U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

August 28, 2015

Exemption No. 12656
Regulatory Docket No. FAA–2015-1679

Mr. David W. Johnston
Duke University
Marine Laboratory
135 Duke Marine Lab Road
Beaufort, NC 28516

Dear Mr. Johnston:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated April 15, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Duke University (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct research, education, and training[1].

See Appendix A for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

[1] The petitioner requested authority to conduct UAS training. At this time, the FAA is unable to authorize UAS operations for training until a further assessment is completed. When the FAA completes its review, we will proceed accordingly and no further action will be required by the petitioner. However, the petitioner is permitted to train its own pilot in commands and visual observers in accordance with condition no. 14 and the other conditions and limitations in this exemption.

Airworthiness Certification

The UAS proposed by the petitioner are the SenseFly eBee, Mikrokopter Hex XL, and Freefly CineStar 6.

The petitioner requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*. In accordance with the statutory criteria provided in Section 333 of Public Law 112−95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection[2]. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA−2014−0352), 11109 to Clayco, Inc. (*see* Docket No. FAA−2014−0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA−2014−0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA−2014−0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, and 11213;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, and 11213 also apply to the situation you present; and
- A grant of exemption is in the public interest.

[2] Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Duke University is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

Conditions and Limitations

In this grant of exemption, Duke University is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the SenseFly eBee, Mikrokopter Hex XL, and Freefly CineStar 6 when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

2. Operations for the purpose of closed-set motion picture and television filming are not permitted.

3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.

4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.

5. 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 airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC

must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations 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 operating documents, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS−80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.

9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. 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.

11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.

12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. 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.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. 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.

15. UAS 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.

16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.

17. 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.

18. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

19. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

20. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least five minutes or with the reserve power recommended by the manufacturer if greater.

21. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the attached COA.

22. All aircraft operated in accordance with this exemption 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. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

24. The UA must remain clear and give way to all manned aviation operations and activities at all times.

25. The UAS may not be operated by the PIC from any moving device or vehicle.

26. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
    b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

    The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

27. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative.

Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

28. 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 UAS 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.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

29. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.

30. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming 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 aerial filming;
    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; and
    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.

31. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on August 31, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/
John S. Duncan
Director, Flight Standards Service

Enclosures

Duke | NICHOLAS SCHOOL OF THE ENVIRONMENT
DUKE UNIVERSITY MARINE LAB

April 15, 2015

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Duke University Marine Laboratory
135 Duke Marine Lab Road
Beaufort, NC 28516

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

RE: Petition for Exemption and Relief from Specific Regulations of Title 14 of the Code of Federal Regulations Pursuant to Section 333 of the FAA Modernization and Reform Act of 1012 (Public Law 112-95) Regarding Commercial Employment of Unmanned Aircraft Systems (UAS)

Dear Sir/Madam,

Pursuant to Section 333 of Public Law 112-95 commonly known as the "FAA Modernization and Reform Act of 2012" or "The Reform Act", Duke University hereby applies for authorization to conduct commercial unmanned aerial systems (UAS) operations within the United States National Airspace System (NAS) for the purpose of Research, Education and UAS platform development.

Federal Register Summary

Pursuant to 14 CFR §11.81, the following summary is provided for publication in the Federal Register, should it be determined that publication is needed:

Duke University seeks exemption from 14 CFR Part 21, Subpart H; 14 CFR Part 27; 14 CFR 45.23(b); 14 CFR 61.113(a)(b); 14 CFR 91.7(a); 14 CFR 91.9(b)(2)(c); 14 CFR 91.103; 14 CFR 91.109(a); 14 CFR 91.119; 14 CFR 91.121; 14 CFR 91.151(a); 14 CFR 91.203(a)(b); 14 CFR 91.405(a); 14 CFR 91.407(a)(1); CFR 91.409(a)(1) and (a)(2); 14 CFR 91.417(a)(b) to allow commercial employment of Unmanned Aerial Systems (UAS) in support of research, education and UAS platform development in the areas of oceanography, limnology, and environmental science. This exemption will enhance safety by reducing risk to the general public and property owners from the substantial hazards associated with performing equivalent work with conventional aircraft and rotorcraft.

The name and address of the applicant is:

Dr. David W. Johnston
Marine Conservation Ecology UAS Program
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Duke University Marine Laboratory
135 Duke Marine Lab Road
Beaufort, NC 28516
david.johnston@duke.edu
252-504-7593

Signed:

GLOSSARY OF ABBREVIATIONS

AGL	Above Ground Level
AOI	Area of Interest
ATC	Air Traffic Control
ATO	Air Traffic Organization
AV	Aerial Vehicle
CFR	Code of Federal Regulations
COA	Certificate of Authorization
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
GCS	Ground Control Station
LOL	Loss of Link
NAS	National Airspace System
NOTAM	Notice to Airmen
PIC	Pilot in Command
Section 333	FAA Modernization and Reform Act of 2012, Section 333
SOP	Standard Operating Procedures
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
VFR	Visual Flight Rules
VLOS	Visual Line of Sight

VMC Visual Meteorological Conditions

VO Visual Observer

INTRODUCTION AND INTEREST OF THE PETITIONER

The use of small unmanned aerial systems (sUAS) in terrestrial commercial and science applications is now widespread and transforming agricultural assessments, environmental compliance regimes and spatial ecological science. These devices are used regularly to reduce costs, increase safety and boost knowledge of key agricultural parameters, to assess progress and environmental compliance in mining operations and occasionally to study the terrestrial habitats and aggregations of wildlife [3]. The use of sUAS in ocean science applications is also growing, and the availability of safe and sophisticated commercial hardware and software solutions is now facilitating their use by marine researchers. The use of sUAS by marine researchers can provide significant benefits including reduced costs, greater survey efficiency, reduced wildlife disturbance, reduced risk to human pilots and observers and higher data quality and quantity, yet there are few programs exploring these opportunities. The Duke University Marine Laboratory is developing a UAS program to 1) help meet the growing educational needs of marine scientists seeking to use sUAS in ocean and coastal applications and; 2) to support sUAS-based research in coastal and marine environments nationally and internationally. To achieve these goals, our research program must engage in domestic sUAS operations for research, education and training purposes. Due to the nature of our work, these flights will occur predominantly in remote coastal areas, away from human activities and often exclusively over water. UAS are developing as a legitimate and robust means of conducting research that heretofore have been possible only from manned aircraft. Such traditional survey techniques are expensive, incur substantial risk to personnel and produce lower quality data. Our work addresses these issues through marine science UAS applications to the benefit of society at large.

OVERVIEW CHARACTERISTICS OF PROPOSED UAS

	SenseFly eBee	**Mikrokopter Hex XL**	**Freefly CineStar 6**
Aircraft Type	Fixed wing	Multirotor (6 Rotor)	Multirotor (6 Rotor)
Aircraft Weight	0.69kg/1.52lbs	1.5kg/3.31bs	2.65kg/5.84lbs
Max Take off Weight	0.69kg/1.52lbs	5.00kg/11.02lbs	5.80kg/12.79lbs
Dimensions	980mm Wingspan	730x730x350mm	900x800x350mm
Max Flight time (aprox)	50min	32min	30min
Max airspeed	48kts	40kts	40kts
Propulsion	Brushless DC motor	Brushless DC motor	Brushless DC motor
Power	11.1v 3 Cell Lithium Polymer battery	14.8v 4 Cell Lithium Polymer battery	14.8v 4 Cell Lithium Polymer battery
Payload	Digital compact	Digital compact /Video	Digital compact / SLR /

	camera	camera	Video camera
Airframe material	EPP foam & carbon structure	Carbon Fiber & Aluminum	Carbon Fiber

QUALIFICATION FOR APPROVAL UNDER SECTION 333 OF THE REFORM ACT

The proposed operations in this petition for exemption qualify for expedited approval under Section 333 of the Reform Act. Each of the statutory criteria and other potentially relevant factors are satisfied.

The proposed operations would permit the use of small and relatively inexpensive UAS under controlled conditions in airspace that is: (1) limited; (2) predetermined; (3) away from populated areas; (4) would provide an increased level of safety beyond that existing when fixed or rotor wing aircraft are used to accomplish the same purpose.

The UAS's planned to be operated are rotorcraft and fixed wing aircraft, each weighing typically less than 15 lbs., and always less than 55 lbs., including payload. They would operate, under normal conditions, at a speed of no more than 50 knots. The principal construction material of the UAS aircraft would typically be foam, carbon fiber, aluminium and/or plastic. Operations will be performed by a qualified UAS Pilot in Command (PIC), as outlined below, to insure that the UAS will "not create a hazard to users of the national airspace system or the public." Given the small size of the UAS involved and the pre-planned environment within which they will operate, the applicant believes that these operations fall squarely within that zone of safety (an equivalent level of safety) in which Congress envisioned that the FAA must, by exemption, allow commercial operations of UAS to commence immediately. Also, due to the size of the UAS and the pre-defined, restricted area in which the UAS will operate approval of the application presents no national security issue. The operation of UAS by knowledgeable professionals will serve to enhance safety, add to the public benefit, and reduce environmental impacts related to current methods of manned aircraft flight operations. These limitations and conditions to which the operator, or its employees, acting as UAS PIC agrees to be bound when conducting commercial operations under a FAA issued exemption:

1. Operations authorized by this grant of exemption are limited to the following aircraft: **SenseFly eBee**, **MikroKopter HEX XL** and **Freefly Cinestar 6**.
2. UA (aircraft and payload) will weigh less than 55lbs.
3. UA will be operated at altitudes not greater than 400 feet AGL. Altitudes reported to ATC will be in feet AGL.
4. UA will be flown at ground speeds not greater than 87 knots.

5. The UAS PIC will hold either an airline transport, commercial, private, recreational or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the recent flight experience requirement stated in 14 CFR § 61.57 and flight review requirements stated in 14 CFR § 61.56. The Duke University Marine Conservation Ecology UAS Program (applicant) employs a full-time instrument rated commercial pilot.
6. In addition to holding an FAA issued airman certificate, UAS PIC must complete a Duke University Marine Conservation Ecology UAS Training Program. This training will include detailed review of manufacturer operating manuals and practical demonstration of ability to safely operate UAS in a manner consistent with how the UAS will be operated under this exemption (to include evasive and emergency maneuvers and maintaining appropriate distances from persons, vehicles, vessels and structures). PIC qualification will have a currency requirement of at least three take-offs and landings within the preceding 90 days. PIC qualification flight hours will be logged in a manner consistent with 14 CFR § 61.51.
7. UA will not be operated within 5 nautical miles (NM) of an airport having an operational control tower, or 3 NM of an airport with a published instrument flight procedure but not an operational control tower, or 2 NM of an airport without a published instrument flight procedure or operational control tower, or 2 NM of a heliport with a published instrument flight procedure. Flights will be operated in Class G airspace whenever possible. If operation in other airspace is required, the relevant controlling agency will be notified at least 24 hours prior to the operation and, if required, any necessary permission obtained
8. UAS flights will operate within visibility and cloud clearance requirements equivalent to Visual Flight Rules (VFR).
9. UAS operations will not be conducted during night, as defined within 14 CFR § 1.1.
10. UA flights over land will not be operated by the PIC from any moving vehicle or device. UA flights conducted entirely over water may be operated from a suitable vessel.
11. UA will not be operated from a raised platform.
12. The UA will remain clear of and yield right of way to manned aviation operations.
13. UA will be operated within visual line of sight (VLOS) of the PIC at all times. The PIC will use human vision unaided by device other than corrective lenses as specified on PIC's FAA medical certificate.
14. UAS operations will employ a visual observer (VO). The VO may be used to satisfy the VLOS requirement as long as the PIC maintains VLOS capability. The

VO and PIC must be able to communicate verbally for the duration of the flight. Electronic messaging or texting is not allowed during flight operations.

15. The VO will perform no duties other than assisting the PIC see and avoid other aircraft, obstacles, persons or property.
16. UAS will be equipped with an autopilot system which will be at least equivalent to a MikroKopter or Sensefly system. The UAS will utilize GPS navigation, failsafe's, return-to-home (RTH) and flight abort safety features.
17. Prior to each flight the PIC will inspect the UAS to ensure it is in a condition for safe flight. Checklists developed from manufacturer operating documents will be the basis for this inspection. If the inspection reveals a condition that affects safe operation of the UAS, the aircraft is prohibited from operating until necessary maintenance has been performed and the UAS is found to be in a safe condition for flight. The Ground Control Station must be included in the preflight inspection.
18. All UAS operations will be conducted over remote and sparsely populated property or over open waters. Permission for flight will be obtained in advance from property owners or controlling agency. A Ground Station will be connected, by radio communication, to the UAS during the entire flight, which will give the PIC flight information such as GPS Position, Altitude, Air speed, Battery Remaining, and other telemetry information.
19. Flight boundaries will be established for each flight and such boundaries will be designed such that the UA will pass no closer than 500 feet from nonparticipating persons, vehicles or structures.
20. If the UAS loses communications or loses GPS signal, the UA will return to a predetermined location within the established flight boundary and land or be recovered in accordance with manufacturer operations documents.
21. The PIC will abort any flight in the event of unpredicted obstacles, occurrence of adverse weather or loss of UAS flight control capability in accordance with manufacturer operations documents.
22. The PIC is prohibited from beginning a flight unless (considering wind and forecast conditions) there is enough power to fly the planned route to the intended landing point and land the UAS with 25% of battery capacity remaining.
23. Documents required by 14 CFR § 91.9 and 91.203 will be available to the PIC at the Ground Control Station of the UAS whenever the aircraft is operating. These documents will be made available to the Administrator or any law enforcement official upon request.
24. Before conducting flight operations, the radio frequency spectrum used for operation and control of the UA must comply with Federal Communications Commission (FCC) or other appropriate government oversight agency requirements.

25. A Flight Operations and Maintenance Log will be maintained for each UAS. Cumulative flight hours, maintenance activities, repairs, alterations and inspections will be noted.
26. Any UAS maintenance or alterations that affect UAS operation or flight characteristics, e.g. replacement of a flight critical component, must undergo a functional test flight. The PIC who conducts the functional test flight must make an entry in the Flight Operations and Maintenance Log.

SPECIFIC SECTIONS OF 14 CFR FROM WHICH PETITIONER SEEKS EXEMPTION OR RELEIF

14 CFR Part 21, Subpart H – Airworthiness Certificates and 14 CFR § 91.203(a)(1)

The FAA has stated that no exemption is needed from this section if a finding is made under Part 11 and Section 333 of the Reform Act that the UAS selected provides an equivalent level of safety when compared to civil aircraft normally used for the same application. The petitioner submits that given the small size of the UAS, the limited operating areas and procedures defined within the training and operations section of the petition, an equivalent level of safety is obtained and exemption is not required (see Grant of Exemption to Astraeus Aerial, Docket No. FAA-2014-0352). If however, the FAA determines that there are some characteristics of the chosen UAS that fail to meet the requirements of the Reform Act, an exemption is requested.

14 CFR Part 27 – Airworthiness Standards: Normal Category Rotorcraft

14 CFR Part 27 sets forth the procedural requirements for airworthiness certification of normal category rotorcraft. To the extent petitioner's UAS would otherwise require certification under Part 27, petitioner seeks exemption for the same reasons identified in the request for exemption from 14 CFR Part 21, Subpart H.

14 CFR § 45.23 (a)(b) and 91.9 (c) – Marking of the Aircraft

Regulation 45.23 provides: *(a) Each operator of an aircraft must display on that aircraft marks consisting of the Roman capital letter "N" (denoting United States registration) followed by the registration number of the aircraft. Each suffix letter used in the marks displayed must also be a Roman capital letter. (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 UAS has no entrance to the cabin, cockpit or pilot station on which markings can be placed. Given the small size of the UAS, two-inch lettering will not be possible. In a previous Grant of Exemption, the FAA determined that exemption from these requirements was warranted provided that the aircraft "have identification (N-Number) markings in accordance with 14 CFR Part 45, Subpart C if the markings are as large as practicable." The petitioner additionally proposes to place all required markings, placards, flight envelope restrictions, cautionary notices in an easily visible location at the UAS Ground Control Station. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 8738, 10167, 10167A and 10700.

14 CFR § 91.9(b)(2) – Aircraft Flight Manual in the Aircraft

Regulation 91.9 stipulates *(b) No person may operate a U.S.-registered civil aircraft— (2) For which an Airplane or Rotorcraft Flight Manual is not required by §21.5 of this chapter, unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof.*

Given the size of the UAS, they have no place or ability to carry a flight manual aboard the aircraft. An equivalent level of safety will be achieved by keeping the flight manual at the Ground Control Station where the pilot operating the UAS will have immediate access to it. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 8607, 8737, 8738, 9299, 9299A, 9565, 10167, 10602, 32827 and 10700.

14 CFR § 61.113 (a)(b) and 61.133(a)(i)(ii) – Private and Commercial Pilot Privilege and Limitations

Regulation 61.113 stipulates *(a) Except as provided in paragraphs (b) through (h) of this section, no person who holds a private pilot certificate may act as pilot in command of an aircraft that is carrying passengers or property for compensation or hire; nor may that person, for compensation or hire, act as pilot in command of an aircraft.*
(b) A private pilot may, for compensation or hire, act as pilot in command of an aircraft in connection with any business or employment if: (1) The flight is only incidental to that business or employment; and (2) The aircraft does not carry passengers or property for compensation or hire.

Regulation 61.133 stipulates *(a) Privileges—(1) General. A person who holds a commercial pilot certificate may act as pilot in command of an aircraft—*

(i) Carrying persons or property for compensation or hire, provided the person is qualified in accordance with this part and with the applicable parts of this chapter that apply to the operation; and
(ii) For compensation or hire, provided the person is qualified in accordance with this part and with the applicable parts of this chapter that apply to the operation.

Unlike a conventional aircraft that carry pilot, passengers and cargo, the proposed UAS are remotely controlled and carry no persons or cargo. The UAS are capable of a high degree of flight automation and employ technical capabilities that limit the potential for operation in an unintended manner. It is the petitioner's belief that given the size, weight, speed, operating environment and operating capabilities of the UAS, an equivalent level of safety may be obtained by stipulating the UAS PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Colombia, Puerto Rico, a territory, a possession, or the Federal government. 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. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 11284, 11281, 11282 and 11296.

14 CFR § 91.7(a) – Civil Aircraft Airworthiness

Regulation 91.7 stipulates *(a) No person may operate a civil aircraft unless it is in an airworthy condition.*

Should this exemption be granted allowing commercial operation of UAS without an airworthiness certificate, no FAA regulatory standard will exist for airworthiness of the UAS. An equivalent level of safety will be obtained by ensuring compliance with UAS operator and maintenance manuals and safety checklists prior to each flight.

14 CFR § 91.121 – Altimeter Settings

Regulation 91.121 requires that *(a) Each person operating an aircraft shall maintain the cruising altitude or flight level of that aircraft, as the case may be, by reference to an altimeter that is set, when operating— (1) Below 18,000 feet MSL, to— (i) The current reported altimeter setting of a station along the route and within 100 nautical miles of the aircraft; (ii) If there is no station within the area prescribed in paragraph (a)(1)(i) of this section, the current reported altimeter setting of an appropriate available station; or (iii) In the case of an aircraft not equipped with a radio, the elevation of the departure airport or an appropriate altimeter setting available before departure.*

Conventional aircraft are provided altitude data by a barometric altimeter that is most commonly set to a local barometric pressure and therefore reports altitude relative to MSL (Mean Sea Level). UAS operations are restricted to altitudes no greater than 400 feet AGL (Above Ground Level). For those UAS with a barometric sensor, greater utility and an equivalent level of safety will be obtained by setting the altimeter to read "zero altitude" when the UAS is on the ground prior to takeoff thus providing an AGL altitude readout. If no barometric sensor is aboard the UAS, a GPS derived altitude similarly set to zero at the takeoff point will provide an equivalent level of safety. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 11066, 11065, 11062 and 11063.

14 CFR § 91.151 – Fuel Requirements for Flight in VFR Conditions

Regulation 91.151 stipulates that *(a) No person may begin 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. (b) No person may begin a flight in a rotorcraft 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, to fly after that for at least 20 minutes.*

This regulation is written based on the capabilities of traditional civil aircraft which typically have flight times with full fuel of several hours. For the majority of UAS which have flight times of an hour, or much less, this regulation would effectively deny an ability for the UAS to operate. The petitioner submits that an equivalent level of safety will be obtained by requiring that no UAS flight will begin unless (considering wind and forecast conditions) there is enough fuel (battery) to fly the planned route to the first point of intended landing and land with 25% of battery capacity in reserve. This restriction would be more than adequate to return the sUAS to its planned landing zone from anywhere in its limited operating area.
The FAA has issued several exemptions to this regulation: see Exemptions Nos. 2689F, 5745, 10673 and 10808.

14 CFR § 91.405(a), 91.407(a)(1), 91.409(a)(2), 91.417(a) and (b) – Maintenance Inspections

Regulation 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…"* Regulation 91.407*(a)(1) similarly makes*

reference to requirements in Part 43. Regulation 91.409(*a)(2) requires an annual inspection for the issuance of an airworthiness certificate.* Regulation 91.417(*a) and (b) 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.*

Exemption from these regulations is needed because Part 43 and these sections apply only to aircraft with an airworthiness certificate. An equivalent level of safety will be obtained by requirement that each UAS will have a flight and maintenance log. Maintenance and inspections will be accomplished in accordance with manufacturer recommendations. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 11066, 11062, 11067A and 11065.

14 CFR § 91.103 – Preflight Action

Regulation 91.103 stipulates *Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. This information must include—(a) For a flight under IFR or a flight not in the vicinity of an airport, weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which the pilot in command has been advised by ATC; (b) For any flight, runway lengths at airports of intended use, and the following takeoff and landing distance information: (1) For civil aircraft for which an approved Airplane or Rotorcraft Flight Manual containing takeoff and landing distance data is required, the takeoff and landing distance data contained therein; and (2) For civil aircraft other than those specified in paragraph (b)(1) of this section, other reliable information appropriate to the aircraft, relating to aircraft performance under expected values of airport elevation and runway slope, aircraft gross weight, and wind and temperature.*

The petitioner seeks exemption to the extent that an FAA-approved Flight Manual is required. An equivalent level of safety will be provided by following the Operations Manual provided by the manufacturer. Additionally, the PIC will conduct preflight actions, to include performing all required checklists, reviewing weather, flight requirements, battery charge, landing and takeoff distance, aircraft performance data, and contingency landing areas, before initiation of flight.

14 CFR § 91.109 – Flight Instruction

Regulation 91.109 stipulates, in part, that *(a) 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.*

UAS by their design do not have fully functional dual controls. Flight control is accomplished through the use of a control interface that communicates with the aircraft via radio. Given the size, speed and limited operational parameters of the UAS, an equivalent level of safe training can be performed without dual controls. The FAA has issued several exemptions to this regulation: see Exemptions Nos. 11066, 11062, 11067A and 11065.

14 CFR § 91.119 – Minimum Safe Altitudes

Regulation 91.119 stipulates, in part, that, *Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes: (a) Anywhere. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface. (b) Over congested areas. Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft. (c) Over other than congested areas. 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.*

An exemption to 91.119(c) is required because UAS operations will be conducted at altitudes no greater than 400 feet above the surface. The size, speed, weight and limited operational parameters of the UAS allow for an equivalent level of safety.

WHY GRANTING THIS PETITION IS IN THE PUBLIC INTEREST

As introduced above, the requested exemption would authorize the Applicant to perform commercial operations with sUAS that will provide significant benefits to the public interest:

1. The commercial use of sUAS to perform marine research and educational activities at Duke University in support of government entities, private research institutions, scientific studies and wildlife monitoring, all of which are critical to the well-being of the general public. This includes rapid studies of coastal geomorphology crucial to storm assessments and sea level rise, water quality studies, wildlife population assessments and critical habitat mapping.
2. A significant reduction in costs to conduct research, training and education programmes. At present, our marine research programs that use aerial surveys can cost tens of thousands of dollars per day. By incorporating sUAS into these programs we can incur significant savings and more efficiently conduct research in the public interest

3. The use of sUAS will decrease congestion in the National Airspace System along with reducing the noise and air pollution generated during traditional manned aircraft flight operations.
4. When using UAS to complement field personnel, they reduce safety concerns when gathering data from inaccessible or unstable/unsafe areas and in extreme weather or terrain.
5. Operation of sUAS will substantially reduce the risk to life and property in the air, and on the ground, which is commonly associated with traditional manned aircraft flight operations for marine science missions.
6. Similar to the current manned aircraft flight operations in marine science that have been conducted for many decades, sUAS used for similar tasks will not generate any new privacy issues.

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." Approval of this exemption will allow for safer, more efficient and less costly marine science missions, and produce much higher data quality.

SUMMARY OF REGULATIONS FROM WHICH PETITIONER SEEKS EXEMPTION OR RELIEF

14 CFR Part 21, Subpart H
14 CFR Part 27
14 CFR 45.23(b)
14 CFR 61.113(a)(b)
14 CFR 91.7(a)
14 CFR 91.9(b)(2)(c)
14 CFR 91.103
14 CFR 91.109(a)
14 CFR 91.119
14 CFR 91.121
14 CFR 91.151(a)
14 CFR 91.203(a)(b)
14 CFR 91.405(a)
14 CFR 91.407(a)(1)
CFR 91.409(a)(1) and (a)(2)
14 CFR 91.417(a)(b)

SUPPORTING AND TECHNICAL DOCUMENTS

To be delivered under separate attachment
Duke eBee User manual
DUKE MikroKopter/Cinestar Pilot Operating Manual
Duke sUAV Specifications and Logbooks
Duke MCE sUAS SOP all aircraft