Yamaha Motor Corporation, U.S.A.'s Petition for Exemption
for the RMAX Remotely-Piloted Helicopter

FAA Rules Docket: _____

NAME AND ADDRESS OF APPLICANT

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A. Petition Summary

Yamaha Motor Corporation, U.S.A. ("Yamaha") hereby respectfully requests expedited approval and necessary exemptions from the Federal Aviation Administration's ("FAA") airworthiness certification and related requirements (i.e., 49 U.S.C. § 44704, 14 C.F.R. parts 21, 27, and 137, and 14 C.F.R. §§ 45.23(b), 61.113(a)–(b), 91.7(a), 91.9(b)(2), 91.103, 91.109, 91.119, 91.121, 91.151(b), 91.203(a)–(b), 91.405(a), 91.407(a)(1), 91.409(a)(2), 91.417(a)–(b), and 91.1501) for the purpose of operating its remotely-piloted helicopter, the RMAX, to provide commercial agricultural-related services in the United States. The RMAX is 9 feet long and 3 feet 6 inches tall, weighs 141 lbs. dry weight, has a load capacity of approximately 61 lbs., and is operated by a trained pilot and spotter maintaining visual line-of-sight. The RMAX has been safely and extensively used to provide agricultural related services in Japan, Australia, and other countries for over 20 years, as well as in testing in the United States. The RMAX has logged over 2 million flight hours and proven to be a safe, efficient, and effective unmanned aircraft system ("UAS") for these purposes, as most recently determined by Australia's Civil Aviation Safety Authority ("CASA"). Yamaha seeks the exemptions to bring the commercial benefits of the RMAX to the United States.

Yamaha seeks the exemptions pursuant to Section 333 of the FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, 126 Stat. 11 (to be codified at 49 U.S.C. § 40101 (2012)) ("Section 333") and the FAA's general exemption authority under 49 U.S.C. § 44701(f) ("Section 44701(f)"). The requested exemptions satisfy the applicable statutory criteria and policies, will serve the public interest, would not adversely affect safety, and would provide a level of safety at least equal to the existing airworthiness and related regulations.

B. Background

1. Yamaha

Applicant Yamaha is a United States corporation based in Cypress, California, with manufacturing, research and development, testing, and sales facilities throughout the United States. *See* Exhibit 1. Yamaha employs over 2,800 persons in the United States and Canada, and its products are sold by thousands of dealers across the country.

2. RMAX

The RMAX is a remotely-piloted helicopter controlled by trained, on-site pilots using a radio transmitter. *See* Exhibit 2. The RMAX is powered by a 2-cylinder, 246-cc engine that sounds much like a small motorcycle when operating. It uses regular unleaded fuel with 2-stroke engine oil and has a maximum output of 21 horsepower. The RMAX is 9 feet long and 3 feet 6 inches tall. It weighs 141 lbs. dry weight. For agricultural spraying, the RMAX has approximately a 61 lbs. load capacity for both liquid (4.25 gallons) and granular (7 gallons) applications. *See* Exhibit 3. The RMAX is generally flown at speeds of 12 mph or less at heights below 20 feet.

The RMAX has been safely and extensively used for agricultural purposes for over 20 years in Japan. Most recently, the RMAX was approved for use in Australia by its national aviation safety authority, CASA. The FAA and CASA have a bilateral agreement for the promotion of aviation safety.[1] The RMAX is also approved for use in South Korea.

To date, the RMAX has logged over 2 million flight hours. Approximately 2,600 RMAX are currently in use, treating more than 2.4 million acres of farmland each year in Japan alone – equivalent to treating the entire states of Delaware and Rhode Island combined.

[1] *See* Agreement on the Promotion of Aviation Safety between the Government of the United States of America and the Government of Australia, June 21, 2005.

In the United States, the RMAX has been used for research and development purposes by the University of California – Davis ("UC Davis"). The UC Davis project has involved the spraying of vineyards in Napa Valley, California, pursuant to an FAA Certificate of Authorization ("COA"). *See* Exhibit 4. Since the project was started in the Summer of 2012, the RMAX has safely and successfully flown approximately 30 hours. (One of the desired commercial applications for the RMAX involves vineyards immediately adjacent to the UC Davis fields.) The RMAX also has been and is being used in other research programs in the United States under COAs, involving Virginia Tech, Georgia Tech, and others public entities.

C. Relevant Statutory Authority

1. Section 333

Section 333(a) states that the FAA "shall determine if certain unmanned aircraft systems may operate safely in the national airspace system before completion of the [comprehensive] plan and rulemaking required by section 332 of this Act or the guidance required by section 334 of this Act." In Section 332(b)(1), Congress expressly described Section 333 as a pathway for "expedited operational authorization." The FAA has committed to complying with this mandate; for example, FAA Administrator Michael P. Huerta informed Members of Congress in September 2012 that:

> As mandated by Section 333 of the FAA Modernization and Reform Act, the FAA will seek additional opportunities to approve safe access under the provisions of this section. The agency is currently evaluating whether access to the operational area can be controlled to reduce risk to persons and property on the ground, as well as other users of the NAS [i.e., national airspace].[2]

Section 333(b) identifies several factors that the FAA should consider in determining whether a UAS should be approved for certain uses in the NAS. These include UAS that, "as a

[2] Letter from FAA Administrator Michael P. Huerta to Hon. Edward J. Markey, Sept. 21, 2012, at 3.

result of their size, weight, speed, operational capability, proximity to airports and populated areas, and operation within visual line of sight do not create a hazard to users of the [NAS] or the public or pose a threat to national security." Based upon these factors, and for purposes of this Petition, the FAA may determine that "airworthiness certification under section 44704 of title 49, United States Code" is not required for operation of the UAS for certain uses. *Id.* In making that determination, the FAA "shall [also] establish requirements for the safe operation of" the UAS in the NAS. *See* Section 333(c).

2. Section 44701(f)

In addition, the FAA Administrator has general authority to grant exemptions from its safety regulations and minimum standards when the Administrator decides a requested exemption is in the public interest. *See* 49 U.S.C. § 44701(f) (authorizing the grant of exemptions from a requirement of regulations prescribed pursuant to section 44701(a)–(b) and sections 44702–44716). A party requesting an exemption must explain the reasons why the exemption (a) would benefit the public as a whole, and (b) would not adversely affect safety (or how it would provide a level of safety at least equal to the existing rules). *See* 14 C.F.R. § 11.81; FAA, *Petition for Exemptions*, http://www.faa.gov/regulations_policies/rulemaking/petition/#exemptions (last visited June 13, 2014).

For the reasons shown below, the RMAX qualifies for expedited approval and the requested exemptions under Sections 333 and 44701(f), subject to the proposed requirements for safe operation of the RMAX in the NAS.

D. The RMAX Satisfies The Statutory Criteria For Approval Under Section 333.

The RMAX is a type of UAS that qualifies for expedited approval under Section 333 for the agricultural purposes proposed by Yamaha. Each of the statutory criteria and other potentially relevant factors are satisfied:

1. Section 333(b)(1) Criteria

a. Size

The RMAX is 9 feet long and 3 feet 6 inches tall. The main propeller is about 10 feet long. It extends 4 feet from each side of the RMAX, and less than 3 feet from the front. The rear propeller is about 1 foot 9 inches in diameter. *See* Exhibit 3.

b. Weight

The RMAX weighs 141 lbs. dry weight. For agricultural spraying, the RMAX has approximately a 61 lbs. load capacity for both liquid (4.25 gallons) and granular (7 gallons) applications. *See id.*

c. Speed

For agricultural purposes, the RMAX is generally flown at speeds of 12 mph or less. The RMAX has a maximum speed of approximately 45 mph.

d. Operational Capability

The RMAX is capable of providing a wide array of essential agricultural spraying services, including watering, fertilizers, pesticides, and herbicides. The RMAX can also be equipped with sensors and equipment to detect and monitor agricultural areas that require irrigation, fertilization, or other treatments.[3] In many applications, the RMAX has proven to be

[3] Autonomous-featured RMAX are used in Japan to monitor radiation levels at the Fukushima nuclear reactor, drop measuring and sensing equipment into active volcanoes, conduct topographical surveying, and other purposes. This petition does not cover RMAX models with autonomous features.

more economical and effective than other spraying methods, helping farmers increase productivity, lower costs, and reduce the amount of chemicals used.

e. Proximity to Airports/Populated Areas

For agricultural purposes, the RMAX is only flown over uninhabited areas (e.g., fields, groves, and orchards) and away from airports (i.e., three nautical miles or more) or populated areas. In most applications, the RMAX is flown at low altitudes of 20 feet or less. For field sensing and surveying, the RMAX is generally flown at altitudes of 200 feet or less, with a maximum altitude of less than 400 feet. In both cases, these altitudes are well below the airspace where manned vehicles operate (typically, 500 feet or higher) and lower than where many kites, hobby aircraft, and hobby helicopters fly. In addition, the RMAX is typically flown within a range of only 150 meters (i.e., 492 feet) from the operator.

f. Visual Line-of-Sight

For agricultural purposes, the RMAX is only flown during daylight hours, in good weather, and always within the pilot's line-of-sight. *See* Exhibit 5. In addition, under Yamaha protocol, the pilot is always accompanied by a trained "spotter," who is positioned at the opposite side of the agricultural area and is in constant radio communication with the pilot. The spotter ensures that the RMAX is always within line-of-sight, and helps identify and alert the pilot to any potential obstacles on the ground or in the air. By operating the RMAX only within line-of-sight, and at low altitudes and speeds, a pilot and/or spotter can see and avoid any other aircraft or other potential obstacles. This eliminates the need for other "sense and avoid" capabilities during such restricted operation, as well as the need for any method of air traffic control communications. *See Interim Operational Approval Guidance 08-01, Unmanned Aircraft Systems Operations in the U.S. National Airspace System* (Mar. 13, 2008) [hereinafter *Interim UAS Guidance*], at 4 (noting that "Visual Line-of-Sight" is "[a] method of control and

collision avoidance that refers to the pilot or observer directly viewing the unmanned aircraft with human eyesight").

2. Other Relevant Factors

a. Pilot/Spotter Training and Certification

Yamaha has established comprehensive pilot and spotter training and certification requirements prior to use of the RMAX. The training and certification requirements that Yamaha most recently developed, in cooperation with CASA in Australia, include:

- a comprehensive UAV training course which includes theory and practical components;
- a pilot theory exam;
- Supervised flight training including agricultural spraying;
- completion of Yamaha's training program requirements including examination; and
- continuing periodic training even after certification.

Completion and satisfaction of Yamaha training and certification requirements would be a condition for pilots and spotters operating the RMAX for agricultural purposes in the United States. *See* Exhibit 6 (submitted on a confidential basis). In addition, for chemical applications, the pilot operating the RMAX would be certified under the FAA's rules governing Agricultural Aircraft Operations, 14 C.F.R. part 137 ("AAO Application").[4]

b. RMAX Production, Certification, and Maintenance Requirements

In addition to pilot certification and training requirements, Yamaha has developed extensive production, certification, operation, and maintenance requirements for the RMAX,

[4] The AAO Application requirements are designed for manned aircraft. Based on RMAX usage experience, Yamaha may seek an exemption from certain of these agricultural pilot certification requirements in the future (similar to certain allowances made by CASA for RMAX spraying operations in Australia). Exemptions from other AAO Application requirements relevant to the aircraft itself are requested below. *See infra* Part F.15.

including ones recently adopted by CASA. These same kind of CASA-approved requirements would likewise be a condition for RMAX use in the United States. *See* Exhibit 7 (submitted on a confidential basis). Additionally, all uses of the RMAX for agricultural purposes would be under the direction, supervision, and control of Yamaha.

c. Safety Systems

The RMAX has a host of onboard safety systems, including:

- Self-Monitor Function (diagnostic before takeoff);
- Altitude Control System ("YACS");
- GPS flight control system;
- Loss link safety default (hover and land);
- YACS and GPS Warning/Indicator Lights;
- Speed Indicator Light; and
- Rotor Brake (propellers tilt upon shut down to allow air resistance to quickly bring the propellers to full stop).

RMAX units operated in the United States would include these onboard safety systems and features.

d. Physical Security

Yamaha will retain custody of the units and arrange for provision of the agricultural-related services, which will only be performed by trained and certified pilots and spotters. This will enable Yamaha to maintain custody over each unit and to ensure safe and proper usage. The same system has proven effective in other countries, without any loss or misuse of RMAX units by third parties.

e. Privacy

Yamaha policy prohibits use of the RMAX in any ways that might invade personal privacy. Yamaha will comply with any federal, state, and/or local privacy policies or rules that may apply in particular areas where the RMAX is used. Further, because Yamaha will retain custody and control of all RMAX used for agricultural purposes, Yamaha will be in a position to ensure compliance with these policies. From a practical perspective, privacy has not been (and should not be) an issue for this kind of usage, since it involves spraying, sensing, and surveying over farmland and other rural, uninhabited spaces. To the best of its knowledge, Yamaha has not received a single privacy complaint involving use of the RMAX in other countries.

3. Well-Established Performance and Safety Record

The RMAX has a well-established performance and safety record that further justifies expedited approval of the product for agricultural uses pursuant to Section 333. *See Interim UAS Guidance*, at 6 ("[I]f the applicant makes a safety case and presents sufficient data for an alternate means of compliance, then this data should be taken into consideration and evaluated for possible approval."). The RMAX has been extensively used for agricultural purposes for over 20 years in Japan. As noted above, more recently, the RMAX was approved for use in Australia by CASA. The RMAX is also approved for use in South Korea.

To date, the RMAX has logged over 2 million flight hours, treating more than 2.4 million acres of farmland each year in Japan alone. During this more than two decade period, there have been no injuries due to problems with the aircraft in Japan, Australia, or South Korea. In the limited instances where a problem with the aircraft has occurred, the unit has either been safely

landed and shut down by the pilot or fallen to the ground without personal injury.[5] There have been no collisions with other aircraft.

4. Lack of Threat to the NAS, Public, or National Security

Together, the relevant Section 333 criteria, proposed operating restrictions and requirements, Yamaha's established training, safety, and performance record, and the other factors discussed above mitigate any threat or risk of hazard that the desired RMAX uses would pose to the NAS, public, or national security.

For all of these reasons, the RMAX qualifies for expedited approval and exemption from airworthiness certification, pursuant to Section 333, for the specified uses and under the proposed operating requirements and restrictions.

E. The RMAX Also Qualifies For The Requested Exemption Under Section 44701(f).

The RMAX and its proposed uses also satisfy the requirements and policies for exemption under Section 44701(f) from the FAA's related safety regulations. *See also* 14 C.F.R. § 11.81 (setting forth petition requirements).

1. Public Interest Benefits

As noted above, the RMAX can provide some agricultural services more efficiently, economically, and safely than other air- or ground-based methods. In the recent UC Davis project, for example, the RMAX was able to treat 11.1 acres of a Napa Valley vineyard in the same time (one hour) that a conventional tractor took to treat 1.2 acres.[6] *See* Exhibit 9. Other benefits identified in the project include:

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[5] *See* Exhibit 8 (submitted on a confidential basis).

[6] Immediate desired uses of the RMAX include similar spraying, on a commercial basis, at an immediately adjacent vineyard owned by Mondavi (Oakville, California), as well as vineyards owned by Ken Wright Cellars (Carlton, Oregon). If this Petition is granted, Yamaha intends to request commercial COA(s) for these locations.

- Greater operator safety (on steep/slippery hills and terrain);
- Reduced chemical usage;
- Reduced operator and other human exposure to chemicals;
- No crop damage or soil compaction; and
- Greater fuel efficiency.

These same public interest benefits will be realized for similar agricultural and other precision uses (e.g., mosquito/insect treatment) of the RMAX in the United States. *See also* Exhibit 10 (AUVSI report discussing research and studies indicating that this kind of precision spraying can reduce chemical usage by up to 40% and other benefits of UAS precision agricultural services). Farmers, growers, and land managers, therefore, will immediately benefit from the availability of the spraying services. These benefits will ultimately redound to American consumers.

In addition, the availability of these kind of RMAX uses in the United States will also provide additional material economic benefits. These include jobs for pilots, spotters, and others who help administer and manage the services.

Usage experience and data resulting from the RMAX's operations may also be valuable to the FAA in developing comprehensive rules for civil UAS integration. This represents an additional important public interest benefit that would be served by the requested exemption.

2. No Adverse Safety Effects

Granting the Petition will not adversely affect aviation safety or pose any undue risks to the public. As shown above, the RMAX has logged over 2 million safe flight hours. CASA and additional aviation authorities (e.g., the Japan Agricultural Aviation Authority) have approved the RMAX for use in other countries recognizing that it has been and can be safely operated for commercial agricultural and related purposes. Moreover, although the requested exemption

would enable Yamaha to use the RMAX commercially in the United States, each use would be subject to further review by the FAA under the COA process. Yamaha expects that, in each instance, use of the RMAX would be conditioned upon the same stringent training, certification, operating, manufacturing, maintenance, and other requirements and restrictions set forth above (collectively, "RMAX operating requirements and restrictions")—e.g., for precision agricultural spraying purposes; use of the RMAX solely by trained pilots and spotters; during daylight and good weather; at speeds generally 12 mph and altitudes below 20 feet; and away from airports (three nautical miles or more) and inhabited areas.

For these reasons, granting the requested exemptions would not adversely affect safety. Furthermore, the RMAX operating requirements and restrictions would provide a level of safety at least equal to the regulations covered by the exemptions.

F. Description of the Relief Sought

Based on the foregoing, the RMAX satisfies the relevant statutory criteria and related factors for expedited approval pursuant to Section 333, including waiver of airworthiness certification under Section 44704. In addition, the RMAX meets the requirements and policies for exemptions, pursuant to Section 44701(f), from the FAA's related airworthiness certification and related regulations (i.e., 14 C.F.R. parts 21, 27, and 137, and 14 C.F.R. §§ 45.23(b), 61.113(a)–(b), 91.7(a), 91.9(b)(2), 91.103, 91.109, 91.119, 91.121, 91.151(b), 91.203(a)–(b), 91.405(a), 91.407(a)(1), 91.409(a)(2), 91.417(a)–(b), and 91.1501).[7]

[7] Yamaha has attempted to identify the applicable FAA regulations for purposes of this Petition. To the extent that the FAA determines any other safety regulations might apply to the desired uses of the RMAX (and would not otherwise be addressed as part of a future COA), Yamaha further requests that its Petition be deemed to cover and seek exemption from any such other safety regulations for the reasons established above.

1. 14 C.F.R. Part 21: Airworthiness Certification

Part 21 establishes procedural requirements for certifications under Section 44704, including airworthiness certificates. Both Sections 333 and 44701(b) authorize the FAA to exempt aircraft from airworthiness certification under this Part. As shown above, the RMAX meets the criteria for exemption from Part 21 based upon consideration of its size, weight, speed, operational capability, and proximity to airports and populated areas. *See* Section 333. Furthermore, the proposed use of the RMAX without an airworthiness certificate in the restricted operating environment and conditions identified above would be at least as safe or safer than conventional aircraft operating with an airworthiness certificate, and would provide multiple benefits to the public. Therefore, Yamaha requests an exemption from Part 21's requirements for airworthiness certification.

2. 14 C.F.R. Part 27: Airworthiness Standards for Normal Category Rotocraft

Part 27 sets forth the procedural requirements for airworthiness certification of normal category rotocraft. To the extent the RMAX would otherwise require certification under Part 27, as a rotocraft, Yamaha requests an exemption from Part 27's airworthiness standards for the same reasons identified in subpart F.1, above.

3. 14 C.F.R. § 45.23(b): Marking Requirements

Section 45.23(b) requires that on limited, restricted, or light-sport category aircraft, markings indicating the aircraft category must be displayed "near each entrance to the cabin, cockpit, or pilot station." Exemption from § 45.23(b) is warranted because the RMAX has no entrance to the cabin, cockpit, or pilot station on which the required marking can be displayed. Yamaha proposes instead to display markings to the fullest extent possible in compliance with

the location requirements of § 45.27(a) and the size requirements of § 45.29(f). Thus, Yamaha requests an exemption to § 45.23(b)'s marking requirements.

4. 14 C.F.R. § 61.113(a) & (b): Private Pilot Privileges and Limitations: Pilot in Command

Section 61.113(a) limits private pilots to being in command of non-commercial flights. Section 61.113(b) provides an exception that allows a private pilot to command an aircraft, without passengers or property, in connection with business or employment if "[t]he flight is only incidental to that business or employment." That exception likely does not apply to flights involving the RMAX, as the flights are not incidental to the proposed agricultural-related services but rather essential to it. Yamaha therefore requests an exemption to § 61.113(a)'s commercial limitation and/or § 61.113(b)(1)'s requirement that the flight be incidental to the business to benefit from the exception.

5. 14 C.F.R. § 91.7(a): Civil Aircraft Airworthiness

Section 91.7(a) requires that a civil aircraft be in an airworthy condition to be operated. The RMAX has over two million flight hours and a stellar safety record, demonstrating that the UAS is airworthy. Furthermore, Yamaha's CASA-approved flight manual and operating instructions include a comprehensive preflight safety protocol for operation of each unit. *See* Exhibit 7 (submitted on a confidential basis). Nonetheless, to the extent that the requirements of § 91.7(a) would otherwise apply to the RMAX, Yamaha requests an exemption from these requirements for the same reasons stated in subparts F.1 and 2, above.

6. 14 C.F.R. § 91.9(b)(2): Civil Aircraft Flight Manual in the Aircraft

Section 91.9(b)(2) prohibits a person from operating a civil aircraft "[f]or 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 its size, configuration, and load capacity, the RMAX has no capacity or capability to carry such a manual. Furthermore, there is no pilot on board the RMAX, making an on-board manual unnecessary. The safety-related purposes of this manual requirement can be equally satisfied by maintaining the RMAX flight manual at the ground control point where the pilot operating the RMAX has access to it. Therefore, Yamaha requests an exemption from § 91.9(b)(2)'s flight manual requirements, on the condition that the RMAX flight manual be available at the ground control point during each operation.

7. 14 C.F.R. § 91.103: Preflight Action

Section 91.103 requires a pilot in command to become familiar with specific information before each flight, including information contained in the FAA-approved Flight Manual on board the aircraft. As no FAA-approved Flight Manual will be provided, Yamaha requests an exemption from § 91.103 that would allow for the use of Yamaha's flight manual, which includes a comprehensive preflight checklist. *See* Exhibit 7 (submitted on a confidential basis).

8. 14 C.F.R. § 91.109: Flight Instruction

Section 91.109(a) provides that "[n]o 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 RMAX is a remotely-piloted aircraft and designed without fully functioning dual controls; instead, the RMAX is piloted by a single remote control box that communicates with the aircraft via radio communications.[8] Safe training can still be performed without dual controls because no pilots or passengers are aboard the RMAX and all persons are a

[8] During initial training, Yamaha uses a "training tether" between the trainee's remote control box and the trainer's remote control box that allows the trainer to assume control of the RMAX if needed.

safe distance away should the RMAX experience any difficulties during flight instruction. Therefore, Yamaha requests an exemption to § 91.109's flight instruction requirements.

9. 14 C.F.R. § 91.119: Minimum Safe Altitudes

Section 91.119 prescribes the minimum safe altitudes under which aircraft may not operate, including 500 feet above the surface and away from any person, vessel, vehicle, or structure in non-congested areas. *See* 14 C.F.R. § 91.119(c). Section § 91.119(d)(1) allows for a helicopter to operate at less than those minimum altitudes when it can be operated "without hazard to persons or property on the surface," provided that "each person operating the helicopter complies with any routes or altitudes specifically prescribed for helicopters by the FAA."

To provide the intended agricultural-related services, the RMAX is normally operated at approximately 16 to 20 feet above the surface of a field or other agricultural area. In addition, due to the nature of the RMAX's operation, the pilot in command and the designated spotter may at times be less than 500 feet away during operation. The successful safety record of the RMAX, involving more than two million flight hours, demonstrates that the RMAX can be safely used at these lower altitudes and closer operating environments. Thus, when operated for these purposes, the RMAX will be at least as safe as operating within the specified regulatory requirements. Furthermore, by operating at such lower altitudes, the RMAX will not interfere with other aircraft that are subject to the minimum safe altitude regulations. An exemption from § 91.119's minimum safe altitude regulations is therefore warranted.

10. 14 C.F.R. § 91.121: Altimeter Settings

Section 91.121 requires a person operating an aircraft to maintain cruising altitude or flight level by reference to an altimeter that is set to the elevation of the departure airport or

barometric pressure. The RMAX does not have a barometric altimeter, but rather its location is determined using a GPS, and its height is constantly monitored by the pilot in command and spotter, thus ensuring operation at safe altitudes. For these reasons, Yamaha requests an exemption to § 91.121's altimeter requirements.

11. 14 C.F.R. § 91.151(b): Fuel Requirements for Flight in VFR Conditions

Section 91.151(b) prohibits a person from "begin[ning] a flight in a rotorcraft under VFR [(i.e., Visual Flight Rules)] 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." Although the RMAX has sufficient fuel capacity to provide for one hour of flight time, flight times for agricultural-related purposes are typically only 30 minutes due to the RMAX's load capacity for spraying and other applications. The RMAX is typically refueled while it refills its payload, and thus is likely to comply with the 20-minute requirement most of the time. Regardless of the potential for compliance, such a requirement is not necessary for the RMAX because it only operates 20 feet above an empty field, so the risk or danger associated with failing to reach a safe landing place is not present. Therefore, Yamaha requests an exemption to § 91.151(b)'s fuel requirements.

12. 14 C.F.R. § 91.203(a) & (b): Carrying Civil Aircraft Certification and Registration

Section 91.203 requires a civil aircraft to have "*within it* . . . [a]n appropriate and current airworthiness certificate" that must be "displayed at the cabin or cockpit entrance so that it is legible to passengers or crew." (Emphasis added.) In addition to the fact that Yamaha is seeking an exemption from the airworthiness certificate requirement, an exemption to this regulation is necessary because the RMAX (1) has a precise load capacity and size such that it cannot carry such a certification within it, (2) does not have a cabin or cockpit entrance at which such a

certificate could be displayed, and (3) there are no passengers or crew for whom the certificate need be displayed. Thus, Yamaha requests an exemption to § 91.203(a) & (b)'s requirements for carrying airworthiness certifications.

13. 14 C.F.R. §§ 91.405(a); 91.407(a)(1); 91.409(a)(2); 91.417(a) & (b): Maintenance Inspections

These regulations specify maintenance and inspection standards in reference to 14 C.F.R. Part 43. *See, e.g.*, 14 C.F.R. § 91.405(a) (stating that each owner or operator of an aircraft "[s]hall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections . . . have discrepancies repaired as prescribed in part 43 of this chapter"). An exemption to these regulations is needed because Part 43 and these sections apply only to aircraft with an airworthiness certificate, which the RMAX will not have. *See id.* § 43.1(a). Furthermore, equivalent levels of safe maintenance and inspection can be achieved using the same kind of CASA-approved maintenance requirements and Yamaha's own certified technicians. *See* Exhibit 7 (submitted on a confidential basis). Therefore, Yamaha requests an exemption to the maintenance and inspection requirements contained in §§ 91.405, 91.407(a)(1), 91.409(a)(2), 91.417(a), and 91.417(b).

14. 14 C.F.R. § 91.1501: Continued Airworthiness

Section 91.1501(a) "requires operators to support the continued airworthiness of each airplane." An exemption from this rule is necessary because the RMAX will not have an airworthiness certificate but will provide an equivalent level of safety when operated under the restricted uses and conditions identified above. Therefore, Yamaha requests an exemption from § 91.1501's continued airworthiness requirements.

15. 14 C.F.R. Part 137: Agricultural Aircraft Operations

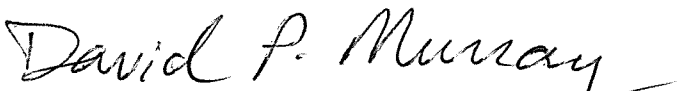
Part 137 provides requirements for the certification and operation of agricultural aircraft. Some of these requirements include that the aircraft must be certificated and airworthy, *see* 14 C.F.R. § 137.19(d), and "equipped with a suitable and properly installed shoulder harness for use by each pilot," *id.* § 137.31(b). These requirements, and many others contained in Part 137, were designed for manned aircraft and do not apply to the unmanned RMAX. Additionally, the RMAX will not have an airworthiness certification to satisfy the Part 137 requirements. Thus, Yamaha requests an exemption from the Part 137 airworthiness certification and operations requirements for agricultural aircraft, for the same reasons stated in subparts F.1 and 2, above.

G. Conclusion

For all the reasons shown above, the RMAX satisfies the relevant statutory criteria and related factors for expedited approval pursuant to Section 333, including waiver of airworthiness certification under Section 44704, and meets the requirements and policies for exemptions, pursuant to Section 44701(f), from the FAA's related airworthiness certification and other specified regulations. Accordingly, Yamaha requests that the foregoing relief be granted for the purpose of operating the RMAX to provide commercial agricultural-related services in the United States.

Please advise the undersigned if you have any questions or need any additional information.

Respectfully submitted,



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cc: Henio Arcangeli
Yamaha Motor Corporation, U.S.A.

EXHIBIT 1

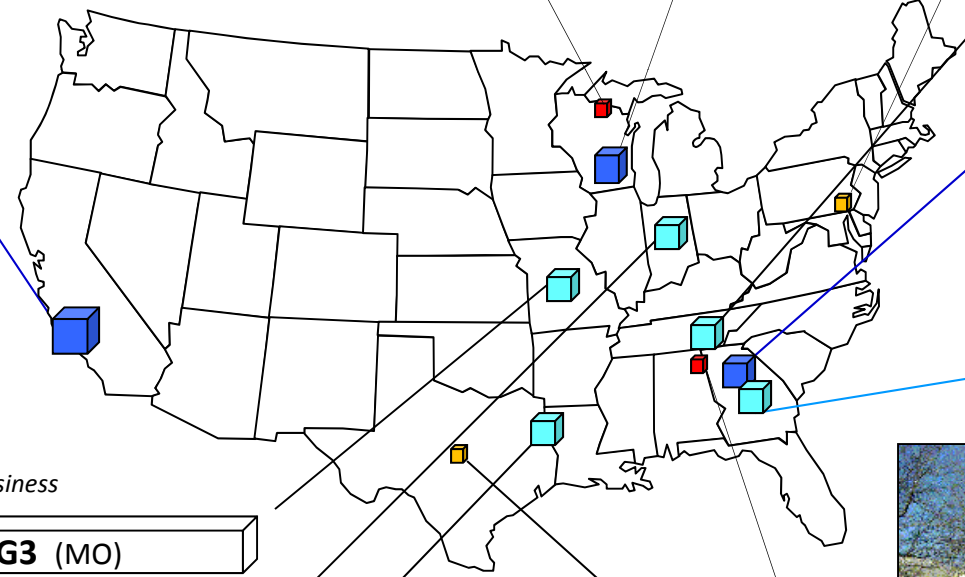
Yamaha Motor Corporation, U.S.A. (YMUS)

Total N.A. Employees: 2,800

- Main Office
- Manufacturing
- R&D / Test
- Sales Office

YMUS Cypress

North America Headquarters



LakeView Office

Parts Center/Service
Snowmobile Sales/R&D
Midwest Regional Office

Minocqua R&D Center

Snowmobile R&D Testing

Bluebell Office

N.E. Regional Office

YJBM (TN)

Manufacturing (Watercraft)

Kennesaw Office

YMMC

Manufacturing (GC/RV/WV)

Boat Business

G3 (MO)

PPI (IN)

SKEETER (TX)

Dallas Office

W. Regional Office

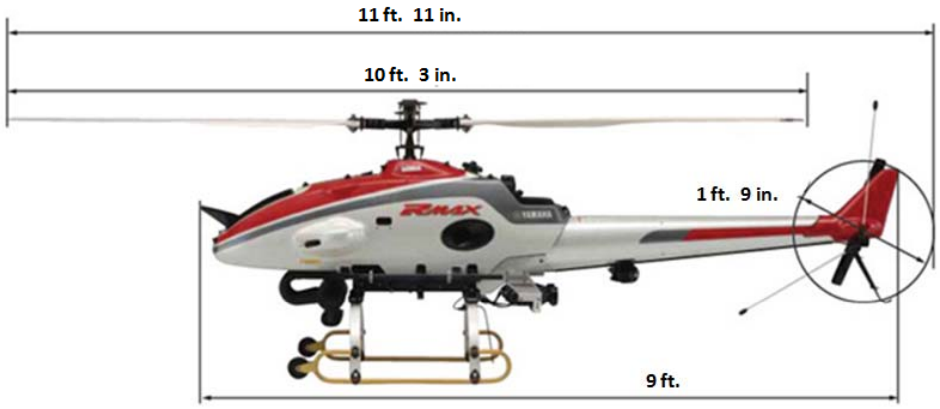
Alabama Test Facility

Marine Testing

EXHIBIT 2

EXHIBIT 3

RMAX Overview



PERFORMANCE

LOAD CAPACITY – approx.	61 lbs. 11 oz.
PRACTICAL RANGE (Visual range)	Up to 1/4 mile

ENGINE

horizontally opposed 2-cylinder
2-stroke
246 cc
21 max hp

DIMENSIONS – appox.

MAIN ROTOR DIAMETER	10 ft. 3 in.
TAIL ROTOR DIAMETER	1 ft. 9 in.
OVERALL LENGTH	9 ft. (with rotor 11 ft. 11 in.)
OVERALL WIDTH	2 ft. 4 in.
OVERALL HEIGHT	3 ft. 6 in.
DRY WEIGHT	141 lbs.

Easy to Load into Vehicle

Remote Control Operation

Cartridge Tanks

Wide – Dual Nozzle Spray

EXHIBIT 4

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

CERTIFICATE OF WAIVER OR AUTHORIZATION

ISSUED TO

University of California, Davis, Biological & Agricultural Engineering Department

University of California, Davis, Biological & Agricultural Engineering Department
University of California, Davis
One Shields Ave.
Davis, CA 95616

This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED

Operation of the RMAX Type II Unmanned Aircraft System (UAS) in Class G airspace less than 50 feet Above Ground Level (AGL) in the three (3) user defined operating areas depicted in Attachment 1 under the jurisdiction of Oakland Air Route Traffic Control Center (ARTCC) and Bakersfield Terminal Radar Approach Control (TRACON). See Attachment 1.

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE

N/A

STANDARD PROVISIONS

1. A copy of the application made for this certificate shall be attached and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.
4. This certificate is nontransferable.

Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.

SPECIAL PROVISIONS

Special Provisions are set forth and attached.

The certificate 2013-WSA-76 is effective from November 07, 2013 to November 06, 2015 and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.

BY DIRECTION OF THE ADMINISTRATOR

FAA Headquarters, AJV-115
(Region)

Douglas Gould
(Signature)

November 07, 2013
(Date)

Air Traffic Manager, UAS Tactical Operations Section
(Title)

COA Number: 2013-WSA-76

Issued To: University of California, Davis, Biological & Agricultural Engineering Dept. referred herein as the "proponent"

Address: Biological & Agricultural Engineering Dept.
UCD, One Shields Avenue
Davis, CA 95616

Activity: Operation of the RMAX Type II Unmanned Aircraft System (UAS) in Class G airspace less than 50 feet Above Ground Level (AGL) in the three (3) user defined operating areas depicted in Attachment 1 under the jurisdiction of Oakland Air Route Traffic Control Center (ARTCC) and Bakersfield Terminal Radar Approach Control (TRACON).

Purpose: To prescribe UAS operating requirements in the National Airspace System (NAS) for the purpose of crop protection in agricultural fields.

Dates of Use: This COA is valid from November 7, 2013 through November 6, 2015. Should a renewal become necessary, the proponent shall advise the Federal Aviation Administration (FAA), in writing, no later than 45 business days prior to the requested effective date.

Public Aircraft

1. A public aircraft operation is determined by statute, 49 USC §40102(a)(41) and §40125.
2. All public aircraft flights conducted under a COA must comply with the terms of the statute.
3. All flights must be conducted per the declarations submitted on COA on-line.

STANDARD PROVISIONS

A. **General.**

The review of this activity is based upon current understanding of UAS operations and their impact in the NAS. This COA will not be considered a precedent for future operations. (As changes in or understanding of the UAS industry occur, limitations and conditions for operations will be adjusted.)

All personnel connected with the UAS operation must read and comply with the contents of this authorization and its provisions.

A copy of the COA including the special limitations must be immediately available to all operational personnel at each operating location whenever UAS operations are being conducted.

This authorization may be canceled at any time by the Administrator, the person authorized to grant the authorization, or the representative designated to monitor a specific operation. As a general rule, this authorization may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with the authorization is cause for cancellation. The proponent will receive written notice of cancellation.

During the time this COA is approved and active, a site safety evaluation/visit may be accomplished to ensure COA compliance, assess any adverse impact on ATC or airspace, and ensure this COA is not burdensome or ineffective. Deviations, accidents/incidents/mishaps, complaints, etc will prompt a COA review or site visit to address the issue. Refusal to allow a site safety evaluation/visit may result in cancellation of the COA. Note: This section does not pertain to agencies that have other existing agreements in place with the FAA.

B. **Airworthiness Certification.**

The unmanned aircraft must be shown to be airworthy to conduct flight operations in the NAS. The University of California, Davis, Biological & Agricultural Engineering Dept. has made its own determination that the RMAX Type II unmanned aircraft is airworthy. The RMAX Type II must be operated in strict compliance with all provisions and conditions contained in the Airworthiness Safety Release, including all documents and provisions referenced in the COA application.

1. A configuration control program must be in place for hardware and/or software changes made to the UAS to ensure continued airworthiness. If a new or revised Airworthiness Release is generated as a result of changes in the hardware or software affecting the operating characteristics of the UAS, notify the UAS Integration Office of the changes as soon as practical.

a. Software and hardware changes should be documented as part of the normal maintenance procedures. Software changes to the aircraft and control station as well as hardware system changes are classified as major changes unless the agency has a formal process, accepted by the FAA. These changes should be provided to the UAS Integration office in summary form at the time of incorporation.

b. Major modifications or changes, performed under the COA, or other authorizations that could potentially affect the safe operation of the system must be documented and provided to the FAA in the form of a new AWR, unless the agency has a formal process, accepted by the FAA.

c. All previously flight proven systems to include payloads, may be installed or removed as required, and that activity recorded in the unmanned aircraft and ground control stations logbooks by persons authorized to conduct UAS maintenance Describe any payload equipment configurations in the UAS logbook that will result in a weight and balance change, electrical loads, and or flight dynamics, unless the agency has a formal process, accepted by the FAA.

d. For unmanned aircraft system discrepancies, a record entry should be made by an appropriately rated person to document the finding in the logbook. No flights may be conducted following major changes, modifications or new installations unless the party responsible for certifying airworthiness has determined the system is safe to operate in the NAS and a new AWR is generated, unless the agency has a formal process, accepted by the FAA. The successful completion of these tests must be recorded in the appropriate logbook, unless the agency has a formal process, accepted by the FAA.

2. The RMAX Type II must be operated in strict compliance with all provisions and conditions contained within the spectrum analysis assigned and authorized for use within the defined operations area.

3. All items contained in the application for equipment frequency allocation must be adhered to, including the assigned frequencies and antenna equipment characteristics. A ground operational check to verify the control station can communicate with the aircraft (frequency integration check) must be conducted prior to the launch of the unmanned aircraft to ensure any electromagnetic interference does not adversely affect control of the aircraft.

4. The use of a Traffic Collision Avoidance System (TCAS) in any mode while operating an unmanned aircraft is prohibited.

C. **Operations.**

1. Unless otherwise authorized as a special provision, a maximum of one unmanned aircraft will be controlled:
   a. In any defined operating area,

b. From a single control station, and

c. By one pilot at a time.

2. A Pilot-in-Command (PIC) is the person who has final authority and responsibility for the operation and safety of flight, has been designated as PIC before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the PIC as described by 14 CFR 91.3, Responsibility and Authority of the Pilot-in-Command, apply to the unmanned aircraft PIC. The PIC position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight. **Note:** The PIC can only be the PIC for one aircraft at a time. For Optionally Piloted Aircraft (OPA), PIC must meet UAS guidance requirements for training, pilot licensing, and medical requirements when operating OPA as a UAS.

3. The PIC must conduct a pre-takeoff briefing as applicable prior to each launch. The briefing should include but is not limited to the:

   a. Contents of the COA,

   b. Altitudes to be flown,

   c. Mission overview including handoff procedures,

   d. Frequencies to be used,

   e. Flight time, including reserve fuel requirements,

   f. Contingency procedures to include lost link, divert, and flight termination, and

   g. Hazards unique to the flight being flown.

Note: Flight Crew Member (UAS). In addition to the flight crew members identified in 14 CFR Part 1, Definitions and Abbreviations, an Unmanned Aircraft System flight crew members include pilots, sensor/payload operators, and visual observers and may include other persons as appropriate or required to ensure safe operation of the aircraft.

4. All operations will be conducted in compliance with Title 14 CFR Part 91. Special attention should be given to:

   a. § 91.3 Responsibility and authority of the pilot in command

   b. § 91.13 Careless or reckless operation

   c. § 91.17 Alcohol or drugs

   d. § 91.103 Preflight Actions

   e. § 91.111 Operating near other aircraft.

   f. § 91.113 Right-of-way rules: Except water operations

   g. § 91.115 Right-of-way rules: Water operations

   h. § 91.119 Minimum safe altitudes: General

i. § 91.123 Compliance with ATC clearances and instructions.

j. § 91.133 Restricted and prohibited areas

k. § 91.137 Temporary flight restrictions in the vicinity of disaster/hazard areas

l. § 91.145 Management of aircraft operations in the vicinity of aerial demonstrations and major sporting events

m. § 91.151 Fuel requirements for flight in VFR conditions

n. § 91.155 Basic VFR weather minimums

o. § 91.159 VFR cruising altitude or flight level

p. § 91.209 Aircraft Lights

q. § 91.213 Inoperative instruments and equipment

r. § 91.215 ATC transponder and altitude reporting equipment and use

s. Appendix D to Part 91—Airports/Locations: Special Operating Restrictions

5. Unless otherwise authorized as a special provision, all operations must be conducted in visual meteorological conditions (VMC) during daylight hours in compliance with Title 14 of the Code of Federal Regulations (CFR) Part 91 §91.155 and the following:

6. Special Visual Flight Rules (VFR) operations are not authorized.

   a. VFR cloud clearances specified in 14 CFR Part 91 §91.155, must be maintained, except in Class G airspace where Class E airspace visibility requirements must be applied, but not less than 3 statute miles (SM) flight visibility and 1000’ ceiling.

   b. Flights conducted under Instrument Flight Rules (IFR) in Class A airspace shall remain clear of clouds. NOTE: Deviations from IFR clearance necessary to comply with this provision must have prior ATC approval.

   c. Chase aircraft must maintain 5 NM flight visibility.

7. Night operations are prohibited unless otherwise authorized as a special provision.

8. Operations (including lost link procedures) must not be conducted over populated areas, heavily trafficked roads, or an open-air assembly of people.

D. **Air Traffic Control (ATC) Communications.**

1. The pilot and/or PIC will maintain direct, two-way communication with ATC and have the ability to maneuver the unmanned aircraft in response to ATC instructions, unless addressed in the Special Provision Section.

a. When required, ATC will assign a radio frequency for air traffic control during flight. The use of land-line and/or cellular telephones is prohibited as the primary means for in-flight communication with ATC.

2. The PIC must not accept an ATC clearance requiring the use of visual separation, sequencing, or visual approach.

3. When necessary, transit of airways and routes must be conducted as expeditiously as possible. The unmanned aircraft must not loiter on Victor airways, jet routes, Q and T routes, IR routes, or VR routes.

4. For flights operating on an IFR clearance at or above 18,000 feet mean sea level (MSL), the PIC must ensure positional information in reference to established National Airspace System (NAS) fixes, NAVAIDs, and/or waypoints is provided to ATC. The use of latitude/longitude positions is not authorized, except oceanic flight operations.

5. If equipped, the unmanned aircraft must operate with:

   a. An operational mode 3/A transponder with altitude encoding, or mode S transponder (preferred) set to an ATC assigned squawk.

   b. Position/navigation and anti-collision lights on at all times during flight unless stipulated in the special provisions or the proponent has a specific exemption from 14 CFR Part 91.209.

6. Operations that use a Global Positioning System (GPS) for navigation must check Receiver Autonomous Integrity Monitoring (RAIM) notices prior to flight operations. Flight into a GPS test area or degraded RAIM is prohibited for those aircraft that use GPS as their sole means for navigation.

E. **Safety of Flight.**

1. The proponent or delegated representative is responsible for halting or canceling activity in the COA area if, at any time, the safety of persons or property on the ground or in the air is in jeopardy, or if there is a failure to comply with the terms or conditions of this authorization.

2. ATC must be immediately notified in the event of any emergency, loss and subsequent restoration of command link, loss of PIC or observer visual contact, or any other malfunction or occurrence that would impact safety or operations.

3. Sterile Cockpit Procedures:

   a. Critical phases of flight include all ground operations involving:

      (1) Taxi (movement of an aircraft under its own power on the surface of an airport).

      (2) Take-off and landing (launch or recovery).

(3) All other flight operations in which safety or mission accomplishment might be compromised by distractions.

b. No crewmember may perform any duties during a critical phase of flight not required for the safe operation of the aircraft.

c. No crewmember may engage in, nor may any PIC permit, any activity during a critical phase of flight which could:

(1) Distract any crewmember from the performance of his/her duties, or

(2) Interfere in any way with the proper conduct of those duties.

d. The pilot and/or the PIC must not engage in any activity not directly related to the operation of the aircraft. Activities include, but are not limited to, operating UAS sensors or other payload systems.

e. The use of cell phones or other electronic devices is restricted to communications pertinent to the operational control of the unmanned aircraft and any required communications with Air Traffic Control.

4. See-and-Avoid.

Unmanned aircraft have no on-board pilot to perform see-and-avoid responsibilities; therefore, when operating outside of active restricted and warning areas approved for aviation activities, provisions must be made to ensure an equivalent level of safety exists for unmanned operations. Adherence to 14 CFR Part 91 §91.111, §91.113 and §91.115, is required.

a. The proponent and/or delegated representatives are responsible at all times for collision avoidance with all aviation activities and the safety of persons or property on the surface with respect to the UAS.

b. UAS pilots will ensure there is a safe operating distance between aviation activities and unmanned aircraft at all times.

c. Any crew member responsible for performing see-and-avoid requirements for the UA must have and maintain instantaneous communication with the PIC.

d. UA operations will only be conducted within Reduced Vertical Separation Minimum (RVSM) altitudes, when appropriately equipped or having received a clearance under an FAA deviation. **NOTE:** UA operations should not plan on an en-route clearance in RVSM altitudes, without being RVSM equipped.

e. Visual observers must be used at all times except in Class A, airspace, active Restricted Areas, and Warning areas designated for aviation activities.

(1) Observers may either be ground-based or in a chase plane.

(2) If the chase aircraft is operating more than 100 feet above/below and/or more than ½ NM laterally of the unmanned aircraft, the chase aircraft PIC will advise the controlling ATC facility.

f. The PIC is responsible to ensure visual observers are:

(1) Able to see the aircraft and the surrounding airspace throughout the entire flight, and

(2) Able to provide the PIC with the UA's flight path, and proximity to all aviation activities and other hazards (e.g., terrain, weather, structures) sufficiently to exercise effective control of the UA to:

(a) Comply with CFR Parts 91.111, 91.113 and 91.115, and

(b) Prevent the UA from creating a collision hazard.

5. Observers must be able to communicate clearly to the pilot any instructions required to remain clear of conflicting traffic, using standard phraseology as listed in the Aeronautical Information Manual when practical.

6. A PIC may rotate duties as necessary to fulfill operational requirements; a PIC must be designated at all times.

7. Pilots flying chase aircraft must not concurrently perform observer or UA pilot duties.

8. Pilot and observers must not assume concurrent duties as both pilot and observer.

9. The required number of ground observers will be in place during flight operations.

10. The use of multiple successive observers (daisy chaining) is prohibited unless otherwise authorized as a special provision.

11. The dropping or spraying of aircraft stores, or carrying of hazardous materials (including ordnance) outside of active Restricted, Prohibited, or Warning Areas approved for aviation activities is prohibited unless specifically authorized as a special provision.

F. **Crewmember Requirements.**

1. All crewmembers associated with the operation of the unmanned aircraft, including chase operations, must be qualified or must be receiving formal training under the direct supervision of a qualified instructor, who has at all times, responsibility for the operation of the unmanned aircraft.

2. Pilots and observers must have an understanding of, and comply with, Title 14 Code of Federal Regulations, and/or agency directives and regulations, applicable to the airspace where the unmanned aircraft will operate.

3. Pilots, supplemental pilots, and observers must maintain a current second class (or higher) airman medical certificate that has been issued under 14 CFR Part 67, or an FAA accepted agency equivalent based on the application.

4. At a minimum, the use of alcohol and/or drugs in violation of 14 CFR Part 91 §91.17 applies to UA pilots and observers.

5. At a minimum, observers must receive training on rules and responsibilities described in 14 CFR Part 91 §91.111. §91.113 and §91.115, regarding cloud clearance, flight visibility, and the pilot controller glossary, including standard ATC phraseology and communication.

6. Recent Pilot Experience (Currency). The proponent must provide documentation, upon request, showing the pilot/supplemental pilot/PIC maintains an appropriate level of recent pilot experience in either the UAS being operated or in a certified simulator. At a minimum, he/she must conduct three takeoffs (launch) and three landings (recovery) in the specific UAS within the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations). If a supplemental pilot assumes the role of PIC, he/she must comply with PIC rating requirements.

7. A PIC and/or supplemental pilot have the ability to assume the duties of an internal or an external UAS pilot at any point during the flight.

8. A PIC may be augmented by supplemental pilots.

9. PIC Ratings.
   Rating requirements for the UAS PIC depend on the type of operation conducted. The requirement for the PIC to hold, at a minimum, a current FAA private pilot certificate or the FAA accepted agency equivalent, based on the application of 14 CFR Part 61, is predicated on various factors including the location of the planned operations, mission profile, size of the unmanned aircraft, and whether or not the operation is conducted within or beyond visual line-of-sight.

   a. The PIC must hold, at a minimum, a current FAA private pilot certificate or the FAA accepted agency equivalent, based on the application or 14 CFR Part 61.under all operations:

      (1) Approved for flight in Class A, B, C, D, E, and G (more than 400 feet above ground level (AGL)) airspace.

      (2) Conducted under IFR (FAA instrument rating required, or the FAA accepted agency equivalent, based on the application or 14 CFR Part 61.

      (3) Approved for night operations.

      (4) Conducted at or within 5 NM of a joint use or public airfields.

      (5) Requiring a chase aircraft.

(6) At any time the FAA has determined the need based on the UAS characteristics, mission profile, or other operational parameters.

b. Operations without a pilot certificate may be allowed when all of the following conditions are met:

(1) The PIC has successfully completed, at a minimum, FAA private pilot ground instruction and passed the written examination, or the FAA accepted agency equivalent, based on the application. Airman Test reports are valid for the 24-calendar month period preceding the month the exam was completed, at which time the instruction and written examination must be repeated.

(2) Operations are during daylight hours.

(3) The operation is conducted in a sparsely populated location.

(4) The operation is conducted from a privately owned airfield, military installation, or off-airport location.

(5) Operations are approved and conducted solely within visual line-of-sight in Class G airspace.

(6) Visual line-of-sight operations are conducted at an altitude of no more than 400 feet Above Ground Level (AGL) in class G airspace at all times.

c. The FAA may require specific aircraft category and class ratings in manned aircraft depending on the UAS seeking approval and the characteristics of its flight controls interface.

10. PIC Recent Flight Experience (Currency).

a. For those operations that require a certificated pilot or FAA accepted agency equivalent, based on the application, the PIC must have flight reviews 14 CFR Part 61.56, and if the pilot conducts takeoff, launch, landing or recovery the PIC must maintain recent pilot experience in manned aircraft per 14 CFR Part 61.57,; Recent Flight Experience: Pilot in Command.

b. For operations approved for night or IFR through special provisions, the PIC must maintain minimum recent pilot experience per 14 CFR Part 61.57, Recent Flight Experience: Pilot in Command, as applicable.

11. Supplemental pilots must have, at a minimum, successfully completed private pilot ground school and passed the written test or the FAA accepted agency equivalent, based on the application. The ground school written test results are valid for two years from the date of completion, at which time the instruction and written examination must be repeated. If a supplemental pilot assumes the role of PIC, he/she must comply with PIC rating, currency, medical, and training requirements listed in this document.

12. Ancillary personnel such as systems operators or mission specialists must be thoroughly familiar with and possess operational experience of the equipment being used. If the systems being used are for observation and detection of other aircraft for collision

avoidance purposes, personnel must be thoroughly trained on collision avoidance procedures and techniques and have direct communication with the UAS pilot, observer, and other crewmembers.

13. The Agency will ensure that Crew Resource Management (CRM) training is current for all crew members before flying operational or training missions. The CRM program must consist of initial training, as well as CRM recurrent training during every recurrent training cycle, not to exceed a 12 month interval between initial training and recurrent training or between subsequent recurrent training sessions.

G. **Notice to Airmen (NOTAM).**

1. A distant (D) NOTAM must be issued when unmanned aircraft operations are being conducted. This requirement may be accomplished:
   a. Through the proponent's local base operations or NOTAM issuing authority, or
   b. By contacting the NOTAM Flight Service Station at 1-877-4-US-NTMS (1-877-487-6867) not more than 72 hours in advance, but not less than 48 hours prior to the operation, unless otherwise authorized as a special provision. The issuing agency will require the:
      (1) Name and address of the pilot filing the NOTAM request
      (2) Location, altitude, or operating area
      (3) Time and nature of the activity.

2. For proponents filing their NOTAM with the Department of Defense: The requirement to file with an Automated Flight Service Station (AFSS) is in addition to any local procedures/requirements for filing through the Defense Internet NOTAM Service (DINS).

H. **Data Reporting.**

1. Documentation of all operations associated with UAS activities is required regardless of the airspace in which the UAS operates. This requirement includes COA operations within Special Use airspace. NOTE: Negative (zero flights) reports are required.
2. The proponent must submit the following information through UAS COA On-Line on a monthly basis:
   a. The number of flights conducted under this COA. (A flight during which any portion is conducted in the NAS must be counted only once, regardless of how many times it may enter and leave Special Use airspace between takeoff and landing)
   b. Aircraft operational hours per flight
   c. Ground control station operational hours in support of each flight, to include Launch and Recovery Element (LRE) operations

d. Pilot duty time per flight

e. Equipment malfunctions (hardware/software) affecting either the aircraft or ground control station

f. Deviations from ATC instructions and/or Letters of Agreement/Procedures

g. Operational/coordination issues

h. The number and duration of lost link events (control, vehicle performance and health monitoring, or communications) per aircraft per flight.

I. **Incident/Accident/Mishap Reporting.**

Immediately after an incident or accident, and before additional flight under this COA, the proponent must provide initial notification of the following to the FAA via the UAS COA On-Line forms (Incident/Accident).

1. All accidents/mishaps involving UAS operations where any of the following occurs:
   a. Fatal injury, where the operation of a UAS results in a death occurring within 30 days of the accident/mishap
   b. Serious injury, where the operation of a UAS results in a hospitalization of more than 48 hours, the fracture of any bone (except for simple fractures of fingers, toes, or nose), severe hemorrhage or tissue damage, internal injuries, or second or third-degree burns
   c. Total unmanned aircraft loss
   d. Substantial damage to the unmanned aircraft system where there is damage to the airframe, power plant, or onboard systems that must be repaired prior to further flight
   e. Damage to property, other than the unmanned aircraft.

2. Any incident/mishap that results in an unsafe/abnormal operation including but not limited to:
   a. A malfunction or failure of the unmanned aircraft's on-board flight control system (including navigation)
   b. A malfunction or failure of ground control station flight control hardware or software (other than loss of control link)
   c. A power plant failure or malfunction
   d. An in-flight fire
   e. An aircraft collision
   f. Any in-flight failure of the unmanned aircraft's electrical system requiring use of alternate or emergency power to complete the flight
   g. A deviation from any provision contained in the COA

h. A deviation from an ATC clearance and/or Letter(s) of Agreement/Procedures

i. A lost control link event resulting in

(1) Fly-away, or

(2) Execution of a pre-planned/unplanned lost link procedure.

3. Initial reports must contain the information identified in the COA On-Line Accident/Incident Report.

4. Follow-on reports describing the accident/incident/mishap(s) must be submitted by providing copies of proponent aviation accident/incident reports upon completion of safety investigations. Such reports must be limited to factual information only where privileged safety or law enforcement information is included in the final report.

5. Public-use agencies other than those which are part of the Department of Defense are advised that the above procedures are not a substitute for separate accident/incident reporting required by the National Transportation Safety Board under 49 CFR Part 830 §830.5.

6. This COA is issued with the provision that the FAA be permitted involvement in the proponent's incident/accident/mishap investigation as prescribed by FAA Order 8020.11, Aircraft Accident and Incident Notification, Investigation, and Reporting.

FLIGHT STANDARDS SPECIAL PROVISIONS

A. **Contingency Planning**

1. **Point Identification**. The proponent must submit contingency plans that address emergency recovery or flight termination of the unmanned aircraft (UA) in the event of unrecoverable system failure. These procedures will normally include Lost Link Points (LLP), Divert/Contingency Points (DCP) and Flight Termination Points (FTP) for each operation. LLPs and DCPs must be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart (or similar format). FTPs or other accepted contingency planning measures must also be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart, or other graphic representation acceptable to the FAA. The FAA accepts the LLPs, DCPs, FTPs, and other contingency planning measures, submitted by the proponent but does not approve them. When conditions preclude the use of FTPs, the proponent must submit other contingency planning options for consideration and approval. At least one LLP, DCP, and FTP (or an acceptable alternative contingency planning measure) is required for each operation. The proponent must furnish this data with the initial COA application. Any subsequent changes or modifications to this data must be provided to AJV-13 for review and consideration no later than 30 days prior to proposed flight operations.

2. **Risk Mitigation Plans**. For all operations, the proponent must develop detailed plans to mitigate the risk of collision with other aircraft and the risk posed to persons and property on the ground in the event the UAS encounters a lost link, needs to divert, or the flight needs to be terminated. The proponent must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDs, and congested areas. In the event of a contingency divert or flight termination, the use of a chase aircraft is preferred when the UAS is operated outside of Restricted or Warning Areas. If time permits, the proponent should make every attempt to utilize a chase aircraft to monitor the aircraft to a DCP or to the FTP. In the event of a contingency divert or flight termination, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

   a. **LLP Procedures**.
      (1) LLPs are defined as a point, or sequence of points where the aircraft will proceed and hold at a specified altitude, for a specified period of time, in the event the command and control link to the aircraft is lost. The aircraft will autonomously hold, or loiter, at the LLP until the communication link with the aircraft is restored or the specified time elapses. If the time period elapses, the aircraft may autoland, proceed to another LLP in an attempt to regain the communication link, or proceed to an FTP for flight termination. LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established or fuel exhaustion occurs.

(2) For areas where multiple or concurrent UAS operations are authorized in the same operational area, a segregation plan must be in place in the event of a simultaneous lost link scenario. The segregation plan may include altitude offsets and horizontal separation by using independent LLPs whenever possible.

b. **DCP Procedures**.

(1) A DCP is defined as an alternate landing/recovery site to be used in the event of an abnormal condition that requires a precautionary landing. Each DCP must incorporate the means of communication with ATC throughout the descent and landing (unless otherwise specified in the Special Provisions) as well as a plan for ground operations and securing/parking the aircraft on the ground. This includes the availability of ground control stations capable of launch/recovery, communication equipment, and an adequate power source to operate all required equipment.

(2) For local operations, the DCP specified will normally be the airport/facility used for launch and recovery; however, the proponent may specify additional DCPs as alternates.

(3) For transit and/or mission operations that are being conducted in Class A airspace or Class E airspace above flight level (FL)-600, DCPs will be identified during the flight to be no further than one hour of flight time at any given time, taking into consideration altitude, winds, fuel consumption, and other factors. If it is not possible to define DCPs along the entire flight plan route, the proponent must identify qualified FTPs along the entire route and be prepared to execute flight termination at one of the specified FTPs if a return to base (RTB) is not possible.

(4) It is preferred that specified DCPs are non-joint use military airfields, other government-owned airfields, or private-use airfields. However, the proponent may designate any suitable airfield for review and consideration.

c. **Flight Termination Procedures**.

(1) Flight termination is the intentional and deliberate process of performing controlled flight into terrain (CFIT). Flight termination must be executed in the event that all contingencies have been exhausted and further flight of the aircraft cannot be safely achieved or other potential hazards exist that require immediate discontinuation of flight. FTPs or alternative contingency planning measures must be located within power off glide distance of the aircraft during all phases of flight and must be submitted for review and acceptance. The proponent must ensure sufficient FTPs or other contingency plan measures are defined to accommodate flight termination at any given point along the route of flight. The location of these points is based on the assumption of an unrecoverable system failure and must take into consideration altitude, winds, and other factors.

(2) Unless otherwise authorized, FTPs must be located in sparsely populated areas. Except for on- or near-airport operations, FTPs will be located no closer than five nautical miles from any airport, heliport, airfield, NAVAID, airway, populated

area, major roadway, oil rig, power plant, or any other infrastructure. For offshore locations, the proponent must refer to appropriate United States Coast Guard (USCG) charts and other publications to avoid maritime obstructions, shipping lanes, and other hazards. Populated areas are defined as those areas depicted in yellow on a VFR sectional chart or as determined from other sources.

(a) It is preferred that flight termination occurs in Restricted or Warning Areas, government-owned land, or offshore locations that are restricted from routine civil use. However, the proponent may designate any suitable location for review and consideration.

(b) The proponent is required to survey all designated areas prior to their use as an FTP. All FTPs will be reviewed for suitability on a routine and periodic basis, not to exceed six months. The proponent assumes full risk and all liability associated with the selection and use of any designated FTP.

(c) It is desirable that the proponent receive prior permission from the land owner or using agency prior to the use of this area as an FTP. The proponent should clearly communicate the purpose and intent of the FTP.

(d) For each FTP, plans must incorporate the means of communication with ATC throughout the descent as well as a plan for retrieval/recovery of the aircraft.

(e) Contingency planning must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDs, and congested areas to the maximum extent possible.

(f) In the event of a contingency divert or flight termination, if time permits, the use of a chase aircraft is preferred when the UA is operated outside of Restricted or Warning Areas.

(g) In the event of a contingency divert or flight termination or other approved contingency measures, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

B. **Night Operation Limitations.**

UAS night operations are those operations that occur between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time. (Note: this is equal to approximately 30 minutes after sunset until 30 minutes before sunrise).

1. Night operations are not authorized.

C. **Area of Operations.**

The RMAX Type II G UAS cannot be preprogrammed with lost-link points for autonomous operations. Therefore, the proponent's entire operations area is considered to be a flight termination point.

D. **Warning Notes.**

All warning notes categorized and shown as "Danger", "Warning", "'Notice", "Tip" and "0" in the RMAX II G Operations Manual and the Liquid Sprayer Manual must be observed during inspection, operation and maintenance of the UAS.

E. **14 CFR Part 137.**

The proponent shall become familiar with and comply with Title 14 Code of Federal Regulations sections 137.37, Manner of dispensing, and 137.39, Economic poison dispensing.

AIR TRAFFIC CONTROL SPECIAL PROVISIONS

A. **Coordination Requirements.**

1. For operations at NorCal Vines and NorCal Trees operations areas, proponent will contact Oakland ARTCC (ZOA) at (510) 745-3331 at least one (1) hour prior to conducting UA flight operations and provide NOTAM information and cell phone number to be used in the event of an emergency, and again to advise when operations are completed.

2. For operations at SoCal Trees operations area, proponent will contact Bakersfield TRACON (BFL) at (661) 861-4325 at least one (1) hour prior to conducting UA flight operations and provide NOTAM information and cell phone number to be used in the event of an emergency, and again to advise when operations are completed.

B. **Communication Requirements.**

ATC special provisions A and C will be used in lieu of maintaining direct two-way communications with ATC.

C. **Emergency/Contingency Procedures.**

1. Lost Link Procedures:

   a. In the event of a lost link, the UAS pilot will immediately notify ZOA at (510) 745-3331, or BFL at (661) 861-4325 (as appropriate), state pilot intentions, and comply with the following provisions:

      (1) Comply with those procedures outlined in Attachment 2.

      (2) If lost link occurs within a restricted or warning area, or the lost link procedure above takes the UA into the restricted or warning area – the aircraft will not exit the restricted or warning areas until the link is re-established.

      (3) The unmanned aircraft lost link mission will not transit or orbit over populated areas.

      (4) Lost link programmed procedures will avoid unexpected turn-around and/or altitude changes and will provide sufficient time to communicate and coordinate with ATC.

      (5) Lost link orbit points shall not coincide with the centerline of Victor airways.

2. Lost Communications:

   a. Comply with those procedures outlined in Attachment 3.

D. **Operations Area**

User Defined Area ID : NorCal Vines
1 NM radius centered on 38-25-45.92N / 122-24-09.47W

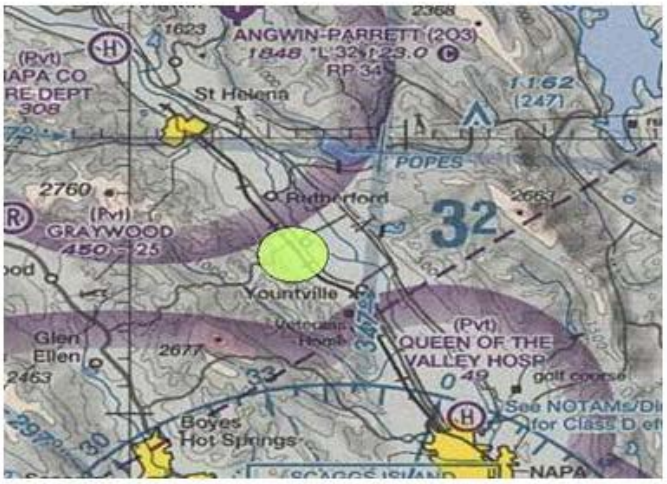
User Defined Area ID : NorCal Trees
1 NM radius centered on 38-57-30.52N / 122-04-45.70W

User Defined Area ID : SoCal Trees
1 NM radius centered on 35-34-33.88N / 119-35-37.18W

AUTHORIZATION

This Certificate of Waiver or Authorization does not, in itself, waive any Title 14 Code of Federal Regulations, nor any state law or local ordinance. Should the proposed operation conflict with any state law or local ordinance, or require permission of local authorities or property owners, it is the responsibility of the University of California, Davis, Biological & Agricultural Engineering Dept. to resolve the matter. This COA does not authorize flight within Special Use Airspace (SUA) without approval from the using agency. The University of California, Davis, Biological & Agricultural Engineering Dept. is hereby authorized to operate the RMAX Type II Unmanned Aircraft System in the operations area depicted in the Activity section of this attachment.

Attachment 1



NorCal Vines

NorCal Trees

SoCal Trees

Attachment 2

LOST LINK PROCEDURE(S)

Failsafe (Safety Function During Radio Signal Interference) Actions

If the radio signals for controlling the flight do not reach the helicopter due to interference, the helicopter will be rendered out of control, which creates a dangerous situation. In case of radio signal interference, the system has a safety feature that alternately flashes the inner and outer lights of the red YACS warning lights and automatically effects the flight control described on the following pages. Thoroughly familiarize yourself with this feature to take the appropriate actions.

DANGER: During signal interference, never approach the helicopter until the main rotor has come to a complete stop and the engine has stopped. If there are any people in the area, instruct them to leave the area immediately.

WARNING: Do not fly any higher than 3 to 4 m (above the ground or crops). When radio signal interference occurs (i.e. when failsafe mode is engaged), the engine speed is automatically brought to idling state after 40 seconds. Flying at a higher altitude will cause the helicopter to descend abruptly.

Make sure to follow the "Actions" instructed in the manual. Failure to do so could cause the helicopter to move unexpectedly or descend suddenly once it recovers from the radio signal interference, and could lead to an accident.

Do not resume flying until you have verified and eliminated the cause of the radio signal interference. Otherwise, you could lose control of the helicopter again, leading to an accident.

Poor GPS Reception (Outer Lights of GPS Indicator Light Are OFF):

In the event of radio signal interference, the inner and outer lights of the red YACS warning lights will flash alternately and the system will force the helicopter to descend quickly regardless of the flight mode. If the control radio signals recover while the helicopter is descending, the flight mode will switch automatically to operator control. For this reason, calmly move all the sticks on the transmitter to the neutral (center) position, and wait for the signals to recover.

If the helicopter is forced to land because the radio signals have not recovered, the engine is brought to idle. Depending on the terrain, weather, and flight conditions, the helicopter could overturn. If the helicopter overturns, never approach the helicopter, as the engine speed might not decrease.

After a forced landing, turn the throttle to the slowest position and wait for the radio signals to recover or the engine to stop.

If the radio signals do not recover after 1 minute from the time the radio signal interference occurred, the engine will stop automatically. After the rotor has come to a complete stop, approach the helicopter and turn OFF its main switch.

Good GPS Reception (Outer Lights of GPS Indicator Light Are ON):

When radio signal interference occurs, the inner and outer lights of the red YACS warning lights will flash alternately, and the system will apply the brake and force the helicopter to hover regardless of the flight mode. Then, the helicopter will automatically start descending slowly. If the control radio signals recover while the helicopter is descending, the flight mode will switch automatically to operator control. For this reason, calmly move all the sticks on the transmitter to the neutral (center) position, and wait for the signals to recover.

If the helicopter is forced to land because the radio signals have not recovered, the engine is brought to idle. Depending on the terrain, weather, and flight conditions, the helicopter could overturn. If the helicopter overturns, never approach the helicopter, as the engine speed might not decrease.

After a forced landing, turn the throttle to the slowest position and wait for the radio signals to recover or the engine to stop.

If the radio signals do not recover after 1 minute from the time the radio signal interference occurred, the engine will stop automatically. After the rotor has come to a complete stop, approach the helicopter and turn OFF its main switch.

Safety Features and Actions During Poor GPS Signal Reception

The GPS control operates by receiving radio signals from 4 or more satellites. It may become inoperable depending on the surroundings, terrain, weather conditions, time zone, and other reasons. If the reception of GPS signals becomes poor while operating in a GPS control flight mode (SG, CG, or AG), a safety feature will cause the outer and inner lights of the orange GPS indicator lights to flash alternately. Then, the system will automatically effect flight control or switch the flight mode as described below. Thoroughly familiarize yourself with this feature to take the appropriate actions.

Operating in SG mode
As the GPS signal reception worsens, the orange GPS indicator lights will cycle through “outer lights ON > inner lights ON > OFF”, and the brake control will be applied only in the longitudinal direction of the helicopter. At this point, quickly turn OFF the GPS control switch. When the GPS control switch is turned OFF, the GPS indicator light will turn OFF and control will switch to S mode. Therefore, operate carefully.

Operating in CG mode
As the GPS signal reception worsens, the orange GPS indicator lights will cycle through “outer lights ON > inner lights ON > OFF”. Control will switch automatically to C mode. At this point,

quickly turn OFF the GPS control switch and operate carefully. When the GPS control switch is turned OFF, the GPS indicator light will turn OFF.

Operating in AG mode
As the GPS signal reception worsens, the orange GPS indicator lights will cycle through “outer lights ON > inner lights ON > OFF”. Control will switch automatically to A mode. At this point, quickly turn OFF the GPS control switch and operate carefully. When the GPS control switch is turned OFF, the GPS indicator light will turn OFF.

The reception of GPS radio signals can be adversely affected by conditions indicated below or due to other reasons.

-Flying near obstacles such as mountains, trees, or buildings.

-The antenna is surrounded by people.

-Fewer satellites are available during certain time slots.

Attachment 3

LOST COMMUNICATIONS PROCEDURE(S)

If the PIC and observer are unable to communicate with one another, the lost link procedures will be executed.

EXHIBIT 5

RMAX Operations

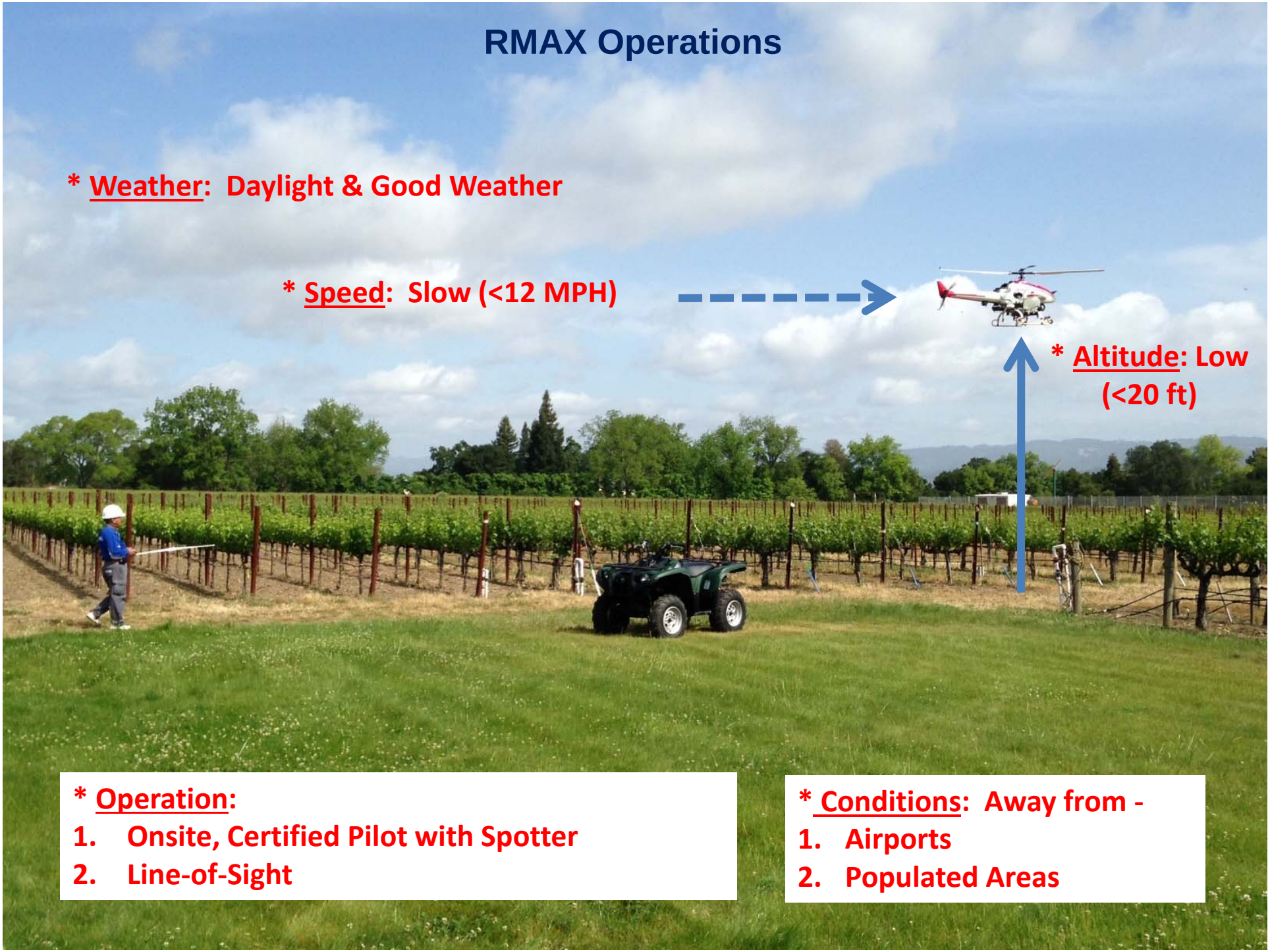


EXHIBIT 6

SUBMITTED ON A CONFIDENTIAL BASIS

EXHIBIT 7

SUBMITTED ON A CONFIDENTIAL BASIS

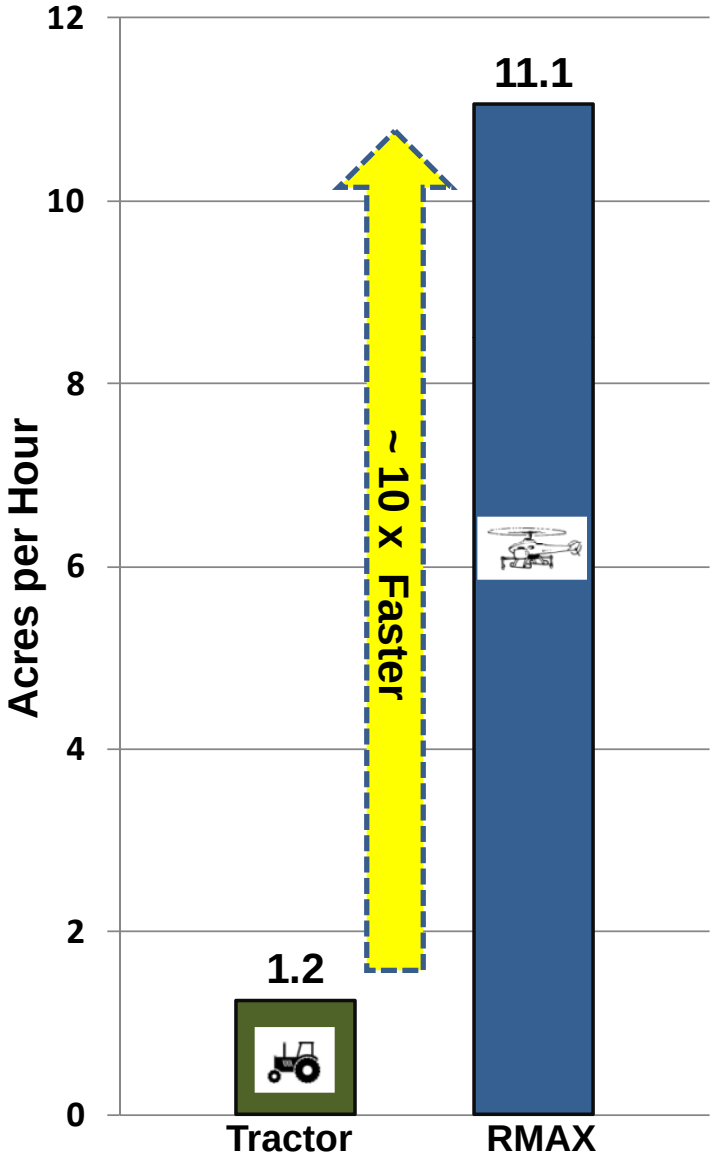
EXHIBIT 8

SUBMITTED ON A CONFIDENTIAL BASIS

EXHIBIT 9

Yamaha / UC Davis Project

Spraying Efficiency
Tractor vs. Yamaha RMAX



U.C Davis Project Data

- Project Start – Summer of 2012
- 30 Hours of flight time completed (as of May 2014)

Identified Advantages

- ☑ **Improved operational efficiency**
- ☑ **No crop damage or soil compaction**
- ☑ **Improved Safety ~ Hilly Terrain**
- ☑ **Reduced chemical usage and exposure**
- ☑ **Less drift vs. manned aerial application**

EXHIBIT 10


AUVSI
The Association for Unmanned Vehicle Systems International
CONNECTING THE
UNMANNED SYSTEMS COMMUNITY
ACROSS THE GLOBE
AUVSI
ASSOCIATION FOR UNMANNED
VEHICLE SYSTEMS INTERNATIONAL

National Agriculture Aviation Association

Gretchen West

Executive Vice President

Association for Unmanned Vehicle Systems International (AUVSI)

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Why Unmanned Systems?

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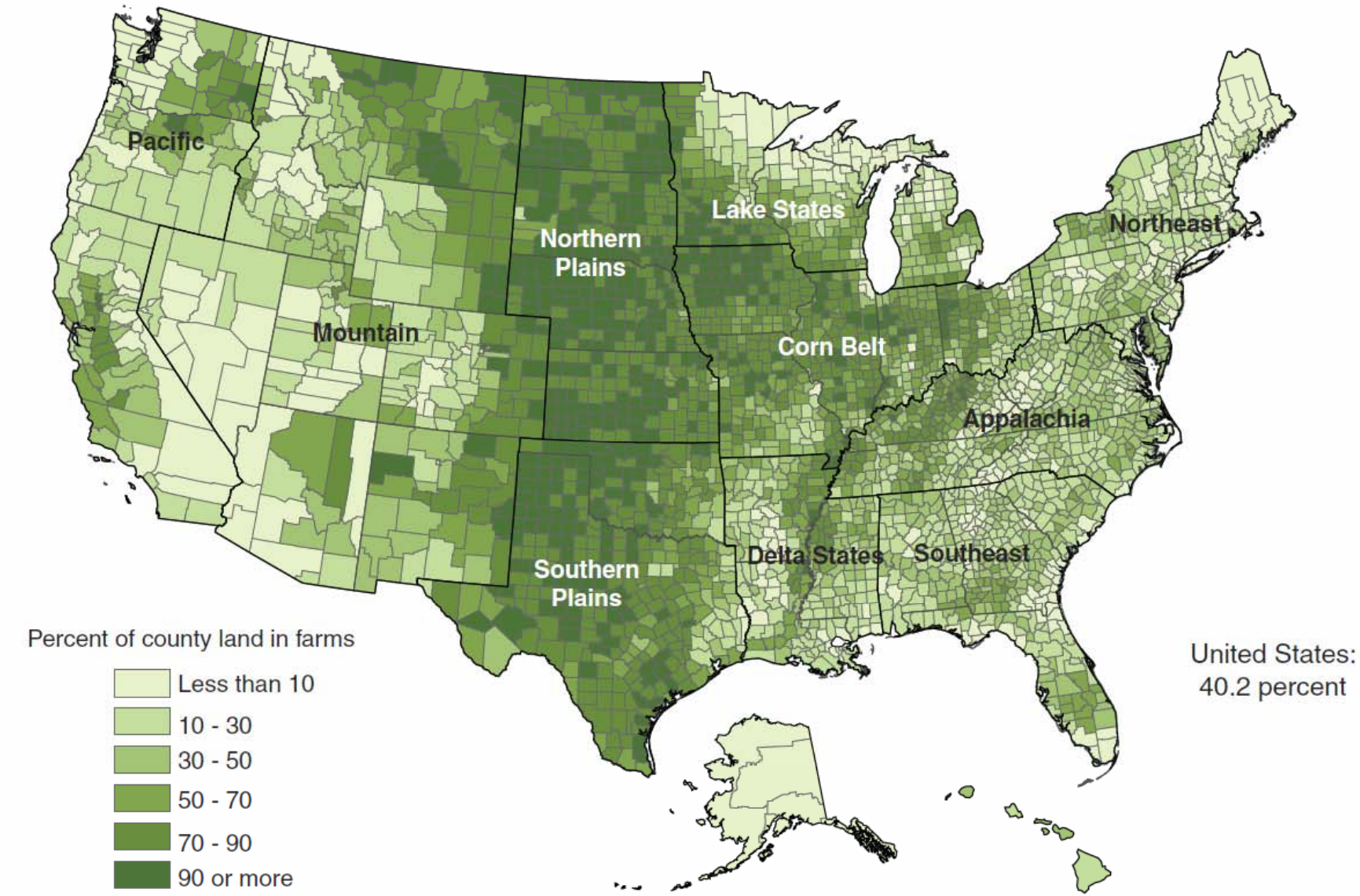
Acres of land in farms, 2007



Source: USDA, National Agricultural Statistics Service.

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Current State of U.S. Farms

- A hundred years ago**, more than 30%** of Americans were directly involved in the agriculture industry; today, the number is **less than 2%.**
- The Bureau of Labor Statistics anticipates an **8% drop** in farmer employment between 2010 and 2020, meaning there will be **96,100 less farmers**
- Market Value of Products Sold: **almost $300 billion**
- In a 2012, *AP* interview, former U.S. Deputy Secretary of Agriculture Kathleen Merrigan said experts also project **the world will require 70% more food production by 2050 to keep up with population growth**

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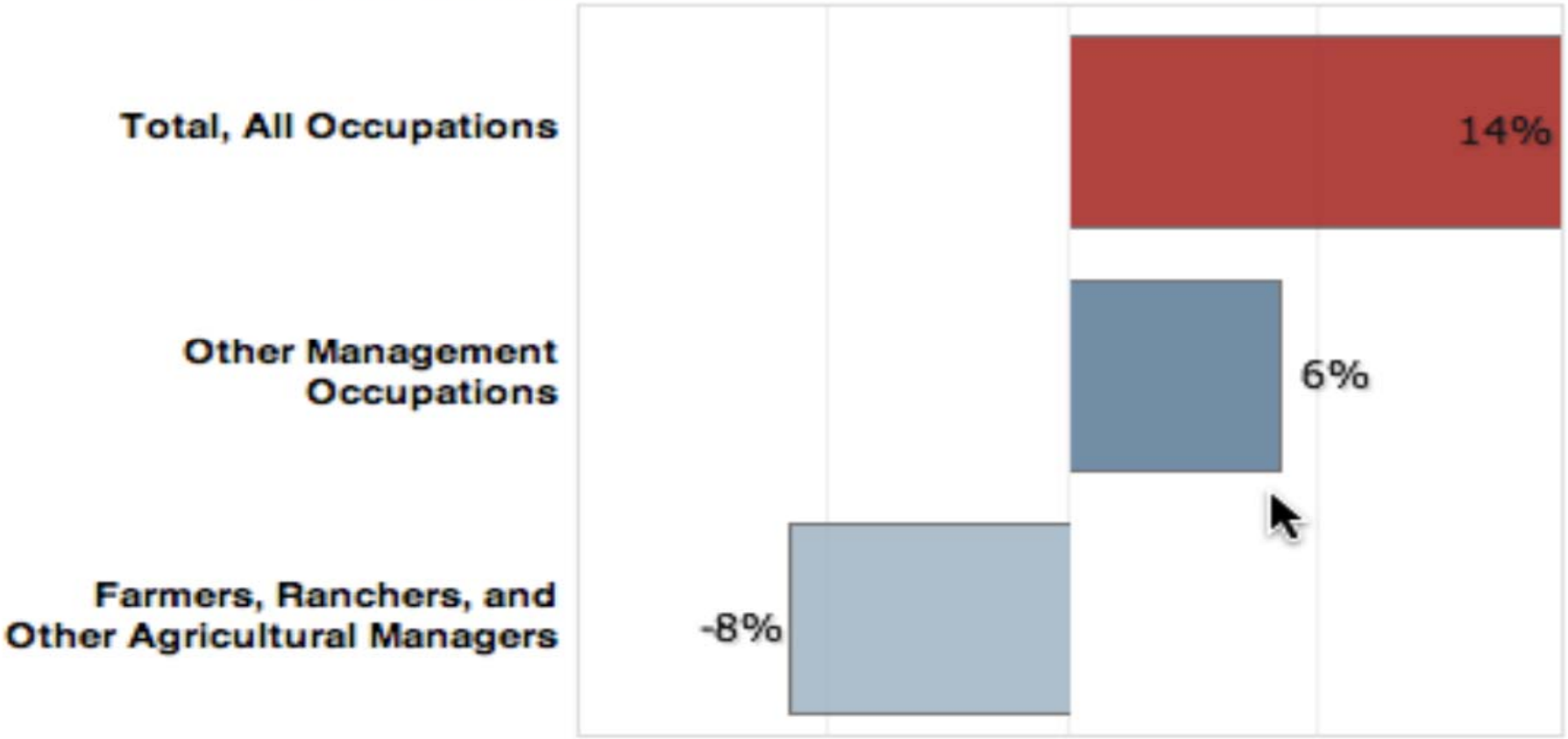
Farmers, Ranchers, and Other Agricultural Managers

Percent change in employment, projected 2010-20



Note: All Occupations includes all occupations in the U.S. Economy.

Source: U.S. Bureau of Labor Statistics, Employment Projections program

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Benefits of Precision Agriculture

- UAS will make precision agriculture more cost-effective and accessible than ever before. Research already confirms its enormous benefits to farmers.

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Unmanned Systems and Efficiency

- Cost-effective way to spray for pests and diseases, manage crops, check for signs of drought
- Conduct up-close surveillance of farm plots and provide high-resolution data
- Safely survey sloped, muddy or dangerous terrain

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Unmanned Systems and Efficiency

- Detect invasive species in grasslands and crops
- Assist in planning improvements in field drainage
- Map and estimate acreage and crop types
- Assist in developing crop yield estimates
- Efficiently spray crops with fertilizers, pesticides and fungicides

"You are getting a bird's eye view and that is extremely valuable in targeted irrigation, targeted pesticides and targeted nutrients. Targeted means you don't need to put pesticides everywhere, and that saves a lot of money."

Larry Silverberg, Associate Head & Director of Undergraduate Programs NC State

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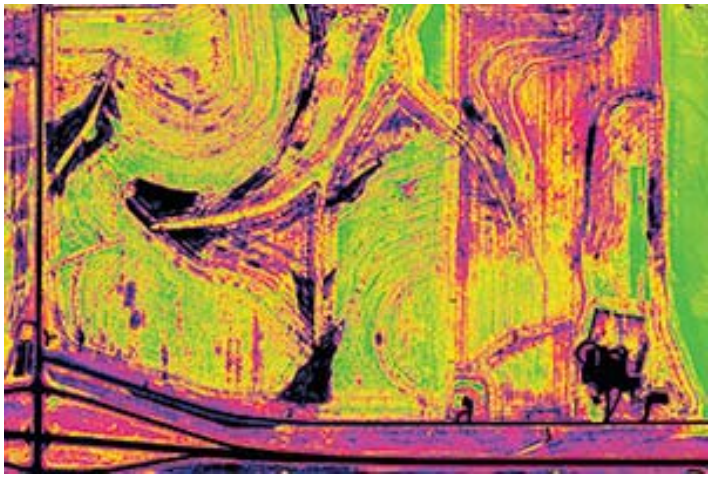
Unmanned Systems Technology

- Much of the research in agricultural applications of UAS is based around providing high-resolution, multispectral aerial imagery.
- By assessing the amount of near-infrared and visible light that reflects from the leaves of the plant, the normalized difference vegetation index can then be calculated, which provides an indication of the relative health of the plant.



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Unmanned Systems Beyond Crops

- **Livestock**
  - Monitoring stock ponds for quantity and health risks that can be harmful to livestock
  - Determine how much ground cover is edible for livestock
  - Obtaining photography for counting livestock in the pasture
- **Pasture and rangelands**
  - Estimating pasture and rangelands productivity
  - Assessing grazing impacts
  - Assessing impacts of management plans of pasture and rangeland condition

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Agriculture Applications In the U.S.

- **Half of the universities** with active COAs in 2012 were doing either **agriculture or fisheries and wildlife research**.
- **Virginia Tech** using UAS to track Fusarium, a devastating fungi to plants and animals
- **University of New Hampshire** is using UAS to help fight apple scab
- A company in Hawaii is using UAS to improve irrigation to sugar cane fields
- **UAI International of Grand Forks, UA Vision of Dayton, Ohio, and the University of Dayton** led Institute for the Development and Commercialization of advanced Sensor Technology (IDCAST) are working to develop and market UAV-based solutions for agricultural applications to detect early signs of crop problems.

International Agriculture Applications

- In **Japan**, unmanned helicopters are used for the spraying of crops for pest control, supplanting manned systems with a safer, more effective alternative.
- The **Beijing Agricultural Bureau** has spent 500,000 yuan ($81,490) introducing a homemade UAS for vegetable protection in Shunyi district.
- **Australian** researchers are developing UAS as small as a dinner plate that could help cut down the amount of herbicide sprayed on crops.
- **CATEC and CSIC**, from Spain, with partners from Belgium and the Netherlands in the community project FieldCopter to collect information through multispectral cameras equipped on UAS. The experiments have been conducted on potato fields in **Belgium** and the **Netherlands**, as well as in vineyards in **Spain**. Tests have shown excellent results, with an accuracy of 3 to 10 cm per pixel, compared to the meters accuracy given by satellites.

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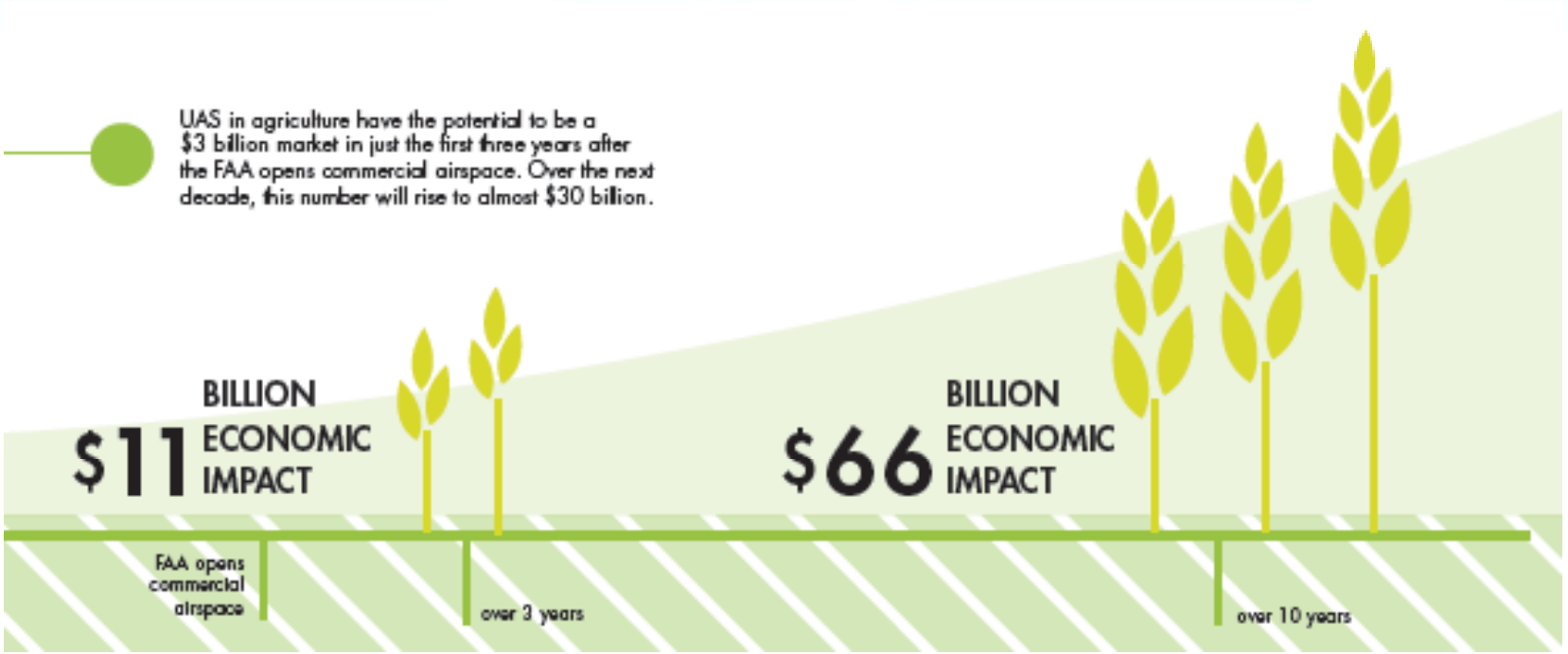
UAS Economic Potential

- AUVSI's Recently Released Economic Impact Report:
  - The UAS global market is currently more than **$11 billion** and will total almost **$140 billion** over the next 10 years.
  - **Precision agriculture** will total **approximately 80%** of the known potential commercial markets for UAS.



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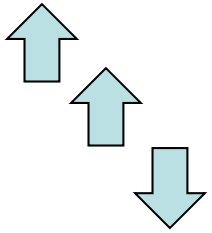
Summary

- US Agriculture industry poised to reap economic benefit and job creation utilizing UAS and UGS
- Using Unmanned Systems can be more efficient, cost-effective, safer
- Potential Advantages in eliminating soil compaction and crop damage, reducing applicator exposure to chemicals, enhancing spray deposition and more
- Variety of Challenges still to be addressed
- Finally…

Production Revenues Increasing
Production Expenses Increasing
Labor Resources Decreasing
Potential Solution?



UNMANNED SYSTEMS

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Questions?

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