October 15, 2014

U.S. Department of Transportation
Docket Management System
1200 New Jersey Ave., SE
Washington, DC 20590

Re: Exemption Request Under Section 333 of the FAA Reform Act and Part 11 of the Federal Aviation Regulations

Dear Sir or Madam:

Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 (the "Reform Act") and 14 C.F.R. Part 11, Commonwealth Edison Company ("ComEd"), a northern Illinois-based electric utility that delivers reliable electricity for 3.8 million customers throughout more than 400 municipalities and 25 counties, seeks exemptions from the Federal Aviation Regulations ("FARs") so that it may test utility system monitoring by small Unmanned Aircraft Systems (sUASs) in a remote area of Cook and Will Counties, Illinois. ComEd's limited proposed use of sUASs does not create a hazard to users of the national air space (NAS) or the public or threaten national security due to their small size, low weight and speed, safety features, and operating distance from airports and populated areas. As detailed in Appendix A, ComEd's proposed use of sUASs thoroughly addresses all of the safety criteria found in the FAA's grants of exemption to Astraeus Aerial, Aerial MOB, LLC, Pictorvision Inc., HeliVideo Productions LLC, Snaproll Media LLC, and RC Pro Production Consulting LLC dba Vortex Aerial (the "Production Companies").

The requested exemptions would permit ComEd and the Illinois Institute of Technology (IIT) to conduct trial operations of the DJI Innovations S900 ("the DJI S900" or the "sUAS") for the limited purposes of electric transmission and distribution utility system ("ComEd System") monitoring and university research. In particular, the requested exemption would authorize operation of the DJI S900 to gather information on the condition of the ComEd System in hard-to-access areas, including the assessment of storm damage. sUAS technology has the potential to enhance ComEd's ability to assess the condition of the ComEd System safely and efficiently. It would allow ComEd to survey more territory faster, safer, and more fuel efficiently than it can using existing methods on foot or using helicopters or other low flying aircraft, resulting in improved reliability of electrical services for our customers. IIT, as part of their Engineering Department's Robotics Lab, seeks to evaluate the performance of this technology in real world conditions.

As described more fully within this petition, the DJI S900's operations under the exemption will be subject to strict operating requirements and conditions to ensure at least an equivalent level of safety to currently authorized operations using manned aircraft and under conditions as may be modified by the FAA as required by Section 333. The DJI S900 will be operated under controlled conditions by qualified operators. It will be flown at low altitudes in airspace that is limited in scope, as described more fully herein, and detailed in the Certificate of Authorization application. DJI S900 operations will not be conducted in a way that violates reasonable expectations of privacy.

CHARACTERISTICS OF THE DJI INNOVATIONS S900

The DJI S900 consists of a graphical, touch-screen control station, an aerial vehicle, and a radio repeater station. The aerial vehicle consists of a small hexrotor, a type of rotorcraft, which is lifted and propelled by six rotors. It is electrically powered by lithium polymer batteries and therefore presents no fuel spill risk. To further increase safety, IIT researchers have designed a cage structure that encloses the aerial vehicle, allowing it to roll on the ground to prevent damaging crashes. Previous experiments with other similar systems indicate that the cage structure has no detrimental impact on the flight capabilities of the system.

The radio repeater station is used to extend the control station's transmission range. The radio repeater station and control station comply with all FCC requirements. The aerial vehicle itself performs all actions necessary to hold a fixed position or to travel to a destination. All system components monitor their own "health" and battery capacity. A fail safe system takes appropriate, pre-programmed actions when error conditions are detected, including hovering in place for ten seconds and returning to the take-off point. For further details regarding the DJI Innovations S900 see Appendix B.

ComEd respectfully submits that because this small, unmanned aircraft system will be used in lieu of comparatively hazardous operations now conducted with conventional rotary aircraft and inspections on foot in areas with downed power lines, the FAA can have confidence that the proposed operations will achieve at least an equivalent or greater level of safety. Additionally, ComEd employs many procedures that demonstrate a commitment to the safety of employees and the public. Many of these procedures relate to overhead work, including an extensive safety rule book and protocols preventing 'line of fire from above' events. Approval of this exemption would thereby enhance safety and fulfill the Secretary of Transportation's (the FAA Administrator's) responsibilities under Section 333(c) of the Reform Act to "establish requirements for the safe operation of such aircraft systems in the national airspace system."

The name and address of the applicant is as follows:

Commonwealth Edison Company
Attn: Linda G. Rhodes, CSP (Certified Safety Professional)
Ph: 630-576-7623
Fax: 630-652-6857
Email: linda.rhodes@comed.com
Address: 2 Lincoln Centre
Oakbrook Terrace, IL 60181

EXEMPTIONS SOUGHT

The regulations from which the exemption is requested are as follows (see Appendix C for exemption request reasons and equivalent level of safety):

14 CFR Part 21, specifically Subpart H (Certification procedures for products and parts; Airworthiness Certificates)
14CFR 43.7
14 CFR 43.11
14 CFR 45.11
14 CFR 45.23(b)
14 CFR 45.25
14 CFR 45.29
14 CFR 47.3(b)(2)
14 CFR 47.31(c)
14 CFR 91.9(b)(2)
14 CFR 91.9 c
14 CFR 91.103(b)(2)
14 CFR 91.105
14 CFR 91.109
14 CFR 91.113(b)
14 CFR 91.115
14 CFR 91.119(b)(c)
14 CFR 91.121
14 CFR 91.151
14 CFR 91.203(a)(1)
14 CFR 91.203(a)(2)
14 CFR 91.215
14CFR 91.319(a)(1)
14 CFR 91.403
14 CFR 91.405
14 CFR 91.407
14 CFR 91.409
14 CFR 91.417

THE APPLICABLE LEGAL STANDARD UNDER SECTION 333

ComEd submits that grant of this exemption application for use of the DJI S900 in Utility System inspections and damage assessments will advance the Congressional mandate in Section 333 of the Reform Act to accelerate the introduction of sUASs into the national airspace system (NAS) if it can be accomplished safely. This law directs the Secretary of Transportation to consider whether certain sUASs may operate safely in the NAS before completion of the rulemaking required under Section 332 of the Reform Act. In making this determination, the Secretary is required to determine which types of sUASs do not create a hazard to users of the NAS or the public or pose a threat to national security in light of the following:

- The sUAS' size, weight, speed, and operational capability;
- Operation of the sUAS in close proximity to airports and populated areas; and
- Operation of the sUAS within visual line of sight of the operator.

The Federal Aviation Act expressly grants the FAA the authority to issue exemptions. This statutory authority, by its terms, includes exempting civil aircraft, as the term is defined under §40101 of the Act, from the requirement that all civil aircraft must have a current airworthiness certificate and those regulations requiring commercial pilots to operate aircraft in commercial service:

> The Administrator may grant an exemption from a requirement of a regulation prescribed under subsection (a) or (b) of this section or any of sections or any of sections 44702-44716 of this title if the Administrator finds the exemption is in the public interest.

Applicant submits that this provision places a duty on the Administrator to not only process applications for exemptions under Section 333, but for the Administrator, if he deems the conditions proposed herein require modification in order to allow approval, to supply conditions for the safe operation of the sUAS. ComEd welcomes the opportunity to consult with FAA staff in order to address any issues or concerns that this proposal may raise that they believe may require modification.

The grant of the requested exemption is in the public interest based on the clear direction in Section 333 of the Reform Act; the additional authority in the Federal Aviation Act, as amended; the strong equivalent level of safety surrounding the proposed operations; and the significant public benefit, including enhanced safety and cost savings associated with transitioning to sUASs for inspections and research. Accordingly, the applicant respectfully requests that the FAA grant the requested exemption without delay.

MANDATORY OPERATING REQUIREMENTS

Grant of the exemptions to ComEd will be subject to the following mandatory conditions, which provide at least an equivalent or higher level of safety than under the current operations.

1. The sUAS must weigh less than 18 pounds, including energy source(s) and equipment. Operations authorized by the grant will be limited to the following aircraft as described in the operator's manual: the DJI Innovations S900. Proposed operations of any other aircraft will require a new petition or a petition to amend.
2. The sUAS may not be flown at a ground speed exceeding 50 knots.
3. Flights must be operated at an altitude of no more than 400 feet above ground level (AGL), as indicated by the procedures specified in the operator's manual. All altitudes reported to ATC must be in feet AGL.
4. The UA (Unmanned Aircraft) must be operated within visual line of sight (VLOS) of the PIC (Pilot in Command) at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued medical certificate.
5. All operations must utilize a visual observer (VO). The VO may be used to satisfy the VLOS requirement as long as the VO and PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times.
6. The operator's manual and this grant of exemption must be maintained and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operator's manual, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operator's manual. The operator may update or revise its operator's manual. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator upon request. The operator must also present updated and revised documents if it petitions for extension or amendment. If the operator determines that any update or revision would affect the basis for which the FAA granted this exemption, then the operator must petition for amendment to their exemption. The FAA's s UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operator's manual.
7. Prior to each flight, the DJI S900 must perform automatic pre-flight checks as outlined in the operator's manual and failure of any check must prevent take-off. In addition, prior to each flight the PIC must inspect the sUAS to ensure it is in a condition for safe flight. If the inspection reveals a condition that affects the safe operation of the sUAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the sUAS is found to be in a condition for safe flight. The Ground Control Station, if utilized, must be included in the preflight inspection. All maintenance and alterations must be properly documented in the aircraft records.
8. Any sUAS that has undergone maintenance or alterations that affect the sUAS operation or flight characteristics, e.g. replacement of a flight critical component, must undergo a functional test flight in accordance with the operator's manual. The PIC who conducts the functional test flight must make an entry in the sUAS aircraft records of the flight. The requirements and procedures for a functional test flight and aircraft record entry must be added to the operator's manual.
9. The operator must follow the manufacturer's sUAS aircraft/component, maintenance, overhaul, replacement, inspection, and life limit requirements. When unavailable, aircraft maintenance/component/overhaul, replacement, and inspection/maintenance requirements must be established and identified in the operator's manual. At a minimum, requirements for the following must be included in the operator's manual: Actuators / Servos; Transmission (single rotor); Powerplant (motors); Propellers; Electronic speed controller; Batteries; Mechanical dynamic components (single rotor);Remote command and control; Ground control station (if used); and any other components as determined by the operator.

10. The Pilot In Command (PIC) must possess at least an FAA approved private pilot's license and current third-class medical certificate and flight review. Currency requirements are not relevant to sUASs because they do not carry passengers.
11. Prior to operations, the PIC must successfully complete a DJI factory certified pilot training program, designed for proficient operation and maintenance of the DJI S900.
12. Prior to Utility System monitoring operations (or similar operations), a flight demonstration, administered by an operator-approved and -qualified pilot must be successfully completed and documented. This documentation must be available for review upon request by the Administrator. Because the knowledge and airmanship test qualifications have been developed by the operator, and there are no established practical test standards that support a jurisdictional FAA FSDO evaluation and approval of company designated examiners, the petitioner will conduct these tests in accordance with the operator's manual.
13. The sUAS may not be operated directly over any person, except authorized and consenting utility personnel, below an altitude that is hazardous to persons or property on the surface in the event of an sUAS failure or emergency.
14. Regarding the distance from participating persons, the operator's manual has safety mitigations for authorized and consenting personnel. At all times, those persons must be essential to the utility operations and wear hardhats. Because these procedures are specific to participating persons, no further FSDO or aviation safety inspector approval is necessary for reductions to the distances specified in the petitioner's manuals.
15. The pre-job brief will verify control of the flight area and further ensure the safety of test participants following guidance provided in Appendix D (Job Briefing and Job Turnover). Note that one requirement of the briefing process is to make sure proper personal protective equipment is worn by all participants. As required in the "Personal Protective Equipment" program attached in Appendix E, decisions about equipment required will be based on exposure risks (such as head protection, foot protection and eye protection).
16. All operations must be conducted over property that is owned or controlled by ComEd or is utility right-of-way. The pre-job brief must verify control of the flight area, including the absence of members of the public in the flight area. Operations must be stopped if unauthorized persons enter the flight area, consistent with the "Time Out for Safety Process" detailed in Appendix F. Work performed on the ComEd System is governed by rigorous operational safety procedures, including protocols to protect the public from 'line-of-fire from above' events.
17. If the sUAS loses communications or loses the GPS signal, the sUAS will hover in place for 10 seconds and then must return to the take-off point or be recovered in accordance with the operator's manual.
18. The sUAS must abort the flight in the event of unpredicted obstacles or emergencies in accordance with the operator's manual.
19. Each sUAS operation must be completed within 30 minutes flight time or with 20% battery power remaining, whichever occurs first. The fail-safe and countdown timer on the sUAS will be used to alert the operator when 20% of the battery power is remaining so a controlled landing can be facilitated. The fail-safe feature results in a first level warning light. A second level warning follows with flashing lights. The countdown timer acts as a third level warning with an audible alarm, alerting the operator so they have adequate time to return to base.
20. The operator must obtain an Air Traffic Organization (ATO) issued Certificate of Waiver or Authorization (COA) prior to conducting any operations under this grant of exemption.
21. ComEd must fulfill any reasonable request by the FAA related to the identification and registration marking of the sUAS.
22. The operator must develop procedures to document and maintain a record of the sUAS maintenance, preventative maintenance, alterations, status of replacement/overhaul component parts, and the total time in service of the sUAS. These procedures must be added to the operator's manual.

23. Each sUAS operated under this exemption must comply with all manufacturer Safety Bulletins.
24. The operator must develop sUAS technician qualification criteria. These criteria must be added to the operator's manual.
25. The preflight inspection section in the operator's manual must be amended to include the following requirement: The preflight inspection must account for all discrepancies, i.e. inoperable components, items, or equipment, not covered in the relevant preflight inspection sections of the operator's manual.
26. Before conducting operations, the radio frequency spectrum used for operation and control of the UA must comply with the Federal Communications Commission (FCC) or other appropriate government oversight agency requirements.
27. The following agencies/departments will be notified in advance about all sUAS flights: Within Municipalities (so municipality officials can proactively communicate sUAS operations to residents and respond to public inquiries): Mayor's Office, Illinois Department of Transportation, Sheriff's Office/Police Department. Within ComEd (so department leaders can proactively communicate sUAS operations to the public and respond to public inquiries): Communications, External Affairs, Customer Care Center (Customer Service Agents), EChannels (Social Media Department), Corporate Relations, and Public Relations. Notifications will include the following information: Dates and times for all flights, Name and phone number of the person responsible for the onsite operation of the sUAS, Make, model and serial number of the sUAS to be used, Name and certificate number of the sUAS person-in-charge, signature of exemption holder or representative, and a description of the flight activity, including maps or diagrams of any area over which inspections will be conducted and the altitudes essential to accomplish the operation.
28. The documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the sUAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.
29. The UA must remain clear and yield the right of way to all other manned operations and activities at all times (including, but not limited to, ultralight vehicles, parachute activities, parasailing activities, hang gliders, etc.).
30. sUAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.
31. The sUAS may not be operated by the PIC from any moving device or vehicle.
32. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.
33. The sUAS may not operate in Class B, C, or D airspace without written approval from the FAA. The sUAS may not operate within five nautical miles of the geographic center of a non-towered airport unless a letter of agreement with that airport's management is obtained. When reasonable and practical, ComEd will initiate a NOTAM. However, in the event of an emergency, such as a power outage caused by a storm, it is not practicable for ComEd to initiate a NOTAM because of the advanced notification requirement. ComEd will follow any reasonable and practicable notice requirements mandated by the FAA.
34. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's sUAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov. Further flight operations may not be conducted until the incident, accident, or transgression is reviewed by AFS-80 and authorization to resume operations is provided.

35. The sUASs must operate at a safe distance from power lines. Operation of the sUAS to be allowed by trained pilots using approved protocols only. The pre-job brief will communicate approved clearances and operation of the sUAS will be closely monitored. The job will be stopped if clearances are breached. The DJI S900 must be equipped with a digital zoom lens camera that will be used to increase visibility of components being inspected so there will be no operational need to fly close enough to lines to risk electromagnetic interference. sUAS operating rules establish minimum power line spacing for each voltage. Operators will evaluate how to safely fly around power lines without bridging phases before each flight (for example, power line spacing must be confirmed as greater than the minimum before the sUAS would be allowed to fly between power lines). Also, flying between lines must be avoided when possible.
36. The sUASs must provide visual warnings to the pilot for all systems, alarm condition and out-of-range sensor values.
37. Consistent with other ComEd jobs performed in the field, compliance with a briefing process will be required before, during and after operations of the sUAS for increased safety (see Appendix G for the ComEd sUAS Aerial Inspections Flight Briefing Sheet).
38. sUAS operations will not be conducted in a way that violates reasonable expectations of privacy. Operations will follow the Association for Unmanned Vehicle Systems International Code of Conduct for Unmanned Aircraft System Operations and affected municipalities will be notified in advance about sUAS flights.

CONCLUSION

The planned used of the DJI S900 satisfies the criteria set forth in Section 333 of the Reform Act. ComEd's proposed sUAS operations, subject to the conditions listed above, do not create a hazard to users of the national air space (NAS) or the public or threaten national security due to its small size, low weight and speed, safety features, and operating distance from airports and populated areas.

The operation of the sUAS for inspections and research in accordance with the strict conditions outlined herein will provide more than an equivalent level of safety, supporting the grant of the exemptions requested. Approval of the exemption allowing operations of the DJI S900 for inspections and research will enhance safety by reducing the risks inherent in ComEd's present operations. Current aerial inspection operations of the ComEd System using conventional rotary aircraft, present risks associated with vehicles that often weigh in excess of 5,000 to 7,000 lbs. and carry large quantities of fuel, passengers, and cargo. Such aircraft must fly to and from the inspection locations, often over residential properties. The DJI S900 will operate at similar speeds and altitudes of conventional aircraft, but only weighs approximately 18 lbs. (less than half the weight approved for sUAS use by the Production Companies), is powered by batteries, and will be carried to the inspection location. The DJI S900 will not fly over residences like conventional aircraft. Further, the DJI S900 will carry no passengers or crew and, therefore, will not expose any individuals to the risks associated with manned aircraft flights. All of these factors greatly reduce the risks associated with conventional operations.

Given its size, speed, load capacity, and lack of fuel spill risk, the DJI S900 poses no threat to national security. Further, the operating capabilities, lack of proximity to airports and populated areas, avoidance of airspace used by other aircraft, operation within visual line of sight, and use of licensed pilots provide more than adequate justification to grant the requested exemptions.

Yours in Safety,

Linda G. Rhodes, CSP (Certified Safety Professional)
Commonwealth Edison

APPENDIX A

Exelon Section 333 Exemption Application Compared with Granted Applications

	ComEd Petition	Conditions resulting from 6 identical approved applications--Film Producers
1	The sUAS must weigh less than 18 pounds, including energy source(s) and equipment. Operations authorized by the grant will be limited to the following aircraft as described in the operator's manual: the DJI Innovations S900. Proposed operations of any other aircraft will require a new petition or a petition to amend.	The unmanned aircraft (UA) must weigh less than 55 pounds (25 Kg), including energy source(s) and equipment. Operations authorized by this grant of exemption are limited to the following aircraft described in the operator's manual: Astraeus Aerial Cinema System V.3CS UAS aircraft variant, serial #001 onward (V.3). Proposed operations of any other aircraft will require a new petition or a petition to amend this grant.
2	The sUAS may not be flown at a ground speed exceeding 50 knots .	Same parameters
3	Flights must be operated at an altitude of no more than 400 feet above ground level (AGL), as indicated by the procedures specified in the operator's manual. All altitudes reported to ATC must be in feet AGL.	Same parameters
4	The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued medical certificate.	Same parameters
5	All operations must utilize a visual observer (VO). The VO may be used to satisfy the VLOS requirement as long as the VO and PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times.	Same parameters
6.	The operator's manual and this grant of exemption must be maintained and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operator's manual, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operator's manual. The operator may update or revise its operator's manual. It is the operator's responsibility to track	Same parameters

	such revisions and present updated and revised documents to the Administrator upon request. The operator must also present updated and revised documents if it petitions for extension or amendment. If the operator determines that any update or revision would affect the basis for which the FAA granted this exemption, then the operator must petition for amendment to their exemption. The FAA's sUAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operator's manual.	
7	Prior to each flight, the DJI S900 must perform automatic pre-flight checks as outlined in the operators manual and failure of any check must prevent take-off. In addition, prior to each flight the PIC must inspect the sUAS to ensure it is in a condition for safe flight. If the inspection reveals a condition that affects the safe operation of the sUAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the sUAS is found to be in a condition for safe flight. The Ground Control Station, if utilized, must be included in the preflight inspection. All maintenance and alterations must be properly documented in the aircraft records.	Prior to each flight the PIC must inspect the UAS to ensure it is in a condition for safe flight. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight. The Ground Control Station, if utilized, must be included in the preflight inspection. All maintenance and alterations must be properly documented in the aircraft records.
8	Any sUAS that has undergone maintenance or alterations that affect the sUAS operation or flight characteristics, e.g. replacement of a flight critical component, must undergo a functional test flight in accordance with the operator's manual. The PIC who conducts the functional test flight must make an entry in the sUAS aircraft records of the flight. The requirements and procedures for a functional test flight and aircraft record entry must be added to the operator's manual.	Same parameters
9	The operator must follow the manufacturer's sUAS aircraft/component, maintenance, overhaul, replacement, inspection, and life limit requirements. When unavailable, aircraft maintenance/component/overhaul, replacement, and inspection/maintenance requirements must be established and identified in the operator's manual. At a minimum, requirements for the following must be included in the operator's manual: Actuators / Servos; Transmission (single rotor); Powerplant (motors); Propellers; Electronic speed controller; Batteries; Mechanical dynamic components (single rotor);	The operator must follow the manufacturer's UAS aircraft/component, maintenance, overhaul, replacement, inspection, and life limit requirements. When unavailable, aircraft maintenance/component/overhaul, replacement, and inspection/maintenance requirements must be established and identified in the operator's manual. At a minimum, requirements for the following must be included in the operator's manual: Actuators / Servos; Transmission (single rotor); Powerplant (motors); Propellers; Electronic speed controller; Batteries; Same parameters

	Remote command and control; Ground control station (if used); and any other components as determined by the operator.	
10	The Pilot In Command (PIC) must possess at least an FAA approved private pilot's license and current third-class medical certificate and flight review. Currency requirements are not relevant to sUASs because they do not carry passengers.	The Pilot In Command (PIC) must possess at least a private pilot certificate and at least a current third-class medical certificate. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.
11	Prior to flight operations, the PIC must successfully complete a DJI factory certified pilot training program, designed for proficient operation and maintenance of the DJI S900. The PIC must have accumulated and logged, in a manner consistent with 14 CFR 61.51(b), a minimum of twelve hours as a sUAS pilot operating the DJI S900 to be used for operations under the exemption: three hours of flight over an open area, three hours inspecting distribution structures, three hours inspecting transmission structures, and three hours inspecting substations. The twelve hour operating time may be satisfied by training using the DJI Operating Manual as a training guide. The training must also include three take-offs, three landings, and emergency procedures – all conducted under this grant of exemption. Training will take place at a ComEd training facility (such as the Rockford Training Facility, Rockford, IL, where there's 85,000 square feet of secure outdoor training space).	Prior to operations conducted for the purpose of motion picture filming (or similar operations), the PIC must have accumulated and logged, in a manner consistent with 14 CFR § 61.51(b), a minimum of 200 flight cycles and 25 hours of total time as a UAS rotorcraft pilot and at least ten hours logged as a UAS pilot with a similar UAS type (single blade or multirotor). Prior documented flight experience that was obtained in compliance with applicable regulations may satisfy this requirement. Training, proficiency, and experience-building flights can also be conducted under this grant of exemption to accomplish the required flight cycles and flight time. During training, proficiency, and experience building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.
12	Prior to flight operations, the PIC must successfully complete a DJI factory certified pilot training program, designed for proficient operation and maintenance of the DJI S900. The PIC must have accumulated and logged, in a manner consistent with 14 CFR 61.51(b), a minimum of twelve hours as a sUAS pilot operating the DJI S900 to be used for operations under the exemption: three hours of flight over an open area, three hours inspecting distribution structures, three hours inspecting transmission structures, and three hours inspecting substations. The twelve hour operating time may be satisfied by training using the DJI Operating Manual as a	Prior to operations conducted for the purpose of motion picture filming (or similar operations), the PIC must have accumulated and logged, in a manner consistent with14 CFR § 61.51(b), a minimum of five hours as UAS pilot operating the make and model of UAS to be utilized for operations under the exemption and three take-offs and three landings in the preceding 90 days. Training, proficiency, experience-building, and take-off and landing currency flights can be conducted under this grant of exemption to accomplish the required flight time and 90 day currency. During training, proficiency, experience-building, and take-off and landing currency flights all persons not essential for flight operations are considered nonparticipants,

	training guide The training must also include three take-offs, three landings, and emergency procedures – all conducted under this grant of exemption. Training will take place at a ComEd training facility (such as the Rockford Training Facility, Rockford, IL, where there's 85,000 square feet of secure outdoor training space).	and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR §91.119.
13	Prior to any flight operations by this grant of exemption, the PIC and VO must have successfully completed a qualification process. The test must be developed and implemented by a qualified person designated at the sole discretion of the operator and must include training, proficiency and experience-building flights. The DJI S900 Operating Manual must be used as the foundation for a qualification process guide. The qualification process must include take-offs, landings, and emergency procedures – all conducted under this grant of exemption. A record of completion of this qualification process must be documented and made available to the Administrator upon request.	Prior to any flight operations authorized by this grant of exemption, the PIC and VO must have successfully completed a qualification process, as outlined in the operator's manual. As this is a requirement stipulated by the operator, the test must be developed and implemented by a qualified person designated at the sole discretion of the operator. A record of completion of this qualification process must be documented and made available to the Administrator upon request.
14	Prior to ComEd System monitoring operations (or similar operations), a flight demonstration, administered by an operator-approved and -qualified pilot must be successfully completed and documented. This documentation must be available for review upon request by the Administrator. Because the knowledge and airmanship test qualifications have been developed by the operator, and there are no established practical test standards that support a jurisdictional FAA FSDO evaluation and approval of company designated examiners, the petitioner will conduct these tests in accordance with the operator's manual.	Same parameters
15	The sUAS may not be operated directly over any person, except authorized and consenting utility personnel, below an altitude that is hazardous to persons or property on the surface in the event of an sUAS failure or emergency.	Same parameters

16	Regarding the distance from participating persons, the operator's manual has safety mitigations for authorized and consenting personnel. At all times, those persons must be essential to the utility operations and wear hardhats. Because these procedures are specific to participating persons, no further FSDO or aviation safety inspector approval is necessary for reductions to the distances specified in the petitioner's manuals.	Regarding the distance from participating persons, the operator's manual has safety mitigations for authorized and consenting production personnel. At all times, those persons must be essential to the closed-set film operations. Because these procedures are specific to participating persons, no further FSDO or aviation safety inspector approval is necessary for reductions to the distances specified in the petitioner's manuals. This is consistent with the manned aircraft procedures described in FAA Order 8900.1, V3, C8, S1 Issue a Certificate of Waiver for Motion Picture and Television Filming.
17	All operations must be conducted over property that is owned or controlled by ComEd or is utility right-of-way. The pre-job brief must verify control of the flight area, including the absence of members of the public in the flight area. Operations must be stopped if unauthorized persons enter the flight area, consistent with the "Time Out for Safety Process" detailed in Appendix F. Work performed on ComEd's system is governed by rigorous protocols, including the extensive work performed overhead. Work Area Protection protocols, for example, include protecting the public from work being performed and from the associated conditions.	Regarding distance from nonparticipating persons, the operator must ensure that no persons are allowed within 500 feet of the area except those consenting to be involved and necessary for the filming production. This provision may be reduced to no less than 200 feet if it would not adversely affect safety and the Administrator has approved it. For example, an equivalent level of safety may be determined by an aviation safety inspector's evaluation of the filming production area to note terrain features, obstructions, buildings, safety barriers, etc. Such barriers may protect nonparticipating persons (observers, the public, news media, etc.) from debris in the event of an accident. This is also consistent with the same FAA Order 8900.1, V3, C8, S1.
18	If the sUAS loses communications or loses the GPS signal, the sUAS will hover in place for 10 seconds and then must return to the take-off point or in accordance with the operator's manual.	If the UAS loses communications or loses GPS signal, the UA must return to a pre-determined location within the security perimeter and land or be recovered in accordance with the operator's manual.
19	The sUAS must abort the flight in the event of unpredicted obstacles or emergencies in accordance with the operator's manual.	Same parameters
20	Each sUAS operation must be completed within 30 minutes flight time or with 20% battery power remaining, whichever occurs first. The fail-safe and countdown timer on the sUAS will be used to alert the operator when 20% of the battery power is remaining so a controlled landing can be facilitated. The fail-safe feature results in a first level warning light. A second level warning follows with flashing lights. The countdown timer acts as a third level warning	Each UAS operation must be completed within 30 minutes flight time or with 25% battery power remaining, whichever occurs first.

	with an audible alarm, alerting the operator so they have adequate time to return to base.	
21	The operator must obtain an Air Traffic Organization (ATO) issued Certificate of Waiver or Authorization (COA) prior to conducting any operations under this grant of exemption.	The operator must obtain an Air Traffic Organization (ATO) issued Certificate of Waiver or Authorization (COA) prior to conducting any operations under this grant of exemption. This COA will also require the operator to request a Notice to Airman (NOTAM) not more than 72 hours in advance, but not less than 48 hours prior to the operation.
22	ComEd must fulfill any reasonable request by the FAA related to the identification and registration marking of the sUAS.	All aircraft must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, subpart C. Markings must be as large as practicable.
23	The operator must develop procedures to document and maintain a record of the sUAS maintenance, preventative maintenance, alterations, status of replacement/overhaul component parts, and the total time in service of the sUAS. These procedures must be added to the operator's manual.	Same parameters
24	The sUAS operated under this exemption must comply with all manufacturer Safety Bulletins.	Same parameters
25	The operator must develop UAS technician qualification criteria. These criteria must be added to the operator's manual.	Same parameters
26	The preflight inspection section in the operator's manual must be amended to include the following requirement: The preflight inspection must account for all discrepancies, i.e. inoperable components, items, or equipment, not covered in the relevant preflight inspection sections of the operator's manual.	Same parameters
27	Before conducting operations, the radio frequency spectrum used for operation and control of the UA must comply with the Federal	Same parameters

	Communications Commission (FCC) or other appropriate government oversight agency requirements.	
28	The following agencies/departments will be notified in advance about all sUAS flights: Within Municipalities (so municipality officials can proactively communicate sUAS operations to residents and respond to public inquiries) Mayor's Office Illinois Department of Transportation Sheriff's Office/Police Department Within ComEd (so department leaders can proactively communicate sUAS operations to the public and respond to public inquiries) Communications External Affairs Customer Care Center (Customer Service Agents) EChannels (Social Media Department) Corporate Relations Public Relations Notifications will include the following information: 1) Dates and times for all flights. 2) Name and phone number of the person responsible for the onsite operation of the sUAS. 3) Make, model and serial number of the sUAS to be used. 4) Name and certificate number of the sUAS person-in-charge. 5) Signature of exemption holder or representative. 6) A description of the flight activity, including maps or diagrams of any area over which inspections will be conducted and the altitudes essential to accomplish the operation.	Must submit a written Plan of Activities to the local FSDO including at least the following: a. Dates and times for all flights b. Name and phone number of the operator for the UAS filming production conducted under this grant of exemption c. Name and phone number of the person responsible for the on-scene operation of the UAS d. Make, model, and serial or N-number of UAS to be used e. Name and certificate number of UAS PICs involved in the filming production event f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request. g. Signature of exemption-holder or representative h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation;
29	The documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the sUAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.	Same parameters
30	The UA must remain clear and yield the right of way to all other manned operations and activities at all times (including, but not limited to, ultralight vehicles, parachute activities,	Same parameters

	parasailing activities, hang gliders, etc.).	
31	sUAS operations may not be conducted during the night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.	Same parameters
32	The sUAS may not be operated by the PIC from any moving device or vehicle.	Same parameters
33	The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.	Same parameters
34	The sUAS may not operate in Class B, C, or D airspace without written approval from the FAA. The sUAS may not operate within five nautical miles of the geographic center of a non-towered airport unless a letter of agreement with that airport's management is obtained. When reasonable and practical, ComEd will initiate a NOTAM. However, in the event of an emergency, such as a power outage caused by a storm, it is not practicable for ComEd to initiate a NOTAM because of the advanced notification requirement. ComEd will follow any reasonable and practicable notice requirements mandated by the FAA.	The UA may not operate in Class B, C, or D airspace without written approval from the FAA. The UA may not operate within 5 nautical miles of the geographic center of a non-towered airport as denoted on a current FAA-published aeronautical chart unless a letter of agreement with that airport's management is obtained, and the operation is conducted in accordance with a NOTAM as required by the operator's COA. The letter of agreement with the airport management must be made available to the Administrator upon request.
35	Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's sUAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov. Further flight operations may not be conducted until the incident, accident, or transgression is reviewed by AFS-80 and authorization to resume operations is provided.	Same parameters

APPENDIX B

SMALL UNMANNED AIRCRAFT SYSTEM DESCRIPTION & SPECIFICATIONS

DJI Innovations – DJI S900

The DJI S900 consists of a graphical, touch-screen control station, an aerial vehicle, and a radio repeater station. The aerial vehicle consists of a small hexrotor, a type of rotorcraft, which is lifted and propelled by six rotors. It is electrically powered by lithium polymer batteries and therefore presents no fuel spill risk. To further increase safety, IIT researchers have designed a cage structure that encloses the aerial vehicle, allowing it to roll on the ground to prevent damaging crashes. Previous experiments with other similar systems indicate that the cage structure has no detrimental impact on the flight capabilities of the system.

The radio repeater station is used to extend the control station's transmission range. The radio repeater station and control station comply with all FCC requirements. The aerial vehicle itself performs all actions necessary to hold a fixed position or to travel to a destination. All system components monitor their own "health" and battery capacity. A fail safe system takes appropriate, pre-programmed actions when error conditions are detected, including hovering in place for ten seconds and returning to the take-off point.

DJI Innovations

6F, Hkust Sz IER Bldg.
No.9 Yuexing 1st Rd.
Hi-Tech Park (South),
Nanshan Dist.
Shenzhen, Guangdong, China, 518057.
Phone: +86 755 26656677
Email: info@dji.com

DJI Innovations Authorized Dealer – UAV Direct

14365 W. State Highway 29
Liberty Hill, TX 78642
Phone: 1-855-778-6363
Email: ops@uavdirect.com

Frame	Diagonal Wheelbase 900mm Frame Arm Length 358mm Frame Arm (Including Motor, ESC, Propeller) 316g Center Frame Diameter 272mm Center Frame Weight (With Landing Gear Mounting Base, Servos) 1185g Landing Gear Size 460mm(Length)×450mm(Width)×360mm(Height)
Motor	Stator Size 41×14mm KV 400rpm/V Max Power 500W Weight(With Cooling Fan) 158g
ESC	Working Current 40A Working Voltage 6S LiPo Signal Frequency 30Hz ~ 450Hz Drive PWM Frequency 8KHz Weight(With Radiators) 35g

Foldable Propeller (1552/1552R)	Material High strength performance engineered plastics Size 15×5.2inch Weight 13g
Flight Parameters	Takeoff Weight 4.7Kg ~ 8.2Kg Total Weight 3.3Kg Power Battery LiPo (6S、10000mAh~15000mAh、15C(Min)) Max Power Consumption 3000W Hover Power Consumption 1000W (@6.8Kg Takeoff Weight) Hover Time 18min (@12000mAh& 6.8Kg Takeoff Weight) Working Environment Temperature -10 °C ~ +40 °C
Gain Value Settings	For A2 Flight Controller Basic: Roll 110%, Pitch Attitude: Roll 220%, Pitch 220%, Vertical 120% For WooKong-M Flight Controller Basic: Roll 160%, Pitch Attitude: Roll 190%, Pitch 190%, Vertical 100%

FRAME	**Diagonal Wheelbase**	**Frame Arm Length**	**Frame Arm Weight (Including Motor, ESC, Propeller)**	**Center Frame Diameter**
	800mm	350mm	356g	240mm

	Center Frame Weight	**Landing Gear Size**	**Retractable Landing Gear Weight (Including Battery Tray)**	
	550g	460mm(Length)×425mm(Width)×320mm(Height) (Top width: 155mm)	1050g	
FLGHT PARAMETERS	**Takeoff Weight**	**Total Weight**	**Power Battery**	**Max Power Consumption**
	6.0Kg ~ 8.0Kg	3.7Kg	LiPo (6S、10000mAh~15000mAh、15C(Min))	3000W
	Hover Power Consumption	**Hover Time**		
	800W(@ Takeoff Weight 6.7Kg)	Max: 20 min (@15000mAh&6.7Kg Takeoff Weight)		
MOTOR	**Stator Size**	**KV**	**Max Power**	**Weight (w/ Cooling Fan)**
	41×14mm	400rpm/V	500W	158g
ESC	**Current**	**Voltage**	**Signal Frequency**	**Drive PWM Frequency**
	40A OPTO	6S LiPo	30Hz ~ 450Hz	8KHz
	Weight(with Radiators)			
	35g			

PROPELLER (FOLDABLE)	**Material**	**Size**	**Weight**	
	Carbon Fiber	15×04in	10g	

APPENDIX C

EXEMPTION REQUESTS
WITH REASONS FOR REQUESTS AND EQUIVALENT LEVEL OF SAFETY

ComEd requests an exemption from the following regulations as well as any additional regulations that may technically apply to the operation of the DJI S900:

Part 21 Airworthiness Certification

14 CFR Part 21, Subpart H Airworthiness Certificates and 14 CFR 91.203(a)(1) Civil aircraft. Certifications required.

Section 91.203(a)(1) requires all civil aircraft to have a certificate of airworthiness. Part 21, Subpart H, entitled Airworthiness Certificates, establishes the procedural requirements for the issuance of airworthiness certificates as required by FAR § 91.203(a)(1). Given the size of the aircraft (8.2 kg; 18 lbs) and the limited operating area associated with its utilization, it is unnecessary to go through the certificate of airworthiness process under Part 21 Subpart H to achieve or exceed current safety levels.

Such an exemption meets the requirements of an equivalent level of safety under Part 11 and Section 333 of the Reform Act. The Federal Aviation Act and Section 333 of the Reform Act both authorize the FAA to exempt aircraft from the requirement for an airworthiness certificate, upon consideration of the size, weight, speed, operational capability, and proximity to airports and populated areas of the sUAS involved.

In this case, an analysis of these criteria demonstrates that the DJI S900 operated without an airworthiness certificate, under the conditions proposed herein, will be at least as safe, or safer, than a conventional aircraft (fixed wing or rotorcraft) with an airworthiness certificate. The DJI S900 weighs 8.2 kg (18 lbs) It will not carry a pilot or passenger, will not carry flammable fuel, and will operate exclusively within an area pre-disclosed (and detailed on ComEd's Certificate of Authorization) and in compliance with conditions set forth herein. Operations under this exemption will be tightly controlled and monitored by both the operator, pursuant to the conditions set forth above, and by local public safety requirements. Notification of affected municipalities, the size of the aircraft, the lack of flammable fuel, and the fact that the aircraft is carried to the location and not flown there all establish the equivalent level of safety. The DJI S900 provides at least an equivalent, and most likely exceeds, level of safety to that of such operations being conducted with conventional aircraft that would be orders of magnitude larger and would be carrying passengers, cargo, and flammable fuel.

The automated safety features highlight the design intentions towards safety and reliability on the DJI S900.

Part 43 Maintenance

14 CFR 43.7 Persons authorized to approve aircraft, airframes, aircraft engines, propellers, appliances, or component parts for return to service after maintenance, preventive maintenance, rebuilding, or alteration.

This section lists seven different persons who may sign return-to-service documentation, approving aircraft and affected components for service after maintenance, preventive maintenance, rebuilding or alteration:

1) Certified mechanic or holder of an inspection authorization.
2) Holder of a repair station certificate.
3) Manufacturer.
4) Holder of an air carrier certificate.
5) Certificated private pilot.
6) Repairman certificated with a maintenance rating for light sport aircraft only.
7) Certificated sport pilot for preventive maintenance on an aircraft owned and or operated by him or her.

Besides the DJI S900 being nearly maintenance free, the nature of sUAS technology (such as inherent safety features) provides for decisions about return-to-service following maintenance and/or related activities to be made with minimal risk by persons well trained in the technology (whether any of the above seven criteria exist or not).

The DJI S900 performs automatic pre-flight checks and the failure of any check will prevent take-off. Checks that cannot be performed by the system will be performed by a qualified person prior to each flight and include the following:

- A full visual inspection of the airframe.
- Visual inspection of rotor integrity.
- Charge of all batteries (sUAS, command station and radio repeater station)

14 CFR 43.11 Content, form and disposition of records for inspections conducted under parts 91 and 125 and 135.411(a)(1) and 135.419 of this chapter.

This section deals with inspection record entries for aircraft, including a requirement that these records contain the following information:

- Certificate numbers for the inspectors.
- Kind of certificates for the persons approving or disapproving the return to service.

As referenced in the exemption request for 14 CFR 43.7, the DJI S900 is nearly maintenance free. The nature of sUAS technology (such as inherent safety features) provides for decisions about return-to-service following maintenance and/or related activities to be made with minimal risk by persons well trained in the technology (whether the person making decisions about return-to-service hold a certificate or not).

Likewise, all persons inspecting the sUAS will have successfully completed training for such activity, making them at least as proficient as certificated inspectors.

Part 45 Identification and Registration Marking

14 CFR 45.11 Marking of products.

This section requires the securing of a fireproof marker on the aircraft fuselage exterior so it is legible to persons on the ground. Also, the requirement continues that propellers, propeller blades and hubs must receive markers.

While the sUAS will involve flight at only 400 feet AGL and within line of site of the pilot, it is not feasible that markers described in this section will be legible from the ground given the sUAS and sUAS component sizes:

- sUAS width = 900 mm (35.4 in.)
- sUAS height = 460 mm (18.1 in.)
- Propeller length = 381 mm (15 in.)

Further, marker required locations are in some cases non-existent on the battery-powered DJI S900 (i.e., aircraft fuselage). Additional specifications are detailed on Appendix B (S900 Specifications). ComEd will fulfill any reasonable request by the FAA related to the identification and registration marking of the sUAS.

14 CFR 45.23(b) Display of marks; general and

91.9(c) Civil aircraft flight manual, marking, and placard requirements.

Regulation 45.23(b) provides:

(b) When marks include only the Roman capital letter "N" and the registration number is displayed on limited, restricted or light-sport category aircraft or experimental or provisionally certificated aircraft, the operator must also display on that aircraft near each entrance to the cabin, cockpit, or pilot station, in letters not less than 2 inches nor more than 6 inches high, the words "limited," "restricted," "light-sport," "experimental," or "provisional," as applicable.

Regulation 91.9(c) provides:

No person may operate a U.S.-registered civil aircraft unless that aircraft is identified in accordance with part 45 of this chapter.

The DJI S900 has no entrance to the cabin, cockpit, or pilot station on which the markings can be placed. Given the size of the sUAS, two inch lettering will be impossible. Official marking systems for sUASs have not yet been established for operations inside the NAS. ComEd is prepared to fulfill any request by the FAA related to identification and registration marking in accordance with 45.29(f) where the pilot, observer, and others working with the sUAS will see the identification of the sUAS.

The FAA has issued the following exemptions to this regulation: Exemption Numbers 8738, 10167, 10167A and 10700.

14 CFR 45.25 Location of marks on fixed wing aircraft.

This section requires that operators display marks "…on either the vertical tail surfaces or the sides of the fuselage." As referenced in the exemption request for 14 CFR 45.11, this marking requirement is not feasible given the size of sUASs. Also note that the DJI S900 does not contain a fuselage.

14 CFR 45.29 Size of marks.

This section provides requirements for the size of aircraft markings; however, marking requirements for sUASs are not specifically listed. Instead, aircraft types referenced in this section include fixed-wing, gliders, exhibition, antique, airships, spherical balloons, powered parachutes, etc.

As referenced in the exemption request for 14 CFR 45.23(b) and 91.9(c), ComEd is prepared to fulfill any request by the FAA related to identification and registration marking of the sUAS.

Part 47 Aircraft Registration

14 CFR 47.3(b)(2) Registration required.

This section prohibits the operation of aircraft that is eligible for registration unless 1) the aircraft has been registered by its owner; 2) the aircraft is carrying aboard the temporary authorization required by 47.31(c); or 3) the aircraft is an aircraft of the Armed Forces.

Unless the sUAS ground control station is considered part of the sUAS, ComEd requests exemption from requirement number two above. While it is feasible to maintain the aircraft registration document at the ground control station, it is not feasible for the sUAS to carry the registration document 'on board' (given the size of the sUAS, as summarized in exemption request 14 CFR 45.11).

14 CFR 47.31(c) Application.

This section requires that each applicant for a Certificate of Aircraft Registration, after completing and submitting the application, submitting the aircraft bill of sale and paying the required fee – must comply with paragraph c:

"…the applicant for registration of an aircraft last previously registered in the United States must carry the second copy of the Aircraft Registration Application in the aircraft as temporary authority to operate without registration."

ComEd does not possess an aircraft that was previously registered in the United States, making the referenced requirement in this section infeasible.

Part 91 General Operating and Flight Rules

14 CFR 91.9(b)(2) Civil aircraft flight manual, marking and placard requirements.

This section prohibits operation of a U.S.-registered civil aircraft for which a flight manual is not required, unless there is "…available in the aircraft a current approved Airplane or Rotocraft Flight Manual, approved manual material, markings, and placards, or any combination thereof."

As per the size of the sUAS, provided in exemption request 14 CFR 45.11, it is not feasible to make a manual and associated materials available in the aircraft.

14 CFR 91.9(c) Civil aircraft flight manual, marking and placard requirements.

This section prohibits operation of U.S.-registered civil aircraft without identification specified in part 45.

As stated in the exemption requests specific to part 45:

- It is not feasible that markers described in this part will be legible from the ground.
- Marker required locations are in some cases non-existent on the battery-powered DJI S900 (i.e., aircraft fuselage, cabin, cockpit, etc.).

ComEd is prepared to fulfill any request by the FAA related to identification and registration marking of the sUAS.

14 CFR 91.103(b)(2) Preflight action.

This regulation requires each pilot in command to take certain actions before flight to insure the safety of flight. As FAA approved rotorcraft flight manuals will not be provided for the aircraft an exemption will be needed. An equivalent level of safety will be provided as set forth in the DJI S900 Operating Manual (Appendix H). The person-in-charge will take all actions including reviewing weather, flight battery requirements, landing and takeoff distances and aircraft performance data before initiation of flight.

The Aerial Inspection Flight Briefing Sheet in Appendix G provides additional required pre-flight actions.

14 CFR 91.105 Flight crewmembers at stations.

This section contains requirements for crewmembers during takeoff and landing of aircraft. Specifically:

(a) During takeoff and landing, and while en route, each required flight crewmember shall—

(1) Be at the crewmember station unless the absence is necessary to perform duties in connection with the operation of the aircraft or in connection with physiological needs; and

(2) Keep the safety belt fastened while at the crewmember station.

(b) Each required flight crewmember of a U.S.-registered civil aircraft shall, during takeoff and landing, keep his or her shoulder harness fastened while at his or her assigned duty station. This paragraph does not apply if—

(1) The seat at the crewmember's station is not equipped with a shoulder harness; or

(2) The crewmember would be unable to perform required duties with the shoulder harness fastened.

In any sUAS, the ‘crewmember station’ is separate from the actual aircraft (such as a station established on the ground). Therefore, compliance with the seat belt and shoulder harness requirements are not feasible. Also, members of the crew (such as operators and observers) may reside in separate crewmember stations during takeoff and landing of the aircraft (for purposes of safely navigating the aircraft). Therefore, compliance with ‘a(1)’ may involve identification of multiple crewmember stations.

14 CFR 91.109 Flight instruction; Simulated instrument flight and certain flight tests and 91.319(a)(1) Aircraft having experimental certificates: Operating limitations.

These regulations provide that no person may operate a civil aircraft (except a manned free balloon) that is being used for flight instruction unless that aircraft has fully functioning dual controls.

The DJI S900 is a remotely piloted aircraft and by design, does not have fully functional dual controls. Flight control is accomplished through the use of a control box that communicates with the aircraft via radio communications. The flight plan is manually controlled through point-and-click navigation. The FAA has approved exemptions for flight training without fully 11 of 20 functional dual controls for a number of aircraft and for flight instruction in experimental aircraft. See Exemption Nos. 5778K & 9862A.

The equivalent level of safety will be achieved through prudent use of manufacturer training materials and through the use of licensed and qualified pilots familiar with the DJI S900.

14 CFR 91.113(b) Right of way rules: Except water operations.

This section addresses the vigilance required during aircraft operations to see and avoid other aircraft by prohibiting aircraft from "…passing over, under, or ahead of…" aircraft that has the right-of-way (until the area is clear), weather permitting.

sUASs are not specifically listed in this section to clarify the right-of-way priority for this type of aircraft. Also, while sUASs may technically pass under or ahead of other aircraft, safety protocols have been established to mitigate risks associated with contacting other aircraft and they include the following:

- Notification to impacted municipalities about flight plans (as shown in the Mandatory Operating Requirements (#27).
- Operation of the sUAS may not be in Class B, C, or D airspace without written approval from the FAA, and must be below 400 feet AGL at all times.
- Operation of the sUAS during daylight hours, within visual line of sight and during Visual Flight Rules Meteorological Conditions.

Additional precautions designed to help ensure safe operation of the sUAS can be found in the Mandatory Operating Conditions section of this document and in the Certificate of Authorization application.

14 CFR 91.115 Right of way rules: Water operations.

This section provides requirements for operating aircraft on the water (to keep clear of and to avoid impeding the navigation of any vessel).

ComEd does not intend to operate aircraft on any body of water as part of this petition.

14 CFR 91.119(b)(c) Minimum safe altitudes: General.

Section 91.119 establishes safe altitudes for operation of civil aircraft. Specifically, 91.119(c) limits aircraft flying over areas other than congested areas to an altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure.

As set forth herein, the DJI S900 will not operate at higher than 400 feet AGL. It will, however, be operated to avoid congested or populated areas that are detailed on ComEd's Certificate of Authorization application. Because many electric utility system condition inspections must be accomplished at relatively low altitudes and at altitudes less than 400 feet AGL, an exemption from Section 91.119(c) is needed.

The equivalent level of safety will be achieved given the size, weight, speed, and material with which the DJI S900 is built. Also, no flight will be taken without notification to affected municipalities. Because of the advance notice, all affected individuals will be aware of the flights. Compared to aerial inspection operations conducted with aircraft or rotorcraft weighing far more than 8.2 kg (18 lbs) and carrying flammable fuel, any risk associated with these operations will be far less than those currently allowed with conventional aircraft operating at or below 400 AGL. The low altitude operations of the sUAS will maintain separation between sUAS operations and the operations of conventional aircraft that must comply with Section 91.119.

14 CFR 91.121 Altimeter settings.

This section requires that each person operating an aircraft maintain cruising altitude by reference to an altimeter that is set "to the elevation of the departure airport or an appropriate altimeter setting available before departure."

As the DJI S900 does not have an altimeter, ComEd requests an exemption from this requirement. An equivalent level of safety will be achieved according to guidelines outlined in the Operating Manual (Attachment H) and will include confirmation of GPS signals, the Moving Map Indicator and tracking capability from the ground control station. Also, because all operations are within 400 feet AGL of the ground and clear of the airspace used by most aircraft, this procedure ensures an increased level of safety.

14 CFR 91.151 Fuel requirements for flights in VFR conditions.

This regulation prohibits an individual from beginning "a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed – (1) During the day, to fly after that for at least 30 minutes; or (2) At night, to fly after that for at least 45 minutes."

The DJI S900 batteries provide approximately 18 minutes of powered flight, and the enclosed cage to be tested around the sUAS by the Illinois Institute of Technology may prove to effectively extend sUAS battery life. Without an exemption from 14 CFR 91.151, the sUAS' flights would be limited to approximately 20 minutes in length. Given the limitations on its proposed operations and the location of those proposed operations, a longer time frame for flight in daylight VFR conditions is reasonable.

ComEd believes that an exemption from 14 CFR 91.151 is safe and within the scope of a prior exemption. See Exemption 10673 (allowing Lockheed Martin Corporation to operate without compliance with 91.151(a)). Operating the sUAS, without 30 minutes of reserve fuel does not engender the type of risks that Section 91.151 was meant to prevent given the size and speed at which the sUAS operates. The fact that it carries no pilot, passenger, or cargo also enhances its safety. Additionally, limiting DJI S900 flights to 20 minutes would greatly reduce their utility. In the unlikely event that the DJI S900 should run out of fuel (battery power), it would land. Given its weight and construction material, the risks are less than contemplated by the current regulation.

ComEd believes that an equivalent level of safety can be achieved by maintaining reserve battery power to return the sUAS to its planned landing zone from anywhere in its prescribed and controlled operating area.

The FAA has granted similar exemptions to others, including Exemptions 2689F, 5745, 10673 and 10808.

14 CFR 91.203 (a)(1) and 91.203(a)(2) Civil aircraft: Certifications required.

This regulation provides as follows:

(a) … no person may operate a civil aircraft unless it has … an appropriate and current airworthiness certificate.

(b) No person may operate a civil aircraft unless the airworthiness certificate required by paragraph (a) of this section or a special flight authorization issued under §91.715 is displayed at the cabin or cockpit entrance so that it is legible to passengers or crew.

The DJI S900 weighs approximately 8.2 kg (18 lbs) As such, there is no ability or place to carry certification and registration documents or to display them on the sUAS. In addition, there is no pilot on board the aircraft.

An equivalent level of safety will be achieved by keeping these documents at the ground control point where the pilot flying the sUAS will have immediate access to them. The FAA has issued numerous exemptions to this regulation. A representative sample of other exceptions includes the following Exemption Numbers: 9565, 9665, 9789, 9789A, 9797, 9797A, 9816A, and 10700.

And it is ComEd's understanding that the ground control point may be considered part of the sUAS; thereby anything displayed at this location is technically consistent with this requirement and possibly not necessary from which to seek exemption.

14 CFR 91.215 ATC transponder and altitude reporting equipment and use.

This section prohibits operation of aircraft without a transponder in certain airspace.

Exceptions are provided for aircraft "…not originally certificated with an engine-driven electrical system or which has not subsequently been certified with such a system installed, balloon, or glider…." The DJI S900 does not have an "engine-driven electrical system," so these exemptions apply.

Operational safety will be further improved because, in lieu of being equipped with a transponder, the DJI S900 will comply with all mandatory operating conditions specified in this document (and the Certificate of Authorization application), including the following:

- Operation of the sUAS may not be in Class B, C, or D airspace without written approval from the FAA, and must be below 400 feet AGL at all times.
- Operation of the sUAS during daylight hours, within visual line of sight and during Visual Flight Rules Meteorological Conditions.
- See and Avoid coverage by both the qualified pilot and the qualified observer throughout operations.

14 CFR 91.403 General.

This section provides requirements for maintenance in reference to several parts including part 39 (Airworthiness Directives), part 43 (Maintenance) and part 121 (Altimeter settings).

Given that the following requirement: "(a) The owner or operator of an aircraft is primarily responsible for maintaining that aircraft in an airworthy condition, including compliance with part 39 of this chapter" appears to only apply to aircraft with airworthiness certificates, the requirement does not apply to the operation of the DJI S900.

Given that the following requirement: "(b) No person may perform maintenance, preventive maintenance, or alterations on an aircraft other than as prescribed in this subpart and other applicable regulations, including part 43 of this chapter" appears to apply to aircraft with complicated maintenance needs, the requirement does not apply to the maintenance of the DJI S900 (which is nearly maintenance free).

Appendix H (the Operating Manual) contains maintenance instructions for the DJI S900 and it illustrates some of the safety features inherent to this technology and how they provide for decisions about return to service following maintenance and/or related activities.

14 CFR 91.405 Maintenance required, 91.407 Operation after maintenance, preventive maintenance, or alteration, 91.409 Inspections, and 91.417 Maintenance records.

Section 91.405(a) requires that an aircraft operator or owner "shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in part 43 of this chapter ..."

Section 91.407 similarly makes reference to requirements in Part 43; Section 91.409(a)(2) requires an annual inspection for the issuance of an airworthiness certificate. Section 91.417(a) requires the owner or operator to keep records showing certain maintenance work that has been accomplished by certificated mechanics, under Part 43, or licensed pilots and records of approval of the aircraft for return to service.

The DJI S900 is nearly maintenance free, it performs automatic pre-flight checks and the failure of any check will prevent take-off. Checks which cannot be done by the system will be performed by a qualified person prior to each flight and at predefined intervals as part of the maintenance schedule in the Operating Manual (see Appendix H).

Pre-flight checklist includes:

1. Visual inspection of the airframe
2. Visual inspections of rotor integrity
3. Check charge of all batteries (aerial vehicle, command station, radio repeater station)

An equivalent level of safety will be achieved because the sUAS is small in size, will carry no external payload, will operate only in restricted pre-selected areas and is not a complex mechanical device. As provided in the attached Operating Manual (Appendix H), the operator of DJI S900 will ensure that the sUAS is in working order prior to initiating flight, perform required maintenance, and keep a log of any

maintenance that is performed. Moreover, the operator is the person most familiar with the aircraft and is best suited to maintain the aircraft in an airworthy condition and to ensure an equivalent level of safety.

The DJI S900's maintenance instructions (Appendix H) ensure an equivalent level of safety to the maintenance requirements in Part 91. In addition, any component failure detectable by the system will be reported to the control station and will cause the sUAS to perform a Fatal Condition Response (FCR) or Nonfatal Conditioned Response (NFCR), depending on the type of failure.

APPENDIX D

‘ComEd Job Briefing and Job Turnover Process’

Consistent with exemption applications already granted, and in the best interest of promoting public safety, we are submitting this document confidentially

APPENDIX E

‘Personal Protective Equipment Program’

Consistent with exemption applications already granted, and in the best interest of promoting public safety, we are submitting this document confidentially

APPENDIX F

‘Time Out for Safety Process’

Consistent with exemption applications already granted, and in the best interest of promoting public safety, we are submitting this document confidentially

APPENDIX G

STAR – Stop – Think – Act – Review

COMED UAV AERIAL INSPECTION FLIGHT BRIEFING SHEET

STAR – Stop – Think – Act – Review

Work Order#: _____ Date: _____

Obsr_____ Ph # (____) _____ Email _____

☐ TSO Approval Received ☐ PRE flight Notifications made ☐ POST flight Notifications made

☐ Preflight Inspection Comp

Pilot: _____ Ph # (____) _____ ☐ Crew briefed on safely

☐ Checked Weather ☐ Checked for TFRS in flight path ☐ Safe to fly ☐ FAA Waiver Received ☐ N/A

Insp: _____ Data Rec: _____ Launch Site: Elevation (MSL): ___

☐ Crew Chief ☐ Crew Chief Lat: _____ Long: _____

Ph # (____) _____ Ph # (____) _____ Max Expected Alt. (AGL):_____

Flight Descr./ Overview: _____

_____

LEGIBLE EMPLOYEE INITIALS	
1ST BRIEF	2ND BRIEF

Inspection Type Codes: **ST**andard **C**omprehensive **SP**ecial **E**mergency

LINE	INSP TYPE	CRITICAL FND / REP	LINE	INSP TYPE	CRITICAL FND / REP	LINE	INSP TYPE	CRITICAL FND / REP	LINE	INSP TYPE	CRITICAL FND / REP
		☐			☐			☐			☐
		☐			☐			☐			☐
		☐			☐			☐			☐
		☐			☐			☐			☐
		☐			☐			☐			☐

Nearest Airports: Miles: ____ Code: ___ Name: _____ Contact: _____ Phone #: _____ Briefed: ☐

Miles: ____ Code: ___ Name: _____ Contact: _____ Phone #: _____ Briefed: ☐

Miles: ____ Code: ___ Name: _____ Contact: _____ Phone #: _____ Briefed: ☐

Police Notification: Community:_____ Department: _____ Contact: _____ Phone #: _____ Briefed: ☐

Weather: In area of Inspection _____

Crew: ☐ Understand Crew Resource Management ☐ UAV Safety Rules ☐ Understand Flight duties ☐ Equipment

Equipment *checked and determined to be in safe, working condition*

☐ UAV ☐ Flight Controls ☐ Camera Systems ☐ Batteries ☐ _____ ☐ _____

☐ MAPS: Line and SM ☐ Current Structure Lists ☐ Work Package Structure List for Comprehensive Inspections

Discussed: ☐ Inflight special precautions _____ ☐ Communication _____

☐ Flight obstructions _____ ☐ Job assignments _____

☐ Situational awareness _____ ☐ Line-of-fire control _____

Post Flight: ☐ Reports completed and submitted ☐ Equipment cleaned, checked and properly stored

ACTION REQUIRED: *Every* Crew Member is expected to be able to explain the details of the Flight Briefing

POST FLIGHT DEBRIEFING: ☐ **Yes** **CONDITION / SCOPE CHANGE:** ☐ Yes ☐ N/A

Completed at the end of each shift! ***Job Scope Change necessitates conducting a NEW Job Brief!***

Comments GIVE DETAILS**:** _____

_____

Supervisor Quality Review of Job Brief (Initials) Date:

APPENDIX H

'DJI Innovations S900 Specifications'

See link for online manual and operating videos:

http://www.troybuiltmodels.com/items/DJI-S900.html

PILOT OPERATING HANDBOOK

DJI S-900/Zenmuse

Author: Gene Payson Revised: 9/02/2014

http://www.troybuiltmodels.com

PILOT OPERATION HANDBOOK
DJI S-900/Zenmuse

This book is offered in a format so that pilots can customize the checklists to their exact needs. Please print out this handbook, make notes while watching the video regarding the checklist, then change the wording and order to suit your needs. Then print out the revised form and laminate it in plastic. Use it every time you operate your aircraft. Keep the log books regarding the following:

- Pilot flight time
- Aircraft flight time
- Aircraft maintenance and updates
- Battery usage, date put into service, voltage, mah vs time

Print out and make readily available the error message legend of various flashing lights. Know what to do without hesitation should you observe warnings.

Insurance is a must! Not only will it be expensive to repair your aircraft in the event of an incident, if you injure bystanders or damage other people's property you are liable for damages which could run into the millions of dollars. One insurance company which currently writes policies on sUAS is www.Transportrisk.com

Errors & Omissions should be sent to customerservice@troybuiltmodels.com. We will promptly update the POH for everyone to have the latest updates available.

DJI S900 KEY PARAMETERS

Max Takeoff Weight: 18 lbs.
Approved Cameras: Sony Nex5/7, Panasonic GH3/4, Blackmagic Cinema

--- No Gimbal
13.5lbs = S900 NO Gimbal and TBM 21000
12.3lbs = S900 NO Gimbal and TBM 15000
--- Nex-7 Gimbal
17.2lbs = S900 with Nex-7 and TBM 21000
16lbs = S900 with Nex-7 and TBM 15000
--- GH3/GH4 Gimbal
17.68lbs = S900 with GH3/GH4 and TBM 21000
16.48lbs = S900 with GH3/GH4 and TBM 15000
--- BMPCC Gimbal
17.3lbs = S900 and TBM 21000
16.1lbs = S900 and TBM 15000
--- 5D Gimbal
22.5lbs = S900 and TBM 21000 - OVERWEIGHT!
21.3lbs = S900 and TBM 15000- OVERWEIGHT!

Flight Times using 90% of battery:
15,000 mah battery with gimbal and camera: 15+ min
21,000 mah battery with gimbal and camera: 20+ min

These times are averages in our tests. Individual flight times may differ based on weight and flying style.

DJI S-900/Zenmuse CHECKLISTS

- **DJI S-900 BENCH SET UP & TESTS**
  - All screws/bolts are tight
  - Timer alarm for flight time to not exceed 80% battery capacity set properly
  - Batteries are secure
  - Antennas are secure
  - Props balanced
  - Props aligned
  - Props not chipped
  - Check blades, arms, etc. for cracks/damage
  - Wiring Tight
  - No excessive flexing of motors or booms
  - Booms/motors will not twist
  - Center of gravity is correct
  - Warning lights set for low battery if used
  - Batteries charged. Replace any battery which cycles below 80% of rated capacity
    - Laptop Battery
    - Flight Battery
    - Handheld Rx Battery
    - RC Tx Battery

- Video Rx Battery
- Spare Laptop Battery

- **DJI S-900 INVENTORY CHECKLIST**
  - Load Flight plan
  - Aircraft
  - Camera with SD card
  - Spare parts/tools
  - Spare batteries
  - Two RC transmitters
  - Laptop
  - Battery Charger
  - Flight Controller Cable
  - Video monitor, stand, battery, antennas
  - Goggles
  - Datalink & cable
  - Battery Y-harness

- **DJI S-900 PREFLIGHT CHECKLIST**
  - Position: GCS, S900
  - Emergency LZ
  - Wind
  - Area secure
  - Antennas
  - GCS
  - Lens cap
  - Camera On
  - SD card
  - Flight battery: voltage – install - CG
  - C2 Tx: Switches – On - Model Selection - 5.4V+
  - Photo Tx – Switches – On - Model Selection - 5.4V+
  - Copter On
  - Calibrate? - Cycle
  - Copter Voltage on GCS
  - GPS Mode – Double Purple/Single Purple
  - Course Lock Mode - Green
  - Camera/Gimbal tests
  - Upload mission
  - Zero altitude

- **TAKEOFF CHECKLIST**
  - Timer
  - GPS mode (Course lock?)
  - Motor startup/checks
  - Takeoff
  - Landing Gear

- **LANDING CHECKLIST**
  - LZ clear
  - Landing Gear
  - Land
  - Flight Time
  - Copter/Camera Power down

- Adjust Params
- Power Down batteries
- Motor Temps
- Logbooks

- **ERROR MESSAGES**
  - White flashes
    - IMU malfunction. Land and determine cause. Possibilities:
      - GPS/Compass not pointing forward
      - IMU not pointing forward
      - Set up of X, Y, Z for location of IMU and Compass is incorrect
  - Excessive rocking/instability possible causes:
    - Weak motor
    - Structure flexing from fatigue or cracks
      - Motor mount
      - Main frame
      - Booms
    - Loose Bolts causing flexing or misalignment
      - Props
      - Mounts
    - Props out of balance
    - Props misaligned
    - Excessive wind speeds or gusts
    - Excessive Gains
    - Excessive motor power. Max motor power must a little more than typical ascent power.
  - Red Flashes (1, 2 or 3 flashes with pauses) – GPS loss (3 is more serious). Land if loss lasts for more than 30 seconds. Possible causes:
    - Clouds
    - Structures
    - GPS mal-function
    - GPS too close to electrical components
    - GPS vibration

TABLE OF CONTENTS

SECTION 1
GENERAL

NOTE: In an effort to minimize costs and maximize spare parts availability, many COTS (commercial off the shelf) components have been utilized. Some may have slight modifications to better suit this application. Most COTS products have separate data sheets, assembly manuals and instruction manuals. They are reference in this document, with key factors being emphasized.

As with all high technology products utilizing constantly evolving software, it is important to periodically check for online upgrades to the COTS components, including hardware, firmware and software.

WARNING: Great care must be taken with the batteries. Much of this manual and supplemental information is devoted to the use and care of the batteries, especially the flight batteries. They are less volatile than gasoline, though they should be treated with the same respect. Become very familiar with proper techniques of their use.

- GENERAL CHARACTERISTICS
  - Primarily for ISR (Intelligence, Surveillance, and Reconnaissance)
  - Economical due to extensive use of COTS products
  - Low Visual Signature
  - Low Aural Signature
  - Quick Launch and Recovery
  - Short Training Period
  - Simple Operation
  - Waypoint Navigation
  - Backpackable
  - VTOL
  - Quick Repairs
  - Redundant Flight Systems
  - Safety Return to Home during lost link or low battery
  - High Degree of Mission Success
  - GPS navigation aid
  - Various sensors
  - 18 lb max takeoff weight
  - Operating Temp Range: -5°C to +60°C
  - Flight Modes: Manual and GPS aided waypoint navigation
  - Maximum Operating Altitude: 1000 meters
  - Maximum Operation Wind Conditions: 10 m/s
  - Propulsion System: LiPoly batteries
  - Takeoff: Manual or Automatic
  - Landing: Manual or Automatic
  - Takeoff/Recovery Area: 5m square
  -
- IMPORTANT DIMENSIONS
  - Distance rotor to rotor across the center: 35”
  - Height with GPS/Compass folded down: 21”
  - Height with GPS/Compass up: 25”
  - Length of landing gear skids: 17”
  - Distance between landing gear skids: 18”
  - Collapsed size: 22” x 19”

- IMPORTANT WEIGHTS
  - --- No Gimbal
  - 13.5lbs = S900 NO Gimbal and TBM 21000
  - 12.3lbs = S900 NO Gimbal and TBM 15000
  - --- Nex-7 Gimbal
  - 17.2lbs = S900 with Nex-7 and TBM 21000
  - 16lbs = S900 with Nex-7 and TBM 15000
  - --- GH3/GH4 Gimbal
  - 17.68lbs = S900 with GH3/GH4 and TBM 21000
  - 16.48lbs = S900 with GH3/GH4 and TBM 15000
  - --- BMPCC Gimbal
  - 17.3lbs = S900 and TBM 21000
  - 16.1lbs = S900 and TBM 15000
  - --- 5D Gimbal
  - 22.5lbs = S900 and TBM 21000 - OVERWEIGHT!
  - 21.3lbs = S900 and TBM 15000- OVERWEIGHT!
- MOTORS
  - Manufacturer: DJI-Innovations
  - Number of motors: 8
  - Motor type: 41mm x 14mm
  - Motor Model Number: 4114-11
  - Motor KV/RPM: 400
  - Motor max @ 25.2V: 10,000 rpm
  - Motor Max Power: 500 Watts
  - Power rating: 3000 Watts maximum power consumption for all 6 motors
  - Current Max: 100 amps
  - Amp Draw Typical Average: 55 amps
- PROPELLERS
  - Manufacturer: DJI-Innovations
  - Material: Composite
  - Number of propellers: 6
  - Propeller model number: DJI 15 x 5.2
  - Number of blades: 2 - folding
  - Propeller Diameter: 15”
  - Propeller Pitch (fixed): 5.2”
  - Max rpm: 10,000 rpm
-
- ELECTRONIC SPEED CONTROLS
  - Manufacturer: DJI-Innovations
  - Number of speed controls: 6
  - Speed control model number: DJI 40A Opto
  - Rating in amps: 40 Amps continuous
  - Signal Frequency: 30 - 450 Hz
  - Drive PWM Frequency: 8 KHz
- AUTOPILOT
  - Manufacturer: DJI-Innovations
  - Autopilot Model Number: DJI A2
  - Components: GPS/Compass, IMU, Master Controller, Power Distribution System, LED Indicator Lighting System, Data Transceiver, GCS Software

- Power Consumption: 5W
- Operating Temp Range: -5°C to +60°C
- Software Compatible: Windows XP sp3 / Windows 7
- Hovering Accuracy: Vertical : ± 0.5m; Horizontal: ± 2m

- ANALOG WIRELESS LINKS
  - Distributor: DJI-Innovations
  - Frequencies:
    - 2.4 Ghz datalink with WiFi
    - 2.4 Ghz Command & Control
      - 5.8 Ghz Video
  - Power Consumption: <1 watt
  - Usable Range: <2 km.

- DIGITAL WIRELESS LINKS (Lightbridge)
  - Distributor: DJI-Innovations
  - Frequencies:
    - 2.4 Ghz (C2 & Video)
  - Power Consumption: <1 watt
  - Usable Range: <2 km.

- FLIGHT BATTERY
  - Manufacturers: Various COTS suppliers
  - Battery chemistry recommended: Lithium Polymer
  - Battery Capacity: up to 21,000 mah or greater depending on max gross weight
  - Battery cell count required: 6S (6 cells in series)
  - Battery Voltage: 21V minimum during hover, 22.2V nominal, 25.2V maximum
  - Battery Minimum Rated Discharge Rate: 20C minimum
  - Battery Minimum Charge Rate: 1C (3C preferable)
  - Battery Rest Time between discharging and charging: 0-30 minutes
  - Batteries used simultaneously: typically 1
  - Recommended Battery Discharge Amount: 80-90%

- FLIGHT PARAMETERS
  - Flight Time: 20+ minutes typical
  - Payload Max: 9.5 lbs for battery, sensor and gimbal

- ***WARNINGS***
  - Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
  - Read all information regarding batteries contained in this manual and supplements.
  - Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
  - Batteries fully charged must be handled with extreme care.
  - Batteries must not be stored above 60% charged state.
  - Store batteries between 20% - 60% charged state. Fully charge just before use.
  - Fully charged batteries which are not to be used within 24 hours should be discharged to 20% - 50% charged state.
  - Discharging LiPoly batteries in excess of 80% of their rated capacity can cause harm to the batteries.

- Using more than one battery at a time requires the proper wiring harness so that the voltage is no more than 25.2V. Over voltage will cause serious damage to electrical equipment.
- Using more than one battery at a time requires weight and balance checks. Proper CG is critical to performance. Airframe must not be overloaded.
- GPS/Compass must be facing forward.
- Do not use GPS Mode without GPS lock.
- Use low strength thread locking compound on all screws.
- Wireless Video and Data ranges vary considerably on many factors including weather, equipment, and obstructions. Be prepared for com failures.

SECTION 2
LIMITATIONS

- AIRSPEED LIMITATIONS
  - Vne – Velocity to Never Exceed: 15 m/s
  - Va – Typical Maneuvering Speed – 5 m/s

- POWER & POWERPLANT LIMITATIONS
  - 40 Amps max per motor
  - 40 Amps max per speed control
  - 320 Amps max total
  - Do not exceed 80-90% discharge of rated battery capacity
  - Do not charge batteries which are warmer than air temperature
  - Allow batteries to cool after use before charging
  - Leave an air gap between batteries when multiple batteries are used simultaneously

- WEIGHT LIMITS
  - Takeoff Weight Max: 18 lbs
    - Must be checked prior to takeoff if any change in equipment is made

- CENTER OF GRAVITY LIMITS
  - 3mm from the center of any of the three pairs of arms
    - Must be checked before every flight to ensure batteries were installed in the proper location.
    - Check all 4 pairs of arms before flight

- MANEUVER LIMITS
  - This aircraft is intended for non-aerobatic operations
  - G-loading maximum: 2G

- TEMPERATURE LIMITS
  - Operating Temp Range: -10°C to +40°C
  - In cold temperatures
    - Keep IMU at room temperature if possible before the flight
    - Keep Batteries above 5°C before flight
    - Do not fly with any frost or ice on the propellers
  - In warm temperatures
    - Batteries heat up when discharged
    - The higher the discharge rate the higher the temperature increase during use
    - At temperatures above 45°C, use of 2 or more batteries is required to lower the load on any one battery pack to keep it cooler.

- WEATHER LIMITS
    - Light dust and light rain require the use of a shield for the electronics in the center section.
    - Light dust and light rain are acceptable for the unshielded motor and ESC.

- RANGE LIMITS
    - FUEL
        - Fuel capacity is a primary limiting factor.
        - Flying into the wind will use more battery power to travel the same ground distance. Higher air speeds will be required to penetrate the wind which used more battery power. Take this into account when flying a mission.
        - Where possible, fly upwind at the start of a mission and downwind at the end to avoid depleting the battery before returning to base. Have alternative landing sites available in case of emergency landing.

    - WIRELESS LINK
        - Wireless links will be stable in LOS (line of sight) in most conditions
        - Wireless links are always susceptible to shorter ranges due to
            - Atmospheric conditions
            - Other transmission devices in the area
            - Jamming
            - Antennas not aligned properly
            - Improper voltage
            - Antenna blockage from AV in certain positions
            - Multipath – reflection off buildings or ground which cause multiple signals to arrive at different times and/or phase.

SECTION 3
EMERGENCY PROCEDURES

- MOTOR FAILURE
    - Operation is possible with one motor/ESC/propeller failure
        - The two adjacent motors/ESCs will be increased in thrust automatically by the flight controller to overcome the loss
        - In cases where the airframe is highly loaded the maximum rating of 40 amps may be exceeded by these two motors/ESCs
        - Operation should be terminated as soon as possible to reduce the possibility of damage to the remaining motors

- COMMUNICATION FAILURE
    - Video link failure
        - 5.8 Ghz being the shortest wavelength in general AV use has the least ability to penetrate. This link should be the first to be lost.
        - It is best to lose video first! It is the least likely to cause a crash when it fails.
        - 5.8 Ghz can lose link with little warning.
        - Ensure that the GCS station antennas are perpendicular to the AV. Do not point the antenna at the AV.
        - Yaw the AV to change the antenna position
        - Other links should still be good. Return back to the GCS until link is restored.

- Transmitters produce heat when in operation. When overheated they may have thermal protection which interrupts use temporarily. Use of a heat sink or fan may be required especially with high ambient temperatures.
- Higher gain antennas may be used, but do so with caution. High gain antennas are directional.
- Multiple antennas using “diversity” can be used. Diversity is a device which determines the best signal, and uses that.
- 5.8 Ghz even at high wattages theoretically has less range than lower frequencies. Changing to 1.3 Ghz is an option, though there are other issues to be considered.

o RC link failure
- 2.4 Ghz antennas can lose link with little warning.
- Anything in between the two antennas can cause temporary signal loss especially a person.
- Hold the transmitter up in the air and walk in the general direction of the AV (aerial vehicle).
- Ensure that the antenna is vertical. Do not point the antenna at the AV.
- The failsafes on the RC link should be set so that the AV returns to home. Should this require a heading change, the antenna may move into a more desirable position and link will be restored.
- The onboard equipment may block the signal. Yaw the AV so that the antennas point towards the GCS.
- A LRS (long range system) can be used as a permanent solution. This is higher in wattage and usually on 433 Mhz.

o Data Link Failure
- 900 Mhz do not lose link without some warning. When drop outs are noticed to increase in frequency that is the limit of the range.

- If using 900 Mhz, this is on cell phone frequency. If a cell tower is nearby it can swamp the signal. 900 Mhz may not be usable in that area. Change to a different freq. or remain closer to the AV

o LOW BATTERY POWER
- Fail-safes can be set such that in the event of low battery power, either due to a failure or too long of a flight, the warning light on the AV will constantly flash amber. This is the first level of warning.
- The second warning level is red flashing lights
- Auto landing will occur when battery power is low. It may land in a tree or a lake, so this is not desirable.
- Landing with 80-90% of battery depleted is best. Therefore landing with 17,000 mah used and 3,000 mah remaining of a 20,000 mah battery is desirable. Batteries should be drawn down equally when in use if they are both charged equally and both in relatively the same condition/age.
- Do not mix partially charged batteries. Only use completely charged batteries.
- Over discharging a battery below 19.8V can permanently damage the battery.

o GCS FAILURE
- Takeover by the external pilot should happen ASAP using the RC link.
- Most often happens due to a low battery.
- Keep a spare 3 cell LiPoly battery with the appropriate plug to plug into the charge jack for emergency use. Most chargers are 19V output which is roughly equivalent to a 4-cell battery. 3-cell batteries may work.

- COMPASS CALIBRATION ERROR
  - If the compass is out of calibration the warning light will flash red. This is the same signal as low voltage. If the voltage is correct, there is a calibration error.
  - Recalibrate the compass following the instruction manual

- FIRE
  - Fires can occur due to a short circuit or battery failure.
  - Disconnect the battery ASAP unless there is danger in doing so if there is any electrical issue.
  - It is not possible to put out a battery fire.
  - Do not attempt to put out a battery fire. Use a fire extinguisher to put out fires surrounding the battery. A CO2 fire extinguisher is better than the powder or chemical type. CO2 does not leave a residue. Water can be used though it may cause other electrical component failures.

- FORCED LANDINGS
  - If alternate emergency landing zones should be chosen ahead of time.
  - Be sure that the LZ is clear of people to avoid any incidents.
  - Land in the nearest LZ which is clear of people.
  - Announce your intentions of landing as loud as necessary to alert people of the incoming AV.

SECTION 4
SET UP SUGGESTIONS

- ELECTRONICS BURN IN
  - We recommend that you put weights onto the landing skids to keep the copter on the ground and run the copter at about 70% throttle for about 2 hours to burn in the electronics. Most electronic failures occur in the first 2 hours of operation.
- GPS/COMPASS MAST LENGTH
  - We found that the higher the mast, the better the GPS reception
- Nex5N vs. Nex7 vs. Panasonic GH3
  - These cameras are excellent for stills, and very good for video. The best for video is the Panasonic GH4 with 4k capabilities.
  - We found that the Nex 5N takes exceptional quality stills and video, though most professionals use the Nex 7.
  - Use the Panasonic GH4 if you primarily shoot video
- RADIO SET UP
  - Follow the instructions in the manual
  - We prefer the switch assignment as shown in the checklists above though feel free to modify to your liking
- COPTER COMMAND AND CONTROL
  - We recommend the use of a dual rate switch for main copter operation.
    - High rate – used to initialize the motors. The flight controller will not engage unless it sees full down throttle, full left rudder, full left cyclic and full back cyclic. However, these may be too high for normal flying. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
    - Low rate – used for typical flying. Set the end point adjustments such that full stick deflection offers the maximum speed required in normal flying. If conditions require higher flight speeds, switch to high rate. On low rate it is also helpful to utilize a small

amount of exponential to make the stick feel soft around center. Adjust to your preference.

- ZENMUSE COMMAND AND CONTROL
  - We recommend the use of a dual rate switch for gimbal operation.
    - High rate – used to initialize the gimbal. The gimbal may not engage unless it sees full motion. However, these may be too high for shooting video smoothly. This is best for still photography so as to put the camera on target quickly. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
    - Low rate – used for videography. Set the end point adjustments such that full stick deflection offers the maximum speed required for videography. If conditions require higher gimbal speeds, switch to high rate. On low rate it is also helpful to utilize a small amount of exponential to make the stick feel soft around center. Adjust to your preference.

- TIMERS
  - Use of the countdown timer is a good backup method to ensure landing with battery power.
    - Set the timer for 20 minutes (or what you deem appropriate) and have it start when the throttle is over ¼. Then adjust the timer upwards until the amount of battery used is about 80-90% of the total available. If using 20,000 mah batteries, a total of 17,000 mah would be the target. Set the timer such that you have a minute or so to land after

- BATTERIES

the alarm sounds so that you have adequate time to return to base. Adjust to your preference.

  - Replace the transmitter standard battery with a Lipoly battery to extend use times to 8 hours. Supplied batteries often last about 2 hours.

NORMAL PROCEDURES

- PREFLIGHT CHECKLIST
  - Confirm all communication radios are operational
    - Radio with ATC
    - Radios with others in the group
  - Set a perimeter of 100 meters
    - Area must be clear of people to avoid collision
  - Check for overhead power lines and other obstacles to avoid
  - Check structural integrity
    - In event of prior crash, inspect all booms, props and motor mounts for excessive flex indicating structural fatigue/failure
  - Have a manual flight plan avoiding obstacles.
  - Load auto flight plan if using one
    - Be sure that the total flight time is under 10 minutes to avoid low battery
  - Clean lens
    - Remove lens cap
  - Ensure camera has SD card installed
    - Many flights have been wasted due to this!
  - Install batteries
    - Ensure that the straps are tight and the Velcro keeps the batteries from moving which

will avoid a shift in the CG (Center of Gravity – or that it balances evenly)
- Check CG (Center of Gravity)
  - Lift the copter on each of the 3 pairs of arms. The copter should balance properly. If not, do not fly. Rearrange the equipment such that the CG is
- IMU pointing forward
  - The Inertial Measurement Unit is set so that it must face forward
- GPS/Compass installed, limited free play, pointing forward
  - This device must be installed with a screw to hold it in place. It cannot vibrate easily. If it does not point forward, the corrections in ATTI and GPS mode will be incorrect and it will crash. The FC will provide a warning with constant flashing white lights.
- Level copter using a bubble level with front pointing in correct direction for course lock – do not turn on
  - Keep in mind the best angle for pointing the landing gear in the direction that will keep the landing gear out of the shot when flying.
- Turn on Pilot Tx
- If using the rate gyro, set it at the correct position. This is usually a slider switch. Gains should have the range set from 200 – 350. Use the highest gain possible which does not cause oscillation.
- Check Model Selection on Tx to be S900
- Throttle on Tx Down
- Return to Home switch Off
- Adjust gain to correct position (if required)
- Manual Flight Mode Switch to manual (not ATTI or GPS mode)
- Flight Path Switch Off – Not Course or Home or POI
- Check Tx battery voltage (above 7.5v)
  - These settings above are required to initialize the copter properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like course lock or GPS mode to not operate properly.

  - If the copter does not function properly after takeoff, land immediately and disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Count down timer should be set correctly depending on battery capacity. This can be adjusted to your flying style. The timer should engage at ¼ throttle and trigger an alarm at the proper time. This is a backup alarm in case the indicator lights on the copter are not visible.
- Turn on Photography Tx
- Check Model Selection on Tx – should read Zenmuse
- Check Tx battery voltage (above 5.4v for Futaba 14ch)
- HDMI switch Off
- Freestyle switch Off (FPV On)
  - These settings above are required to initialize the Zenmuse properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like live video or gimbal operation to not operate properly.
  - If the camera or gimbal do not function properly, disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Engage power to copter
  - Plug in the 2 battery packs. Typically the battery packs use red T-style connectors in a parallel wire harness. This Y-harness has a yellow connector. It is preferable to connect the batteries to the Y-harness first, then plug in the yellow connector. This reduces (but does not eliminate) electrical arcing.

        - 6 quick chirps should be heard confirming 6S LiPoly batteries are recognized by the ESCs.
            - Hearing less than 6 chirps indicates fewer cell battery packs are being recognized which is incorrect. Check for improper or damaged batteries.
    - Do not move or vibrate the Squadcopter until 30 seconds after full GPS Lock
        - Initial 3 red blinks is normal meaning no GPS lock. No red flashes indicates full GPS lock.
        - Continue with checklist as you are waiting for full GPS lock, but do not move the copter.
        - If the GPS takes more than 5 minutes to lock, there is a problem with the area. It is not receiving the proper signals from the satellites. GPS signals are weak, so trees, people, buildings, terrain, weather, have an effect. Move the copter into a more open area where it can more easily see the satellites.
    - Check Copter Voltage from both Tx's (transmitters)
        - The transmitters receive a signal from the corresponding receivers. The voltages are regulated to about 5v. If the voltage is below 4.4v or above 6v do not fly. There may be power regulation issues. The receivers cannot work outside this voltage consistently. Also there is some issue if the voltage is outside that range which should be resolved before flying.
    - Engage Attitude Mode – Must achieve double amber flash
    - Engage GPS Mode – Must achieve double purple flash
    - Engage course cock mode – Must achieve double green flash
    - Disengage course lock mode. Must achieve double purple flash. Stay in this mode until just prior to takeoff, after takeoff at any time, or do not use.
    - Do not engage motors. Set throttle to center position. Must achieve single purple flash when in GPS mode.
        - To verify that the sticks are all centered properly:

        - With throttle in the center position, use the trim buttons on the transmitter to check that the sticks are centered. Trim the roll (the stick located on the right side of the transmitter when moved to the right and left) to the right, counting the number of clicks until a double flash occurs. Then center the trim. Then move the trim to the left, counting the number of clicks until a double flash occurs. An equal number of clicks should be counted each side of center.
        - Do this check for the 3 stick movements other than throttle.
        - Center the trim such that when the stick is in the neutral position that there are equal numbers of clicks in each direction. This ensures that when the sticks are neutralized that the flight controller will recognize this signal and engage GPS mode.
    - Calibrate GPS/Compass before the first flight each day or if receiving continuous red blinks or continuous white blinks.
        - Flip the GPS mode switch 7 times very quickly from manual to GPS. End with the switch in the manual position. The indicator light will be blue. Rotate the copter about 1.5 turns in a horizontal position. A green flashing light indicates that this is complete. Then hold the copter vertically and rotate about 1.5 turns. A white flashing light indicates that this is complete. Repeat if necessary until this is completed.
    - After calibration, reset the copter by cycling battery with copter pointed in the correct heading for course lock.
    - Engage Camera
    - HDMI switch On
        - This will stop video from playing on the back of the camera and will send the video signal to the video transmitter via the HDMI connection.

- Freestyle switch On (FPV Off)
  - This allows the camera to be operated freely through the transmitter
- Verify camera operation
  - Operate the shutter
  - Set the focus to auto or manual. Manual setting is usually set to infinity to stop constant focusing of the camera.
- Verify data link if installed
  - Roll the copter about 45 degrees on its side by lifting one side of the copter and resting one side of the landing gear on the ground
  - A corresponding roll should be seen on the gauge.
  - If the copter is rolled to the right, it will appear on the gauge that the horizon rolls to the left – not the right because the view from inside the copter is that the horizon rolls the opposite direction of the copter.
- Verify altitude is about 0 via gauge on computer
  - If it is not about 0, the altitude settings for the waypoints will be off by this amount. This could cause the copter to fly at 10 meters or 30 meters if the waypoint is set for 20 meters and the altitude is off by 10 meters one way or another. If the copter thinks it is at 10 meters when it is on the ground, then it will only rise 10 meters above the ground to achieve what it believes it to be 20 meters above the ground.
  - The altitude can be reset using the ground control software by going to altitude offset.
- Alternate Emergency Landing Sites Established

- NORMAL TAKEOFF
  - Confirm clear for takeoff with ATC
    - Necessary if within 5 miles of an airport

    - ATC clearance is required days or weeks before flying.
  - Engage GPS mode – Double purple flash when the throttle is down.
  - Switch to Course Lock flight mode if required. Purple flashes are replaced with green flashes. Flying in course lock is not required, but helpful in many instances.
  - Announce loudly: “CLEAR PROP”
  - Move both of the sticks to the bottom left corners to engage the motors. Within 1 second move the throttle up 1/8 – 1/4. The copter should not lift off until about ½ stick is reached.
  - Verify data and video links before lifting off. If anything is not working properly, move the throttle stick to low to disengage the motors and determine a solution.
  - If all flight checks are passed, announce loudly: “TAKING OFF”
  - Advance throttle to about 3/4. Copter must jump off of the ground to avoid one skid coming up before the other skid, and the skid on the ground getting caught and flipping the copter over sideways.
  - Ascend to 3 meters. Then decrease throttle to ½ to engage the GPS hold.
  - Verify links, GPS, Attitude, etc. Should be single purple flash.
  - Verify that the copter is holding position within .5m in all directions.
  - Verify camera operation
  - Verify course lock is operational by rotating 90 degrees and pushing forward on stick.
  - Verify copter stability. If unstable, land and reset gains, recalibrate, or retest as necessary.
  - Proceed with manual mission or
  - For autopilot operation
    - Ascend to 10 meters
    - Command AVO to proceed with mission.
      - Pilot should say “It’s yours”
      - Response from AVO “I have it”

- Manual pilot/observer must monitor the informational LED and be ready to take over in manual mode when necessary.
    - White flashes indicates flight controller issue
    - Amber flashes indicates low battery
    - Red flashes indicate loss of GPS or severe battery condition
        - Quick decisions are required when red flashes are indicated
        - 10 seconds or more of loss of GPS signal will stop waypoint guidance and any GPS hold and put into manual mode.
        - Red indicator light battery warning requires immediate landing
- Manual pilot to request copter flight battery voltage readout from AVO periodically.
    - Reset the first and second indicator lights as required for your set up.
    - When recharging the batteries, the goal is to put 4,000 mah into a 5,000 mah battery pack. Adjust the voltage warnings to your style of flying.
    - Also use the countdown timer on the transmitter. This gives a good indication of battery level because the current used is fairly constant from flight to flight.

- POST LANDING
    - Note flight time from transmitter. Write this down in the log book.
    - Note battery power used during the flight. Write this down in the log book.
    - ALWAYS disconnect the main power to the AV first, then turn off the transmitter.

    - Check motor temperatures by touching them with your fingers. Any motors which are excessively hot should be further inspected and possibly replaced.
    - Check battery temperatures by touching them with your fingers. Battery temperatures should not be hot to the touch. Battery temperatures should be slightly above ambient.
    - Inspect all components especially the propellers for wear.
    - Note in logbook which batteries were used to calculate life cycle.

- AIRCRAFT FLIGHT LOG BOOK (Can be purchased inexpensively)
    - Keep a log of all flights.
        - Date
        - Time of Day
        - Time in Operation (in hours)
        - Battery serial numbers
        - Mah used in flight
        - Location
        - Pilot, Observer, Sensor Operator Names
        - Flight Objective
        - Remarks

- AIRCRAFT MAINTENANCE LOG BOOK (Can be purchased inexpensively)
    - Keep a log of significant inspections, tests, repairs, alterations, equipment changes.
        - Date maintenance is performed
        - Accumulated hours of operation
        - Remarks

- PILOT LOG BOOK (Can be purchased inexpensively)
    - Keep a log of all flights. Include the following:
        - Aircraft flown

- Aircraft serial number
- Date
- Time of Day
- Time in Operation (in hours)
- Location
- Flight Objective
- Remarks

SECTION 5
PERFORMANCE

- FLIGHT TIMES
  - The AV is designed to hover at high efficiency. Hovering is much less efficient than flying on a wing, thus flight times are low compared to fixed wing aircraft.
  - All the weight of the AV is supported by power from the batteries. As the batteries are used in a flight, the amount of power available decreases. Therefore the power reserve is constantly decreasing as the battery is being used. Thus loading a rotorcraft above its limit is not recommended. While the AV may have enough power to lift off initially on a full charge, the power reserve at partial charge may be too low to allow for maneuvering and will result in a crash.
  - High lateral speeds will add lift to slightly improve efficiency. The rotors act similar to fixed wings at higher speeds. This increase in efficiency may be negated by the increased power consumption of forward flight.
  - High winds or gusts decrease efficiency/flight time. The motors work harder to hold position.
  - As weight increases flight times decrease.
- WIRELESS TRANSMISSION
  - Refer to the specific manuals for performance ratings.
  - Wireless communications utilized provide acceptable communication for LOS.
  - In general:
    - LOS is required
    - The higher the GCS antennas, the better the range
    - Any freq. at may have severe degradation due to location to other admitters such as cell towers
    - RSSI (Received Signal Strength Indication) should be monitored for indication of communication drop out.

SECTION 6
WEIGHT AND BALANCE EQUIPMENT LIST

- CG is critical to the efficient operation of any AV
- When components are shifted, the CG will be altered.
- The main components which are moved on a regular basis are the sensors and the batteries.
- The sensors are typically in the front of the AV, and the batteries are located in the correct position to offset all the components on the AV.
- The CG must be tested after any change to the components or their placement.
- The CG should be tested by lifting the UV with fingers on the bottom of the arms. Check all 3 pairs of arms. The CG should be no more than 2mm off in any on the 3 checks. The closer the CG is to the centerlines of the arms the more efficient and the more stable the AV will be.

- WEIGHT
    - Weight is critical to the operation of any aircraft
    - Weight is especially critical to a rotor wing aircraft. At full throttle the motors have a finite amount of thrust. All the weight is lifted by the battery power, there is no wing to assist in providing lift.
    - As the batteries are operated, they lose power. At full charge they have about 25v. At 20% remaining capacity they have about 21v. This is a loss of 8% of the power available which is significant.
    - Do not overload the aircraft or there will not be sufficient reserve power to maneuver at low battery levels.
-

SECTION 7
AIR VEHICLE AND SYSTEMS DESCRIPTION

- FLIGHT BATTERY REQUIRED
    - Manufacturers: Various COTS suppliers
    - Battery chemistry recommended: Lithium Polymer
    - Battery Capacity: up to 21,000 mah or greater depending on max gross weight
    - Battery cell count required: 6S (6 cells in series)
    - Battery Voltage: 21V minimum during hover, 22.2V nominal, 25.2V maximum
    - Battery Minimum Rated Discharge Rate: 20C minimum
    - Battery Minimum Charge Rate: 1C (3C preferable)
    - Battery Rest Time between discharging and charging: 0-30 minutes
    - Batteries used simultaneously: typically 1
    - Recommended Battery Discharge Amount: 80-90%

- WERELESS COMMUNICATIONS
    - Refer to the specific manuals for performance ratings.
    - Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
    - Wireless communications utilized provide acceptable communication for LOS.
    - In general:
    - LOS is required.
    - Lower frequencies penetrate objects such as trees better than higher freqs.
    - Lower freqs have longer range than high freqs
    - Higher freqs can transfer more data than lower freqs
    - Higher freqs use smaller/shorter antennas
    - The higher the GCS antennas, the better the range and reception
    - Any freq at may have severe degradation due to location to other admitters such as cell towers
    - Range must be constantly monitored.
    - Alternate antenna types may be utilized to improve link/range. Patch, helical, omni, etc. can be substituted. They must be verified before use.
    - Alternate freqs may be utilized to improve link/range.
-

SECTION 8
HANDLING, SERVICE AND MAINTENANCE

- PROPELLER CARE
    - Propellers must be checked each flight for nicks or cracks

- Propellers are designed to last indefinitely if they do not impact dust, dirt or more.

- BATTERY CARE AND USE
  - Refer to instruction sheet included from the battery manufacturer. Typical information follows.
  - Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
  - Batteries fully charged must be handled with extreme care.
  - Any battery which puffs up is considered damaged and must not be used. It is in a dangerous state. Never charge a puffed up battery.
  - Any battery which holds less than 80% of its rated capacity should be discarded.
  - Cycle test each battery after every 50 cycles or if a battery is suspected to have lost as significant amount of its capacity to determine the current capacity.
  - Properly dispose of batteries. First discharge the battery fully using a battery cycler. Bring to a recycler such as a home improvement store.
  - Always charge flight batteries under “balance” mode.
  - Flight Battery Recommended Charge Rate: 1C which takes approximately 1 hour to charge
  - Flight Battery Maximum Charge Rate: May exceed 5C. Charge rates higher than 1C will decrease life cycles. Maximum charge rating per the manufacturer will provide 300+ cycles. Use the lowest charge rate which is practical.
  - Battery Rest Time between discharging and charging: 30 minutes minimum, 1 hour maximum.
  - Do not charge if the battery is more than 2°C warmer than ambient, especially if the temperature is above 20°C. The outer surface is cooler than the inner core after use. Damage will occur when charging a warm battery.
  - Recommended Battery Discharge Amount: 80%. Using more of the capacity of the battery will decrease the life cycles
  - As battery temperature approaches freezing the capacity of Lithium Polymer batteries decrease. Keep warmer than 5°C before installing into the UV (unmanned vehicle).
  - Battery capacity decreases at higher discharge rates. Using more batteries decreases the discharge rate of each battery thereby extending individual battery capacity slightly.
  - Lower discharge rates improve the life cycles.
  - Batteries are rated at greater than 300 life cycles. 1,000+ life cycles are possible.
  - Batteries must not be stored above 60% charged state for extended periods.
  - Batteries should be stored below 25°C for extended periods
  - Store batteries between 40% - 60% charged state. Fully charge just before use.
  - Fully charged batteries which are not to be used within 24 hours should be discharged to 40% - 60% charged state using the battery discharger.
  - Using more than one battery at a time requires the proper wiring harness so that the voltage is no more than 25.2V. Over voltage will cause serious damage to electrical equipment.

- PREVENTATIVE MAINTENANCE
    - ANNUAL INSPECTION (SUGGESTED)
        - If the airframe has in excess of 300 hours in a one year period, an annual inspection must be completed by an approved technician.
        - An approved technician should disassemble the AV and inspect all components for wear and replace any components as required.
        - Test all batteries for capacity.
        - Upgrade firmware and software to latest revisions

    - 500 HOUR PM (SUGGESTED)
        - An approved technician should disassemble the AV and inspect all components for wear and replace any components as required.
        - Replace all motors.
        - Test all batteries for capacity.
        - Upgrade firmware and software to latest revisions.