safely.
- **Streamline Guidance and Processes:** The FAA, DOD, Army and Corps each have their own guidance, submittals, tools, and processes for appropriately pursuing UAS services. These processes and guidance could be streamlined to create fewer, but more comprehensive, UAS submittal packages. Added, an overlaid digital workflow could improve the processing of the submittal package across all agencies.
- **Inventory All Existing UAS Equipment and Expertise within the Corps of Engineers.** A key step within the Corps is to have an active and maintained list of equipment and expertise. This will help identify opportunities for collaboration and also help assist other military and government agencies in the future that want to work with the Corps. The Jacksonville District has created a web application to input some of this information in a geospatial database.
- **Hire a Corps Aviation Safety Officer and UAS Operator Instructor at Corps Headquarters.** A safety officer would ensure that each UAS office had a safety officer and that standards were met within the Corps. An UAS Operator Instructor would ensure that all UAS operators are properly trained and qualified. Both positions are common in Army units.
- **Centralize Payments to Associated Army Offices.** The Corps is required to coordinate with the Army Aviation Engineering Directorate (AED), Army Aeronautical Services Administration (ASA), and the Army Program Execution Office (PEO) Aviation. The Army AED receives payment from each project within the Corps for assistance. This payment

could be consolidated and thus reduced if the Corps paid for general support across all projects.

- **Encourage Shared Services Across the Army.** Throughout the Army and within the Corps, there is a variety of UAS expertise and equipment that can be shared and exchanged to perform various missions as needed. Expanding internal Corps expertise is costly and requires ongoing training. Likewise, equipment is expensive and it is unreasonable for each individual district to continually make updates to their systems, ensure approvals are maintained and that systems are repaired and maintained. Agreements between the Army and the Corps to provide support. Added, military units that are updating their UAS fleet could provide their previous used devices for Corps use. The Army Program Execution Office (PEO) for Aviation may be able to facilitate this exchange better.
- **Encourage Equipment and Expertise Exchange Within Corps.** Even within the Corps, there are several districts that currently own and use an UAS. These districts informally work together in a UAS Community of Practice (COP). This collaboration should continue and encourage equipment and expertise exchanges between offices. This would save time and money across the Corps, but it also requires a shared responsibility. Therefore, some general expenses should be budgeted within the Corps at the enterprise level to keep natural synergies sustainable. Added, not all Corps district will require a UAS or UAS office unit. Programs such as Personnel Force Innovation could allow National Guard and Reserve Service Members with UAS expertise to be used within the Corps (http://pfi.dod.mil/).
- **Encourage UAS proponents to explore all acquisition options**. Those exploring UAS within the Corps often do not realize that ownership is not the only option. There are more options than ever and these will expand as the FAA continues to ease UAS commercial opportunities. Leasing or contracting for services have advantages for organizations with inconsistent funding. These may be better options for individual projects if a national center or shared services from other military units are not available.
- **Create Strategic Plan for USACE Fleet Standardization and Upgrades.** Currently, the Corps is pursuing UAS services ad hoc. A strategic plan could help identify the most efficient purchasing plan and upgrades in the future across all UAS offices. This effort could identify a standard Corps requirement and baseline models that meet the requirements. Identified models could be purchased for the entire Corps and this process could be repeated on a routine basis. Mission needs that are outside of these capabilities could be acquired from the Army, other military units or through commercial providers. This process would result in fewer unmanned aircraft systems, which would reduce administrative costs of managing multiple system types that have overlapping functionality, equipment expenses, training, and more.

- **Uniform System Safety Management Plans (SSMPs), Standard Operating Procedures (SOPs), System Safety Working Group (SSWG), Concept of Operations (CONOP), etc.** Adoption of baseline fleet of system types would minimize the ongoing costs of maintaining SSWG, hazard tracking databases, etc. Greater collaboration at a technical level will reduce risks and increase productivity.
- **Baseline minimum level of qualification of Operators for all systems (similar to power boat and air boat operations) across USACE.** Identify what level of skill and training is required to operate particular non-standard UAS system types.

CONCLUSION

Unmanned aircraft systems (UAS) are a burgeoning field that offers a plethora of opportunities to improve existing Corps processes. An UAS can be either a fixed-wing or vertical take-off/vertical-landing systems used to gather aerial photography, advance imagery, or other types of data. Class 1 DOD UAS aircrafts (<50 lbs.) will likely see the most expansion given their small size, versatility, and affordability. The operation of unmanned aircraft systems are regulated by the Federal Aviation Administration, Department of Defense, and the Army. The Corps has just published its first Engineer Circular (1110-1-106) on unmanned aircraft systems and formally established an UAS Working Committee. Regulations and guidance across all organizations (FAA, DOD, Army, and Corps) is changing quickly to keep up with technology changes and UAS proponents must stay informed of these updates and adapt as needed.

UAS services can be acquired through purchasing, borrowing, leasing, or contracting. However, the increasing demand and easy accessibility to UAS could easily lead to ad hoc purchases and operations that are not compliant with regulations, unsafe, and costly to the Corps. The process for using UAS services is complicated for those first entering the UAS field; but, these processes are necessary and required to ensure safety in the National Airspace System (NAS) within the country. The Corps stands to make substantial gains from UAS technology and the publishing of EC 1110-1-106 is a great start. However, further efforts to create a strategic plan and centralize efforts for efficiency, sustainability, safety, coordination and innovation will become more pressing within the Corps. UAS technology will not be stopped or slowed, so it is critical that the Corps of Engineers Civil Works tackles this technology quickly and strongly. In turn, the Corps will be able to head off potential problems in the future and create opportunities for improved products and services.

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APPENDIX A: 2013 MEMORANDUM OF AGREEMENT CONCERNING THE OPERATION OF DEPARTMENT OF DEFENSE UNMANNED AIRCRAFT SYSTEMS IN THE NATIONAL AIRSPACE SYSTEM

Memorandum of Agreement

Concerning the Operation of Department of Defense

Unmanned Aircraft Systems in the

National Airspace System

1. **Introduction:** This Memorandum of Agreement (MOA) between the Department of Defense (DOD) and the Federal Aviation Administration (FAA) sets forth provisions that will allow, in accordance with applicable law, increased access for DOD unmanned aircraft systems (UAS) into the National Airspace System (NAS) outside of Restricted, Warning, or Prohibited Areas through accommodation, implementation of advanced mitigations, and integration, where applicable. This agreement assigns the DOD and the FAA specific tasks and responsibilities and applies to all DOD UAS operations, whether operated by Active, Reserve, National Guard, or other personnel of the United States Air Force, Army, Marine Corps, and Navy (known herein as "Military Departments"). This agreement replaces the MOA dated 24 September, 2007 and incorporates policies and procedures adopted since the previous version was implemented.

   1.1. It is DOD's goal to operate UAS seamlessly with manned aircraft in all classes of airspace without the need for airspace segregation or special authorizations, such as Certificates of Waiver or Authorization (COA) or Temporary Flight Restrictions (TFR).

   1.2. It is FAA's goal to integrate appropriately-equipped UAS consistent with no degradation of the safety and efficiency of the NAS, as well as the safety of persons and property on the ground.

   1.3. DOD and the FAA will continue to collaborate in the development of policy, regulatory, technical and safety-related requirements in order to safely increase UAS access to the NAS. This collaboration will include the sharing of safety data as well as joint participation in research and development activities.

   1.4. DOD and the FAA jointly agree to the following provisions to safely increase DOD UAS access to the NAS:

2. **Scope:** The policies, procedures and operations prescribed in this MOA apply to the operation of DOD UAS within the NAS outside of Restricted, Warning or Prohibited Areas.

3. **Authority:**

   3.1. Title 10 of the United States Code provides the authority for the Military Departments to set military aviation standards, certify military aircraft (including UAS) and direct military aviation operations.

   3.2. Sections 106, 40103(b), and 44701(a)(5) of Title 49, United States Code, provides the authority of the Federal Aviation Administrator to set aviation safety standards and regulate aviation operations in the NAS.

4. **UAS Airworthiness Certification:** DOD UAS operated outside of Restricted, Warning or Prohibited Areas shall be certified by one of the Military Departments as airworthy to operate in the intended segments of national and international airspace in accordance with applicable DOD and Military Department standards.

5. **UAS Pilot/Operator Qualification:** Pilots/operators[1] and crew members of DOD UAS shall be qualified and medically certified by the appropriate Military Department to operate in the class of airspace in which operations are to be conducted.

6. **FAA Certificate of Waiver or Authorization (COA) Process:** At present, the primary means of granting access to the NAS for public UAS is through the COA process. COAs will be issued using the guidance contained in the FAA's Order JO 7210.3 and FAA N8900.207, Unmanned Aircraft Systems Operational Approvals (as amended/superseded).

   6.1. New COAs: A proponent will submit a request for a new COA via the FAA Obstruction Evaluation, Airport Airspace Analysis (OE/AAA) website: http://ioeaaa.faa.gov. The FAA will complete processing of requests for new COAs within 60 business days[2] of receipt of a submitted application. In instances where this metric will not be met, the FAA will notify the requestor of the nature of the anticipated delay, any additional information required and the expected COA completion date.

   6.2. Renewal COAs: Renewal for a COA with no changes will be processed using a streamlined process and may be renewed one time as prescribed below. The FAA agrees to process COA renewal requests within 30 business days[2] of receipt of a complete application.

      6.2.1. The proponent will submit the request for COA renewal via the FAA OE/AAA website no later than 45 business days before the COA expiration date.

      6.2.2. The FAA will approve the COA renewal NLT 15 business days prior to the COA expiration date.

      6.2.3. If a renewal requires an extension to complete processing, extension(s) will be granted by the FAA via letter until the COA is approved, not to exceed 24 months from the original expiration date.

      6.2.4. Existing COAs that have FAA approved modifications ("pen and ink" changes) may be processed as a renewal COA.

      6.2.5. Requests for COA renewals that contain additions or changes by the proponent will not be accepted as a renewal, but will be processed as a new COA.

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[1] The term "operator" is a DOD specific term to describe individuals with the appropriate training and Military Department certification for the type of UAS being operated, and as such, is responsible for the UAS operations & safety. It is understood that all DOD UAS will be flown with a designated Pilot in Command (PIC).

[2] If a COA is released to the proponent with a request for additional information, the FAA processing timeline will stop and resumes once the information is received.

6.3. COA via Notification: Streamlined process for DOD proponents to notify FAA of intended UAS operations within Class D or G airspace under provisions delineated in paragraphs 7. and 8. below. FAA will review all COA via Notification submissions for MOA compliance, acknowledge the notification and notify proponent of any issues/ concerns regarding the proposed operations prior to the start date or within five business days, whichever occurs first. Notifications are deemed approved absent receipt of notices of issues/concerns within the stated time frame.

6.4. FAA issued new and renewal COAs will be valid for 24 months from the date of approval, unless a shorter duration has been requested by the proponent. Requests involving policy or airspace changes may require an applicant to provide additional information to the FAA before a renewal COA can be approved.

6.5. COA proponents will ensure airworthiness certification, spectrum approvals, and Letters of Agreement (such as written agreements with air traffic control facilities or for land use, if applicable) remain current for the duration of the COA and will provide the FAA any updates to those documents.

6.6. Priority COA Requests: In the case of urgent and compelling need to prioritize a specific COA application/renewal, the DOD Policy Board on Federal Aviation (PBFA) representative will notify the FAA of the COA request for priority action, the reason for priority action and the requested approval date. The FAA will move the requested COA to the top of the DOD queue and process it as quickly as possible. Metrics for DOD COAs currently in the queue when the request for prioritization is received will be adjusted as appropriate.

7. **DOD UAS Access to Class D airspace:** The FAA agrees to authorize DOD access to Class D airspace through either a COA or a Class D COA via Notification. A Class D COA via Notification is a notification to the FAA of DOD intent to operate UAS in a specific Class D airspace at a DOD airfield. This Notification will be valid for up to 24 months and may be used to operate multiple UAS types in multiple locations within the specified Class D airspace. The following applies to DOD airfields with an operational Air Traffic Control Facility where Air Traffic Control (ATC) services are provided by the DOD during published hours:

7.1. At DOD joint-use airfields or airfields whose operations are within airspace covered under Title 14 CFR Section 91.215 (b) (2), a new or renewal COA is required. Submissions must include an ATC management plan that outlines segregation of manned and unmanned aircraft. The proponent will submit requests for a COA via the FAA OE/AAA website.

7.2. At DOD airfields not classified as joint-use airfields, a new/renewal COA or a Class D COA via Notification is required. Submissions must include an ATC management plan that outlines segregation of manned and unmanned aircraft. The proponent will submit requests for Class D COA via Notification through the FAA OE/AAA website a minimum of 45 business days prior to intended operation(s).

7.2.1. Approval of Class D COAs via Notification mandate implementation of ATC procedures in compliance with FAA Order JO 7110.65. DOD, as the ATC service provider, does not have the authority to issue any waivers to 14 CFR Part 91 or to FAA Order JO 7110.65.

7.2.2. Approval of Class D COAs via Notification include permission for DOD UAS to transition between the specified Class D airspace and adjoining active Restricted and/or Warning Areas if delineated in the application.

7.3. Operations will not be conducted over populated areas, unless the level of airworthiness allows. For planning purposes, populated areas are those areas indicated in yellow on Visual Flight Rules (VFR) Sectional Aeronautical Charts.

7.4. Night operations are permitted provided:

7.4.1. The UAS meets the night lighting requirements as defined in CFR 91.209, or an agreed equivalent standard.

7.4.2. Flight Crews have been trained on the lighting configuration of the unmanned aircraft and are in place 30 minutes prior to night operations to ensure night vision adaptation has occurred, as applicable.

7.4.3. The tower radar display is operational.

7.4.4. The Air Traffic Control Tower is appropriately staffed for normal operations.

7.5. Proponent will publish Notices to Airmen (NOTAM) to alert non-participating aircraft not more than 72 hours in advance, but not less than 48 hours prior to the operation.

7.6. Military Departments will implement common ATC procedures, tailored for local use, at each airfield where this provision is utilized. These procedures will be approved by a locally authorized command official and provided to the FAA via COA online. The ATC procedures will comply with FAA Order JO 7110.65 and the January 23, 2009 memorandum titled "ATC Procedures for DOD Non-Joint-Use Airfields with Associated Class D Airspace" (Attachment 1), as amended/superseded.

8. **DOD UAS Access to Class G airspace using COA via Notification procedures:** In addition to use of standard COAs, the FAA agrees to authorize access to Class G airspace for DOD UAS outside Restricted or Warning Areas through the COA via Notification procedure. This notification will be valid for up to 24 months. Operations within Class G airspace underlying Class B or C airspace (Mode C veil) must be conducted via a standard COA. Requirements for the COA via Notification procedures are as follows:

8.1. COA via Notification in Class G airspace applies to UAS weighing 55 pounds or less, except where limited to 20 pounds or less, as depicted in Figure 1.

8.2. The proponent will notify the FAA via OE/AAA COA online and publish a NOTAM to alert non-participating aircraft not less than 24 hours prior to the operation.

8.3. Operations will be conducted within visual line of sight of the pilot/operator/visual observer utilizing Class E VFR weather requirements.

8.4. Operations will be conducted over military bases, reservations or land protected by purchase, lease, or with express permission of the landowner.

8.5. Operations will not be conducted over populated areas, unless the level of airworthiness allows. For planning purposes, populated areas are those areas indicated in yellow on VFR sectional charts.

8.6. Operations will not be conducted over charted wildlife preserves, national parks or other similarly protected airspace indicated on VFR Sectional Aeronautical Charts.

8.7. The UAS will remain outside of five (5) NM from any civil airport or heliport (Figure 1).

8.7.1. Operations between five (5) and ten (10) NM from a civil airport or heliport will remain below 700 ft AGL/14,500 ft MSL. EXCEPTION: UAS weighing 20 lbs or less may operate up to 1200 ft AGL/14,500 ft MSL when not beneath a depicted transition area (Figure 1).

8.7.2. Operations greater than ten (10) NM from a civil airport or heliport will remain below 1,200 ft AGL/14,500 ft MSL (Figure 1).

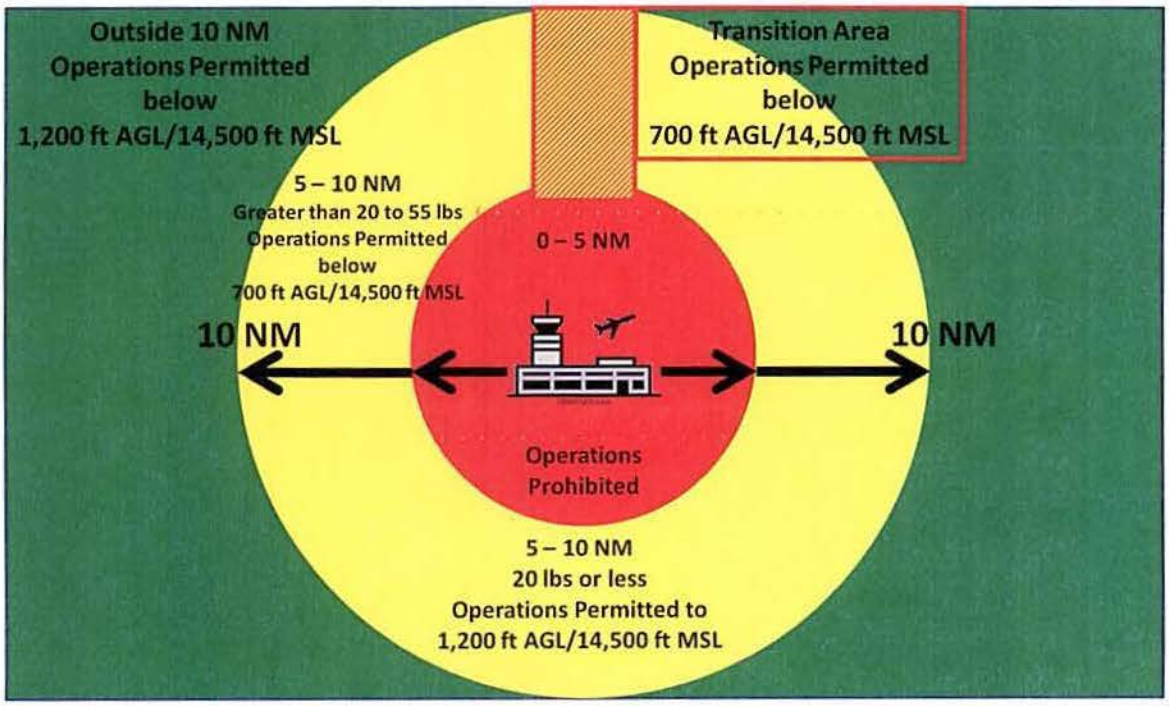

Figure 1

8.8. Night operations are permitted provided:

8.8.1. The UAS meets the night lighting requirements as defined in 14 CFR 91.209.

8.8.2. Flight Crews have been trained on the lighting configuration of the unmanned aircraft and are in place 30 minutes prior to night operations to ensure night vision adaptation has occurred, as applicable.

9. **Inspection/Reporting Programs[3]:** DOD and FAA agree that regular assessment of UAS operations under COAs is essential to ensuring the continued safety of the NAS.

9.1. DOD and FAA agree that each Military Department will put into place a system of regular inspections and self-assessments for units that operate UAS, as well as at DOD Air Traffic Control facilities and airfields where UAS operations are conducted.

9.2. DOD and FAA agree that the form, manner and frequency of information exchanges related to Military Department inspections and self-assessments will be formally determined in a separate Memorandum of Understanding.

10. **DOD/FAA Partnering Initiatives:** To the maximum extent practicable, DOD and the FAA will partner on efforts to further UAS research, development, standards, testing and certification initiatives as follows:

10.1. Sharing UAS Safety Data: DOD and FAA will continue to collect and share safety related data on UAS operations to support DOD/FAA UAS safety studies and analysis. The FAA agrees to share with DOD the same type UAS safety data collected from other non-DOD sources, as permitted by law and the non-DOD sources. The FAA agrees to release to DOD requested data, results and findings of studies and analysis conducted using DOD and non-proprietary non-DOD UAS data. The ultimate goal of safety data reporting will be to arrive at an agreed-upon set of data reporting requirements that can be supported by the individual Military Departments. In the interim, the data reporting methodology delineated below will be utilized.

10.1.1. Data will be provided in accordance with the DOD/FAA MOA, Sharing Safety Mishap Information Related to the Operation of Unmanned Aircraft Systems (UAS) between the DOD Components and the Federal Aviation Administration (FAA), 23 June 2011 as amended/superseded.

10.1.2. COA and COA via Notification data reported via COA On-Line.

10.1.3. Additional data elements as defined by future agreement(s) between the DOD and FAA regarding the sharing of safety or operational data (incorporated by reference).

10.2. UAS Research and Development (R&D). It is DOD and the FAA intent to share methodologies, information and results of R&D efforts conducted by their respective organizations, as described more fully in a separate Memorandum of Understanding.

[3] Not intended to replace procedures identified in FAA JO 7610.4

The FAA point of contact will be the Manager of the Advanced Concepts & Technology Development Office, ANG-C. The DOD point of contact will be DOD/Acquisition, Training and Logistics (AT&L)/Unmanned Warfare (UW).

11. **Safeguarding of Shared Information (Non-Public Information):** The DOD and FAA agree to take all actions reasonably necessary to preserve, protect, and maintain all privileges and claims of confidentiality related to non-public government-generated information provided pursuant to the MOA, in accordance with applicable law. Release of any non-public government-generated information to third parties is prohibited without the written consent of signatories to this agreement or their duly appointed designees. The DOD and FAA intend that sharing of non-public government-generated information with each other pursuant to the terms of the MOA will not constitute public disclosure, nor will it constitute a waiver of confidentiality or any privilege applicable to such information. The DOD and FAA expressly reserve all evidentiary privileges and immunities applicable to the information shared under this MOA.

12. **Implementation Plan:** The Chairman, DOD Policy Board on Federal Aviation, the FAA's Associate Administrator for Aviation Safety, and the FAA's Chief Operating Officer for the Air Traffic Organization are charged with formulating policy for their respective organizations to ensure compliance with the provisions of this agreement.

13. **Effective Date, Amendment, and Termination:** This MOA will be effective upon the last signature of the Parties, subject to review every five (5) years, or by request of either party, and may be renewed or amended by agreement of the parties. This MOA may be terminated by either party upon 60 calendar days written notice or upon mutual written consent of the parties. Or either party wishing to terminate this agreement will submit written notification 60 calendar days prior to the effective date of termination.

14. **Amendments to Attachments of this MOA:**

    14.1. Attachments to this MOA may be added or updated by agreement of both agencies' representatives to the UAS Executive Committee Senior Steering Group (SSG).

For the Department of Defense

David G. Ahern — June 14, 2013

David G. Ahern — Date

Chairman, DOD Policy Board for Federal Aviation

For the Federal Aviation Administration

Margaret Gilligan — 7/2/13

Margaret Gilligan, AVS-1 — Date

Associate Administrator for Aviation Safety

David Grizzle — 9/16/2013

David Grizzle, AJO-0 — Date

Chief Operation Officer, Air Traffic Organization

1 Attach

1) ATC Procedures for DOD Non-Joint-Use Airfields with Associated Class D Airspace

APPENDIX B: 2012 MEMORANDUM – ARMY DIRECTIVE 2012-02 (SUPPLEMENTAL POLICY FOR OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS IN THE NATIONAL AIRSPACE SYSTEM)

SECRETARY OF THE ARMY
WASHINGTON

13 JAN 2012

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Army Directive 2012-02 (Supplemental Policy for Operations of Unmanned Aircraft Systems in the National Airspace System)

1. The Army's unmanned aircraft systems (UAS) represent emerging technology that requires access to the National Airspace System. The Army intends to use UAS for warfighter training and directed mission support. To ensure that UAS operations are conducted safely and efficiently, and in accordance with Federal aviation regulations and other governing laws and procedures, the Deputy Chief of Staff (DCS), G-3/5/7 developed the enclosed supplemental policy. This policy applies to the Active Army, the Army National Guard/Army National Guard of the United States, and the United States Army Reserve, unless otherwise stated.

2. As UAS operations evolve and mature, the DCS G-3/5/7 shall ensure this policy is reviewed with Army stakeholders on a biannual basis and updated, as necessary.

3. This policy is effective immediately and supersedes the Interim Guidance for UAS Operations in the National Airspace System that the DCS G-3/5/7 issued on 24 March 2009. This policy will be incorporated in the next revisions of Army Regulation 95-23 (Unmanned Aircraft System Flight Regulations), Army Regulation 95-2 (Airspace, Airfields/Heliports, Flight Activities, Air Traffic Control and Navigation Aids) and the Unified Facilities Criteria 3-260-01 and 3-260-02.

Enclosure

John M. McHugh

SUBJECT: Army Directive 2012-02 (Supplemental Policy for Operations of Unmanned Aircraft Systems in the National Airspace System)

Principal Officials of Headquarters, Department of the Army
Commander
U.S. Army Forces Command
U.S. Army Training and Doctrine Command
U.S. Army Materiel Command
U.S. Army Europe
U.S. Army Central
U.S. Army North
U.S. Army South
U.S. Army Pacific
U.S. Army Africa
U.S. Army Special Operations Command
Military Surface Deployment and Distribution Command
U.S. Army Space and Missile Defense Command/Army Strategic Command
Eighth U.S. Army
U.S. Army Network Enterprise Technology Command/9th Signal Command
U.S. Army Medical Command
U.S. Army Intelligence and Security Command
U.S. Army Criminal Investigation Command
U.S. Army Corps of Engineers
U.S. Army Military District of Washington
U.S. Army Test and Evaluation Command
U.S. Army Installation Management Command
Superintendent, United States Military Academy
Director, U.S. Army Acquisition Support Center

CF:
Commander, U.S. Army Accessions Command
Executive Director, Army National Cemeteries Program
Commander, U.S. Army Cyber Command
Director, Office of Business Transformation
Commander, U.S. Army Aviation and Missile Command
Commander, U.S. Army Aviation Center of Excellence
Program Executive Officer, Aviation
Commander, U.S. Army Combat Readiness Center

SUPPLEMENTAL POLICY FOR OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS IN THE NATIONAL AIRSPACE SYSTEM

JANUARY 2012

Enclosure

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1. **Purpose**

a. This enclosure establishes Armywide supplemental policy for the operations of unmanned aircraft systems (UAS) not currently covered in Army regulations (ARs), field manuals, Unified Facilities Criteria, and other regulatory guidance. This supplemental policy is derived in part from recent Department of Defense (DoD) and Federal Aviation Administration (FAA) agreements necessary for expanded UAS access to the National Airspace System.

b. This supplemental policy supersedes all versions of the interim guidance from the Deputy Chief of Staff, G-3/5/7 for UAS in the National Airspace System. The Commander, U.S. Army Aeronautical Services Agency will continue working with regulatory proponents and Army stakeholders to incorporate elements of this policy into existing regulations as UAS guidance matures during normal cycle updates.

2. **Request for Federal Aviation Administration Certificate of Authorization**

a. UAS operations outside of restricted or warning areas require an FAA-approved certificate of authorization, except for some operations in Class G airspace. (See paragraph 3, Operations of Small Unmanned Aircraft Systems in Class G Airspace Without a Certificate of Authorization, on page 2.)

b. To submit a request for a certificate of authorization:

(1) Complete the checklist application for the certificate of authorization via the FAA Obstruction Evaluation / Airport Airspace Analysis (OE/AAA) Web site (https://ioeaaa.faa.gov/). Contact the FAA Service Area Department of the Army Representative (DAR) for Web site access and questions. (Refer to AR 95-2 (Airspace, Airfields/Heliports, Flight Activities, Air Traffic Control, and Navigational Aids), table 3-1, for DAR contact information.)

(2) Requests must be submitted to the DAR by the O-6/civilian equivalent or higher in the unit's chain of command a minimum of 90 days before the requested start of UAS operations. Earlier submission is recommended to streamline processing time for the certificate of authorization.

c. Certificates of authorization normally apply to one type and concept of UAS operations. The DoD/FAA UAS memorandum of agreement (MOA) dated 24 September 2007 (appendix A) allows leadership of an air traffic control (ATC) facility at a non-joint-use airfield to apply for a certificate of authorization to cover all UAS operations in the associated Class D airspace. These requests for a certificate of authorization will be referred to as the UAS MOA Class D certificate of authorization. ATC leadership will develop local procedures to comply with existing local traffic patterns, arrival and departure procedures, noise abatement procedures, and airfield operating rules. Local procedures are supplementary, but cannot waive or replace the procedures for DoD non-joint-use airfields with associated Class D airspace at

appendix B, beginning on page 10. Local procedures must be approved by the ATC facility chief before implementation and will be published and maintained in the ATC facilities. Contact the DAR to determine if you may initiate a UAS MOA Class D certificate of authorization for your facility. Complete the certificate of authorization checklist and provide it to the DAR for submission to the FAA in accordance with paragraph 2b. The DAR will inform the requesting organization that its certificate of authorization is approved or disapproved. Once the certificate of authorization is approved, provide any changes to local procedures, unmanned aircraft systems, and airworthiness release to the DAR. The DAR will notify Headquarters, Army Aeronautical Services Agency (Airspace Branch) of any additional UAS type added to the approved MOA Class D certificate of authorization.

3. **Operation of Small Unmanned Aircraft Systems in Class G Airspace Without a Certificate of Authorization**

a. The DoD/FAA UAS MOA authorizes a Class G airspace notification in lieu of a certificate of authorization for UAS weighing 20 pounds or less operating below 1,200 feet above ground level in Class G airspace over military bases, reservations, or land protected by purchase, lease, or other restrictions. This is not applicable to airspace identified in 14 CFR 91.215 (Mode C veil within 30 miles of major airports depicted on Visual Flight Rules sectional charts by a solid magenta line). The UAS must remain more than 5 nautical miles from any civil use (public or private) airport or heliport and within clear visual range of the operator or certified observer in contact with the operator.

b. The UAS unit representative will contact the DAR to determine if this notification applies to proposed small UAS operation. Upon verification, the first O-6/civilian equivalent in the chain of command submits the Class G airspace memorandum, along with the current airworthiness release, to the DAR before conducting planned operations. (A sample memorandum for Class G airspace is in appendix C, beginning on page 17.) The DAR will officially notify the FAA and inform the requesting unit when notification procedures are complete.

c. The UAS commander will ensure that a Notice to Airmen (NOTAM) is issued 24 hours in advance to alert nonparticipating aircraft of the operation. The UAS commander will verify that a NOTAM was issued before beginning operations. Contact your air traffic and airspace officer if you require assistance submitting a NOTAM.

4. **Arrival and Departure Criteria.** The following arrival and departure criteria apply to UAS operating at Army facilities. UAS operations at joint military-civilian use airfields will also comply with provisions of FAA UAS certificates of authorization and joint use letters of agreement (LOAs) developed with the civil authority operating at the airport.

a. Minimum approach angle: 3˚.

b. Minimum departure climb rate: 200’ per nautical mile.

c. Approach speed: Treat UAS as CAT A aircraft.

5. **Surface and Clearance Criteria for Landings and Takeoffs**

a. Landing and takeoff surfaces used only by UAS shall comply with criteria established in Engineer Technical Letter 1110-3-506 (Aviation Complex Planning and Design Criteria for Army Unmanned Aircraft Systems (UAS)). Surfaces used by manned aircraft shall comply with criteria established in Unified Facilities Criteria 3-260-01 and 3-260-02.

b. The first O-6/civilian equivalent in the UAS unit commander’s command chain may waive surface length criteria for landings and takeoffs after completing a risk assessment and when lesser criteria is specified in the manufacturer’s or appropriate military operations manual.

c. Local commanders are not authorized to waive lateral clearance or clear zone criteria. Requests for waivers shall be processed in accordance with Unified Facilities Criteria 3-260-01 through command channels to Headquarters, Army Aeronautical Services Agency.

6. **Air Traffic Control Procedures**

a. A comprehensive LOA is required and coordination may include unit commander, airfield commander/manager, and ATC facility chief. A review of the proposed LOA by the appropriate DAR is required before execution. Prepare and maintain LOAs in accordance with AR 95-2; Training Circular 3-04.81(Air Traffic Control Facility Operations, Training, Maintenance, and Standardization); and AR 25-50 (Preparing and Managing Correspondence). LOAs do not waive or modify restrictions listed in the FAA certificates of authorization.

b. UAS operations require a precoordinated missed approach procedure established in the LOA and in accordance with an approved certificate of authorization. The LOA will cover lost link and/or loss of visual contact procedures.

c. Air Traffic Control Separation and Phraseology

(1) U.S. Army radar approach control facilities will apply standard separation criteria to UAS operations outside of FAA-established active restricted areas.

(2) The agency using the restricted area (as identified in FAA Order 7400.8) will establish separation criteria to ensure safe operations within its restricted areas.

(3) U.S. Army ATC facilities will use standard phraseology in accordance with FAA Order 7110.65 (taxi to, cleared for takeoff, cleared to land, etc.) for communications between ATC and UAS operators. Nonstandard phraseology is not authorized.

7. **Observers (When Required by Certificate of Authorization)**

a. Ground observer duties are in accordance with AR 95-23 (Unmanned Aircraft System Flight Regulations), chapter 4.

b. Chase aircraft pilots are not authorized to perform observer or UAS operator duties while flying the chase aircraft. Observers onboard the chase aircraft will not perform UAS operator duties. The chase aircraft should operate within 1 nautical mile laterally, or according to the certificate of authorization, and no more than 3,000 feet vertically from the UAS. Observers onboard a chase aircraft must keep visual contact with the UAS at all times.

c. Radar observers are rated ATC personnel dedicated to monitoring unmanned aircraft. Radar observers may not simultaneously perform other ATC services. As a minimum, primary radar returns must be enabled. Secondary radar returns may be used in addition to primary radar, but not as a sole source of radar observing.

8. **Weather Requirements.** Weather requirements will be in accordance with AR 95-23, chapter 5.

9. **Facility Requirements**

a. The Army Deputy Chief of Staff, G-3/5/7 (DAMO-AV) is the proponent for Army requirements for manned and unmanned aircraft hangars. The G-3/5/7 is supported by the Assistant Chief of Staff for Installation Management with the aircraft maintenance hangar complex facilities design team.

b. Facility standard design can be obtained for the Grey Eagle, Warrior Alpha, and Hunter UAS at U.S. Army Corps of Engineers, Mobile District (Center of Standardization) (POC: Kathy Prochnow / phone (251) 690-3378).

10. **Unmanned Aircraft Systems Operator and Observer Qualifications.** Unit commanders will establish a standing operating procedure detailing operator and observer training and certification requirements. Training must include the rules and responsibilities in 14 CFR 91.111 (Operating Near other Aircraft) and 14 CFR 91.113 (Right-of-Way Rules).

a. Refer to AR 95-23 for guidance.

b. UAS observers must have vision correctible to 20/20 (both eyes).

c. Medical requirements for UAS operators are addressed in ALARACT 293/2010 – Notification of Changes to the Aeromedical Physical Standards of Unmanned Aviation Systems.

11. **Operational Restrictions**

a. Manned and unmanned traffic pattern operations will be conducted in accordance with AR 95-2, chapter 5. Manned and unmanned aircraft will not simultaneously operate in a traffic pattern. This includes traffic patterns that share a runway (right and left traffic patterns to same runway, including opposite direction operations). Manned and unmanned aircraft will not simultaneously operate to parallel/overlapping landing surfaces or those that have overlapping patterns. The only exceptions to these criteria are the allowance for the following, when authorized by an LOA:

- manned aircraft established on final (making a straight-in approach) to follow an unmanned aircraft already established on final, and
- manned aircraft established on final (making a straight-in approach) to follow an unmanned aircraft departing straight out from the runway.

Requirements in certificates of authorization, LOAs, or other local operating procedures and agreements may be more restrictive, but may not allow for less restrictive operations.

b. Armed UAS flights outside restricted and warning areas are prohibited unless specifically authorized in the FAA certificate of authorization.

12. **Accident and Incident Reporting.** In addition to requirements in AR 95-23, AR 385-10 (The Army Safety Program) and DA Pamphlet 385-40 (Army Accident Investigations and Reporting) provide the initial report of all UAS accidents or incidents to the appropriate DAR within 24 hours.

a. UAS accident reporting applies to all UAS (including small UAS).

b. Small UAS accident reporting is addressed in AR 95-23.

c. DA Form 2397-U (Unmanned Aircraft System Accident Report) is required for all UAS aviation accidents, regardless of the class. Investigation and submission of Form 2397-U will be in accordance with AR 385-10. A copy of Form 2397-U is at Appendix D, beginning on page 19.

APPENDIX A – MEMORANDUM OF AGREEMENT FOR UNMANNED AIRCRAFT SYSTEMS, 24 SEP 07

Memorandum of Agreement
Concerning the
Operation of Department of Defense Unmanned Aircraft Systems
in the
National Airspace System

Introduction. On September 28, 2006, the Deputy Secretary of Defense directed the Executive Director, Department of Defense (DoD) Policy Board on Federal Aviation, to pursue an agreement with the Federal Aviation Administration (FAA) to allow ready access to the National Airspace System (NAS) for DoD Unmanned Aircraft Systems (UAS) domestic operations and training. This Memorandum of Agreement (MOA) between the DoD and the FAA sets forth provisions that will allow, in accordance with applicable law, increased access for DoD UAS into the elements of the NAS outside of DoD-managed Restricted Areas or Warning Areas.

To ensure that DoD UAS operations are conducted safely, efficiently, and in accordance with U.S. law, and to ensure DoD UAS assets have NAS access for domestic operations, including the War on Terror (WOT), this agreement assigns the DoD and the FAA specific tasks and responsibilities. This guidance applies to all DoD UAS, whether operated by Active, Reserve, National Guard, or other personnel.

It is the DoD's goal that appropriately equipped UAS will have ready access to the NAS for the conduct of domestic operations, exercises, training, and testing.

It is the FAA's goal that DoD UAS operations are conducted safely and expeditiously, present no threat to the general public, and do no harm to other users of the NAS.

To reach these goals, the DoD and FAA must aggressively collaborate toward an incremental approach in overcoming the technical, regulatory and safety hurdles to reaching these common goals. Both departments jointly agree to the following provisions as the initial steps in their pursuit of ready access to the NAS for DoD UAS operations.

Scope. The policies, procedures and operations prescribed in this MOA apply to the operation of DoD UAS within the NAS. This MOA specifically excludes commercial UAS operation for non-DoD applications and other Government Agencies that operate Public Use UAS.

Authority. Section 106 of Title 49, United States Code provides the authority of the Federal Aviation Administration to set aviation safety standards and regulate aviation operations in the NAS. Title 10 United States Code provides the authority for the Secretary of Defense to set military aviation standards and direct military aviation operations.

UAS Airworthiness Certification. Except where specifically exempted by the FAA, DoD UAS operated outside of Restricted Areas and Warning Areas shall be certified by one of the military departments as airworthy to operate at the appropriate level in accordance with applicable DoD and Military Department standards.

UAS Pilot/Operator[1]/Crewmember Qualification. Pilots/operators of DoD UAS shall be qualified by the appropriate Military Department activities to fly in the class of airspace in which operations are to be conducted. DoD UAS pilots/operators in qualification training shall be supervised by a qualified UAS pilot/operator until achieving the appropriate qualification level. DoD UAS ground observers will possess the appropriate medical qualification to perform their duties.

Enhanced DoD UAS Access to the NAS. Where the appropriate qualifications listed above are met, the FAA agrees to provide access to the NAS for DoD UAS outside Restricted Areas and Warning Areas as follows:

- All categories of DoD UAS operations conducted wholly within Class D airspace that has an associated DoD-controlled, non-joint-use airfield, provided[2]:
    - Operations are not conducted over populated areas or within airspace covered in Section 91.215 (b)(2) of Title14, Code of Federal Regulations (14 CFR § 91.215(b)(2)).
    - DoD shall develop uniform air traffic control procedures to be applied at all locations. These procedures will be developed in coordination with the FAA prior to implementation and a Certificate of Waiver or Authorization issued to the appropriate DoD Air Traffic facility.
- DoD UAS that weigh 20 pounds or less, under the following conditions:

Operations are conducted within Class G airspace, below 1200' AGL (not applicable to airspace identified by 14 CFR § 91.215 (b)(2)) over military bases, reservations or land protected by purchase, lease or other restriction.

- The UAS remains within clear visual range of the pilot, or a certified observer in ready contact with the pilot, to ensure separation from other aircraft.

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[1]Note: The term "operator" is a DoD-specific term to describe individuals with the appropriate training and Military Department certification for the type of UAS being operated, and as such, is responsible for the UAS operations & safety. It is used to differentiate from DoD rated pilots of manned weapons systems.

[2] The DoD, as a service provider for this airspace, does not have the authority to issue waivers to 14 CFR Part 91.

- The DoD will ensure the UAS remains more than 5 miles from any civil use airport or heliport

DoD components operating under this paragraph will notify the FAA of the proposed operation in advance, and publish Notices to Airmen (NOTAMS) as required to alert non-participating aircraft of the operation. For non-recurring operations, notification will be accomplished, and Notices to Airmen (NOTAMS) published, no later than 24 hours in advance. For recurring operations (e.g. training) standing "blanket" notifications/standing NOTAMs should be used.

DoD/FAA Partnering on UAS Initiatives. To the maximum extent practicable, the DoD and the FAA will partner on efforts to further UAS research, development, standards, testing and certification initiatives as follows:

- NAS Integration. The DoD and FAA will coordinate the development of near, mid and long-term UAS standards, procedures, and technical solutions.
- UAS Research and Development (R&D). The DoD and the FAA agree to share methodologies, information and results of research and development efforts conducted by their respective organizations. Both organizations agree to, wherever practicable, partner in UAS R&D efforts that show promise for enhancing the safety of DoD UAS operations in the NAS.
- UAS Testing and Certification. The DoD agrees to invite FAA participation in DoD-conducted development and testing of UAS components intended to enhance the safety of UAS operations, including detect-and-avoid systems. The FAA agrees to participate in DoD development and testing of said components, and provide input to developing acceptable standards of performance that will allow enhanced DoD UAS NAS access.
- UAS Safety Data. The DoD, through the Military Department safety organizations, will collect and share data on UAS operations to support FAA UAS safety studies and analyses. The FAA will provide the requested data elements and reporting format for this data. The FAA agrees to release to the DoD all results and findings of studies and analyses conducted using DoD UAS data, and to share UAS safety information gleaned from public and private sources with the DoD.

Waiver Process. In those cases where meeting all of the certification provisions of this agreement is not possible, or is cost or mission prohibitive, the FAA will review the specific conditions of DoD requests for UAS operations outside of Restricted, Warning, or other areas outside the scope of this document to determine if a Certificate of Waiver or Authorization (CoA) may be issued.

The FAA will strive to process properly-completed DoD COA applications within 60 days of receipt. In the case of urgent and compelling need (such as "non-training" national security

missions or "active" natural disaster support), the DoD will notify the FAA of the need and reason for priority action, and the FAA will process DoD COA requests as quickly as possible, but not later than 24 hours from receipt of complete mission requirements.

Implementation Plan. The Chairman, DoD Policy Board on Federal Aviation, and the Administrator, Federal Aviation Administration, are charged with formulating policy for their respective organizations to ensure compliance with the provisions of this agreement. The FAA's office of primary responsibility is the Unmanned Aircraft Program Office. This MOA will be reviewed annually or as needed by request of either party and is effective upon the last signature of the Parties.

For the Department of Defense

The Honorable Gordon England, Deputy Secretary — Date 9/24/07

For the Federal Aviation Administration

The Honorable Marion C. Blakey, Administrator — Date June 12, 2007

APPENDIX B – AIR TRAFFIC CONTROL PROCEDURES FOR DOD NON-JOINT-USE AIRFIELDS WITH ASSOCIATED CLASS D AIRSPACE, 23 JAN 09

OFFICE OF THE SECRETARY OF DEFENSE
1480 DEFENSE PENTAGON
WASHINGTON DC 20301-1480

DOD
POLICY BOARD
ON FEDERAL AVIATION

JAN 23 2009

MEMORANDUM FOR ASD(NII) (MR GRIMES)
OUSD(P) (MR VERGA)
OUSD(AT&L) (MR KISTLER)
OSD/DGC A&L (MR LARSEN)
JCS/J-5 (BGEN DISALVO)
DCS/G-3/5/7 (LT GEN THURMAN)
N88 (RADM MYERS)
DCS/A3/5 (LT GEN DARNELL)
USMC/AVIATION (LT GEN TRAUTMAN)

SUBJECT: ATC Procedures for Department of Defense (DOD) Non-Joint-Use Airfields with Associated Class D Airspace

I have enclosed revised ATC Procedures for DOD Non-Joint-Use Airfields with Associated Class D Airspace to operate DOD Unmanned Aircraft Systems for Service use effective on 21 January, 2009. The procedures were developed pursuant to DEPSECDEF memorandum, Subject: Memorandum of Agreement for Operation of Unmanned Aircraft Systems in the National Airspace System dated 24 September 2007. They meet the requirements of the "DOD-FAA MOA Concerning the Operation of DOD UAS in the NAS" entered into by the FAA Administrator and the Deputy Secretary of Defense effective 24 September 2007. The procedures when employed properly will simplify and expedite UAS COA approvals at DOD airfields.

These procedures were developed by Service operations and air traffic control subject matter experts and have been coordinated with the FAA. The procedures replace DOD Operations and ATC Procedures for Non-Joint-Use Airfields with Associated Class D Airspace released May 20 2008. They should be considered an integral part of DOD airfield operations and attached to all applicable UAS COA requests.

Please feel free to contact me at (703) 697-8489, or COL Robert Hess, who chaired the DOD UAS ATC procedures working group, at (703) 806-4862, with any questions.

Sincerely,

GERALD F. PEASE, Jr., SES
Executive Director

1 Attachment
DOD Procedures

ATC Procedures for DOD Non-Joint-Use Airfields with Associated Class D Airspace

1. Purpose. To meet requirements for uniform air traffic control procedures as specified in the DOD/FAA Memorandum of Agreement (MOA) Concerning the Operation of Department of Defense Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) dated 24 September 2007.

2. Scope.

a. The procedures in this document outline standards for ATC procedures at DOD non-joint-use airfields with associated Class D airspace conducting UAS operations.

b. This document cannot be amended without prior coordination with the Service's representative to the DOD Policy Board on Federal Aviation, who will in turn coordinate proposals within DOD and with the FAA.

NOTE: For list of DOD Military-Civilian Joint-Use Airfields see Appendix 1

3. Provisions. All personnel subject to the requirements of this document shall comply with the following provisions:

a. Applicable Federal, State, and local laws, Service Regulations, applicable Code of Federal Regulations (CFRs), FAA Orders and the DOD/FAA Memorandum of Agreement Concerning the Operation of Unmanned Aircraft Systems in the National Airspace System (DOD/FAA MOA).

b. Operation of UAS in Class D airspace at non-joint-use airfields is limited to DOD UAS operations and contract operations conducted solely under the direction of Department of Defense or one of its entities.

c. Prior to commencing and at the conclusion of operations, DOD ATC shall advise ATC facilities providing approach control service to the applicable airfield that Unmanned Aircraft (UA) operations are being conducted. Local coordination will be effected with impacted ATC facilities to include normal, emergency and contingency operations.

4. Definitions.

a. NORDO aircraft: Any aircraft operating within the Class D airspace without two way radio communication with the ATC facility per 14 CFR Part 91.

b. UA Zones: Marshalling areas, defined by geographic, visual or GPS reference, used by UA and ATC as departure/arrival points to/from airfield, as depicted in the Certificate of Authorization (COA). UA Zones are also used for lost link and emergency orbit points for UA.

c. Lost link: UAS pilot/operator has lost the ability to provide real-time control of the UAS. Loss may be permanent or temporary.

5. Procedures. The following procedures will be applied at all non-joint-use DOD-controlled airfields with approved COA.

a. General Procedures.

(1) If equipped, UAs shall be operated at all times with full lighting and transponders.

(2) Procedures for deconfliction of UA and transient aircraft traffic will be specified in the COA. Possible methods of use: altitude restrictions for UA, visual holding points with specific lateral and vertical limits, use of ground observers.

(3) The UA mission commander shall advise ATC of initiation and completion of flight operations.

(4) Radio check between UA pilot/operator and ATC will be conducted prior to operations.

(5) All communications between ATC and UAS pilot/operator will be accomplished on designated primary and/or alternate ATC frequencies. Secondary/backup communications and/or telephone connectivity will be precoordinated.

(6) All UAS operations will be conducted under Visual Flight Rules (VFR) in accordance with applicable Service Regulations and FARs. Increased ceiling and visibility requirements can be applied.

b. ATC Procedures.

(1) Description of aircraft types. Describe UAS to other aircraft by stating "unmanned aircraft."

(2) ATIS Procedures. Make a new recording when UAS operations are in effect or have terminated for the day.

(3) Sequencing and Spacing Application. UAS pilots cannot be instructed to follow another aircraft.

(4) Simultaneous Same Direction, all UAS will be treated as "other" aircraft.

(5) Same Runway Separation, all UAS will be treated as Category III aircraft.

(6) Use of Visual Separation between UAS and manned aircraft or UAS and UAS is not authorized.

(7) SVFR is not authorized with UAS.

(8) Preventive Control. May only be applied in accordance with FAAO JO 7110.65.

(9) Transient Aircraft Procedures. ATC will keep the UA pilot/operator apprised of any known transient aircraft operations that may impact operations. UA pilot/operator will take all necessary actions to maintain lateral and vertical separation. ATC should provide UA pilot/operator recommended altitudes or direct to predetermined points (UA Zones) to ensure deconfliction.

(10) For the purpose of applying wake turbulence rules see FAAO JO 7110.65 PCG A-6 and Appendix 2, (list of DOD UAS). In addition to the requirements of FAAO 7110.65, ATC will apply the following procedures:

(a) Issue cautionary wake turbulence advisories, and the position, altitude and direction of flight to the pilot/operator of UAS landing behind all manned aircraft regardless of weight class.

(b) Wake turbulence rules cannot be waived by the UAS pilot/operator.

c. NORDO Aircraft Procedures.

(1) ATC will notify UA pilot/operators of any known NORDO aircraft.

(2) ATC will broadcast on emergency frequencies when an NORDO aircraft is present to expeditiously establish two-way radio communications with NORDO aircraft.

(3) UAS pilot/operator, assisted by ATC, will determine best method to separate UAS and NORDO aircraft. Examples of separation methods:

(a) UA may proceed to a UA Zone to hold

(b) Cease operations and land if it will not aggravate the situation

(c) Altitude deconfliction

NOTE: All aircraft who do not establish two-way radio communication as per CFR prior to entering Class D airspace will be reported to the FAA.

d. Emergency Procedures.

(1) ATC will apply the procedures listed in Chapter 10, Section 1 of FAAO JO 7110.65. Minimum required information for in-flight emergencies:

(a) Aircraft identification and type

(b) Nature of the emergency (lost link, equipment failure)

(c) Intentions of the UA pilot/operator

(d) Aircraft altitude / position

(e) Fuel remaining in time

(2) The safety of manned aircraft will take precedence over unmanned aircraft in an emergency situation.

(3) If primary radio communications between UA pilot/operator and ATC are lost, UA pilot/operator or ATC will be notified immediately via designated alternate communications method. Failure to establish or maintain radio communication between UA pilot/operator and ATC will require termination of UA operations.

(4) If lost link occurs, UAS pilot/operator will immediately notify ATC with the following information:

(a) Time of lost link

(b) Last known position

(c) Altitude

(d) Direction of flight

(e) Confirm execution of lost link procedures

(f) Confirm pilot/observer have visual contact with UA

NOTE: UA lost link is an emergency, but may not require crash-rescue services

(5) In the event of lost link, lost communication between UAS pilot/operator and ATC or lost communication between UAS pilot/operator and observer, ATC will do the following:

(a) Cease aircraft launches until status of affected UAS is determined

(b) Recover other UA as appropriate

(c) Issue advisories and ATC instructions as appropriate to insure the safe operation of all aircraft

APPENDIX 1 DOD Military-Civilian Joint Use Airfields

Army
Blackstone AAF, Fort Pickett, VA
Guernsey AAF, Camp Guernsey, WY
Dillingham AAF, Waialua, HI
Forney AAF, Fort Leonard Wood, MO
Robert Gray AAF, Fort Hood, TX
Grayling AAF, Camp Grayling, MI
Libby AAF, Fort Huachuca, AZ
Sherman AAF, Fort Leavenworth, KS
McCoy AAF, Fort McCoy, WI
Wright AAF, Fort Stewart, GA
Air Force
Air Force Plant 42, Palmdale, CA
Charleston AFB, Charleston, SC
Dover AFB, DE
Eglin AFB, Valparaiso, FL
Grissom ARB, Kokomo, IN
Kelly AFB, San Antonio, TX
March ARB, Riverside, CA
Scott AFB, Belleville, IL
Sheppard AFB, Wichita Falls, TX
Westover ARB, Springfield, MA
Navy
None
Marines
MCAS Yuma AZ

APPENDIX 2 DOD UAS Types and Weight

Types	Weight
MQ-1 Predator	2,250 lb
MQ-1C Sky Warrior	3, 200 lb
RQ-2 Pioneer	452 lb
RQ-4 Global Hawk	26,750-32,250 lb
RQ-5A/MQ-5B Hunter	1620-1950 lb
RQ -7 Shadow	375 lb
RQ-11 Raven	4 lb
RQ-14 Dragon Eye	6 lb
RQ-16A MAV	15 lb
MQ-8 Fire Scout	3,150 lb
MQ-9 Reaper	10,500 lb

8 Jan 09 6
set, (703) 806-4863

DEPARTMENT OF THE ARMY
ORGANIZATIONAL NAME/TITLE
STREET ADDRESS
CITY, STATE, AND ZIP +4 CODE

APPENDIX C – SAMPLE MEMORANDUM FOR CLASS G AIRSPACE

MEMORANDUM FOR Department of the Army Representative (DAR), Federal Aviation Administration Eastern Service Area (ASO 920), P.O. Box 20636, Atlanta, GA 30320-0631

SUBJECT: Notification of UAS Operations (20 Pounds or Less) in Class G Airspace

1. This memorandum constitutes notification of intent to operate DoD unmanned aircraft systems (UAS) that weigh 20 pounds or less flown below 1,200 feet above ground level within Class G airspace as specified in the memorandum of agreement for operation of UAS in the National Airspace System. The following required information is provided:

a. Unit or organization name.

b. Types of UAS (list each type if more than one UAS).

c. Total weight of each UAS with all additional payloads.

d. Geographical area of operations (attachment: map and coordinates depicting UAS operations area, launch and recovery sites, and lost link orbit area/point).

e. Start and end date (not to exceed 1 year).

f. Times of operations (examples: Daily, 1100 hours to 2200 hours (use Zulu times); Intermittent from sunrise to sunset; 2-3 flights a week, intermittent 24 hours a day).

g. Altitude

2. Operations are conducted over military bases or land protected by purchase, lease, or other restriction. No airspace as described in 14 CFR 91.215 (b)(2) is involved.

3. The Aviation Engineering Directorate issued an airworthiness certificate for this UAS. All operators are qualified to operate UAS in accordance with AR 95-23.

4. All operators will ensure that the UAS remains within clear visual range of the operator, or a certified observer in ready contact with the operator, to ensure separation from other aircraft.

OFFICE SYMBOL
SUBJECT: Notification of UAS Operations (20 Pounds or Less) in Class G Airspace

5. All operators will ensure that the UAS remains more than 5 miles from any civil use (public or private) airport or heliport.

6. A Notice to Airmen (NOTAM) will be published to alert nonparticipating aircraft of UAS operations. For nonrecurring operations, NOTAMs will be published no later than 24 hours in advance. For recurring operations (e.g., training), a standing “blanket” NOTAM will be issued.

7. In accordance with AR 95-23, chapter 2, unmanned aircraft anticollision lights will be on when UAS engines are operating, except when there may be other hazards to safety. Position lights will be on between official sunset and sunrise, unless a waiver has been obtained from HQDA (DAMO-AV) in accordance with AR 95-23. A copy of the waiver is enclosed.

8. All operators and observers will be medically qualified in accordance with Interim Guidance for Unmanned Aircraft Systems (UAS) Operations in the National Airspace System (NAS) and ALARACT 293/2010 (Notification of Change to the Aeromedical Physical Standards of Unmanned Aerial System Operators (UASO).

9. I understand all accidents and incidents must be reported promptly to the DAR FAA Eastern Service Area.

10. My point of contact is XXX, Office Symbol, DSN XXX-XXX, commercial (XXX) XXX-XXXX, or email address:

Encl SIGNATURE BLOCK

APPENDIX D – DA FORM 2397-U
UNMANNED AIRCRAFT SYSTEM ACCIDENT REPORT (UASAR))

UNMANNED AIRCRAFT SYSTEM ACCIDENT REPORT *(UASAR)*
Use for all UAS Aviation Accidents
For use of this form, see DA Pamphlet 385-40; the proponent agency is OCSA.

REQUIREMENTS CONTROL SYMBOL
CSOCS-309

1. ACCIDENT CASE INFORMATION	a. Date *(YYYYMMDD)*	b. Time *(Local)*	c. UA Tail Number
2. ACCIDENT CLASS/ CATEGORY	a. Classification ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F	b. Category ☐ Flight ☐ Flight Related ☐ Aircraft Ground	**3. UAS MTDS**
4. PERIOD OF DAY ☐ Dawn ☐ Day ☐ Dusk ☐ Night	**5. AIRCRAFT INVOLVED** a. Number of Aircraft Involved	b. In Flight/Mid-Air Collision ☐ Yes ☐ No ☐ Unknown	**6. NEAREST MILITARY INSTALLATION**
7. ACCIDENT LOCATION a. ☐ On-Post ☐ Off-Post	b. ☐ On Airfield ☐ Not on Airfield	c. City	d. State / e. Country / f. Grid and/or Lat/Long

8. ORGANIZATION INVOLVED

a. Unit Designation	b. Unit Identification Code (UIC)	c. Home Station	d. Army Headquarters

9. ACCOUNTABLE ORGANIZATION *(If same as block 8 leave blank)*

a. Unit Designation	b. Unit Identification Code (UIC)	c. Home Station	d. Army Headquarters

10. ACCIDENT COST DATA	a. UA Total Loss ☐ Yes ☐ No	b. UA Damage or replacement Cost *(Excluding Man-hours)* $	c. Number of Man-Hours	d. Man-Hours Cost $	e. Other UAS Sub-System Cost $
f. Other Damage Cost-Military $	g. Other Damage Cost-Civilian $	h. Injury/Occupational Illness $	i. Total Cost *(This UAS)* $	j. Total Cost *(All Aircraft)* $	

11. GENERAL DATA	a. Mission	a(1). Type Mission	a(2). Aircraft Mode ☐ Single-ship ☐ Multi-ship ☐ Manned/Unmanned Teaming	a(3). Level of Interoperability (LOI) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ NA
a(4). Simultaneous UA Operation? ☐ Yes ☐ No *(If Yes, specify number & MTDS)*			b. Flight Plan ☐ Military ☐ Civil ☐ Operation's Log	c. Flight Rules ☐ VFR ☐ IFR
d. Mission/ Training	d(1). At what level was mission/training conducted? ☐ Bde ☐ Bn ☐ Co ☐ Plt ☐ Sqd ☐ Team ☐ Crew			d(2). Who approved the mission/training? Rank & Position:
d(3). Was a mission brief completed? ☐ Yes ☐ No	d(4). Who was in charge during the mission? Rank & Position:			d(5). Who was the senior leader present during the mission/training? Rank & Position:

e. Risk Management (RM)	e(1). RM Performed? ☐ Yes ☐ No	e(2). Who performed the RM? Rank & Position:	e(3). RM Approved? ☐ Yes ☐ No	e(4). Who accepted risks? Rank & Position:
e(5). What was the level of the risk after controls applied? ☐ Low ☐ Moderate ☐ High ☐ Extremely High			e(6). How was the RM process communicated? *(Check all that apply.)* ☐ Worksheet ☐ Verbal Brief ☐ Order ☐ Not Communicated	
e(7). Accident event identified/considered during RM process? *If yes, complete blocks 11a(7)a thru 11e(7)d)* ☐ Yes ☐ No			e(7)a. What was the level of the identified risk? ☐ Low ☐ Moderate ☐ High ☐ Extremely High	
e(7)b. Was the control measure(s) applied? ☐ Yes ☐ No	e(7)c. Who was responsible for implementing the controls? Rank & Position:			e(7)d. Was the potential for accident event accepted as residual risk? ☐ Yes ☐ No
f. Digital Source Collector (DSC)	f(1). DSC installed? *(If yes, enter type of DSC)* ☐ Yes ☐ No		f(2). Data captured and preserved? *(If yes, specify storage location)* ☐ Yes ☐ No	
g. Fire ☐ None ☐ Inflight ☐ Postcrash ☐ Other *(Specify)*	h. Hazardous Material Spillage *If yes & a Class A, B or C accident, attach DA Form 2397-6)* ☐ Yes ☐ No		i. Did accident occur while on an exercise or at a training facility/center? *(If yes, enter the name)* ☐ Yes ☐ No	

12. SUMMARY *(Attach a continuation sheet(s) as needed)*

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13. FLIGHT DATA	Flight Duration	Phase of Operation *(Enter max of 3 codes from Table 3-4 of DA Pam 385-40 or specify the phase if there is no code for it in the table)*	Altitude MSL	Altitude AGL	Airspeed KIAS	UA Weight	UA Overgross Weight for Conditions Yes	No	14. TYPE EVENTS *(Enter max of 3 codes from Appendix F table F-3 of DA Pam 385-40 or specify the type event which best describes the accident/incident event if there is no code for it in the table.)*
a. At Emergency/ Onset	Hours / Tenths						☐	☐	
b. At Impact/Acdt or Termination	Hours / Tenths						☐	☐	

c Flight Ctrl Malfunction — Check all that apply:
☐ Human ☐ Environmental ☐ Materiel ☐ Hardware ☐ Software ☐ Component/Part ☐ Not Applicable

15. ACCIDENT CAUSE FACTORS *(For blocks 15a-c, D=definite, S=Suspected, U=Undetermined and N=No/None)*

a. Human Factors *(Check box D, S, U or N. If D or S, complete blocks 15a(1)(a)-(e))* ☐ D ☐ S ☐ U ☐ N

a(1). System Inadequacies *(Enter max of 3 codes in each block below from table B-5 (Additional codes in table B-1) DA Pam 385-40 or if there is no code in the table, write in that which best describes the failure)*

a(1)a. Support Failure	a(1)b. Standards Failure	a(1)c. Training Failure	a(1)d. Leader Failure

a(1)e. Individual Failure	b. Materiel Factors *(Check box D, S, U or N. If D or S, complete blocks 15b(1)-(2))* ☐ D ☐ S ☐ U ☐ N	b(1). Type *(Check all that apply.)* ☐ Component/Part ☐ Hardware ☐ Software

b(2). Component and Part *(Part that initiated failure/malfunction)*

	UAS Subsystem *(UA, GCS, GDT, TALS, etc.)*	Major Component	Part
a. Nomenclature			
b. Type, Design, and Series			
c. Part Number			
d. NSN/ Manufacturer's Number			
e. Manufacturer's Code			
f. Serial Number			
g. Cause of Failure/ Malfunction		☐ Materiel ☐ Maintenance ☐ Design ☐ Manufacture	*(Enter the applicable Failure Codes (max 2) using table 1-2, DA Pam 738-751 (TAMMS-Aviation))*

c. Environmental Factors *(Check box D, S, U or N, as appropriate.)* ☐ D ☐ S ☐ U ☐ N

c(1). General *(Check all that apply.)* ☐ VMC ☐ IMC ☐ Icing ☐ Turbulence

c(2). Weather Conditions *(Enter max of 3 codes from Appendix F table 3-26 of DA Pam 385-40 or specify the weather condition if there is no code for it in the table.)*

c(3). Environmental Signal Factors ☐ Uplink ☐ Downlink ☐ Interference ☐ E[3] ☐ NA ☐ Other *(Specify)*

c(4). Other Environmental Factors *(Enter max of 3 codes from Appendix F table 3-27 of DA Pam 385-40 or specify the weather condition if there is no code for it in the table.)*

16. LOSS OF LINK *(Check box D, S, U or N. If D or S, complete blocks 16 a-d)* ☐ D ☐ S ☐ U ☐ N

a. Type of Link Lost ☐ Uplink ☐ Downlink ☐ Unknown

b. Type of Link ☐ LOS ☐ BLOS ☐ C-Band ☐ Ku-Band ☐ Other *(Specify)*

c. UA distance from the GCS at time of LOL

d. LOL Factors *(Check all that apply.)* ☐ Human ☐ Environment ☐ Materiel ☐ Hardware ☐ Software ☐ Component/Part

17. TAKE OFF/LANDING DATA *(Complete block 17a if accident occured during take-off phase and block 17b if during landing phase.)*

a. Take-Off (T/O) Phase	a(1). T/O Method ☐ ATLS ☐ Launcher ☐ Manual	a(2). T/O Accident Factors *(Check all that apply.)* ☐ Human ☐ Environment ☐ Materiel ☐ Hardware ☐ Software ☐ Component/Part
b. Landing Phase	b(1). Landing Method ☐ ATLS ☐ TALS ☐ FTS ☐ Manual	b(2). Landing Accident Factors *(Check all that apply.)* ☐ Human ☐ Environment ☐ Materiel ☐ Hardware ☐ Software ☐ Component/Part

18. TYPE OF STRIKE

☐ Wire ☐ Bird ☐ Tree ☐ Object ☐ Lighting ☐ Antenna ☐ N/A ☐ Other *(Specify)*

19. PERSONNEL DATA *(Complete for each crew member with access to flight controls, personnel injured/occupational illness, personnel having a contributing role in the accident; use additional forms if needed.)*

a. Name *(Last, First, MI)*	(1) SSN	(2) Grade	(3) Gender ☐ Male ☐ Female	(4) Duty	(5) SVC	(6) UIC *(Assigned)*	(7) Contributing Role ☐ D ☐ S ☐ U ☐ N	(8) On Fit Ctrls ☐ Yes ☐ No	(9) Lab Test ☐ Pos ☐ Neg ☐ Not Required
(10) Activity: (a) Hrs Slept / (b) Hrs Worked / (c) Hrs Flown	(11) Individual Status: (a) RL ☐ 1 ☐ 2 ☐ 3 ☐ Msn Prep ☐ Msn Qual; (b) FAC ☐ 1 ☐ 2 ☐ 3 ☐ NA *(SUAS Operators)*; (c) Redeployed Date *(YYYYMMDD)*					(12) Injury/Occupational Illness *(If "yes" complete and attach DA Form 2397-9)* ☐ Yes ☐ No		(13) MTDS Flt Hrs	(14) Total Flt Hrs
b. Name *(Last, First, MI)*	(1) SSN	(2) Grade	(3) Gender ☐ Male ☐ Female	(4) Duty	(5) SVC	(6) UIC *(Assigned)*	(7) Contributing Role ☐ D ☐ S ☐ U ☐ N	(8) On Fit Ctrls ☐ Yes ☐ No	(9) Lab Test ☐ Pos ☐ Neg ☐ Not Required
(10) Activity: (a) Hrs Slept / (b) Hrs Worked / (c) Hrs Flown	(11) Individual Status: (a) RL ☐ 1 ☐ 2 ☐ 3 ☐ Msn Prep ☐ Msn Qual; (b) FAC ☐ 1 ☐ 2 ☐ 3 ☐ NA *(SUAS Operators)*; (c) Redeployed Date *(YYYYMMDD)*					(12) Injury/Occupational Illness *(If "yes" complete and attach DA Form 2397-9)* ☐ Yes ☐ No		(13) MTDS Flt Hrs	(14) Total Flt Hrs
c. Name *(Last, First, MI)*	(1) SSN	(2) Grade	(3) Gender ☐ Male ☐ Female	(4) Duty	(5) SVC	(6) UIC *(Assigned)*	(7) Contributing Role ☐ D ☐ S ☐ U ☐ N	(8) On Fit Ctrls ☐ Yes ☐ No	(9) Lab Test ☐ Pos ☐ Neg ☐ Not Required
(10) Activity: (a) Hrs Slept / (b) Hrs Worked / (c) Hrs Flown	(11) Individual Status: (a) RL ☐ 1 ☐ 2 ☐ 3 ☐ Msn Prep ☐ Msn Qual; (b) FAC ☐ 1 ☐ 2 ☐ 3 ☐ NA *(SUAS Operators)*; (c) Redeployed Date *(YYYYMMDD)*					(12) Injury/Occupational Illness *(If "yes" complete and attach DA Form 2397-9)* ☐ Yes ☐ No		(13) MTDS Flt Hrs	(14) Total Flt Hrs

20. FINDINGS AND RECOMMENDATIONS *(See instructions in DA Pam 385-40, para 2-24, for writing findings and recommendations. Use additional sheets if needed)*

USACRC use only								
Duty		Role		Failure/error Code	SI 1	RM 1	RM 2	RM 3
Phase of OP		Task/part no.			SI 2	RM 1	RM 2	RM 3

21. LIST OF ATTACHMENTS *(ECOD/ACOD, CCAD, PQDR, DA Forms 2397-series, etc.)*

22. BOARD PRESIDENT/ASO/POC *(Name, Signature, and Date)*	a. Grade	b. Branch	Address and Tel No. *(DSN and Com)*
	E-Mail		

23. COMMAND REVIEW *(Only required for class A, B & C)*

Reviewer	Organization	Name *(Last, First, MI)*	Rank	Comments	Signature
a. Unit Commander				☐ Concur ☐ Non-concur	
b. Reviewing Official				☐ Concur ☐ Non-concur	
c. Approving Authority				☐ Concur ☐ Non-concur	
d. DA Review	USACR/SC			Approved for entry into ASMIS *(YYYYMMDD)*	

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