



UAS Systems Manufacturer

Hylío Inc.
1020 Agnes Rd.
Richmond, TX 77469
832-235-0839
NickNawratil@hyl.io
www.hyl.io

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

RE: Petition seeking relief under Section 44807 of the FAA Reauthorization Act of 2018

Dear Sir or Madam:

Hylío Inc. (Hylío) would like to make an AMENDMENT to a previous petition filed June 22, 2020 requesting to conduct Commercial Agricultural Services under Docket No. FAA-2020-0624.



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I. Summary

Hylío Inc. is requesting amendment to a previously approved exemption under 49 U.S.C. §44807 of the FAA Reauthorization Act of 2018 (P.L. 115-254) to Conduct Commercial Agricultural Services.

Scope of relief includes:

1. Relief from Condition/Limitation 27C
2. Amendment to takeoff weight: 140lb Takeoff Weight for AG-122 Aircraft
3. Petition Consolidation: Combination of AG-122 and AG-116 Petition

The aircraft will be the Hylío AG-122 and Hylío AG-116. Manuals containing proprietary information for training, maintenance, and operation of each aircraft will be included in support of this petition. This petition explains how Hylío can operate to an equivalent level of safety under the amended extent of relief.

II. Petitioner Information

Hylío Inc. Address

Hylío Inc.
1020 Agnes Rd.
Richmond, Tx 77469

Contact Information

Nick Nawratil
832-235-0839
NickNawratil@hyl.io

About Hylío Inc.

Hylío is a Texas-based developer of UAS hardware and flight control software systems. Hylío also has extensive experience as an advanced UAS operations service provider.

Hylío utilized this extensive operational experience to develop a product suite ideal for safe and reliable UAS spray operations. Hylío Inc. plans to operate the AG-122/AG-116 as described below in the United States of America. Hylío will coordinate with individual growers, researchers, universities, and other interested parties to advance the safe operation of agricultural UAS in the USA.

III. Regulations Petitioner Requests Relief

14 CFR § 91.119(c)	Minimum safe altitudes: General
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IV. Extent of Relief

1. Relief from Condition/Limitation 27C

Additional relief is requested from condition 27C. The relief requested below is intended to match relief granted to DroneXum in Grant 18413A. The condition/limitation Grant 18413A requests relief from is as follows:

“27. All flight operations must be conducted at least 500 feet from all persons who are not directly participating in the operation, and from vessels, vehicles, and structures, unless when operating:
c. Near vessels vehicles and structures. Prior to conducting operations, the operator must obtain permission from a person with the legal authority over any vessels, vehicles or structures that will be within 500 feet of the UA during operations. The PIC must make a safety assessment of the risk of operating closer to those objects and determine that it does not present an undue hazard.”

HYLIO INC. requests relief from this condition. HYLIO INC. requests that all previously assigned conditions and limitations be followed with an amendment to 27C, and when flying within 500ft the following additional conditions and limitations be followed. HYLIO INC. Requests that the FAA not request public comment on its petition because it would not set any precedent and because the relief requested is identical to the already approved petition by DroneXum Exemption No. 18413A, granted previously by the FAA. 14 C.F.R. § 11.87. In addition, HYLIO INC. will be utilizing the same proven technologies and mitigations the FAA has already accepted and approved in that exemption.

The new conditions and limitations granted to DroneXum are as follows:

27. All flight operations must be conducted at least 500 feet from all persons who are not directly participating in the operation, and from vessels, vehicles, and structures, unless when operating:
 c. Closer than 500 feet from vessels, vehicles and structures. The UA may be operated closer than 500 feet, but not less than 100 feet, from vessels, vehicles, and structures under the following conditions:

- (1) The UAS is equipped with an active geo-fence boundary, set no closer than 100 feet from applicable waterways, roadways, or structures;
- (2) The PIC must have a minimum of 7 hours experience operating the specific make and model UAS authorized under this exemption, at least 3 hours of which must be acquired within the preceding 12 calendar months;
- (3) The PIC must have a minimum of 25 hours experience as a PIC in dispensing agricultural materials or chemicals from a UA;
- (4) The UA may not be operated at a groundspeed exceeding 15 miles per hour;
- (5) The UA altitude may not exceed 20 feet AGL; and
- (6) The PIC must make a safety assessment of the risk of operating closer than 500 feet from those objects and determine that it does not present an undue hazard.

HYLIO INC. intends to follow these conditions and limitations as well as other internal protocols. The proprietary ConOps and Risk Assessment & Mitigation Manuals outline these protocols and should provide the support necessary to grant the waiver, and demonstrate how an equivalent level of safety is achieved. A section can be found in each of these documents with specific reference to the under 500ft limitation.

(CONOPS Manual Page 10)

(Risk Assessment & Mitigation Manual Page 12)



2. Amendment to Takeoff Weight: 140lb Takeoff Weight for AG-122 Aircraft

The Hylío AG-122 Aircraft approved May 20, 2021 under Exemption No. 18802, Regulatory Docket No. FAA-2020-0624 was approved for a maximum takeoff weight of 121 lbs. Hylío Inc. is requesting that this maximum takeoff weight be increased to 140lbs.

Hylío is requesting this change in maximum takeoff weight because there have been minor changes to some materials used in the frame of this aircraft, leading to a slight increase in weight. This change happened after the initial filing of the 44807. In order to use the full 20-liter payload capacity of this drone, it must be operated above 121 lbs, but not more than 140lbs.

This change does not constitute a change of aircraft, because it has not led to any change in the function or capability of the aircraft. This change simply constitutes a different selection of raw material that has made the airframe slightly stronger, and eased capability for construction within the United States. The flight performance and available flight time have not reduced from any values listed and approved on the initial petition. All sensors, control, and operation of the aircraft is the same as on the initial petition. The design and assembly of the aircraft has not changed. Thousands of functional flight tests have been performed to validate the equivalence of safety and performance with the slight alteration in weight. For all intents and purposes, this is the aircraft that was approved in Exemption No. 18802, the model is just a little heavier now.

Hylío requests that because of the reasons stated above, the FAA view this updated maximum takeoff weight as an amendment to the previous petition and NOT as a new aircraft.

3. Petition Consolidation: Combination of AG-122 and AG-116 Petition

Pursuant to Title 49 U.S.C. § 44807, Special authority for certain unmanned aircraft systems and 14 C.F.R. Part 11, Hylío Inc. recently received an approved Exemption to allow commercial operation of the Hylío AG-116 (Exemption 18807) and the Hylío AG-122 (Exemption 18802), both weighing 55 lbs. or more. In an effort towards convenience and reduction of paperwork for both Hylío Inc. and the FAA, Hylío Inc. would like to effectively combine these two exemptions. Exemption 18807 and Exemption 18802 are similar in all approvals, conditions, and limitations aside from the aircraft model (both of which are over 55lbs and utilize almost identical operating systems). To effectively combine the two exemptions, Hylío requests to amend exemption 18802 to include the Hylío AG-116 aircraft approved under exemption 18807.



V. Relief Purpose and Safety Rationale

14 CFR § 91.119(c)

<p>Regulation</p>
<p>Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:</p> <p>(a) Anywhere. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.</p> <p>(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</p> <p>(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.</p> <p>(d) Helicopters, powered parachutes, and weight-shift-control aircraft. If the operation is conducted without hazard to persons or property on the surface -</p> <p>(1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c) of this section, provided each person operating the helicopter complies with any routes or altitudes specifically prescribed for helicopters by the FAA; and</p> <p>(2) A powered parachute or weight-shift-control aircraft may be operated at less than the minimums prescribed in paragraph (c) of this section.</p>
<p>Why Petitioner is Seeking Relief</p>
<p>This will be very restrictive to spraying with UAS.</p>
<p>Equivalent Level of Safety</p>
<p>During operations with the AG-122 the average altitude will not be more than 10 feet in order to apply the ag products effectively. Due to the configuration of some farms the crop land can be within 500 feet of buildings. An equivalent level of safety for users of the NAS can be achieved because the AG-122/AG-116 will be operated at speeds below 25 mph nearly exclusively over the target treatment area. By keeping the altitude ultra-low and slow during these missions in remote rural areas with the immediate ability to land in a matter of seconds these operations will not add risks to other users of the NAS. It is plausible that on many sorties the vehicle may never need to fly above 20 feet agl in order to complete the mission. For these reasons HYLLO INC. is requesting a waiver to the minimum altitude requirements of section 119 of part 91.</p>



VI. Aircraft Information

Hylío AG-122 Spec Sheet

Flight Parameters	
Total Weight (without batteries)	61.3 lb
Max Recommended Takeoff Weight	140 lb
Max Thrust	269.6 lb
Max Operating Speed	22 mph
Max Flight Speed	40 mph
Propulsion System	
Motor KV	100 rpm/V
Foldable Propeller	30x9.0 in
Configuration	Octocopter
Operating Voltage	12s
Battery	2 x 16000 mAh 12S (44.4V) LiPo Batteries
	9.3 lb/battery
Aircraft Frame	
Wheelbase	83.5 in
Material	Carbon Fiber, Aluminum, Plastic
Dimensions	81x81x25 in (arms unfolded, no propellers)
	44x44x25 in (arms folded, no propellers)
Spray System	
Standard Payload	43.4 lbs, 5.2 gallon
Configuration	2 Pumps, 2 Tanks, 2 Flowmeters, 8 nozzles underneath rotors
Nozzle	Nozzle body compatible with any Teejet spray tip
Pump	Diaphragm Pump, 65 PSI
Flow Rate (no nozzle max)	0.1 – 2.0 Gal/min
Flow Rate (with recommended nozzle TT11001)	1.0 Gal/min
Spray Width	20-30 feet
Flight Control	
Flight Modes	Fully autonomous (no RC), position hold manual (with RC), Fully manual GPS denied (with RC)
Operating Frequencies	902 – 928 MHz, 2.4 GHz
Ground Station Control Software	Hylío Agrosol
Max Transmission Range	~1 mile (5+ unobstructed)



Hylio AG-116 Spec Sheet

Flight Parameters	
Total Weight (without batteries)	39 lb
Max Recommended Takeoff Weight	105 lb
Max Thrust	202.2 lb
Max Operating Speed	22 mph
Max Flight Speed	40 mph
Propulsion System	
Motor KV	100 rpm/V
Foldable Propeller	30x9.0 in
Configuration	Hexacopter - X
Operating Voltage	12s
Battery	1 x 22000 mAh 12S (44.4V) LiPo Battery
	13.4 lb/battery
Aircraft Frame	
Wheelbase	67 in
Material	Carbon Fiber, Aluminum, Plastic
Dimensions	67x59x24 in (arms unfolded, no propellers)
	35x42x24 in (arms folded, no propellers)
Spray System	
Standard Payload	35 lb, 4.5 gallon
Configuration	1 Pumps, 1 Tank, 1 Flowmeter, 6 nozzles on 6ft boom
Nozzle	Nozzle body compatible with any Teejet spray tip
Pump	Diaphragm Pump, 65 PSI
Flow Rate (no nozzle max)	0.1 – 1.8 Gal/min
Flow Rate (with recommended nozzle TT11001)	0.95 Gal/min
Spray Width	15-25 feet
Flight Control	
Flight Modes	Fully autonomous (no RC), position hold manual (with RC), Fully manual GPS denied (with RC)
Operating Frequencies	902 – 928 MHz, 2.4 GHz
Ground Station Control Software	Hylio Agrosol
Max Transmission Range	~1 mile (5+ unobstructed)



AG-122/AG-116 Systems Information

The AG-122 and AG-116 contain an array of features to both enhance safety and assure its ability to effectively conduct the mission. All of the listed features are held by both the AG-122 and AG-116 aircraft. Among these features are:

Rotor Fail Protection - If one rotor fails, the flight controller will compensate for the lost rotor and immediately travel to a safe land point. The flight controller will notify the operator via on-screen warnings as it returns to land. The aircraft will maintain stability, allowing the flight controller to safely land, or the operator to take control and manually land.

Ground Software System – HYLIO INC. and all AG-122/AG-116 owners use a UAS control software known as Hylío AgroSol. Hylío Inc. developed AgroSol for the express purpose of controlling Hylío Inc. agricultural drones. AgroSol has been used for ground station control of all recorded flight hours on the AG-122/AG-116.

Return-To-Launch (RTL) - The operator has access to an RTL command which they can use to instantly stop the UAS and return it to the set landing point at a predetermined, safe altitude.

Land - In the event that the primary and all backup land points have been compromised, the UAS can be autonomously landed in any other safe location. This can be completed using the ground control software without requiring manual RC control.

Emergency Pause - The operator has systems that can be used to instantly stop the UA during the mission, where the drone will pause and hover in place, awaiting further commands. It can then be manually moved to a new location, and forced to land at the alternate safe landing location, or return to launch for landing.

Geofencing - The UAS's flight controller is given GPS coordinates of a boundary that it cannot leave, keeping the UAS from leaving the pre-determined and defined operations area. When enabled, the UAS can "hit" the perimeter, but not fly past or through it. Manual or automatic inputs commanding the UAS to break the geofence are ignored. In the event the geofence is broken, the UAS will automatically enter RTL mode and return home to land.

Beacon - In the extremely unlikely event of a system malfunction that causes a crash, a beacon attached to the UAS will help the PIC and ground crew quickly locate it, ensuring a quick response to secure the equipment and surrounding area.

Redundant GPS - All UAS are equipped with redundant GPS units. Should the primary GPS unit experience a failure, a second GPS unit will automatically takeover as a failsafe to ensure accurate positioning and navigation is maintained. During regular operation, the GPS signals are blended to improve position accuracy. The system offers full redundancy of GPS (2), IMU (3), and Compass (3). If one or multiple units fail, the controller will switch in real-time between the redundant compass, IMU, and GPS.

Telemetry - Should a telemetry link to the base station be lost, the UAS has all mission parameters stored onboard, and can safely continue to execute a mission. The UAS will automatically return to land with or without telemetry link when the tank or batteries are low. The base station computer will alert the PIC when telemetry communication is lost, who may opt to allow the UAS to continue its mission if it is safe to do so, or interrupt the mission and bring the UAS back under RC control.



RC control - All missions occur with pre-programmed commands providing instructions to the UAS. At all times, a PIC has an RC remote located near the ground control station, with the ability to override the current mission. The AG-122/AG-116 offers an optional safety feature where in the case that the RC connection is lost, the autopilot software will immediately end the mission and return the UAS home launch location. In this case, the UAS ascends to an altitude set by the PIC in advance of the mission and determined to be safe given the surrounding terrain. The UAS then returns in a straight line to the launch location.

Emergency Kill Switch - An emergency "Kill Switch" allows the operator to instantly stop motors in the event of an emergency. This kill switch is available through the ground control computer telemetry link.

Additional Safety Functions

Additional supplemental safety information is provided below to strengthen the petitioner's position that the proposed UASs can be operated safely in the NAS in accordance with Public Law 112-95, the FAA Modernization and Reform Act of 2012. The Hylio AG-122 & AG-116 have at least a one-year record of operational test work accumulating 1000 hours of flight time and treating 15000 acres of cropland without any accidents or injuries.

Full Black Box Recording of All Flights: Flight data shows time stamped information of all operator control input, GPS statuses and outputs, vibrations, battery voltage, accessory voltages, IMU outputs, compass readings and all other sensor and flight information. All flight information is automatically saved internally on the UAS. Any operator or system caused issues can be easily identified with this information. Hylio's ground control software offers analysis of this log information to help predict potential future problems. As a supplement to routine maintenance, these logs are analyzed daily to help protect the user from unforeseen issues. This process can be completed locally on AgroSol without the need for internet access. If an operator feels there may be an issue, logs from the last flight can be analyzed using AgroSol in minutes without leaving the field.

Safety parameters: Max altitude, distance from home, horizontal speed and vertical speed defaults are set by Hylio Inc., and the customer can set these as well based on location and operating restrictions. The AG-122/AG-116 uses multiple sensor types to ensure maximum altitude is respected in the event of primary altimeter sensor failure.

Aviation Lighting: All AG-122/AG-116 come with mounted navigation lights in a standard configuration to indicate orientation and health. Hylio offers optional Long-range visible, high intensity LED strobes.

Intelligent Assisted Launch and Landing: Aircraft uses GPS and IMU data to determine when the craft is fully on the ground, meaning the craft will not shut rotors off until firmly on the ground. Aircraft also uses IMU data to safely and smoothly handle "In Ground Effect" caused by the rotor downwash, which lessens stress and accident likelihood for operator.

Flight Stall Prevention: The flight controller prevents accidental 'throttle zero' motor stall while in the air. In an emergency, the operator can switch instantly to 'manual' mode to activate rotor kill, providing complete system override by the pilot during an in-flight emergency. This override is also available through the ground control station computer over the telemetry link.

10.5-second auto-lock rotors: Automatically locks rotor from accidental turning after initial power connected and again five seconds after rotors stop.

Change of Flight Parameters: Ability to change certain parameters in real-time (during flight).



Flight Controller Modifications: Ability to program, calibrate, debug, and modify flight controller information without power to rotors: allows safe physical interaction with UAS while performing maintenance and servicing.

Return to Home Features: Ability to move or edit "Home" (return to home) location if the original becomes obstructed (animals, people, or too far of a distance, etc.) after initial launch. If a failure occurs, UAS will land at newly designated location.

GPS Signals: For UAS operations where GPS signal is necessary to safely operate the aircraft, the PIC must immediately recover/land the UAS upon loss of GPS signal.

Altitude Sensing Redundancies: The AG-122/AG-116 uses 3 different sensors to determine altitude. Radar, barometer, and GPS. The radar is the primary source of altitude. If the radar fails, the drone will automatically RTL using barometer altitudes. If the radar fails, the Geofence will also be maintained using the barometer altitude to ensure the UAS does not exit the geofenced area.

Lost Link: If the PIC loses command or control link for a designated length of time, the aircraft will follow a predetermined route to finish the mission, reestablish link, or immediately return to land if the first two options are not possible. The UAS will automatically return when for low battery, or fluid in the tank, even when the link is lost. To ensure operational safety, this feature is optional and can be turned on/off in AgroSol. All safety features including automatic obstacle detection and avoidance remain in effect in the event of a lost link.

Operational Analysis: The AG122/AG-116 flight controller firmware automatically logs flight hours on the UAS. These flight hours are tracked and displayed in AgroSol. This automatic flight hour tracking is used to ensure strict adherence to maintenance procedures.

AG-122/AG116 Feature Similarity

The Hylio AG-122 and Hylio AG-116 aircraft are similar in all forms of control and safety systems. There are only slight differences in hardware layout which require slightly different maintenance routines. Both aircraft operate over 55lbs. It is reasonable to assume that any pilot competent and certified to fly one would similarly be competent and certified to fly the other. This is why HYLIO INC. believes it is reasonable to combine the petition for both of these aircraft into this unified petition.



VII. Benefit to Public Interest

HYLIO INC. will be utilizing technology developed and manufactured in the USA, helping to advance the local UAS industry.

UAS may be used in the event that there is no other way to safely spray a certain land area. This will reduce the chance of manned aircraft attempting to spray certain dangerous areas. The result will be reduced risk for pilots and the public.

UAS are significantly smaller and lighter than manned aircraft. In the event of a crash, the UAS poses a greatly reduced threat to the public. UAS also have much smaller propellers, reducing the risk of injury to the public in the event of a crash.

UAS are much quieter than manned airplanes. UAS will create much less noise pollution than manned aircraft. This is especially important for near-urban aerial applications.

UAS use batteries for power, which is not as flammable and explosive as the fuel used for the majority of manned aircraft. In the event of a crash, there is a significant risk of explosion. There will also be a reduction in air pollution.

UAS operate at much lower altitude than manned aircraft. This vertical separation greatly reduces the chance of a mid-air collision and the following catastrophic damage to the aircraft involved, and the public.

UAS allow for methods of precision spraying that are not possible with manned aircraft. Precision spraying has the potential to increase the efficiency of US agriculture as a whole. These precision applications will greatly benefit the US farmer while operating with equivalent or greater levels of safety compared to manned aircraft.



VIII. Supporting Documents

In support of this petition, we will submit the following associated documents containing confidential information. The UAS will operate only within the limitations listed in this petition and the supporting documents.

- CONOPS Manual
- Operation and Safety Manual
- Risk Assessment & Mitigation Manual
- Training Manual
- AG-122 Maintenance Manual
- AG-116 Maintenance Manual

These additional confidential documents are not regularly available or being shared with others because they contain specific proprietary information. For these reasons we request they be handled as such under 14 CFR § 11.35(b) and protect them from release under FOIA 5 USC § 552 et seq.

IX. Authority to Grant Petition

The Federal Aviation Act gives the FAA the authority to grant exemptions. “The Administrator may grant an exemption from a requirement of a regulation prescribed under subsection (a) or (b) of this section or any sections 44702-44716 of this title if the Administrator finds the exemption in the public interest.” (49 U.S.C. § 44701(f); accord 49 U.S.C. § 44711(b).)

X. Conclusion

HYLÍO INC. feels it has presented a thorough and compelling case to grant the relief requested in this petition. UAS operations conducted by HYLÍO INC. in the manner as outlined above will provide an equivalent level of safety as the current regulations. In order to improve the safety of aerial applications and efficiency of US farmers, HYLÍO INC. believes it is in the public interest to grant this waiver request without delay.

Sincerely,

Nick Nawratil
COO & Chief Pilot, Hylío Inc.