APPLICATIONS FOR UNMANNED AERIAL VEHICLES in Electric Utility Construction

A Technology Transfer Report

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EXECUTIVE SUMMARY

The cost for flying robots is plummeting while their capabilities are soaring. Whether you identify them as drones, UAVs (Unmanned Aerial Vehicles), sUAS (small Unmanned Aerial Systems), or RPAs (Remotely Piloted Aircrafts), multiple business sectors are likely to be disrupted by this new technology. This summary provides a broad overview of current capabilities and US regulatory framework. Additionally, this research proposes a set of applications that can be useful for electrical line construction and maintenance, along with example training and operating guides.

The goal of this summary is to provide a starting point for interested businesses to come up to speed quickly on the opportunities and challenges related to UAVs in the current technological/legislative landscape.

The landscape of quickly improving hardware and solidifying FAA regulations brings about a critical opportunity to establish a cutting-edge program to leverage UAVs for utility system monitoring, along with requisite qualifications, safety, and training.

There are three main differentiators between UAV platforms: range of communication, flight time, and load/platform capabilities. There are anticipated near-term improvements to all three categories.

Communication is typically limited by line of sight. Flight time is limited by battery capabilities and weight. Novel platform capabilities are constantly being implemented. We recommend:

- **Type of platform** – use multi-rotor platforms where possible.
- **Payload capabilities** - use off-the-shelf cameras initially, incorporating more specialized equipment as merited only after initial platform testing has been completed.
- **Flight time** - initially emphasize shorter flight times for proof of concept implementation and scale up to longer flight times, if needed.

Because of the rapid development of novel platforms, we recommend that interested readers review information on the most recent hardware available before buying. A selection of UAVs offered by three popular companies at the time of writing are:

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Price</th>
<th>Payload</th>
<th>Customizable Payload?</th>
<th>Flight Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Robotics</td>
<td>Solo (Enterprise Edition)</td>
<td>$2,649</td>
<td>Go Pro</td>
<td>Multiple Cameras</td>
<td>20-25</td>
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<tr>
<td>DJI</td>
<td>Inspire Pro</td>
<td>$4000+</td>
<td>360, 3 axis 4K Camera</td>
<td>Yes</td>
<td>15</td>
</tr>
<tr>
<td>DJI</td>
<td>Matrice 100</td>
<td>$4,300</td>
<td>FLIR/DSLR</td>
<td>Yes</td>
<td>40</td>
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<tr>
<td>DJI</td>
<td>Phantom 4</td>
<td>$1,400</td>
<td>4K Camera</td>
<td>No</td>
<td>28</td>
</tr>
<tr>
<td>DJI</td>
<td>S1000</td>
<td>$4000+</td>
<td>DSLR Camera</td>
<td>Yes</td>
<td>15</td>
</tr>
<tr>
<td>Yuneec</td>
<td>Typhoon 4k</td>
<td>$900</td>
<td>4K Camera</td>
<td>No</td>
<td>25</td>
</tr>
</tbody>
</table>

UAVs can perform many types of optical inspections, including:

- **Pole Top Inspections**
- **Distribution Line Inspections**
- **Land and Facility Inspections**
- **Infrared Inspections**
- **Corona Detection**
Other uses for UAVs include LIDAR inspections to measure conductor sag and 3D imagery of structures to virtually reconstruct a tower, and using a line spooler to launch a finger line string over a cross arm for initial installation of a new overhead line. There is also a significant amount of interest in using UAVs for package delivery. This option could easily be applied to small material and/or tool delivery.

A UAV program will initially focus on how best to collect data (e.g., what platform and sensors should be used, how it should be flown, etc.). However, once data are successfully collected, data management becomes increasingly important. Before a UAV program is deployed, it is important to make critical decisions, such as assessing how the data will be analyzed, be aligned, track objects over time, and be stored.

Several websites discuss UAV Safety and Operating Procedures. A typical list of topics might include: Area and Environment, Equipment/UAV/Drone, Mission Plan, Public Awareness, Pre-Flight/Run-up, In-Flight, and Post-Flight. A Training Plan and sample procedures are included in this report, addressing: Safety, Standard Operating, Maintenance, and Incident Reporting.

The regulatory framework in the United States surrounding UAVs is evolving rapidly. Currently, the rules outlined in “Part 107” by the Federal Aviation Administration (FAA) are the primary framework for commercial entities to fly. Flights can operate during daylight or in twilight. The minimum visibility is three miles from the control station. The maximum altitude is 400 feet above the ground, or higher if within 400 feet of the top of a structure. The maximum speed is 100 mph (87 knots). A UAV cannot fly over anyone who is not directly participating in the operation.

An external load or cargo can be carried as long as it is securely attached, does not adversely affect the flight characteristics or controllability of the aircraft, and the total weight is a maximum of 55 lbs. UAVs do not need an airworthiness certificate or aircraft certification, but operators must perform a preflight of the vehicle to establish that it is safe to fly.

Operators flying a UAV must be at least 16 years old and have a remote pilot certificate with a small UAV rating, or be directly supervised by someone with such a certificate. To receive a remote pilot certificate, an individual must either pass an initial aeronautical knowledge test at an FAA-approved knowledge-testing center or have an existing non-student Part 61 pilot certificate. The Transportation Safety Administration (TSA) will conduct security background checks prior to issuing this certificate.

Complicating matters, legislation is changing rapidly to meet the growing needs of the UAV market. During the first half of 2016, at least 41 states have considered legislation related to UAVs. Of these, 14 states have passed 26 pieces of legislation. It is therefore critical to consider state and local legislation, in addition to FAA regulations, when developing a UAV program.

One way for a contractor to establish a UAV program could be to start with a local utility where you have established a relationship and ask the utility for an opportunity to demonstrate your UAV capabilities. At the same time, it is very important to create marketing literature to send to all existing customers. Over the coming years this may help launch new endeavors. Opportunities also include preparing aerial views of installations and augmenting utility maps/records.
In recent years, Unmanned Aerial Vehicles (UAVs) have moved from strictly military platforms to domains that include agriculture, real estate, filmmaking, law enforcement, utilities, and construction. Although the FAA is still working to finalize rules that balance safety against commercial and recreational interests, companies around the globe have been pouring funds into this exploding sector.

By 2025, there will be an estimated 100,000 new jobs related to UAVs created, with an $82 billion impact on the national economy from 2015-2025.

(Figure 1). Unmanned Aerial Vehicles (UAVs) represent an important and growing industry, due largely to their ability to significantly reduce the cost of numerous tasks, relative to traditional approaches.
This research project is based upon initial discussions with two electrical contractors and an electric utility. O’Connell Electric Company is currently considering how drones, or UAVs, can be leveraged for line inspection work. The company sees an opportunity to expand business by offering UAV line inspection services at significantly lower costs than traditional manned helicopter inspection. St. Francis Electric recently obtained approval from the Presidio Trust on its Doyle Drive/Presidio Parkway project to use UAVs during a three-day closure when opening new tunnels, bridges, parkway, etc. San Diego Gas and Electric (SDG&E), an electric utility with over 200,000 assets, currently requires significant costs to monitor via manned helicopters. In March 2016, SDG&E received permission from the FAA to use UAVs to scout its Southern California service area.

Currently, the FAA’s Special Airworthiness Certificate for small UAVs allows SDG&E to research, test, and train flight crews. SDG&E has a three-day training program to demonstrate safe operation and insurance is provided via a rider to their current insurance policy (at no extra cost). The utility’s initial two aircraft cost $6,000 total, including ground controllers with controls similar to a Sony PlayStation. SDG&E has now purchased a total of ten drones from the same company. These UAVs have three compact cameras and sensors for location, compass direction, and elevation. More recent capabilities include heavier payloads, LIDAR sensors, 15 megapixel cameras, and high definition multispectral cameras (which can also see in infrared).

This combined landscape of quickly improving hardware and solidifying FAA regulations brings about a critical opportunity to establish a cutting-edge program to leverage UAVs for utility system monitoring, along with requisite qualifications, safety, and training.

1) Per Constructor magazine (Herbert 2015) “If contractors don’t already use aircraft, or have an aviation policy, they can either ask their insurance broker and carrier for a separate aviation policy, or ask for the ISO UAV endorsement to their general liability policy that would cover the incidental use of drones”
CHAPTER 2: CURRENT STATE OF UAV CAPABILITIES

LITERATURE REVIEW

A recent issue of *Constructor* magazine (Herbert 2015) reported there is great potential for the use of UAVs on construction job sites for many applications, including up-close inspections of energized lines, thermal imaging, general Maintenance and Operations (M&O), and storm damage assessment. All of this can be accomplished without the use of major equipment (bucket trucks, helicopters, etc.) and with no impact on the environment. Other opportunities include generating marketing materials and aerial views of installations to augment utility maps and records. Previously, the FAA had restricted UAV use to experimental or exceptional purposes. In February 2015, the agency proposed a rule to allow UAVs for “non-recreational operation” under certain conditions. The FAA has also proposed a “more flexible” framework for UAVs weighing less than 4.4 pounds, which would be the case for aerial inspection work.

An Electric Power Research Institute (EPRI) report (Phillips 2008), states, “Technology developments in sensors, robotics, unmanned vehicles, satellite and wireless data communications could be leveraged to enable the development of an effective automated inspection system for transmission line/tower monitoring applications.” The report further conceptualizes the instrumentation of electric power utility towers with sensor technology designed to increase the efficiency, reliability, safety, and security of electric power transmission.

Vukojevic (2016) comments that there are three pillars of implementation of small Unmanned Aerial Systems (sUAS): the safety aspect, operational excellence, and the business case aspect. As the emerging technology manager at Duke Energy, Vukojevic spearheaded a sUAS pilot project with two objectives: first, to understand the capabilities of different vertical takeoff and landing platforms, and, second, to understand the fixed-wing Puma platform manufactured by AeroVironment along with advanced payloads. The pilot program performed coal pile inspection, vegetation management, and assessed military-grade versus commercial platforms.
Hickman (2015) proposes many commercial uses for drones within several market areas including construction, energy, insurance, real estate, research, and retail delivery. Specific applications include monitoring and documenting project progress; inspection of pipelines, utility lines, and other infrastructure; inspection of operational assets; surveying and assessing site risks; assessment with site surveys; collection of climatic data; and delivery of purchases within a specified radius.

An international perspective (Transpower New Zealand Ltd. 2015), categorizes Remotely Powered Aircraft Systems (RPASs) into two classes, line-of-sight operations and beyond line-of-site operations. Potential applications include visual inspection, corona detection, thermal inspection, under-build inspection, and vegetation management.

Soar Environmental Consulting, Inc. near Fresno, California offers environmental inspections utilizing UAVs (Witcher 2015). The company’s CEO states that California hydroelectric assets must be inspected twice a year, and that UAVs provide a safer and more efficient alternative to a manned hike via a nearly vertical ascent.

ANALYSIS OF CURRENT, POPULAR UAV SUPPLIERS AND MODELS

A list of commercial and industrial platforms is presented in Table 1. The three main differentiators between the platforms are range of communication, flight time, and load / platform capabilities. There are anticipated near-term improvements to all three of these capabilities.

Communication is typically limited by line of sight. Satellite communication is possible for higher-end platforms and there have been proposals for other communication capabilities such as using the cell-phone network. Current FAA rules require that UAVs operate within the pilot’s visual line of sight.

Flight time is limited by battery capabilities and weight. Industry has long recognized battery capacity as a limiting factor for many applications (e.g., notebook computers) but significant improvements have not been forthcoming. There have been recent successful flights of research vehicles that use fuel cells. Hopefully such batteries will come to the commercial market in the next few years, potentially improving flight times by an order of magnitude.

Novel platform capabilities are constantly being implemented, from the ability to mount new types of cameras and sensors to the ability to interact with the environment, such as manipulating small objects or drawing water samples from a lake. It is likely many of the most revolutionary improvements will be in this area as research and industry finds new tasks that can be accomplished with low weight, low power sensors/actuators. One recent improvement is to use sensors for better situational awareness to reduce the risk of collisions – the DJI Phantom 4 is the first to provide a rudimentary version of such a system.

As noted above, we recommended interested readers review the most recent hardware available before buying. Table 1, repeated for reference on the following page, provides a selection of UAVs offered by three popular companies at the time of writing. A more complete comparison of UAVs from more manufacturers, as well as additional points of comparison, can be found in Table 2. When selecting a platform to use, we suggest purchasing an inexpensive platform based on the three parameters below. Then, after an initial assessment of feasibility and platform performance, more expensive platforms can be purchased, depending on budgetary constraints.
1. Type of platform *(fixed wing vs. multi-rotor)*

Fixed wing UAVs typically fly faster and longer than multi-rotor versions and can operate in higher winds. However, they also require more skill to control and need a much larger landing/takeoff area. Multi-rotors are generally easier to fly and can land/takeoff from a small area. Additionally, because they can hover in place, they may be able to take higher resolution images and be better able to capture data from an optimal distance or angle. *We recommend multi-rotor platforms where possible.*

2. Payload capabilities

The majority of applications relevant to electric utility construction will require a camera to be mounted on the platform. The resolution, lens, and wavelength requirements will, in turn, dictate the weight and power requirements. More specialized payloads, such as those that can measure corona, manipulate items in an environment, or measure distance to an object may require more specialized platforms. *We recommend using off-the-shelf cameras initially, incorporating more specialized equipment as merited after initial platform testing has been completed.*

3. Flight time

Given the type of platform and necessary payload, possible flight time may be restricted by the types of batteries available. More powerful batteries with higher energy density are able to power the platform longer, but with higher expense and weight. There are typically diminishing returns on increasing the capacity of the battery: as the battery becomes larger, more of the power is used just to lift the larger battery. *We recommend initially emphasizing shorter flight times for proof of concept implementation and scaling up to longer flight times, if needed.*

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<th>Payload</th>
<th>Customizable Payload?</th>
<th>Flight Time (minutes)</th>
<th>General Notes</th>
<th>Link</th>
<th>Used By</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Robotics</td>
<td>Solo (Enterprise Edition)</td>
<td>$2,049</td>
<td>Go-Pro Multi-Camera</td>
<td>Yes</td>
<td>30-25</td>
<td>US Made,Mapping Software included</td>
<td><a href="https://3dr.com/enterprise/">https://3dr.com/enterprise/</a></td>
<td></td>
</tr>
<tr>
<td>DJI</td>
<td>Inspire Pro</td>
<td>$4,000+</td>
<td>360, 3 axis 4K Camera</td>
<td>Yes</td>
<td>15</td>
<td>Similar to Inspire 1 but with upgraded gimbal, camera, and controls</td>
<td><a href="http://www.dji.com/product/inspire-1-pro-and-raw">http://www.dji.com/product/inspire-1-pro-and-raw</a></td>
<td>DJI</td>
</tr>
<tr>
<td>DJI</td>
<td>Matrice 100</td>
<td>$4,300</td>
<td>FLIR/DSLR</td>
<td>Yes</td>
<td>40</td>
<td>Vision Processing, 360 degree obstacle avoidance, FLIR Options</td>
<td><a href="http://www.dji.com/product/matrice-100">http://www.dji.com/product/matrice-100</a></td>
<td></td>
</tr>
<tr>
<td>DJI</td>
<td>Phantom 4</td>
<td>$1,320</td>
<td>4K Camera</td>
<td>No</td>
<td>20</td>
<td>Limited Sense &amp; Avoid Technology</td>
<td><a href="http://www.dji.com/product/phantom-4">http://www.dji.com/product/phantom-4</a></td>
<td></td>
</tr>
<tr>
<td>DJI</td>
<td>Tello</td>
<td>$4,000+</td>
<td>360 Camera</td>
<td>Yes</td>
<td>15</td>
<td></td>
<td><a href="http://www.dji.com/product/360-tello">http://www.dji.com/product/360-tello</a></td>
<td>Duke Energy</td>
</tr>
</tbody>
</table>
## Table 2: UAV Capabilities - Full Chart

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Price</th>
<th>Type</th>
<th>Payload</th>
<th>Communication Protocol</th>
<th>Range (miles)</th>
<th>Ceiling Height (ft)</th>
<th>Intended Use</th>
<th>Propulsion</th>
<th>Gimbal and Camera</th>
<th>Videos / Photos</th>
<th>Storage / Data Processing</th>
<th>Software License</th>
<th>General Notes</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJI</td>
<td>Mavic Pro</td>
<td>~$600+</td>
<td>Quadcopter</td>
<td>4 Rotor</td>
<td>2.4ghz</td>
<td>10-20</td>
<td>18</td>
<td>Long Range Outdoor</td>
<td>Electric</td>
<td>DJI</td>
<td>Indoor/Outdoor</td>
<td>~$70,000</td>
<td>Unknown/Proprietary</td>
<td>Open Source</td>
<td>Duke Energy</td>
</tr>
<tr>
<td>DJI</td>
<td>Phantom 4</td>
<td>$900</td>
<td>Quadcopter</td>
<td>4 Rotor</td>
<td>2.4ghz</td>
<td>10-20</td>
<td>18</td>
<td>Long Range Outdoor</td>
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<td>SkyRanger</td>
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<td>Open Source</td>
<td>Duke Energy</td>
</tr>
<tr>
<td>Altitude Unmanned</td>
<td>GEO Mapper</td>
<td>~$14k+</td>
<td>Fixed Wing</td>
<td>4 Rotor</td>
<td>2.4ghz</td>
<td>10-20</td>
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<tr>
<td>Sky Spy</td>
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<td>$900</td>
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</tr>
</tbody>
</table>
The United States regulatory framework surrounding UAS is evolving rapidly. The goal of this section of the report is to provide a summary of current laws and regulations at the time of writing. This information is not intended to constitute legal advice and should not be relied upon in lieu of consultation with appropriate legal advisors in each reader’s own jurisdiction. Some information may not be current as the laws in this area change frequently.

Until recently, the FAA advisory circular issued June 9, 1981, clearly specified how and where model aircraft could be operated. The FAA Modernization and Reform Act of 2012 updated these regulations, but also added significant complexity regarding when and how UAS could be flown legally. Broadly, flight authorization falls into the three categories of commercial, recreational, and public entities. Recreational is generally the most permissive and easiest for which to qualify. Commercial operations will likely be most relevant to the readers of this report.

On June 21, 2016, the FAA released “Part 107,” which, overall, makes it easier for commercial and public sector operators to operate UAS weighing 55 lbs. or less. The sections below reflect changes in these most recent rules, and Section 3.4 highlights a selection of the most relevant changes. The full text of Part 107 can be found online, as well as an official summary of the 600+ page document. These new rules became effective in late August 2016. Not all FAA and non-governmental websites have been updated at the time of this writing. Note that the Part 107 rules generally do not affect recreational operators.

There are currently few rules related to privacy for sUAS operators. Because of the potential for negative publicity, you may wish to take measures before flying to preempt complaints from consumers who may be affected. For example, the National Telecommunications and Information Administration has published a document titled “Voluntary Best Practices for UAS Privacy, Transparency, and Accountability” that may prove useful.
RECREATIONAL

Small UAS (less than 55 lbs.) can be operated for hobby and recreational purposes (Figure 2). For example, a hobbyist can take pictures with a sUAS, but cannot sell them because that would be a commercial venture. The safety guidelines, which also generally apply to non-recreational users, include the following:

- **Flight ceiling is 400 feet**
- **UAS must remain in visual control of the operator**
- **UAS must not interfere with manned aircraft**
- **UAS may not be flown over people or vehicles**
- **Remain at least 25 feet away from individuals and “vulnerable” property**
- **Do not fly in adverse weather**
- **Do not fly while the operator is under the influence of alcohol or drugs**
- **Do not fly near “sensitive infrastructure” such as power stations, correctional facilities, etc.**
- **Do not photograph people where there is an expectation of privacy**

Recreational users must register their aircraft ([https://www.faa.gov/uas/registration/](https://www.faa.gov/uas/registration/)). Non-recreational users must also register their aircraft, but this is done along with their general application to operate.

PUBLIC ENTITIES

Public entities, including governmental agencies, can apply for a Certificate of Authorization (COA) from the FAA. These “Public Operations” are governed by the FAA, which has an on-line system at [https://ioeaaa.faa.gov/oeaaa/Welcome.jsp](https://ioeaaa.faa.gov/oeaaa/Welcome.jsp) where organizations can apply for a COA. Public entities could also be authorized to fly sUAS under the Part 107 rules (page 11).

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COMMERCIAL

FAA-defined Civil Operations were traditionally granted through three methods. First, a Special Airworthiness Certificate (SAC) in the Experimental Category can be used to perform research and development, crew training, and market surveys. Second, an SAC in the Restricted Category may be obtained. Third, and most relevant, a company can petition for a COA with a Section 333 Exemption.

Section 333 of the FAA Modernization and Reform Act of 2012 (FMRA) grants the Secretary of Transportation the authority to determine whether an airworthiness certificate is required for an Unmanned Aircraft System (UAS) to operate safely in the National Airspace System (NAS). An FAA Section 333 Petition Guidance & Checklist form is included in Appendix A.

Section 333 is a popular method companies can use to “pursue safe and legal entry into the NAS for a competitive advantage in the UAS marketplace, thus discouraging illegal operations and improving safety.”6 The process for petitioning for such an exemption is detailed on the FAA website7 and an additional document8 details frequently asked questions, also providing a good place for interested parties to begin to learn more about the relevant procedures. There are also multiple websites that can help you walk through the application process9,10, as well as companies that will help you file a 333 exemption for a fee. There are currently more than 5,000 Section 333 petitions granted in the US and listings for currently authorized companies can be found on-line in both list11 and visual12 formats.

Companies that have a Section 333 exemption can continue to fly under its terms and conditions. However, alternative authorization can also be granted via the new Part 107 rules.

PART 107 UPDATES

This section summarizes the most relevant Part 107 changes to both operation and pilot requirements for non-hobbyists.

OPERATION

Flights can operate during daylight or in twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting. The minimum visibility is three miles from the control station. The maximum altitude is 400 feet above the ground, or higher if within 400 feet of the top of a structure. The maximum speed is 100 mph (87 knots). A sUAS cannot fly over anyone who is not directly participating in the operation.

An external load or cargo can be carried if it is securely attached, does not adversely affect the flight characteristics or controllability of the aircraft, and has a total maximum weight of 55 lbs. The FAA can waive many of the operational restrictions if the proposed operation will still be safe.

6) https://www.faa.gov/uas/legislative_programs/section_333
7) https://www.faa.gov/uas/legislative_programs/section_333/how_to_file_a_petition/
8) https://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/
9) https://www.faa.gov/uas/legislative_programs/section_333/how_to_file_a_petition/
10) http://www.acuas.org/333-exemption/
11) http://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/
12) http://www.suasnews.com/faq-drone-333-exemption-holders/
Note that sUAS no longer need an airworthiness certificate or aircraft certification. However, operators must perform a preflight of the vehicle to establish that it is safe to fly. The FAA provides an example preflight checklist. Part 107 also removed the requirement for commercial operators to file a Notice to Airmen (NOTAM).

**OPERATOR**

The person flying a drone must be at least 16 years old and have a remote pilot certificate with a small UAS rating, or be directly supervised by someone with such a certificate. To receive a remote pilot certificate, an individual must either pass an initial aeronautical knowledge test at a FAA-approved knowledge-testing center or have an existing non-student Part 61 pilot certificate. The TSA will conduct security background checks prior to issuing this certificate.

Additional information about certification for remote pilots can be found online. For example, interested readers can find summaries of the entire certification process, the FAA knowledge test, and a free course designed for existing Part 61 pilot certificate holders. A summary of small unmanned aircraft rule Part 107 is shown in Appendix B.

**ADDITIONAL KEY TERMS AND CONCEPTS**

Both public operations and civil operations have stricter requirements that hobbyist flights. For example, the operator must have emergency procedures. If needed, a COA can be applied for on the FAA’s web-based application system. The FAA website has an example of a Sample COA Application; a blank FAA UAS Civil COA Request form is included in Appendix C.

A Blanket COA is commonly granted with a Section 333 Grant of Exemption, authorizing flights at or below 400 feet to any UAS operator with a Section 333 exemption for aircraft less than 55 lbs. The form also describes other common restrictions, such as operating during daytime, Visual Flight Rules conditions, operating within visual line of sight of the pilots, and staying the following distances away from airports or heliports (Figure 3):

- 5 nautical miles (NM) from an airport having an operational control tower; or
- 3 NM from an airport with a published instrument flight procedure, but not an operational tower; or
- 2 NM from an airport without a published instrument flight procedure or an operational tower; or
- 2 NM from a heliport with a published instrument flight procedure.

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13) [http://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf](http://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf)
14) If qualifying under the latter provision, a pilot must have completed a flight review in the previous 24 months and must take a UAS online training course provided by the FAA.
16) [http://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf](http://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf)
19) [https://www.faa.gov/training_testing/testing/test_questions/media/uag_sample_exam.pdf](https://www.faa.gov/training_testing/testing/test_questions/media/uag_sample_exam.pdf)
20) [https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/saim/organizations/uas/coa/](https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/saim/organizations/uas/coa/)
21) [https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/saim/organizations/uas/coa/how_to_file_a_petition/media/Section-333-Blanket-400-COA-Effective.pdf](https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/saim/organizations/uas/coa/how_to_file_a_petition/media/Section-333-Blanket-400-COA-Effective.pdf)
The FAA has a freely available smartphone application called “B4UFly” that helps operators know what local restrictions or requirements are in effect. This app can help users avoid both permanently restricted areas (such as those too close to an airport) as well as those temporarily restricted areas (e.g., areas with Temporary Flight Restrictions, or TFRs, such as during wildfires, near special events, or due to the movement of government VIPs).

The FAA’s 5/4/2016 memorandum clarifies that section 336 of the FAA Modernization and Reform Act of 2012 allows students to fly UAS as part of the educational program at an accredited educational institution. This clarification, along with the anticipated rules by the FAA, allows more leniency for flying micro-UAS platforms when partnering with educational institutions.

Although this section has focused on operation in the United States, interested parties are encouraged to review what companies in other countries have done as well. For example, the January 2016 Publication “Utilising Remotely Piloted Aircraft Systems on the Transpower Network”[^23] provides many suggestions and templates for the operation of UAS in New Zealand.

### RECENT LEGISLATION


During the first half of 2016, at least 41 states have considered legislation related to UAS[^24]. Fourteen states—Alaska, Arizona, Idaho, Indiana, Kansas, Louisiana, Oklahoma, Oregon, Rhode Island, Tennessee, Utah, Vermont, Virginia and Wisconsin—have passed 26 pieces of legislation (Table 3). This is the same amount of legislation passed as all of 2015.

Table 3: 2016 UAS State Legislation

<table>
<thead>
<tr>
<th>State</th>
<th>Bill</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>HB 256</td>
<td>Requests the Department of Fish &amp; Game evaluate the use of UAS for aerial survey work and report findings related to safety and cost-savings compared to manned aircraft.</td>
</tr>
<tr>
<td>Arizona</td>
<td>SB 1449</td>
<td>Prohibits certain operation of UAS, including operation in violation of FAA regulations and operation that interferes with first responders. The law prohibits operating near, or using UAS to take images of, a critical facility. It also preempts any locality from regulating UAS.</td>
</tr>
<tr>
<td>Idaho</td>
<td>SB 1213</td>
<td>Prohibits the use of UAS for hunting, molesting or locating game animals, game birds and furbearing animals.</td>
</tr>
<tr>
<td>Indiana</td>
<td>HB 1013</td>
<td>Allows the use of UAS to photograph or take video of a traffic crash site.</td>
</tr>
<tr>
<td></td>
<td>HB1246</td>
<td>Prohibits the use of UAS to scout game during hunting season.</td>
</tr>
<tr>
<td>Kansas</td>
<td>SB 319</td>
<td>Expands the definition of harassment in the Protection from Stalking Act to include certain uses of UAS.</td>
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<td></td>
<td>SB 249</td>
<td>Appropriates funds that can be used to focus on research and development efforts related to UAS by state educational institutions. The law specifies a number of focuses for the research, including the use UAS for inspection and surveillance by the department of transportation, highway patrol and state bureau of investigation. It requires that the director of UAS make recommendations regarding state laws and rules that balance privacy concerns and the need for “robust UAS economic development” in the state.</td>
</tr>
<tr>
<td>Louisiana</td>
<td>SB 73</td>
<td>Adds intentionally crossing a police cordon using a drone to the crime of obstructing an officer. Allows law enforcement or fire department personnel to disable the UAS if it endangers the public or an officer’s safety.</td>
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<tr>
<td></td>
<td>HB 19</td>
<td>Prohibits using a drone to conduct surveillance of, gather evidence or collect information about, or take photo or video of a school, school premises, or correctional facilities. Establishes a penalty of a fine of up to $2,000 and up to six months in jail.</td>
</tr>
<tr>
<td></td>
<td>HB 335</td>
<td>Authorizes the establishment of registration and licensing fees for UAS, with a limit of $100.</td>
</tr>
<tr>
<td></td>
<td>HB 635</td>
<td>Adds the use of UAS to the crimes of voyeurism, video voyeurism and peeping tom.</td>
</tr>
<tr>
<td></td>
<td>SB 141</td>
<td>Specifies that surveillance by an unmanned aircraft constitutes criminal trespass under certain circumstances.</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>HB 2599</td>
<td>Prohibits the operation of UAS within 400 feet of a critical infrastructure facility, as defined in the law.</td>
</tr>
<tr>
<td>Oregon</td>
<td>HB 4066</td>
<td>Modifies definitions related UAS and makes it a class A misdemeanor to operate a weaponized UAS. It also creates the offense of reckless interference with an aircraft through certain uses of UAS. The law regulates the use of drones by public bodies, including requiring policies and procedures for the retention of data. It also prohibits the use of UAS near critical infrastructure, including correctional facilities.</td>
</tr>
<tr>
<td></td>
<td>SB 5702</td>
<td>Specifies the fees for registration of public UAS.</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>HB 7511/ SB 3009</td>
<td>Gives exclusive regulatory authority over UAS to the state of Rhode Island and the Rhode Island Airport Corporation, subject to federal law.</td>
</tr>
<tr>
<td>Tennessee</td>
<td>SB 2106</td>
<td>Creates the crime of using a drone to fly within 250 feet of a critical infrastructure facility for the purpose of conducting surveillance or gathering information about the facility.</td>
</tr>
<tr>
<td></td>
<td>HB 2376</td>
<td>Clarifies that it is permissible for a person to use UAS on behalf of either a public or private institution of higher education, rather than just public institutions.</td>
</tr>
<tr>
<td>Utah</td>
<td>HB 126</td>
<td>Makes it a class B misdemeanor to operate a UAS within a certain distance of a wildfire. It becomes a class A misdemeanor if the UAS causes an aircraft fighting the wildfire to drop a payload in the wrong location or to land without dropping the payload. It is a third degree felony if the UAS crashes into a manned aircraft and a second degree if that causes the manned aircraft to crash.</td>
</tr>
<tr>
<td>Vermont</td>
<td>SB 155</td>
<td>Regulates the use of drones by law enforcement and requires law enforcement to annually report on the use of drones by the department. It also prohibits the weaponization of drones.</td>
</tr>
<tr>
<td>Virginia</td>
<td>HB 412</td>
<td>Prohibits the regulation of UAS by localities.</td>
</tr>
<tr>
<td></td>
<td>HB 29 &amp; HB 30</td>
<td>Appropriate funds to Virginia Tech for UAS research and development.</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>SB 338</td>
<td>Prohibits using a drone to interfere with hunting, fishing or trapping.</td>
</tr>
<tr>
<td></td>
<td>AB 670</td>
<td>Prohibits the operation of UAS over correctional facilities.</td>
</tr>
</tbody>
</table>

In the past year, 4 utility companies have received FAA clearance to perform limited testing with UAVs:

- Duke Energy
- San Diego Gas and Electric (SDG&E)
- Southern Company of Atlanta
- Commonwealth Edison of Chicago

As part of this research, a conference call was held with the emerging technologies manager at Duke Energy which has established a pilot program and is still developing deployment. In mid-2015, Duke Energy received its first Section 333 exemption. Thereafter, Duke undertook its first pilot project, consisting of a series of flights over the course of three weeks. Almost 20 use cases were tested during the pilot project, including: coal pile inspection and volume measurement, coal ash pond inspection, coal ash pond dam inspection, solar plant inspection, T&D line and pole inspection, industrial pile inspection, flu-gas-desulphurization stack inspection, and video and aerial imaging. See Vukojevic (2016) for more information.
**SDG&E**

Conferences calls were held with SDG&E and a site visit was conducted to witness the utility’s current program. Meeting highlights include:

**Meeting Discussion. SDG&E is:**

1. Still developing its business model based on the factors that provides the most value to SDG&E; many options are being considered, including contracting-out the work.
2. Performing “Assessment” not “Inspections” and will not replace inspectors.
3. Setting the goal of its flights to support the reliability of the grid. A drone is not going to keep the lights on or prevent fires. A drone can serve as a tool to build the situational awareness of the professionals who keep the lights on and prevent fires.
4. Dealing with the 500’ encroachment limit to people without asking permission; this can be difficult when interested bystanders come to watch since the utility must wait for them to leave before resuming operations.
5. Addressing a huge growth in 333 exemptions- from 43 at the beginning of the application to 4,000 currently. We discussed the limitations of the Section 333 and COAs; this information can be found on the FAA’s website.
6. Maintaining the first priority as safety of people (i.e., inspection of pole integrity prior to climbing).
7. Relying on trained pilots, not hobbyists.
8. Using one make and model to fly and train for operation. Buying one particular make and model might not make sense in all situations because the technology is changing very fast. However, it may make more sense in some situations.
9. Finding solutions for the issue of railroad easement. It is hard to get trucks/people near train tracks.
10. Avoiding birds (i.e., endangered raptors). They do not enter nesting buffer zones and, if a nest is active in proximity to where they are flying, they don’t fly.

**Platforms**

1. SDG&E first used UAVs from Physical Sciences, Inc.
   - The aircraft weigh 16 ounces and use analog cameras.
   - Cost is $6,000 for 2 aircraft with ground controllers.
   - Aircraft have 3 compact cameras and sensors for distance, compass, direction, and elevation.
   - The can fly in winds up to 35 knots. However, they are not deployed in winds in excess of 20 knots and the utility conducts a thorough risk assessment prior to each flight.
   - They have an air time of 35 minutes.
   - IR was able to detect a substation that had a known issue.
   - This can provide storm damage assessment in addition to M&O. Craft come equipped with location beacon.
2. Currently, SDG&E is using DJI Inspire
   - Easy to set up, little maintenance
   - Popular consumer platform made in China
   - Does not use a fisheye camera lens (i.e., GoPro)
   - Dual operation: pilot vs. video/photo data
   - SDG&E uses a three-person crew, with the third person responsible for ground safety
3. ...and is using DJI Inspire Pro
   - Maximum speed – 35 knots
   - Better cameras
   - Requires knowing the actual temperature difference (just knowing that something is “hot” may not be useful, depending on the sunlight, etc.)

**Use Issues**

1. Pulling line over crossarms (vs. shooting it over)
2. Tie-ins for people who need to climb (OSHA requirements)
3. Bright day at noon may not be best (reflective things on poles); however, bright days are great for bird nests, etc.
4. Should tag the top of poles, not the bottom, for mapping accuracy
5. There are Line of Sight limitations for operation
6. The utility still plans to use helicopters, at least for the near-term
7. Required to give 24-hour notice before a flight
8. Uses UAVs prior to changing a crossarm, to determine if they also need to change the pole
9. Range finding device would be very useful since it would help measure objects seen by the UAS

**O’CONNELL ELECTRIC COMPANY**

Conferences calls were also held with O’Connell Electric and a site visit was conducted to discuss those UAS topics that would be of value to utility line contractors interested in establishing a UAV program. Meeting highlights include:

**Discussion with O’Connell Electric about platforms and capabilities**

1. We should emphasize multi-rotor platforms over fixed wing due to their ability to easily stop to collect data and the current legal requirements to maintain line of sight by the operator.
2. We should also emphasize entry level platforms and platforms that cost $50,000 or less. Companies starting to use aerial imaging are unlikely to begin with very expensive platforms without gaining experience on less expensive platforms.
3. Given their competitiveness in the market, it may be best to focus on a few of the major consumer brands: 3D Robotics, DJI, and Yuneec. All other platforms can still be discussed in an appendix
4. Platforms could be grouped by brand or by price.
5. Rather than focusing on intended use (marketing), we may want to focus on their unique capabilities and strengths.
6. It would help to separate out platforms that are customizable (i.e., can carry different sensors) vs. those that come with a fixed payload.
7. In addition to normal visible light cameras, infrared, LIDAR, corona, and multi-spectral cameras may be useful. FLIR is particularly useful as it can overlay heat and visible spectrum images, as well as record video.
8. Some details (e.g., video and communication protocol) are relegated to the appendix of the report.
**Legal structure**

1. It would be most useful to provide a high-level overview of current FAA regulations and hyperlinks to relevant forms.
2. A visual depicting ceiling limits, encroachment ranges, distance from airport, etc., would provide a nice summary of many of the current FAA laws.
3. Describe how to search for current 333 exemptions and provide a summary of which types of companies currently have permission to fly UAS.
4. Ideally, attach an example 333 exemption application as an appendix and, at a minimum, explain how to look them up.
5. Providing too much detail is not necessary, as we expect new regulations to come within the next few months, particularly regarding micro-UAS.
6. The report may want to discuss expected changes to US laws in the near future, even if speculative.
7. It would be advantageous, if possible, to make this whitepaper a “living document” where updates could be tracked regarding the relevant laws, as well as new notable platforms.

**Training**

1. It is likely that future laws will remove the need for UAS pilots to have their (full) pilot’s license.
2. There are small training programs for UAS operators (e.g., www.skyop.com). Are there particular programs we could recommend to businesses interested in learning more about how to operate UAS? Are there qualities in a training program that we would / would not recommend?
3. O’Connell would really like to get the training program SDG&E has developed, at least to use as a straw man that we could improve upon.
4. The company needs to know how to build a flight plan, conduct safety inspections and maintenance, acquire the appropriate permissions & permits.
5. What skill sets are involved for people other than the pilot? For instance, what training, if any, would the camera operator or a spotter need?

**Applications**

1. Visual + IR inspection: run out a line, as is currently done with a helicopter.
2. Look for bad poles, hardware failures, broken strands of wire, bad cross arms, and failing insulators.
3. Must be able to review pictures and videos in real time, as this can determine if more data are needed and where the UAS should travel.
4. Locate and read nameplates / catalogue numbers on equipment. When equipment is lost/damaged/replaced, it may be difficult to know exactly what equipment is up on the pole and what replacement parts would be needed to repair the equipment.
5. Use a corona sensor to measure a field (ionization in the air) to check for problems with connection points or splices in high voltage situations.
6. Pre-construction or pre-bidding. Rather than having to walk a line, it would be better to fly it.
7. When making emergency repairs, flying the line would allow for quickly locating damage and determining what equipment is needed for repairs.
8. Use for right of way management to determine if anyone is encroaching on lines.
9. Look for ospreys and their nests (or other environmentally sensitive animals).
There are several websites that discuss UAV Safety and Operating Procedures. The Air Vid site (http://air-vid.com/wp/uav-safety-checklist/) is one of the most extensive. It states, “Every pilot/operator and mission should be operated within the rules and regulations stipulated by the governing bodies applicable to you and your specific equipment.” Its list includes: Area and Environment, Equipment/UAV/Drone, Mission Plan, Public Awareness, Pre-Flight/Run-up, In-Flight, and Post-Flight. The complete checklist is shown in Appendix D. Sample Templates are shown in the appendices:

- Appendix E: Safety Procedures
- Appendix F: Standard Operating Procedures
- Appendix G: Maintenance Procedures
- Appendix H: Incident Reporting Procedures
- Appendix I: Training Plan
DATA MANAGEMENT

A UAV program will initially focus on how to best collect data (e.g., what platform and sensors should be used, how it should be flown, etc.). However, once data are successfully collected, data management becomes increasingly important (Figure 4). Before a program is deployed, it will be important to make decisions about what data will be stored, how it is to be stored, and how it will be used. For example, given multiple platforms and/or sensors, how will the data:

- **Be analyzed?** Ideally, there will be automatic or semi-automatic data processing to identify pre-specified conditions so that operators do not need to sift through raw data by hand.

- **Be aligned?** When different sensors collect data about a given object at different resolutions or distances, how will users be able to access this data and know that it all refers to the same object?

- **Track objects over time?** If data are collected at different times of day, different days, or even different years, will a user be able to call up all relevant data to identify changes over time? Such a progression is particularly important for tasks like evaluating greenery encroachment and measuring equipment wear.

- **Store the data?** High-resolution video cameras can quickly generate terabytes of data. On what type of media will the data be stored and indexed? How will it be accessed? What data filtering and retention policies will be in place?
SAMPLE OPTICAL INSPECTIONS

**Pole Top Inspections**

This could include an identification of pole, member, or structure condition (or deterioration); pole attachments; or assessment of hardware/equipment condition (Figure 5).

**Distribution Line Inspections**

This could include monitoring a circuit after a fault to identify any abnormalities or defects with equipment (Figure 6).
**Land and Facility Inspections**

Land and facility inspections could include a review of a flood area or a rooftop survey of facility assets (Figure 7). Inspections could also include pre-construction flights adjacent to a right of way to get imagery of entire lines without having to walk/drive, observations for endangered species, or security oversight.

![Figure 7: Land and Facility Inspections](image1)

**Infrared Inspections**

An example of an infrared inspection would be a review of hot spots within a substation. The technology identifies the areas in the substation that could potentially need to be replaced (Figure 8).

![Figure 8: Infrared Substation Inspection](image2)

**Corona Detection**

Corona is a phenomenon that has the capability for degrading insulators and causing systems to fail. Corona sensors could be used to measure an ionization field to check for problems with connection points or splices in high voltage situations (Figure 9). Corona conditions can detrimentally affect electronics. If an improperly shielded UAV comes in contact within a corona condition, the UAV electronics can suffer severe unintended consequences, up to and including turning off the UAV and making it a falling projectile. Contractors should look for "corona effect" certified drones. This is not limited solely to drones, but all electronic devices that could come in contact with corona conditions.

![Figure 9: Corona Discharge at Insulator](image3)
LIGHT DETECTION AND RANGING (LIDAR) INSPECTIONS

LIDAR is a surveying technology that measures distance by illuminating a target with a laser light (Figure 10). LIDAR scanners can generate point clouds to create realistic looking 3D models. LIDAR utility uses include measuring conductor sag and 3D imagery of structures to virtually reconstruct a tower. Carnegie Mellon University is developing a sophisticated system using sUAVs coupled with 3-D imaging and state-of-the-art planning, modeling, and analysis to inspect structures (such as bridges and buildings) and to identify problems automatically, track their progress, and assess the need for follow-up (http://www.northeastern.edu/news/2016/07/miniature-flying-robots-automatically-inspect-analyze-and-assess-damage-to-infrastructure/).

LINE SPOOLER

This device is used to launch a finger line string over a cross arm for initial installation of a new overhead line. The “Lucky Line Launcher” provides power and accuracy for placing lines up to 100’ vertically, or horizontally up to 250’ and uses a 22 caliber shot gun cartridge to fire the line. A line spooler is attached to the UAS, which allows the Finger Line String to be reeled out as the UAS is in flight. The UAS would then land in the desired location at which the Finger Line String could be easily located and detached (Figure 11).

MATERIAL AND TOOL HANDLING

There is a significant amount of interest in using UAVs for package delivery and this could easily be applied to small material and/or tool delivery. Although still in the concept stage, Wal-Mart, Google, and Amazon have all expressed an interest in this subject. Google has stated, “Self-flying vehicles could open up entirely new approaches to moving things around—including options that are faster, cheaper, less wasteful, and more environmentally sensitive than the way we do things today,” (http://www.wired.com/2014/08/google-reveals-project-wing-its-two-year-effort-to-build-delivery-drones/).

Amazon soon plans to deploy Prime Air for delivery service to customers in 30 minutes or less using UAVs. “Prime Air has great potential to enhance the services we already provide to millions of customers by providing rapid parcel delivery that will also increase the overall safety and efficiency of the transportation system” (https://www.amazon.com/b?node=8037720011). If the FAA gives Amazon clearance for commercial rollout, the price that a consumer would pay for the delivery of a five-pound package is projected to cost, on average, $0.88 compared to Federal Express FDX and United Parcel Service UPS which currently cost 8 to 13 times more for much longer delivery times (https://ark-invest.com/research/amazon-drone-delivery#fn-5091-3).
REFERENCES


Transpower New Zealand Ltd., Issue 1.12, January 2016, 1-12.

Vukojevic, A. (2016).

APPENDIX A:
FAA SECTION 333 - PETITION GUIDANCE & CHECKLIST

Note: It is highly recommended petitioners carefully review the “Conditions and Limitations” section in the most recently granted exemptions. This will provide valuable insight as to what the FAA is approving under Section 333.

Where can I find previously granted exemptions?
https://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/

1. Write down the docket number in the exemption you are reviewing (it will be formatted like this: FAA-XXXX-XXXX).
2. Search for that docket number at www.regulations.gov, and review the petition, as well as any supporting documents.

Ready to create your petition?
Use the checklist below to ensure your petition contains all the necessary information. Failure to include the following information may result in delays in processing your request:

- Operator’s name and address
- The specific applicable regulations from which relief is required (CFRs)
- How the operator will maintain an equivalent level of safety or no adverse impact to safety
- How granting the exemption would be in the public interest
- The proposed operations
- The make and model of the aircraft for proposed operations (aircraft manuals are not necessary).

Ready to submit your petition?
Note: Proprietary/Confidential documents should be clearly marked and emailed to 333exemptions@faa.gov. Be sure to include your comment tracking number (received upon successful submission to regulations.gov when emailing these documents. Do not submit them to regulations.gov.

- Visit https://www.faa.gov/uas/legislative_programs/section_333/how_to_file_a_petition/

Please note: Due to the large volume of petitions being submitted, it will take approximately 8-10 weeks for submissions to be posted to the docket at regulations.gov and assigned a docket number.

Questions?
Please reference our Frequently Asked Questions (FAQs) at: https://www.faa.gov/uas/legislative_programs/section_333/333_faqs/

If you did not find the answer to your question on our FAQ page, your questions about the Section 333 exemption process should be directed to 333exemptions@faa.gov. Questions about the operating conditions and limitations should be directed to 9-AFS-UAS-Inquiries@faa.gov.
APPENDIX B:
SUMMARY OF SMALL UNMANNED AIRCRAFT RULE (PART 107)

Federal Aviation Administration, Washington, DC 20591  June 21, 2016

Operational Limitations

- Unmanned aircraft must weigh less than 55 lbs. (25 kg).
- Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS. Alternatively, the unmanned aircraft must remain within VLOS of the visual observer.
- At all times, the small unmanned aircraft must remain close enough to the remote pilot in command and the person manipulating the flight controls of the small UAS for those people to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.
- Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.
- Daylight-only operations, or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.
- Must yield right of way to other aircraft.
- May use visual observer (VO) but not required.
- First-person view camera cannot satisfy the “see-and-avoid” requirement but can be used as long as requirement is satisfied in other ways.
- Maximum groundspeed of 100 mph (87 knots).
- Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure.
- Minimum weather visibility of three miles from control station.
- Operations in Class B, C, D and E airspace are allowed with the required ATC permission.
- Operations in Class G airspace are allowed without ATC permission.
- No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time.
- No operations from a moving aircraft.
- No operations from a moving vehicle unless the operation is over a sparsely populated area.
No careless or reckless operations.

No carriage of hazardous materials.

Requires preflight inspection by the remote pilot in command.

A person may not operate a small unmanned aircraft if he/she knows or has reason to know of any physical or mental condition that would interfere with the safe operation of a small UAS.

Foreign-registered small unmanned aircraft are allowed to operate under part 107 if they satisfy the requirements of part 375.

External load operations are allowed if the object being carried by the unmanned aircraft is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft.

Transportation of property for compensation or hire allowed provided that:

- The aircraft, including its attached systems, payload and cargo weigh less than 55 pounds total
- The flight is conducted within visual line of sight and not from a moving vehicle or aircraft
- The flight occurs wholly within the bounds of a State and does not involve transport between (1) Hawaii and another place in Hawaii through airspace outside Hawaii; (2) the District of Columbia and another place in the District of Columbia; or (3) a territory or possession of the United States and another place in the same territory or possession.

Most of the restrictions discussed above are waivable if the applicant demonstrates that his or her operation can safely be conducted under the terms of a certificate of waiver.

<table>
<thead>
<tr>
<th>Remote Pilot in Command Certification and Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishes a remote pilot in command position.</td>
</tr>
<tr>
<td>A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does hold a remote pilot certificate (remote pilot in command).</td>
</tr>
<tr>
<td>To qualify for a remote pilot certificate, a person must demonstrate aeronautical knowledge by:</td>
</tr>
<tr>
<td>- Passing an initial aeronautical knowledge test at an FAA-approved knowledge testing center or</td>
</tr>
<tr>
<td>- Holding a part 61 pilot certificate other than student pilot, completing a flight review within the previous 24 months, and completing a small UAS online training course provided by the FAA.</td>
</tr>
<tr>
<td>- Being vetted by the Transportation Security Administration and be at least 16 years old.</td>
</tr>
</tbody>
</table>
Part 61 pilot certificate holders may obtain a temporary remote pilot certificate immediately upon submission of their application for a permanent certificate. Other applicants will obtain a temporary remote pilot certificate upon successful completion of TSA security vetting. The FAA anticipates it will be able to issue a temporary remote pilot certificate within 10 business days after receiving a completed remote pilot certificate application.

Until international standards are developed, foreign-certificated UAS pilots will be required to obtain an FAA-issued remote pilot certificate with a small UAS rating.

**A remote pilot in command must:**

- Make available to the FAA, upon request, the small UAS for inspection or testing, and any associated documents/records required to be kept under the rule.
- Report to the FAA within 10 days of any operation that results in serious injury, loss of consciousness, or property damage of at least $500.
- Conduct a preflight inspection, to include specific aircraft and control station systems checks, to ensure the small UAS is in proper condition for safe operation.
- Ensure that the small unmanned aircraft complies with existing registration requirements specified in § 91.203(a)(2).

**A remote pilot in command may deviate from the requirements of this rule in response to an in-flight emergency.**

### Aircraft Requirements

- FAA airworthiness certification is not required. However, the remote pilot in command must conduct a preflight check of the small UAS to ensure that it is in proper condition for safe operation.

### Model Aircraft

- Part 107 does not apply to model aircraft that satisfy all of the criteria specified in section 336 of Public Law 112-95.
- The rule codifies the FAA’s enforcement authority in part 101 by prohibiting model aircraft operators from endangering the safety of the NAS.
**APPENDIX C: FAA UAS CIVIL COA REQUEST**

**Federal Aviation Administration**

**FAA UAS Civil COA Request**

Any information that is provided is bound by the Freedom of Information Act (FOIA) and may be releasable. This requires compliance to FOIA and consent to the release of your information. If you do not consent to the release of your information, you must contact us for further guidance. For more information, please visit [http://www.foia.gov/](http://www.foia.gov/).

<table>
<thead>
<tr>
<th>Date</th>
<th>333 Exemption # or Federal Register Docket #</th>
</tr>
</thead>
</table>

**Proponent Information**

- **Contact Name**
- **Company Name**
- **Street Address 1**
- **Street Address 2**
- **City**
- **State**
- **Zip Code**
- **Phone Number**
- **E-mail Address**

**Aircraft System**

- **Aircraft Type**
- **Aircraft Registration**

**Performance Characteristics**

- **Climb Rate (Feet/Minute)**
- **Descent Rate (Feet/Minute)**
APPLICATIONS FOR UNMANNED AERIAL VEHICLES IN ELECTRIC UTILITY CONSTRUCTION

### Operational Information

**Location**

**Altitude**

**Distance from nearest Town/City**

**Description of Operation**

### Operations Area (Attach VFR Chart with Coordinates)

**Class of Airspace**

- [ ] A
- [ ] Under Mode C Veil
- [ ] D
- [ ] G
- [x] B (Requires FAA HQ approval)
- [ ] C
- [ ] E
- [ ] G (With an operational ATC Tower)

**Flight Conditions**

- [ ] VFR
- [ ] IFR

### Air Traffic Communication

- [ ] VHF
  - [ ] Yes
  - [ ] No
- [ ] Receiver
  - [ ] Yes
  - [ ] No
- [ ] Guard (Emergency Frequency)
  - [ ] Yes
  - [ ] No
APPLICATIONS FOR UNMANNED AERIAL VEHICLES IN ELECTRIC UTILITY CONSTRUCTION

Procedures

Lost Link Procedures

1. How long to activate LL procedure

2. LL Altitude

3. Lost Link Route

4. Lost Link Point

5. Flight Termination Point

Lost Communication Procedures

1. Between Pilot and Air Traffic Control

2. Between Pilot and Observer
Observer

Line of Sight of Observer

☐ Yes
☐ Other

Observer Location

Time of Day

☐ Day  ☐ Night  ☐ Both

Transponder

☐ Yes  ☐ Mode C
☐ No
☐ N/A

Please return completed form to 9-AJV-115-UASOrganization@faa.gov.
APPENDIX D: DRONE AND UAV CHECKLIST (AIR VID)\textsuperscript{26}

\textbf{AREA & ENVIRONMENT}

\checkmark Hazards / Site Selection. Check for:
- Wires / cables
- Animals
- People / bystanders
- Property in the vicinity
- Site is away from nonessential participants
- Ability to maintain adequate buffer zones between aircraft and personnel
- Minimize departures and landings over populated areas
- Take into account local topography, ensuring a visible line of sight towards the UAV at all times. Ensure the telemetry connection is not obstructed.
- Investigate potential alternative landing sites in case take-off site is obstructed

\checkmark Psychological consideration (Are you well rested or rushed? Are you being pressured by client?)

\checkmark Weather considerations
- Temperature
- Visibility
- Precipitation

\checkmark Wind Speed
- Upper winds / at altitude
- Rotor (lee side of large objects)

\checkmark Notify any bystanders or nearby property owners of your intentions (permission)

\checkmark Discuss flight plan with your co-pilot or spotter

\checkmark If flying in controlled airspace, have you notified airspace authority
- NOTAMs
- Can you reach authorities?
- Do you need to maintain communication?

\checkmark First Aid Kit stocked, readily accessible and visible to anyone in the area

\textbf{EQUIPMENT / UAV / DRONE}

\checkmark Walk-around
\checkmark Crack in joints and structural members
\checkmark Loose or damaged screws, ties, fasteners, straps
\checkmark Loose or damaged wiring
\checkmark Loose or damaged connections (solder, plugs, etc.)
\checkmark Inspect prop mounts and screws and apply slight counter pressure on arms to check for loosened components
\checkmark FPV; inspect / clean FPV (Camera) lens and insure it is secured and connects are firmly secured
\checkmark Camera settings are correct (still images, video, frame rate)
\checkmark Battery / Batteries are fully charged, properly seated and secured

\textsuperscript{26} Air Vid site (http://air-vid.com/wp/uav-safety-checklist/), accessed June 3, 2016
✓ Fail-safe equipment functioning
  - RTH (return to home)
  - Recovery chute
  - Firmware Airport Proximity Detection Functioning
✓ Props are smooth and free of damage / defect (check blade, surface and hub)
✓ Prop adapters are tight / secure
✓ Ensure voltage alarm is connected
✓ Ensure arming / idle timeout is properly configured
✓ Correct model is selected in transmitter (if applicable)
✓ Check RC transmitter shows the right range and centering for all sticks
✓ Perform range test

MISSION PLAN

✓ All actions and contingencies for the mission have been planned.
✓ Contingency planning should include safe routes in the event of a system failure, degraded performance, or lost communication link, if such a failsafe exists.
✓ Mission plans and flight plans should be shared with other operators in the vicinity.

PUBLIC AWARENESS

✓ Be courteous and polite.
✓ You are an ambassador and your actions will affect other pilots and the industry in general.
✓ Be professional / appear professional.

PRE-FLIGHT / RUN-UP

✓ Verify all transmitter, on-board aircraft and camera batteries are fully charged; (confirm voltages).
✓ Ensure no frequency conflicts with both video and transmitter / receiver.
✓ Check all control surfaces for signs of damage, loose hinges, and overall condition.
✓ Examine wing/rotors to ensure they are in good structural condition and properly secured.
✓ Check motor/engine and mounting attached to the airframe.
✓ Study propellers / mounting hardware (tight) / rotor blades for chips and deformation.
✓ Check the landing gear for damage and function.
✓ Test electrical connections, plugged in and secure.
✓ Ensure photo / video equipment mounting system is secure and operational.
✓ Check location of GPS equipment controlling the autopilot.
✓ Check the IMU movements in the ground control software.
✓ UAV in stabilization mode, ensure control surfaces move towards the correct positions.
✓ UAV / Drone is in a level location safe for takeoff.
✓ FPV / Power up ground station.
✓ FPV / Power up Video receiver / goggles.
✓ If using video recorder, turn on camera system.
✓ Camera settings are correct (still images, video, frame rate).
✓ SD camera memory clear and inserted into the camera.
✓ Action / Start filming.
✓ All transmitter controls move freely in all directions.
✓ All transmitter trims in neutral position.
✓ All transmitter switches in correct position (typically away).
✓ Transmitter throttle to zero.
✓ Radio transmitter on.
✓ Connect / power on battery to airframe.
✓ Ensure led indicators and audible tones are correct.
✓ Timer on (if applicable).
✓ FPV, confirm video is in monitor / goggles.
✓ Scan for nearby cars / people / animals.
✓ Say “CLEAR!”
✓ Arm flight controller.
✓ Increase throttle slightly listening for any abnormalities.
✓ Short 20-30 second hover at 3-5 feet (listen for vibrations / loose items).
✓ Confirm Voltage levels are correct.

**IN-FLIGHT**

✓ If flying manually, always keep your fingers on the controller/transmitter.
✓ Never let the UAV out of your sight even for a second.
✓ Climb to a safe altitude away from potential hazards and to reduce noise pollution.
✓ Keep aircraft at a safe operating distance from people, electric utility lines and buildings.
✓ If the UAV must be flown over buildings or people, use a lightweight UAV and maintain a safe altitude for recovery and make every effort to minimize exposure.
✓ Use a spotter whenever possible and appropriate, especially when flying by First Person View (FPV).
✓ Do not fly UAVs within distance defined by local laws of any private or commercial airport/helipad.
✓ Do not fly around a pre-existing UAV flying site without a frequency-management agreement.
✓ Do not interfere with operations and traffic patterns at any airport.
✓ Whether a manual or automated UAV landing, scan landing area for potential obstruction hazards.
✓ Announce out loud “Preparing to Land”.
✓ Carefully land the aircraft away from obstructions and people.

**POST-FLIGHT**

✓ Shutting Down: Turn the power off to the aircraft and/or disconnect the batteries.
✓ Turn off the transmitter.
✓ Turn the power off to the photo equipment.
✓ Visually check aircraft for signs of damage and/or excessive wear.
✓ Remove the unused fuel if applicable and secure the aircraft.
✓ Check pictures: Verify that the UAV camera actually took the pictures
✓ LOG FLIGHT
APPENDIX E: SAMPLE SAFETY PROCEDURES TEMPLATE

1. PURPOSE
The safety and health of all personnel is the responsibility of each and every person. This responsibility also includes the prevention of accidental damage to equipment that is entrusted to their care. Safety is of the utmost importance when flying UAS. This standard contains information and guidance that directs the UAS Departments safety program. Individual duties and responsibilities, reporting requirements, safety directives and other safety related communication might routinely supplement this document. This standard will not attempt to consolidate all those functions, but rather provide the guidance necessary to correctly interpret the intent of the UAS safety program.

2. APPLICABILITY
This standard shall apply to all personnel, and those under contract, engaged in the construction and maintenance of fieldwork.

3. DEFINITIONS
Pilot in Command (PIC) - Term used by the Federal Aviation Administration (FAA) in 14 CFR 91.3 to define the responsibility and authority as the following: The PIC of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

4. PROCEDURE

4.1 Policy
It is the safety policy to eliminate injuries to personnel and damage to equipment due to preventable accidents. Minimizing risk and eliminating conditions that produce an unsafe or unhealthy environment will accomplish this. Planning for all operations and activities with positive leadership actions regarding safety and health during the conduct of missions and tasks will include comprehensive risk management at all levels.

4.2 Risk Assessment
All crewmembers will complete the Assessment Matrix before flight operations and will follow the instructions on the assessment sheet as required for flight authorizations. If unable to mitigate to acceptable risk level, the flight will be cancelled. To minimize the inherent risks involved in any flight operation, crewmembers will use Operational Risk Management (ORM) techniques to the maximum extent practicable throughout all phases of the process. All crewmembers shall be fully trained on Operational Risk Management Logic, Risk Management Logic, and understand that ORM is used for safe and successful mission accomplishment as well as the preservation of all assets.

4.3 Responsibilities

4.3.1 UAS Management
• Is responsible for the overall safety and health of all personnel and the prevention of accidental damage to the equipment
• Provides safety guidance and instructions for all training, operations and activities
• Ensures that all accidents are reported
• Attends all safety meetings
4.3.2 UAS Safety manager
- Is responsible to the UAS management for the safety program
- Provides the safety and risk management input to all training plans
- Prepares and updates
- Ensures conduct of annual safety survey and OSHA inspections, and provides a written report of the results of those surveyed
- Conducts and organizes of quarterly Safety council meetings
- Conducts accident investigations and prepares accident reports as directed
- Provides safety training monthly or as directed
- Conducts periodic safety inspections
- Performs other safety duties as assigned

4.3.3 UAS crewmembers
- Assist safety manager with routine risk management
- Conduct safety briefings as necessary or assigned
- Complete the Risk Assessment Matrix before flight operations
- Report injuries and accidents
- Report unsafe acts or conditions in a timely manner

4.4 Reports
4.4.1 Accident notification will be made as soon as possible to UAS Management and per the attached Unmanned Aircraft System Incident procedure.

4.4.2 National Transportation Safety Board (NTSB) Form 61.20.1 shall be completed and reviewed by UAS Management within 5 days of the incident.

4.4.3 National Transportation Safety Board (NTSB) Form 61.20.1 shall be sent to NTSB within ten days.

4.5 Training
4.5.1 The UAS Safety manager will provide safety training to all UAS personnel as directed. Safety topics will include, at a minimum:
- Risk Assessment
- Hearing Conservation
- Cold and heat injuries and prevention
- Hazardous Material (HAZMAT) and MSDS (Material Safety Data Sheets)
- First Aid and CPR
- Environmental hazards
- Dangers from poisonous insects, reptiles and plants
- Use of fire extinguishers
- Personal Protective Equipment (PPE)
4.6 Lost Link

4.6.1 In the event of Lost Link, the Pilot in Command will follow all procedures in the UAV operations manual.

4.6.2 After the vehicle is recovered, it will not be launched again until intensive troubleshooting has been followed to determine the reason for Lost Link.

5. REFERENCES

5.1 National Transportation Safety Board (NTSB) 49 Code of Federal Regulations (CFR) Part 830

5.2 Unmanned Aircraft System Incident procedure

5.3 All UAV operational manuals

5.4 Contractor Health and Safety Manual

6. ATTACHMENTS

6.1 Attachment E-1 –Risk Assessment Matrix

6.2 Attachment E-2 – Operational Risk Management Logic

6.3 Attachment E-3 – Risk Management Logic
### Attachment E-1 – Risk Assessment Matrix

<table>
<thead>
<tr>
<th>Pilot Name</th>
<th>Date</th>
<th>Signature of Pilot in Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera OP Name</td>
<td>Location</td>
<td>Mission Type</td>
</tr>
<tr>
<td><strong>UAS type</strong></td>
<td><strong>RISK LEVEL LOW</strong></td>
<td><strong>PTS</strong></td>
</tr>
<tr>
<td>Crew Experience</td>
<td>All crewmembers have flown this mission in the last 7 days</td>
<td>0</td>
</tr>
<tr>
<td>Crew Proficiency*</td>
<td>All flew in last 10 days</td>
<td>0</td>
</tr>
<tr>
<td>Crew Rest</td>
<td>All Rested</td>
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</tr>
<tr>
<td>Crew Duty Day</td>
<td>Less than 8 hrs.</td>
<td>0</td>
</tr>
<tr>
<td>Mission Type</td>
<td>Currency flight</td>
<td>2</td>
</tr>
<tr>
<td>Hardware changes to UAS</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Software changes to UAS</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Flight conditions</td>
<td>Day</td>
<td>1</td>
</tr>
<tr>
<td>Visibility</td>
<td>&gt; 10 miles</td>
<td>1</td>
</tr>
<tr>
<td>Ceiling in feet AGL</td>
<td>&gt; 10,000</td>
<td>0</td>
</tr>
<tr>
<td>Winds</td>
<td>0-10 KTS</td>
<td>0</td>
</tr>
<tr>
<td>Weather deteriorating</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Local Thunderstorm probability**</td>
<td>None or 1-2% Isolated</td>
<td>1</td>
</tr>
<tr>
<td>Other airspace activity</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Temp (include heat index and wind chill)</td>
<td>40°F - 85°F</td>
<td>0</td>
</tr>
<tr>
<td>Other items (crew judgment)</td>
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<td></td>
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</tbody>
</table>

* If a crewmember hasn’t flown in over 30 days, is a currency flight required? 
** At or above 45(Numerous) = 10 Crew decide whether to go or not

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<table>
<thead>
<tr>
<th>Total Risk Factor</th>
<th>Overall Risk Level</th>
<th>Action Required</th>
<th>Signature</th>
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<tbody>
<tr>
<td>&lt; 10</td>
<td>Low</td>
<td>None</td>
<td>Not Required</td>
</tr>
<tr>
<td>10 - 19</td>
<td>Moderate</td>
<td>Be Careful</td>
<td>Not Required</td>
</tr>
<tr>
<td>20 - 29</td>
<td>Caution</td>
<td>UAS Safety approval</td>
<td></td>
</tr>
<tr>
<td>Over 30</td>
<td>High</td>
<td>UAS Management approval</td>
<td></td>
</tr>
</tbody>
</table>
Risk management is, in reality, a **tool for making smart decisions**, and is used by people at all levels. Each person has a role to play in managing risk and each role is vital to success. UAS Management will use the ORM process and techniques in planning the evolution. Crewmembers are more engaged in managing risk during the execution of evolutions and tasks. Each of these levels requires different skills and knowledge.

The goal of **Risk Management** is not to eliminate risk, but to **manage risk** so the mission can be accomplished with minimum impact.

Apply ORM each and every day. If you adhere to procedures and keep your eyes open for changes, you are applying ORM by "implementing control measures" and "supervising and watching for change".

The most common idea of what ORM is revolves around a simple five-step process that is most frequently used in planning, or at the **Deliberate Level**. These five steps are:

1. **Identify hazards**
2. **Assess the hazards**
3. **Make risk decisions**
4. **Implement controls**
5. **Supervise and watch for change**

**What ORM Is . . .**
- A mindset and/or methodology applicable to any activity
- Accomplishing the mission with acceptable risk
- Planning using a standard process (5 Steps)
- A continuous process
- Based on experience/collective experience
- Following procedures (controls)
- Watching for change (supervising)
- Flexible
- Working as a team
- Best when applied as a team
- Asking "What's Different"
- Skill and knowledge dependent
- Sharing experience, lessons learned
- Using available tools/resources
- Applied, standardized "common sense"
- "Looking before you leap"
WHAT ARE THE HAZARDS IN THIS OPERATION?

WHAT IS THE PROBABILITY OF AN ACCIDENT?
HOW SEVERE WILL THE ACCIDENT BE?
WHAT IS THE EXPOSURE TO THAT ACCIDENT?

WHAT IS THE LEVEL OF RISK?

IS THAT RISK ACCEPTABLE?

CAN ANY RISKS BE ELIMINATED?
CAN ANY RISKS BE REDUCED?

ACCEPT THE RISK!
ELIMINATE THE RISK
REDUCE THOSE RISK

CANCEL THE FLIGHT!
1. PURPOSE
This manual provides safe work procedures that apply to all persons engaged in the use of Unmanned Aircraft systems (UAS) for the purpose of (but not limited to) material and equipment.

2. APPLICABILITY
This standard shall apply to all Company personnel, and those under contract, engaged in the construction and maintenance of fieldwork.

3. DEFINITIONS
Pilot in Command (PIC) - Term used by the Federal Aviation Administration (FAA) in 14 CFR 91.3 to define the responsibility and authority as the following: The PIC of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

4. PROCEDURE
4.1 Flight Currency
At a minimum, the UAS Pilot in Command (PIC) shall complete three takeoffs (launch) and landing (recovery) in the previous 90 days. Refer to the Training Procedures Template for further currency requirements.

4.2 Crew Rest Requirements
4.2.1 Crew day commences when the members reports to work.
4.2.2 Crew day shall not exceed 12 hours without approval from UAS Management
4.2.3 Crew rest should consist of eight consecutive hours of rest prior to reporting to any scheduled flight event.

4.3 Weather Minimums
4.3.1 Weather minimums for all flights shall be conducted in Visual Meteorological Conditions (VMC) and in accordance with 14 CFR 91.555. Minimum flight visibility of not less than three statue miles shall be maintained at all times.
4.3.2 Weather shall be forecasted from one-hour prior to take off to one hour after landing

4.4 Designation
All aircrew must be designated in writing by the UAS management.

4.5 Responsibility of UAS Crew
4.5.1 The UAS PIC will be designated prior to the flight and will be at the controls any time the aircraft rotors are engaged. The UAS PIC has the direct responsibility of all phases of the flight and shall be the final authority as to the operation of the UAS. The UAS PIC is responsible for the safe, orderly flight of the aircraft at all times.
4.5.2 The Visual Observer must be qualified while acting as part of the ground crew. The Visual Observer will provide support for preflight planning, staging, launching, in-flight, and recovery operations.

4.6 Alcohol or Drugs
4.6.1 Compliance with company regulations regarding alcohol or drugs is mandatory. The use of over-the-counter drugs or prescription drugs is not authorized unless prescribed by a competent medical professional who is aware of your flight status.

4.6.2 Flight crew members shall not:
  • Consume alcohol within 12 hours of pre-flight planning
  • Be under the influence of alcohol while operating a UAS
  • Use illegal drugs.

4.7 Checklist
The checklist shall be used before each flight. Do not become complacent and disregard the checklist, even when flying multiple flights in one day. Perform every item on the checklist every time prior to every takeoff.

4.8 Risk Assessment
The Pilot in Command shall complete the Risk Assessment Matrix; this will normally take place during the brief prior to the mission.

4.9 Operating Areas
Employees will drive the flight area and inspect the operating area before each flight to ensure there are no unusual ground activities. Any abnormal operating conditions will be cause for termination of flight.

4.10 Sense and Avoid
Sense and Avoid will be conducted by the operator and vigilance shall be maintained by each PIC and VO so as to “sense and avoid” any other aircraft. All members of the UAS crew to include the PIC and VO are responsible for sense and avoid.

4.11 Flight Planning
A Notice to Airmen (NOTAM) will be filled 72 hours in advance, but not less than 24 followed by the Pilot in Command and will adhere to the Training Manuals for each Make and Model of UAS. Refer to Operating limits assigned by the FAA for additional requirements.

4.12 Flight Log Books
4.12.1 Each individual will be responsible to document and record all individual flight times.

4.12.2 At a minimum, flight log book entries will include:
  • Date
  • Identification of aircraft
  • Total flight time
  • Location
  • Any additional training received
4.13 Customer Privacy concerns

5. REFERENCES
5.1 Federal Aviation Administration Exemption No. 11238, Regulatory Docket No. FAA-2014-0719
5.2 Federal Aviation Administration Form 7711-1 UAS Certificate of Waiver or Authorization
5.3 Training Manuals for each Make and Model of UAS

6. ATTACHMENTS
6.1 ATTACHMENT F-1 - Sample Designation Letter

Attachment F-1 – Sample Designation Letter

From: Unmanned Aircraft Systems Management
To: John Doe
Subject: DESIGNATION AS UNMANNED AIRCRAFT SYSTEMS OPERATOR

1. Per reference (a) through (d), you are hereby designated as the (PUT YOUR UAS TYPE HERE) UAS as an Unmanned Aircraft System (UAS) Pilot in Command (PIC).
2. A copy of this designation letter will be entered into your training and qualification jacket.
3. Congratulations on your new designation.

//SIGNED//

J. Doe

Copy to:
Training Jacket
APPENDIX G: SAMPLE MAINTENANCE TEMPLATE

1. PURPOSE
To implement maintenance and inspection procedures for scheduled and unscheduled maintenance for the Unmanned Aircraft System (UAS). This standard establishes policy, responsibilities, and requirements for a successful UAS maintenance program.

2. APPLICABILITY
This standard shall apply to all personnel, and those under contract, engaged in the construction and maintenance of fieldwork.

3. PROCEDURE
   3.1 Responsibilities
   It is the responsibility of each and every member to the UAS department to adhere to all of the maintenance and inspection procedures.

   3.2 Inspection Requirements
   All Unmanned Aerial Vehicles (UAV) will require scheduled and unscheduled MAINTENANCE.
   3.2.1 The following scheduled maintenance should be performed:
   - Daily Inspection
   - 100 hour and annual inspections are recommended
   - Symptom based inspections as needed

   3.2.1 Unscheduled Maintenance:
   All maintenance shall adhere to manufacture’s requirements per the Operating Manual for each UAS. Unscheduled maintenance such as propellers, motors, and antennas will be changed as per the Mission Data Sheet (MDS). Other unscheduled maintenance, such as avionics, will be sent to the manufacturer or certified representative for repair.

   3.3 Daily Inspections
   Prior to the first flight of the day, a daily inspection will take place. Both the aircraft and the Ground Control Station (GCS) should be inspected for damage before operating the system. Inspect the aircraft in general and specifically look for damaged, loose, or misaligned propellers, loose motors, and cracked motor supports. The GCS should also be generally inspected looking especially for broken or loose antenna connections, cracked screen, and broken or loose joysticks.

   3.3.1 Daily inspection will consist of the following:
   - Check for any damage to the aircraft.
     - Aircraft propellers and motors can become damaged.
       - If a propeller blade is chipped or cracked, it is best to replace it immediately. The aircraft can still fly if the damage to a propeller is minimal, but with decreased endurance.
     - Check for damage to a motor by rotating it manually.
       - If there is any difficulty turning the motor or if it makes a clicking sound, the motor is dysfunctional and should be replaced. It is much less likely for a motor to break than for a propeller to chip.
o Check to make sure that all motor and propeller screws are in place and secure.
o Check for cracks in the aircraft frame that could reduce the aircraft’s structural integrity.
• Check Ground Control stations
  o Ensure that both the GCS and aircraft have fully charged batteries.
o Check that the antennas are attached on tight and no damage.
• After completion of the above steps, complete Preflight inspection before takeoff.

3.4 100 hour and Annual Inspection
If required, this shall be completed by the manufacturer or certified representative.

3.5 System based inspections
When symptoms are identified by the operator, the Unmanned Aircraft System will be sent back to the manufacture or its authorized representative to accomplish the necessary procedures. These inspections will be accomplished and recorded on the Maintenance Action required sheet.

3.6 Battery Safety Procedures
3.6.1 Lithium-Poly (Li-Po) batteries are a revolution in battery technology, but require special consideration and handling techniques due to their extremely high capacity. Ensure following the safety procedures:
• Use only chargers designed specifically for Li-Po batteries and do not leave Li-Po batteries charging unattended.
• Never allow the battery to short circuit.
• Do not charge batteries near flammable materials.
• Do not store Li-Po batteries inside your vehicle. Temperatures inside a parked vehicle can rapidly exceed the recommended maximums.
• Do not allow the battery temperature to exceed 160 °F. Permanent damage will result.
• Li-Po batteries will function in temperature from -20 to +120 °F but for optimal performance should be kept between 40-100 °F.
• Do not allow the battery to discharge below 9 V as this will permanently damage the battery. After a serious crash, inspect the Li-Po battery for swelling or overheating. Do this on a fireproof surface (i.e. concrete or sand) to ensure it has not sustained any internal damage. Also check for any damage to the battery wiring. If the Li-Po battery is damaged in a crash or appears to be swollen, split, or torn: a) Discontinue use immediately; b) Place the battery away from anything flammable (i.e. bare concrete floor); c) Ensure the battery is disposed of properly.

3.6.2 If you notice a performance decrease of greater than 20% in your Li-Po battery, the battery is at the end of its life cycle. Discontinue use and ensure the battery is disposed of properly.

3.7 Battery Disposal
3.7.1 LiPo batteries are environmentally friendly once they are fully discharged. For safety reasons, LiPo cells should be fully discharged before disposal; however, if the battery becomes physically damaged it is NOT recommended to discharge LiPo cells before disposal. To dispose of LiPo cells and packs:
• Allow batteries to cool
• Allow batteries to cool
• If any LiPo cell is swollen, split, or torn, do NOT discharge the battery. Jump to step c.
  a) Place the LiPo battery in a fireproof container or bucket of sand.
  b) Connect the battery to a LiPo discharger.
  c) Set the discharge cutoff voltage.
  d) Discharge the battery until its voltage reaches 1.0V per cell or lower.
  e) For resistive load type discharges, discharge the battery for up to 24 hours.
• Prepare a 2 gallon plastic bucket with a lid by mixing 1 gallon of cold water and ½ cup of salt.
• Submerse the battery into the salt water.
• Place a lid on the container. It does not need to be airtight.
• Allow the battery to remain in salt water for at least two weeks.
• Remove the LiPo battery from the salt water and dispose properly.

3.8 Troubleshooting
All troubleshooting should be completed per the Operating manual for each UAS.

3.9 Flight and Maintenance log
The Mission Data Sheet (MDS), Flight Log, Maintenance action required sheet, Discrepancy Form, Propeller Log, and Engine/Motor Log shall all be filed out completely after each flight.

4. REFERENCES
Operating manual for each UAS

5. ATTACHMENTS
5.1 Attachment G-1 - Mission Data Sheet (MDS)
5.2 Attachment G-2 - Flight Log
5.3 Attachment G-3 - Maintenance action required sheet
5.4 Attachment G-4 - Discrepancy Form
5.5 Attachment G-5 - Propeller Log
5.6 Attachment G-6 - Engine/Motor Log
### Attachment G-1 – Mission Data Sheet (MDS)

<table>
<thead>
<tr>
<th>DATE</th>
<th>TAKEOFF TIME</th>
<th>LANDING TIME</th>
<th>NAME OF PIC</th>
<th>LOCATION</th>
<th>MISSION TYPE</th>
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<tr>
<td>DATE</td>
<td>SYSTEM CHECK Y/N</td>
<td>FLIGHT HOURS</td>
<td>TOTAL FLIGHT HOURS</td>
<td>FLIGHT HOURS SINCE SYSTEM CHECK</td>
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Corrected by and Date: Print

Signature | Maint Cert #

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<td>Corrective Action:</td>
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Discovered by:

Corrected by and Date: Print

Signature | Maint Cert #
PROPELLER CHANGE LOG FOR N

PROPEL #1 YELLOW  FRONT  PROPEL #2 WHITE

PROPEL #3 WHITE  TOP VIEW  PROPEL #4 YELLOW

EVERY TIME YOU CHANGE A PROPEL YOU MUST LOG THE REQUIRED INFORMATION. LOG BEFORE YOU FLY AGAIN
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EVERY TIME YOU CHANGE A MOTOR YOU MUST LOG THE REQUIRED INFORMATION. LOG BEFORE YOU FLY AGAIN
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APPENDIX H:
SAMPLE INCIDENT REPORTING TEMPLATE

1. PURPOSE
This incident guide establishes procedures to be adhered to in the event of an incident involving an Unmanned Aircraft System (UAS).

2.0 APPLICABILITY
This standard shall apply to all personnel, and those under contract, engaged in the construction and maintenance of fieldwork. All personnel must follow Ref (5.1) and (5.2).

3.0 DEFINITIONS

4.0 PROCEDURE

4.1 Policy
4.1.1 As per Ref (5.3), an unmanned aircraft accident means an occurrence associated with the operation of any public or civil unmanned aircraft system that takes place between the time the system is activated with the purpose of flight and the time the system is deactivated at the conclusion of its mission, in which:
   - Any person suffers death or serious injury
   - The aircraft has a maximum gross takeoff weight of 300 lbs. or greater and sustains substantial damage.

4.1.2 If the above occurs, the NTSB requires that it be notified by the most expeditious means available within ten days after an applicable UAS accident. The incident shall be reported by completing the pilot/operator aircraft accident/incident report, National Transportation Safety Board (NTSB) Form 6120.1.

4.1.3 Federal Aviation Administration Form 8020-23 is to be completed for each accident and incident and forwarded to the responsible regional Flight Standards (FS) district office within 30 days.

5.0 REFERENCES

5.1 Service Dispatch Standard

5.2 Safety and Health On-call procedure

5.3 National Transportation Safety Board (NTSB) 49 Code of Federal Regulations (CFR) Part 830

5.4 Federal Aviation Administration Form 8020-23

6.0 ATTACHMENTS

6.1 Attachment H-1 – Initial UAS incident report form

6.4 Attachment H-2 – Immediate after action incident procedures
THE FIRST PERSON TO BECOME AWARE OF AN INCIDENT WILL IMMEDIATELY FOLLOW THE THREE STEPS BELOW:

1. Notify emergency response personnel (911) of incident if they are not already en-route or on scene.

2. Notify the Trouble Department/Dispatch.
   a) All incidents are reported to the Trouble Department/Dispatch who will immediately send out a Blast Page to all those who are on-call.

3. Notify UAS management of the incident.

Notify the personnel above and provide them with the information below. Collect as much information as possible, but do not delay the phone notification due to lack of details.

Give the following information

GENERAL INFORMATION

Date of Incident: ________________        Time of Incident: __________

Caller’s Name: ______________________________________________________

Phone No. Calling From: ___________________

INCIDENT INFORMATION

Incident Location (landmarks, distances, etc.): ______________________________________________________________

Type/Model/Series of UAS: _____________________________________________

Weather at Incident scene: _____________________________________________

Fire involved (Y/N) Explosion occurred (in air, at impact, after impact, not applicable) ________________________

Extent of damage to UAS: _____________________________________________
Number of crewmembers involved and conditions of each: ___________________________________________

__________________________________________

Damage to civilian property. Extent of damage if known: _______________________________________

__________________________________________

Injuries to personnel (employees, civilian, both) other than aircrew. Extent of personnel injuries, if known: ______

__________________________________________

Caller will be at telephone Number (if different from above): ______________________________________

__________________________________________

Name of person receiving the call: ____________________________________________________________

__________________________________________

Attachment H-2 – Immediate after action incident procedures

1. Confirm all procedures in the UAS incident report form are complete. After the incident report is complete, verify the following are in progress:

   a) In the event of injury or death as a result of the incident, ensure casualty reporting procedures are accomplished as per the Contractor Health and Safety plan.

   b) Ensure all crewmember personnel involved in the incident are immediately referred for medical examination to include toxicological testing.

   c) Coordinate with the UAS Safety Manager to ensure reporting and investigation will occur in accordance with the National Transportation Safety Board (NTSB) 49 Code of Federal Regulations (CFR) Part 830 and, if applicable, National Transportation Safety Board (NTSB) Form 6120.1; complete and send to NTSB within ten days.

   d) Direct all questions from the media to the Media and Employee communication on-duty representative through the media hotline.

   e) UAS Maintenance management shall safeguard and lock up all of the following:

      a. ALL Aircraft maintenance records
      b. Training records to include qualification, currency, and medical for all crewmembers.
      c. ANY pertinent records regarding the flight that day
APPENDIX I: SAMPLE TRAINING PLAN TEMPLATE

1. PURPOSE
To implement training procedures for the conduct and management of each Pilot in Command (PIC), and or operator, Visual Observer (VO), and Camera Operator (CO).

2. APPLICABILITY
This standard shall apply to all personnel, and those under contract, engaged in the construction and maintenance of fieldwork.

3. DEFINITIONS
Pilot in Command (PIC) - Term used by the Federal Aviation Administration (FAA) in 14 CFR 91.3 to define the responsibility and authority as the following: The PIC of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

4. PROCEDURE

4.1 Currency
Currency requirements shall be maintained per the Company Standard Operating Procedures. At a minimum, the Pilot in Command (PIC) and/or operator shall complete three takeoffs (launch) and landing (recovery) in the previous 90 days. If a crew member fails to maintain currency and it has been less than 180 days since the last flight, he/she shall complete a minimum of six takeoffs and landings with a flight instructor and complete the written portion of the PIC syllabus. If over 180 days since the last flight, the crew member must complete a new PIC syllabus.

4.2 Pilot in Command (PIC) Qualification
4.2.1 Any person operating the Unmanned Aerial Vehicle (UAV) will complete a training program given by a qualified Instructor and must have a valid FAA Class 2 Medical Certificate. The training course will include all of the information in Federal Aviation Administration Exemption No. 11238, Regulatory Docket No. FAA-2014-0719, Training Manuals for each Make and Model of UAS, and will incorporate topics such as:
- System specifications
- Limitations
- Normal operations to include flight and ground operations
- Emergency Procedures
- Troubleshooting
- Maintenance
- Flight Operations
- Airspace regulations and reporting

4.2.2 At the completion of the course the PIC will be required to complete a verbal evaluation and hands-on performance test. After passing all evaluations, the PIC will receive a completion certificate authorizing UAV operation.
4.3 Instructor Qualification
Each instructor will be qualified by the manufacture of the UAV and complete a verbal evaluation and hands-on performance test. After passing the evaluations, the instructor will receive a certificate of completion. That certificate will authorize the instructor to qualify PICs/Operators. The instructor will be responsible to ensure each PIC is fully qualified and completing currency and annual training flights.

4.4 Observer Qualification
4.4.1 If the observer is not a certified pilot, he/she will attend training to understand the proper roles of an observer, communication procedures, proper visual scan techniques, operations at non-towered airports, see and avoid, clear of clouds, and right of way rules. Observers will also be required to have a current second-class medical certification.

4.4.2 Ground crew will provide support for preflight planning, staging, launching, in-flight, and recovery operations.

4.5 Annual Check Flight
4.5.1 Every PIC will be required to pass an annual check flight given by a designated Instructor. This check flight will consist of:
- Verbal Evaluation
- Hands-on performance test

4.5.2 Refer to the Annual Check Flight Evaluation worksheet; a final grade of Q (Qualified) must be received to qualify as a UAS PIC. Anyone who receives three or more CQ (Conditionally Qualified) or U (Unqualified) marks will be considered U and shall re-do all portions of the check flight.

4.5.3 The re-evaluation of the check flight shall take place at least 15 days after receiving the U to allow additional study time. No more than two re-evaluation check flights will be given to an individual.

4.6 Flight Log Books
4.6.1 Each individual will be responsible for documenting and recording all flight time.

4.6.2 At a minimum, log book entries will include:
- Date
- Identification of aircraft
- Total flight time
- Location
- Any additional training received

4.7 Checklist
The checklist shall be used before each flight. Do not become complacent and disregard the checklist, even when flying multiple flights in one day. Perform every item on the checklist every time prior to every takeoff.

4.8 Risk Assessment
The Pilot in Command shall complete the Risk Assessment Matrix; this will normally take place during the brief prior to the mission.
4.9 Operating Areas
Employees will drive the flight area and inspect the operating area before each flight to ensure there are no unusual ground activities. Any abnormal operating conditions will be cause for termination of flight.

4.10 Sense and Avoid
Sense and Avoid will be conducted by the operator and vigilance shall be maintained by each operator so as to “sense and avoid” any other aircraft. All members of the ground crew to include the pilot and observer are responsible for sense and avoid.

4.11 Flight Planning
Notice to Airmen (NOTAM) will be filled 48 hours in advance, but not less than 24 hours prior to flight operations. Prior to flight, during flight, and post flight checklists will be followed by the Pilot in Command and will adhere to operating training manual.

4.12 Flight crew members shall not:
• Consume alcohol within 12 hours of pre-flight planning
• Be under the influence of alcohol while operating a UAS
• Use illegal drugs

5. REFERENCES
5.1 Federal Aviation Administration Exemption No. 11238, Regulatory Docket No. FAA-2014-0719

5.2 Training Manuals for each Make and Model of UAS

6. ATTACHMENTS
Attachment I-1 – Annual check flight evaluation worksheet
### ANNUAL CHECK FLIGHT EVALUATION WORKSHEET

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#### EVALUATION

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<td>Q</td>
<td>CQ</td>
</tr>
</tbody>
</table>

### Verbal Evaluation

### Flight Evaluation

<table>
<thead>
<tr>
<th>Flight Duration:</th>
<th>Aircraft #</th>
<th>Overall Final Grade:</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**Q**=Qualified  **CQ**=Conditionally Qualified  **U**=Unqualified

### Demonstrate practical knowledge of the following:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Q</th>
<th>CQ</th>
<th>U</th>
</tr>
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<tbody>
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</tbody>
</table>

#### Preflight

- Launch

#### Mode display

- Location display
- Simple maneuvering

#### Bearing heading indicator

##### Altitude indicator

#### Home mode

#### Landing

### Flight evaluation:

- Demonstrate proficiency launch to 100ft AGL
- Maneuver in front of PIC with camera facing away
- Descend to 400ft AGL
- Simulated loss of GPS
- Simulated loss of GPS using video only
- Warning aircraft battery low
- Land, record location
- Verbally test on Loss of GCS power

### Demonstrate proficiency in Emergency Procedures

<table>
<thead>
<tr>
<th>Name of Instructor:</th>
<th>Signature of Instructor:</th>
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</thead>
<tbody>
<tr>
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</table>

### Remarks: