

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**CERTIFICATE OF WAIVER OR AUTHORIZATION**

ISSUED TO

United States Army, Aeroflightdynamics Directorate

ADDRESS

Bldg N248, Room 220
Moffett Field, CA 94035

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 UAS in Class C and G airspace at or below 100 feet Above Ground Level (AGL) at Fort Ord, CA under the jurisdiction of Monterey ATCT. See special provisions.

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE

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.

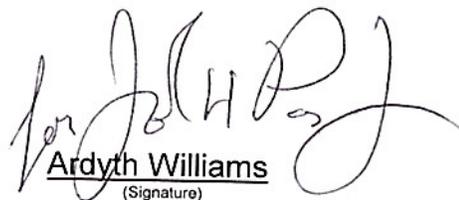
SPECIAL PROVISIONS

Special Provisions are set forth and attached.

This certificate (2009-WSA-94) is effective from December 23, 2010 through December 22, 2011 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-13
(Region)


Ardyth Williams
(Signature)

December 22, 2010
(Date)

Air Traffic Manager, Unmanned Aircraft Systems
(Title)

ATTACHMENT to FAA FORM 7711-1

Issued To: United States Army, Aeroflightdynamics Directorate

Address: Bldg N248, Room 220
Moffett Field, CA 94035

Activity: Operation of the RMAX UAS in Class C and G airspace at or below 100 feet Above Ground Level (AGL) at Fort Ord, CA under the jurisdiction of Monterey ATCT. (See Attachment 1 and 2).

Purpose: To prescribe UAS operating requirements (outside of restricted and/or warning area airspace) in the National Airspace System (NAS) for the purpose of training and/or operational flights.

Dates of Use: This Certificate of Authorization (COA) (2009-WSA-94) is valid from December 23, 2010 through December 22, 2011. Should a renewal become necessary, the proponent shall advise the Federal Aviation Administration (FAA), in writing, no later than 60 days prior to the requested effective date.

General Provisions:

- The review of this activity is based on our current understanding of UAS operations, and the impact of such operations in the NAS, and therefore should not be considered a precedent for future operations. As changes occur in the UAS industry, or in our understanding of it, there may be changes to the limitations and conditions for similar operations.
- All personnel connected with the UAS operation must comply with the contents of this authorization and its provisions.
- This COA will be reviewed and amended as necessary to conform to changing UAS policy and guidance.
- The FAA has the authority to cancel this COA or delay any activities if the safety of persons or property on the ground or in the air is in jeopardy, or if there is a violation of the terms specified.

Safety Provisions:

Unmanned Aircraft (UA) have no on-board pilot to perform see-and-avoid responsibilities, and therefore, when operating outside of restricted areas, special provisions must be made to ensure an equivalent level of safety exists for operations had a pilot been on board. In accordance with 14 CFR Part 91, *General Operating and Flight Rules*, Subpart J-Waivers, 91.903, *Policy and Procedures*, the following provisions provide acceptable mitigation of 14 CFR Part 91.113 and must be complied with:

- For the purpose of see-and-avoid, visual observers must be utilized at all times except in Class A airspace, restricted areas, and warning areas. The observers may either be ground based, aboard a watercraft, or in a chase plane. The UA must remain within a lateral distance of no more than 0.25 Nautical Miles (NM) and 100 feet vertically from the visual observer. The distances listed are the maximum distance; at no time will the UA be operated at a distance beyond the visual line of sight for the visual observer.
- UAS pilots will ensure there is a safe operating distance between manned and unmanned aircraft at all times in accordance with 14 CFR Part 91.111, *Operating Near Other Aircraft*, and 14 CFR Part 91.113, *Right-of-Way Rules*. Cloud clearances and VFR visibilities for Class E airspace will be used regardless of class of airspace. Additionally, UAS operations are advised to operate well clear of all known manned aircraft operations.
- The dropping or spraying of aircraft stores, or carrying of hazardous materials (included ordnance) outside of active Restricted, Prohibited, or Warning Areas is prohibited unless specifically authorized in the Special Provisions of this COA.

Airworthiness Certification Provisions:

- UA must be shown to be airworthy to conduct flight operations in the NAS.
- Public Use Aircraft must contain one of the following:
 - A civil airworthiness certification from the FAA, or
 - A statement specifying that the Department of Defense Handbook "Airworthiness Certification Criteria" (MIL-HDBK-516), as amended, was used to certify the aircraft or
 - Equivalent method of certification.

Pilot / Observer Provisions:

1. **Pilot Qualifications:** UA pilots interacting with Air Traffic Control (ATC) shall have sufficient expertise to perform that task readily. Pilots must have an understanding of and comply with Federal Aviation Regulations and Military Regulations applicable to the airspace where the UA will operate. Pilots must have in their possession a current second class (or higher) airman medical certificate that has been issued under 14 CFR Part 67, *Medical Standards and Certification*, or a military equivalent. 14 CFR Part 91.17, *Alcohol or Drugs*, applies to UA pilots.
2. **Aircraft and Operations Requirements:**
 - Flight Below 18,000 Feet Mean Sea Level (MSL).
 - UA operations below 18,000 feet MSL in any airspace generally accessible to aircraft flying in accordance with visual flight rules (VFR) require visual observers, either airborne or ground-based. Use of ATC radar alone does not constitute sufficient collision risk mitigation in airspace where uncooperative airborne operations may be conducted.
 - Flights At or Above 18,000 Feet Mean Sea Level (MSL)

- When operating on an instrument ATC clearance, the UA pilot-in-command must ensure the following:
 1. An ATC clearance has been filed, obtained and followed.
 2. Positional information shall be provided in reference to established NAS fixes, NAVAIDS, and waypoints. Use of Latitude/Longitude is not authorized.
- 3. **Observer Qualifications:** Observers must have been provided with sufficient training to communicate clearly to the pilot any turning instructions required to stay clear of conflicting traffic. Observers will receive training on rules and responsibilities described in 14 CFR Part 91.111, *Operating Near Other Aircraft*, 14 CFR Part 91.113, *Right-of-Way Rules*, cloud clearance, in-flight visibility, and the pilot controller glossary including standard ATC phraseology and communication. Observers must have in their possession a current second class (or higher) airman medical certificate that has been issued under 14 CFR Part 67, *Medical Standards and Certification*, or a military equivalent. 14 CFR Part 91.17, *Alcohol or Drugs*, applies to UA observers.
- **Pilot-in-Command (PIC) –**
 - **Visual Flight Rules (VFR) as applicable:**
 - The PIC is the person directly responsible for the operation of the UA. The responsibility and authority of the pilot in command as described by 14 CFR Part 91.3 (or military equivalent), applies to the UAS PIC.
 - The PIC operating a UA in line of sight must pass at a minimum the required knowledge test for a private pilot certificate, or military equivalent, as stated in 14 CFR Part 61.105, and must keep their aeronautical knowledge up to date.
 - There is no intent to suggest that there is any requirement for the UAS PIC to be qualified as a crewmember of a manned aircraft.
 - Pilots flying a UA on other than instrument flight plans beyond line of sight of the PIC must possess a minimum of a current private pilot certificate, or military equivalent in the category and class, as stated in 14 CFR Part 61.105.
 - **Instrument Flight Rules (IFR) as applicable:**
 - The PIC is the person directly responsible for the operation of the UA. The responsibility and authority of the pilot in command as described by 14 CFR Part 91.3 (or military equivalent), applies to the UAS PIC.
 - The PIC must be a certified pilot (minimum of private pilot) of manned aircraft (FAA or military equivalent) in category and class of aircraft flown.
 - The PIC must also have a current/appropriate instrument rating (manned aircraft, FAA or military equivalent) for the category and class of aircraft flown.
- **Pilot Proficiency – VFR/IFR as applicable:**
 - Pilots will not act as a VFR/ IFR PIC unless they have had three qualified proficiency events within the preceding 90 days.

- The term "qualified proficiency event" is a UAS-specific term necessary due to the diversity of UAS types and control systems.
- A qualified proficiency event is an event requiring the pilot to exercise the training and skills unique to the UAS in which proficiency is maintained.
- Pilots will not act as an IFR PIC unless they have had six instrument qualifying events in the preceding six calendar months (an event that requires the PIC to exercise instrument flight skills unique to the UAS).

- **PIC Responsibilities:**
 - Pilots are responsible for a thorough preflight inspection of the UAS. Flight operations will not be undertaken unless the UAS is airworthy. The airworthiness provisions of 14 CFR Part 91.7, *Civil Aircraft Airworthiness*, or the military equivalent, apply.
 - One PIC must be designated at all times and is responsible for the safety of the UA and persons and property along the UA flight path.
 - The UAS pilot will be held accountable for controlling their aircraft to the same standards as the pilot of a manned aircraft. The provisions of 14 CFR Part 91.13, *Careless and Reckless Operation*, apply to UAS pilots.

- **Pilot/Observer Task Limitations:**
 - Pilots and observers must not perform crew duties for more than one UA at a time.
 - Chase aircraft pilots must not concurrently perform either observer or UA pilot duties along with chase pilot duties.
 - Pilots are not allowed to perform concurrent duties both as pilot and observer.
 - Observers are not allowed to perform concurrent duties both as pilot and observer.

Standard Provisions: These provisions are applicable to all operations unless indicated otherwise in the Special Provisions section.

- The UA PIC will maintain direct two-way communications with ATC and have the ability to maneuver the UA per their instructions. The PIC shall comply with all ATC instructions and/or clearances.
- If equipped and required, the UA shall operate with an operational mode 3/A transponder, with altitude encoding, or mode S transponder (preferred) set to an ATC assigned squawk.
- If equipped, the UA shall operate with position/navigation lights on at all times during flight.
- The UA PIC shall not accept any ATC clearance requiring the use of visual separation or sequencing.
- VFR cloud clearances and visibilities for Class E airspace will be used regardless of class of airspace the UAS is operating in, except when operating in Class A airspace where 14 CFR Part 91.155 will apply.
- Special VFR is not authorized.

- Operations (including lost link procedures) shall not be conducted over populated areas, heavily trafficked roads, or an open-air assembly of people.
- Operations outside of restricted areas, warning areas, prohibited areas (designated for aviation use) and/or Class A airspace may only be conducted during daylight hours.
- Operations shall not loiter on Victor airways, Jet Routes, Q Routes, T Routes, IR Routes, or VR Routes. When necessary, transit of airways and routes shall be conducted as expeditiously as possible.
- Operations conducted under VFR rules shall operate at appropriate VFR altitudes for direction of flight (14 CFR Part 91.159).
- The UA PIC or chase plane PIC (whichever is applicable) will notify FAA ATC authority of any in flight emergency or aircraft accident as soon as practical.
- All operators that use GPS as a sole source, must check all NOTAMs and Receiver Autonomous Integrity Monitoring (RAIM). Flight into GPS test area or degraded RAIM is prohibited.
- At no time will TCAS be used in any mode while operating an unmanned aircraft.
- The PIC of the UA will have a copy of the COA on hand for reference during the flight.
- The United States Army and/or its representatives, is responsible at all times for collision avoidance with non-participating aircraft and the safety of persons or property on the surface with respect to the UAS.

Special Provisions:

1. In the event of a lost link, Lost Communication or Emergency the:
 - Pilot will notify Monterey ATCT at 831-375-3419 of the condition and provide the following:
 - UA last known location
 - UA altitude
 - Direction of flight/heading
 - Fuel on board
 - Pilots intentions
 - Aircraft will execute Lost Link/Mission Procedures as covered in Lost Link/Mission Procedures paragraph 2.1 Mitigation and land the UA. See attachment 3.
2. A pilot in command (PIC) must be designated prior to the launch of the UA and be at the controls of the UA during all phases of flight.
3. A copy of COA must be at the site whenever UA operations are being conducted. All crewmembers, including the PIC and Visual Observer/s must read the COA, including the special provisions and adhere to the contents in the COA.
4. All crew members including the pilot in command and visual observers must

receive training under the direct supervision of a qualified instructor.

5. The use of cell phones or other telephonic communication must not be used unless required for the operational control of the UA and any required communications with Air Traffic Control.
6. The PIC must conduct a pre-takeoff briefing which includes a briefing of the contents of the COA, maximum altitude to be flown, initial heading, frequencies to be used, lost link procedures, the parameters for use of a ditch point, hazards unique to the flight being flown, emergency procedures on takeoff or landing, and a briefing on the amount of fuel including a reserve on the UA.
7. A frequency integrity check must be conducted prior to the launch of the UA.
8. Sterile cockpit procedures must be observed during critical phases of flight.
9. Due to the uncertainty of where the RMAX may land, in the event of a lost link, the UA will not be flown within 500 feet of hazardous material, power lines, occupied buildings or people, other than crewmembers.
10. In the event the RMAX exceeds the boundary of the authorized flight operations area, manual flight termination will be executed immediately.
11. The visual observer must be in direct communication with the PIC and not accomplish any other duties for the flight.
12. Proponent will notify Monterey ATCT at 831-375-3419 at least one hour prior to UAS activity, with activity proposed, length of time of operation, and FDC NOTAM number. Proponent will also notify Monterey ATCT when ceasing UAS activities for that day. This mitigation will be utilized in lieu of Standard Provision bullet #1.
13. An alternate means of compliance is authorized for the operational transponder requirement as listed in FAR Part 91.215 (5) (c).

NOTAM: A distance (D) Notice to Airman shall be issued when UA operations are being conducted. This requirement may be accomplished through your local base operations or NOTAM issuing authority. You may also complete this requirement by contacting 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 and provide:

- Name and Address of pilot filing NOTAM request
- Location, Altitude or the operating Area
- Time and nature of the activity

NOTE FOR PROPONENTS FILING THEIR NOTAM WITH DoD ONLY: This requirement to file with the AFSS is in addition to any local procedures/requirements for filing through DINS. The FAA Unmanned Aircraft Systems Office is working with the

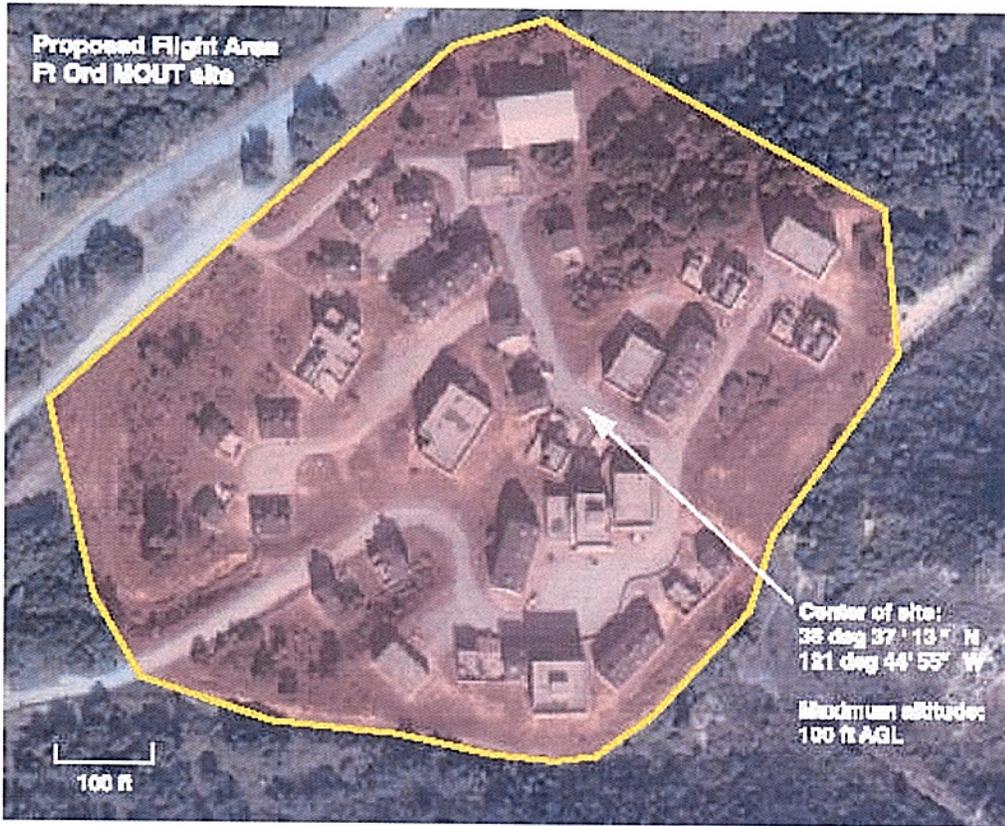
AFSS, and to eliminate the requirement to file a NOTAM with both the AFSS and DINS in the near future.

Incident / Accident and Normal Reporting Provisions: The following information is required to document routine and unusual occurrences associated with UAS activities in the NAS.

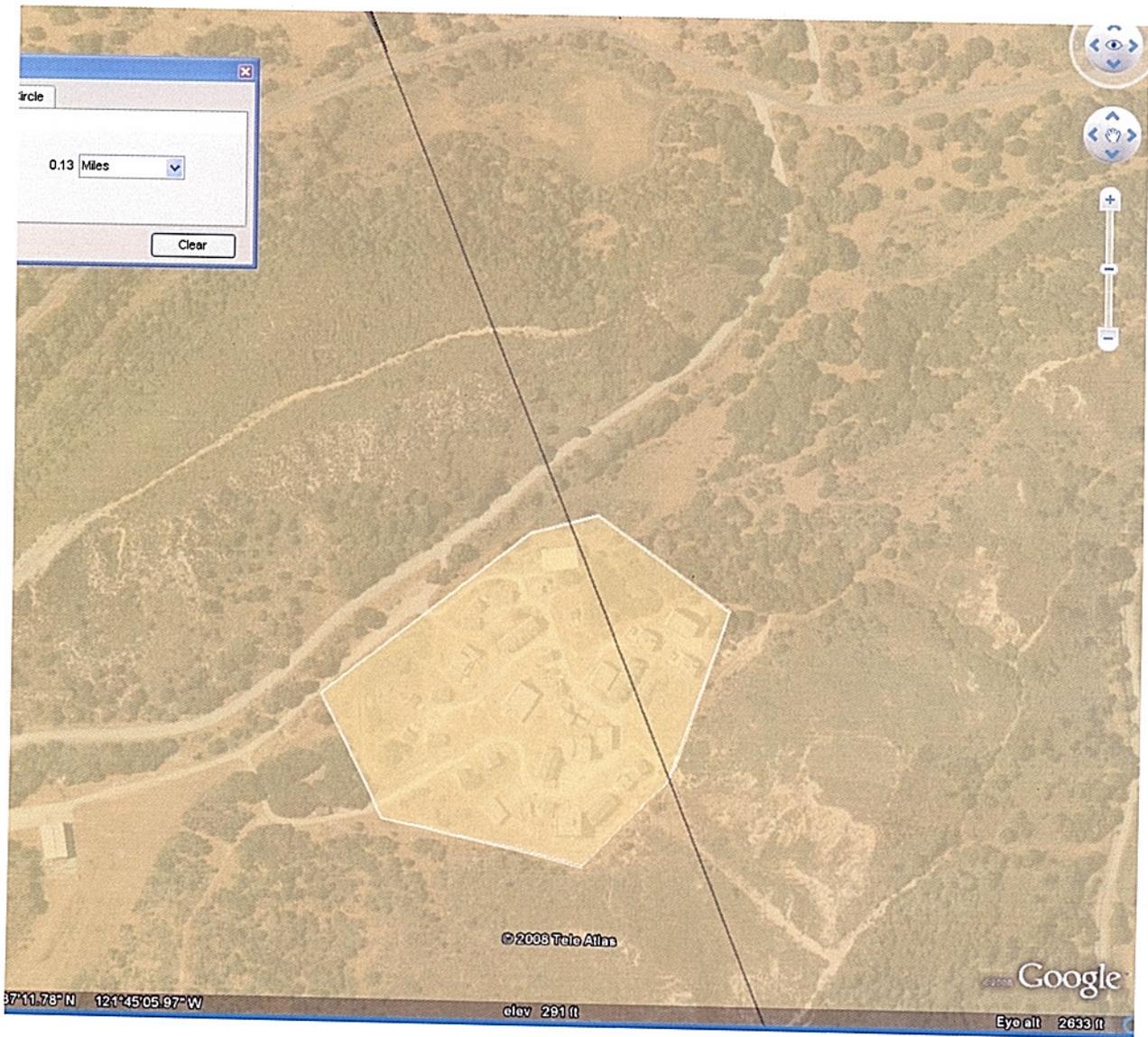
- The proponent for the COA shall provide the following information to Donald.E.Grampp@faa.gov on a monthly basis:
 - Number of flights conducted under this COA.
 - Pilot duty time per flight.
 - Unusual equipment malfunctions (hardware/software).
 - Deviations from ATC instructions.
 - Operational/coordination issues.
 - All periods of loss of link (telemetry, command and/or control)
- The following shall be submitted via COA Online, email or phone (202-385-4542, cell (b) (6)) to Donald.E.Grampp@faa.gov **within 24 hours and prior to any additional flight under this COA:**
 - All accidents or incidents involving UAS activities, including lost link.
 - Deviations from any provision contained in the COA.

This COA does not, in itself, waive any Federal Aviation Regulation (FAR) 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 United States Army to resolve the matter. This COA does not authorize flight within Special Use Airspace without approval from the Using Agency. The United States Army is hereby authorized to operate the RMAX Unmanned Aircraft System UAS in the operations area depicted in "Activity" above and attachment 1 and 2 below.

Attachment 1



Attachment 2



↑
Class C airspace ← → Class G airspace

Lost Link/Mission Procedures

1. Introduction

The Autonomous Rotorcraft Project operates two Yamaha RMAX helicopters. This document describes the lost link procedures.

2. Interference or loss of RC Communication

The RC link to be used for control of the RMAX during this test is an FM pulse code modulation (PCM) radio link operating at a frequency of either 72.110 MHz (L15-100-444) or 72.130 MHz (L15-100-445). There is a remote possibility that this communication link could be interfered with or fail resulting in an inability by the External Pilot (EP) to convey control commands to the aircraft.

2.1 Mitigation

The use of FM PCM communication reduces the possibility of radio interference through improved signal-to-noise ratio and encoding of commands. Also, prior to each flight, an Aero Spectra frequency analyzer will be used to determine if any transmissions are present on the intended operational frequency. Airfield Operations will be given advance notification of any planned use of the RC transmitter in accordance with the flight release. Aero Spectra frequency analyzer Signal strength during flight is monitored by the RMAX vehicle itself and indicated both via an annunciation light on the RC transmitter and a caution light on the aircraft thus enabling rapid detection and landing in the event of signal degradation. If a condition of a very weak or non-existent signal persists for more than approximately two seconds, then the on-board flight control computer will automatically command a leveling of the swashplate and lower the throttle position and main rotor collective position to ground. This will result in a hard landing of the aircraft but will prevent any uncontrolled flight over an extended distance. Since the aircraft will not be allowed to be commanded to fly outside the assigned flight area or over any person or vehicle, it is highly improbable that a hard landing will result in anything other than damage to the RMAX itself.

3. Interference or loss of Telemetry

If both the 900 Mhz and 2.4 Ghz telemetry links to the RMAX (not the RC link) are lost, the ability of the Ground Station to control the RMAX will be lost.

3.1 Mitigation

The manufacturer-reported probability of failure per hour of the Freewave DGR09 radio modem is 2.5×10^{-5} . Since there are two modems (one on each end) the cumulative probability of failure per hour is 3.75×10^{-5} . Multiplying this by a safety factor of 10 yields a probability of failure per hour of 3.75×10^{-4} which is classified as Remote. Even if the telemetry link is lost entirely, the flight control laws continue to function without ill effect. If the link is lost, then the aircraft would travel on to the last waypoint that had been entered where it would stop in a hover. The aircraft would remain there until such

time that telemetry is reestablished and a new command is given, or the EP retakes control by disengaging via the engagement button on the RC transmitter. Upon disengagement the system reverts to normal RC control. The EP always retains the ability to retake control of the aircraft by depressing the engagement switch on the RC transmitter. If the Ground Station determines that the telemetry link has been lost, then the GSO may simply inform the EP to retake control.

Emergency Procedures

1. Introduction

The Autonomous Rotorcraft Project operates two Yamaha RMAX helicopters. This document describes emergency procedures. Most emergency procedures are described in the previous attachments for lost link and lost communications. The remaining emergency procedures are covered by the Yamaha RMAX Operators Manual and the AFDD Aircraft Accident (Incident) Alert Roster.

2. Yamaha Emergency Procedures

The RMAX is factory equipped with an extensive self monitoring system. Vehicle status and health are indicated via warning lights both on the back panel and on the underside of the vehicle. Prior to engine start the system monitors and displays faults in the YACS, the backup control system, the signal system, the actuators, the IMU, the charging system, low fuel, and weak radio communication. The system will prevent engine start if any faults are detected. During flight the ARP system monitors and display the same faults in the ground station. These faults are displayed on the Situational Awareness display in the ground station and audibly annunciated over the ground station sound system and voice communications system.

3. Accident (Incident)

In the event of an accident, ATC shall be notified immediately of the accident and the need for any emergency medical attention or fire suppression. AFDD has an established alert roster in the event of an accident or incident Any incident involving an RMAX will be a ground accident because under current US Army AR 385-40, it is a UAV. Information pertinent to completing a DA Form 285 will be gathered on scene for future reporting.

4. References

1. Yamaha RMAX Operation Manual, L15-28199-01, First edition, Jun. 1998.
2. AFDD Aircraft Accident (Incident) Alert Roster, Dec. 5, 2006.

Lost Communication Procedures

1. Introduction

The Autonomous Rotorcraft Project operates two Yamaha RMAX helicopters. This document describes the lost communication procedures.

2. Loss of Communications

Radio checks are performed prior to operations to ensure working voice communications between the crew members and the Moffett ATC tower on the UHF trunking radio frequency. The External Pilot (EP), the Safety Observer (SO), and the Ground Station Operator (GSO) use UHF trunking radios to enable voice communication with the ground station and the Moffett ATC tower. All the radios are set to scan both the dedicated project frequency and the Moffett ATC tower ground traffic communications. In the event that voice communication is lost, all parties also carry cell phones to enable backup communications.

2.1 Loss of Comm with Ground Crew

If the EP and SO lose communication with the ground station, then the EP retakes manual control of the aircraft with the RC transmitter, lands the helicopter, and brings the rotor to a stop. The EP always retains the ability to retake control of the aircraft by depressing the engagement switch on the RC transmitter. The helicopter is always operated within line-of-sight at a straight line distance of less than 750 ft. After the vehicle has landed, the SO uses a cell phone to call the GSO to inform him that voice communications have been lost and that operations have been stopped. The SO also informs the Moffett ATC tower of the situation using the trunking radio if possible, and if not, using a cell phone.

2.2 Loss of Comm with ATC Tower

If the EP and SO lose communication with the Moffett ATC tower, then the EP retakes manual control of the aircraft with the RC transmitter, lands the helicopter and brings the rotor to a stop. The EP always retains the ability to retake control of the aircraft by depressing the engagement switch on the RC transmitter. After the vehicle has stopped, the SO uses a cell phone to call the Moffett ATC tower to inform him that voice communications have been lost and that operations have been stopped.