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

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

August 10, 2015

Exemption No. 12403
Regulatory Docket No. FAA–2015–1898

Ms. Karen Dyberg
Spectrum Manager
Raytheon Integrated Defense Systems
1001 Boston Post Road
Marlborough, MA 01752

Dear Ms. Dyberg:

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

By letters dated May 7 and May 18, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Raytheon Integrated Defense Systems (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct testing of the Raytheon radar system and other advanced defense technologies.

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

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

The UAS proposed by the petitioner are the DJI Phantom 2 and DJI S900.

The petitioner requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*. In accordance with the statutory criteria provided in Section 333 of Public Law 112−95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the

aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

**The Basis for Our Decision**

You have requested to use a UAS for aerial data collection[1]. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA−2014−0352), 11109 to Clayco, Inc. (*see* Docket No. FAA−2014−0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA−2014−0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA−2014−0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

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

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

**Our Decision**

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

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

**Conditions and Limitations**

In this grant of exemption, Raytheon Integrated Defense Systems is hereafter referred to as the operator.

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

1. Operations authorized by this grant of exemption are limited to the DJI Phantom 2 and DJI S900 when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

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

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

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

5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents,

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

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

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

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.

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

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

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

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

17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

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

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

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

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

22. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N−Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

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

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

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

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

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

27. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

28. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS−80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov.

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

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

30. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
    c. Name and phone number of the person responsible for the on-scene operation of the UAS;
    d. Make, model, and serial or N−Number of UAS to be used;
    e. Name and certificate number of UAS PICs involved in the aerial filming;
    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
    g. Signature of exemption holder or representative; and
    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

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

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

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

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

Enclosures

Raytheon

Raytheon Integrated Defense Systems
1001 Boston Post Road
Marlborough, MA 01752

May 7, 2015

U.S. Department of Transportation, Docket Operations
West Building Ground Floor, Room w12-140
1200 New Jersey Avenue, SE.,
Washington, DC 20590

Re: Raytheon IDS Petition for Exemption under 14 CFR 11.81 for use of DJI S900 Hexacopter

Dear Sir or Madam:

On behalf of Raytheon Integrated Defense Systems (Raytheon IDS) I am filing this Petition for Exemption, as allowed by 14 C.F.R. § 11.81, to request exemption for use of a model aircraft by a company for its research and development purposes.

Below, Raytheon IDS sets forth the required information for consideration of this exemption request. If further explanation is required for any of these criteria to be met, please contact me at: 508-450-9236 or Karen.Dyberg@Raytheon.com.

## 1. Name, Address and Contact Information for Petitioner

Name: Raytheon Integrated Defense Systems
Contact: Karen Dyberg, Spectrum Manager
Address: 1001 Boston Post Road, Marlborough, MA 01752
Phone: 508-450-9236
e-mail: Karen.Dyberg@Raytheon.com

## 2. Regulatory Exemption Sought:

Raytheon IDS is seeking an exemption from the FAA's Regulations requiring a Certificate of Airworthiness. In this case, the exemption sought is a specific exemption for the proposed operations described below from 14 C.F.R. Sections 21.11, 21.15, 21.20, and 21.21 all related to the requirement to have an airworthiness certificate in place prior to use of an aircraft.

## 3. Extent of Relief Sought:

Raytheon IDS is seeking relief to allow it to operate the DJI S900 hexacopter, a model aircraft, as the platform used for testing of a radar simulator device in Raytheon IDS's development of a rapid prototype radar system. The use of this mobile platform will greatly reduce the cost and speed the time to develop the proposed radar system by allowing remote mobile testing and advancement of the prototype radar system. The relief sought is from the prohibition on companies using model aircraft in their business operations. This relief is very limited, since the model aircraft is used in development of a radar, not for any other purpose.

Regulations from which relief is sought:

Raytheon is seeking relief from a number of sections under Title 14 of the Code of Federal Regulations, including:

14 CFR Part 21 – Airworthiness Certification, subpart H
14 CFR Part 61 – Certification: Pilots, Light Instructors, and Ground Instructors

14 CFR Part 91 – General Operating and Flight Rule
- 91.103(b)(2) – Preflight action
- 91.105 – Flight crewmembers at stations
- 91.109 – Flight instruction
- 91.119 – Minimum safe altitudes
- 91.121 – Altimeter settings
- 91.151 – Fuel requirements for flights in VFR conditions
- 91.405 – Maintenance required
- 91.407 – Operation after maintenance
- 91.409 – Inspections
- 91.417 – Maintenance records

Without such relief, Raytheon would not be allowed to use the aircraft for its independent research and development work.

**4. <u>Reason for Relief – Proposed Operations:</u>**

The proposed testing requires use of an airborne mobile transmitter that will simulate the movement of an object that Raytheon's developmental radar needs to track. The radar tracking is part of a rapid prototype technology development effort. Using commercial-off-the-shelf technology is key to keeping costs low and delivering results quickly.

The model aircraft will be equipped with a radar simulator and flown on secure Raytheon property or in specially designated areas with personnel ensuring secure and safe operations. The purpose is for testing of a Raytheon radar system under development at Raytheon's Pelham, New Hampshire facility. Most of the test sites selected are parking lots or open areas that are on Raytheon facilities, which are fenced in and have restricted access. Since the proposed operations will comply with the amateur UAV user parameters – line of sight operations and no operation above 400 feet – the restricted access to the flight areas should ensure that there is no burden on the national airspace and no impact on other aircraft.

Details of the proposed operations are set out below.

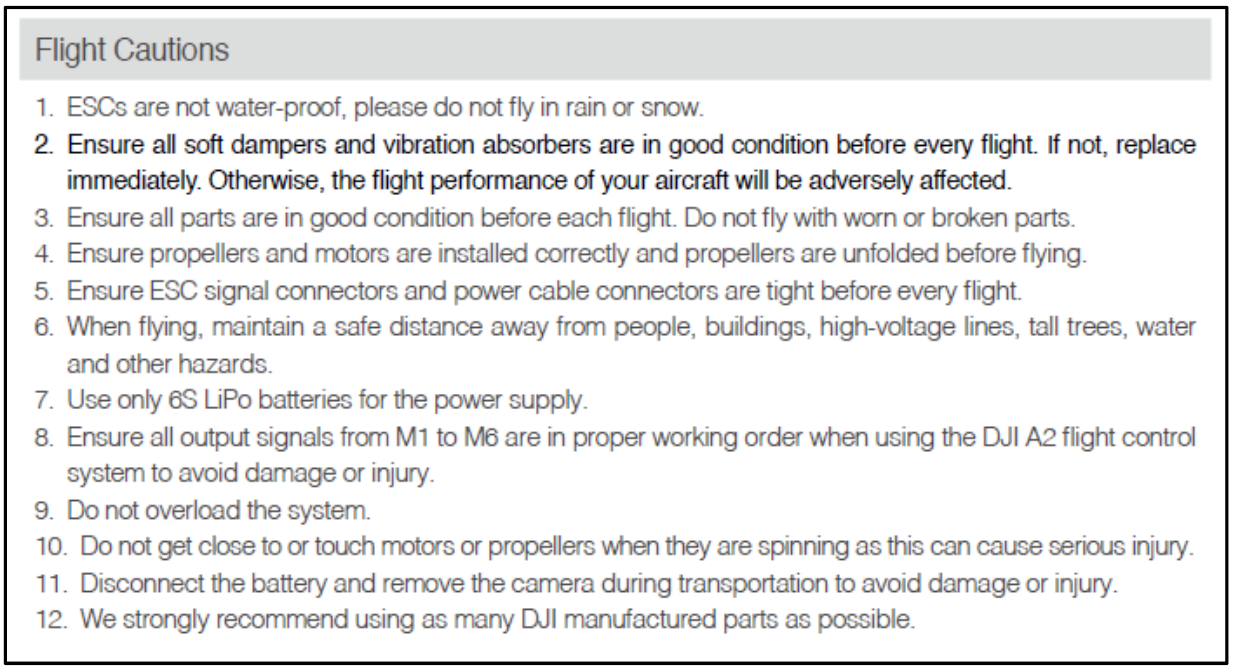
**A. UAS System**

a. Aircraft Performance and Performance Limitations
b. Operating Procedures
c. Aircraft loading information

Make: DJI
Model: S900,
SN: 0370062767
Technical Specifications:
- Diagonal Wheelbase: 90cm
- S900 Takeoff Weight (w/ payload): 5.4Kg
- Payload Weight: 2.1Kg
- Battery Power: LiPo 22.2V 15000mAh
- Estimated Hover Time: 18min (@15000mAh & 5.4Kg Takeoff Weight )

**B. Pre-flight inspections, maintenance, repair**

In accordance with manufacturer instructions we will follow the following instructions to the letter:



Flight Cautions

1. ESCs are not water-proof, please do not fly in rain or snow.
2. Ensure all soft dampers and vibration absorbers are in good condition before every flight. If not, replace immediately. Otherwise, the flight performance of your aircraft will be adversely affected.
3. Ensure all parts are in good condition before each flight. Do not fly with worn or broken parts.
4. Ensure propellers and motors are installed correctly and propellers are unfolded before flying.
5. Ensure ESC signal connectors and power cable connectors are tight before every flight.
6. When flying, maintain a safe distance away from people, buildings, high-voltage lines, tall trees, water and other hazards.
7. Use only 6S LiPo batteries for the power supply.
8. Ensure all output signals from M1 to M6 are in proper working order when using the DJI A2 flight control system to avoid damage or injury.
9. Do not overload the system.
10. Do not get close to or touch motors or propellers when they are spinning as this can cause serious injury.
11. Disconnect the battery and remove the camera during transportation to avoid damage or injury.
12. We strongly recommend using as many DJI manufactured parts as possible.

*Figure 1. Spreading Wings S900 User Manual ver. 1.2, December 2014, at p. 4*

Further, to ensure safe operations, the program will also follow the AMA Radio Control Large Model Airplane Program pre-flight inspection checklist, as shown in Attachment A.

**C. RF spectrum to be used for control of UAS**

The program will use the Futaba 8J controller for remote control operations. It uses the 2.4 GHz unlicensed band configured for RC controllers. The controller is FCC certified. This controller has a special feature. The UAV has an autonomous operation capability. If communication between the UAV and the controller is lost, or if the battery is running low, the UAV has a "return to home" function. The UAV will activate the function autonomously if communication with the controller gets too weak or if the UAV determines its battery life requires return to the home station to ensure safe arrival at the home station before battery exhaustion. Furthermore, if the controller is somehow dropped or broken, the UAV will also return to the home station. If the person in control of the UAV wishes to manually activate the home function, that capability is also available. This would be done if the UAV is operating out of the ordinary or if there is any issue with UAV control. The operator just pushes the home button and the UAV will return home.

**D. Associated equipment that will be part of UAS – sensors, cameras, etc.**

To undertake further development of one of Raytheon's advanced radar systems, an airborne Synthetic Target Generator (STG) is required to exercise the radar. This payload is a radio that is sending out signals at 5 Watts with an ERP of 50 Watts (peak power). This radio signal is used to simulate a remote system that is part of an advanced radar development initiative. Raytheon IDS will obtain an FCC experimental license for the appropriate radio operations.

Installation: The STG with an omni-directional antenna will be added to a small Unmanned Aerial Vehicle (UAV) host platform, the S900, to emulate real target motion through space. The UAV-mounted STG will transmit the FCC-authorized waveforms at low power levels, from several locations, described in detail below. This will allow Raytheon to test the performance of the radar when it is working with an actual moving target that is trackable by the radar system.

No ground-based moving target offers the opportunity to track at the distances required, only a target in motion in the air allows the radar to perform as necessary for its advanced development.

**E. Pilot In Command**

a. Qualifications of person who will be directly responsible for operation of UAS
Private Pilot since 1973: Single Engine Land: Various Single Engine Aircraft
P ilot has flown his own Personal, UAS Quadcopter for more than 1 year

b. Level of airman certificate held
Private Pilot, Single Engine Land

c. Applicable training related to the operation
The pilot has trained and been licensed and certificated as a pilot. He has personal experience operating UAS systems.

d. Minimum hours of flight experience
Over 200 hours of flight experience

e. If operation will use visual observers, describe their roles and qualifications
The remote control operator will be the observer for all flight operations.

f. Medical standards and certification of the person(s) directly responsible for operation of the UAS.
Yearly Physical

**F. Safety:**

a. How operations will not adversely affect safety: The proposed operations are limited in time and scope. Testing will take place only on limited work days, when the radar testing is underway. The testing will be limited to 15 minute increments, which is the power limitation of the UAV. The areas selected, described in more detail in this Petition, are protected from public access, and are isolated areas, even on the Raytheon properties. No operations are proposed that would cause any sort of hazard.

b. How operations will provide a level of safety at least equivalent to that provided by the rule from which exemption is sought: The rules from which exemptions are sought are the rules that precludes this UAV operation by this operator – Raytheon. The current rules preclude a business from operating the UAV, although the rules would allow an amateur to operate the same UAV, under less restricted circumstances. So, to ensure the proper level of safety, the proposed operation will be strictly in accordance with the already-permitted amateur operating guidelines, only by a company that needs to use the platform to expedite development of a radar system. Because Raytheon has a regulatory compliance program, the level of safety of operations will be followed strictly, leading to a level of safety at least equivalent to that which results from amateur operations of the same UAV platform. Pre- and post-flight safety checks and operation by a licensed pilot will also ensure that the level of safety for these operations will be at least equivalent to the rule that allows amateur operations of this UAV.

c. Plans to implement clearly defined operational borders and procedures to ensure public safety, which includes persons and property both in the air and on the ground: The operational borders are in place because of the areas of operation selected. Three areas are contained on secure Raytheon facilities; the others are MDC which is adjacent to a

Raytheon property and Area 4, which is a designated UAS test-site. The Raytheon facilities, which are the top priority sites to use, are fenced off from the general public, with secure access required, and all entrances to the property are gated with security at the gates. At those sites, the area of operation is wholly contained within the Raytheon facilities, and the areas chosen on the Raytheon property are remote and unused. The areas were selected because of their remote and unused condition. Further, Raytheon will post signs around the operational area prior to test operations to ensure that no people will be exposed to any potential harm. In addition, because the area of operations is small and the operator will be within sight of the UAS at all times, the operator will be able to also watch out to protect any Raytheon employee who might be in the test area unexpectedly.

The low mass and low speed of operation for this UAV will also ensure that there is no harm to any individual in the area of operation.

**G. Flight Characteristics**

a. Maximum operating speed – The maximum speed of the UAV is 16 m/second (about 30 miles per hour). The UAV will NOT operate above 20 miles per hour. The UAV device will take off and be used primarily to hover with its radio payload in operation. The goal is to ensure that the remote radar is able to detect the simulated radar target and to work on processing the signals. For that testing, the UAV does not need to move very much, in fact it would impede the operation of the radar testing if it did. The hover capability of this UAV is the reason that the program chose a hexacopter rather than a fixed wing aircraft. There will be some side-to-side movement 30-40 meters either direction, but the testing design calls for the UAV to remain primarily in one general area at the test facility. The flight pattern will be either an oval or a figure 8 pattern over the test area. The maximum speed used in testing could go as high as 20 miles per hour.

b. Altitude – below 400 feet.

c. Describe minimum flight visibility – No flights will be conducted if the weather visibility is less than 3 miles from the control station. If the visibility is 3 miles or greater, and wind conditions allow for safe flight, flights may be conducted as necessary.

d. Distance from clouds for intended operations - The normal cloud ceiling in this area is above 3000 feet, and the maximum altitude of flight will be below 400 feet. If it is a cloudy day, they will not fly anyway. Further, there will always be visual line of sight between the operator and the UAV.

e. Potential hazards and safety mitigations - The mass of the UAV is low enough that the device does not pose much of a safety hazard. The testing area will be cleared of any people who are not part of the test prior to any operations. The operator will ensure that the UAV operates clear of trees, power lines, buildings, street lights, and other obstructions. The failsafe in the UAV will help to ensure that the UAV does not land away from the operator, because it will return to home rather than lose signal or power.

**H. Characteristics of Area of Intended Operation**

a. General Description – The areas selected for operation are four open areas on, and in one case next to, Raytheon property, where there are no people and the actual area of operation would be away from buildings. The fifth site selected is a UAV test range that would only be used if none of the other sites was available.

The Raytheon sites: Pelham, Raytheon HQ, and Sudbury are all on property that is securely fenced off from public access. To gain access to the property, any visitor would have to go through security at the main gate. The security of the facility is high because of the nature of work that Raytheon conducts. There will be no passers by entering the test area. Further, no general public vehicle traffic will be in the area.

MDC is at a Raytheon property in Woburn, Massachusetts. The test area is public land behind the Raytheon property, and the area is generally not accessed by the public. This site is not expected to be in use very much for the testing, but it was added in case its location is necessary for the geometry testing of the radar.

The UAV test range is not on Raytheon property, but it is a known UAV test range, and as such it is known to the public as a place where UAVs are flown. Raytheon, if it uses this site at all, will used enhanced precautions to ensure that there are no hazards present during any flights conducted there.

b. Google Earth images of each of the five test areas are below:

*Site Locations (Lat, Long, & Alt -ft)*
Site0: 42.737013°, -71.354670°, 412
Site1: 42.637037°, -71.249763°, 197
Site2: 42.521533°, -71.141729°, 107
Site3: 42.364951°, -71.430758°, 159
Site4: 42.616659°, -71.510590°, 204

The *Figures 2-6* are taken from Google Earth, depicting the site locations with a 100 meter radius from the site coordinates. The radius is for informational purposes only, since the hexacopter will not fly throughout the whole radius. At the MDC and Sudbury sites, operations will be limited to the sectors shown, to ensure additional safety. When the hexacopter is in use, it will fly/hover in a very limited portion of the area shown. These images are presented to allow the reviewer to see that the areas selected are away from people and mostly away from buildings. In those areas, the hexacopter will fly in an oval or figure eight pattern, if it is not simply hovering.


*Figure 2. Pelham Site*


*Figure 3. Raytheon Headquarters – back parking lot, showing potential flight pattern*


*Figure 4. MDC, showing potential flight pattern*

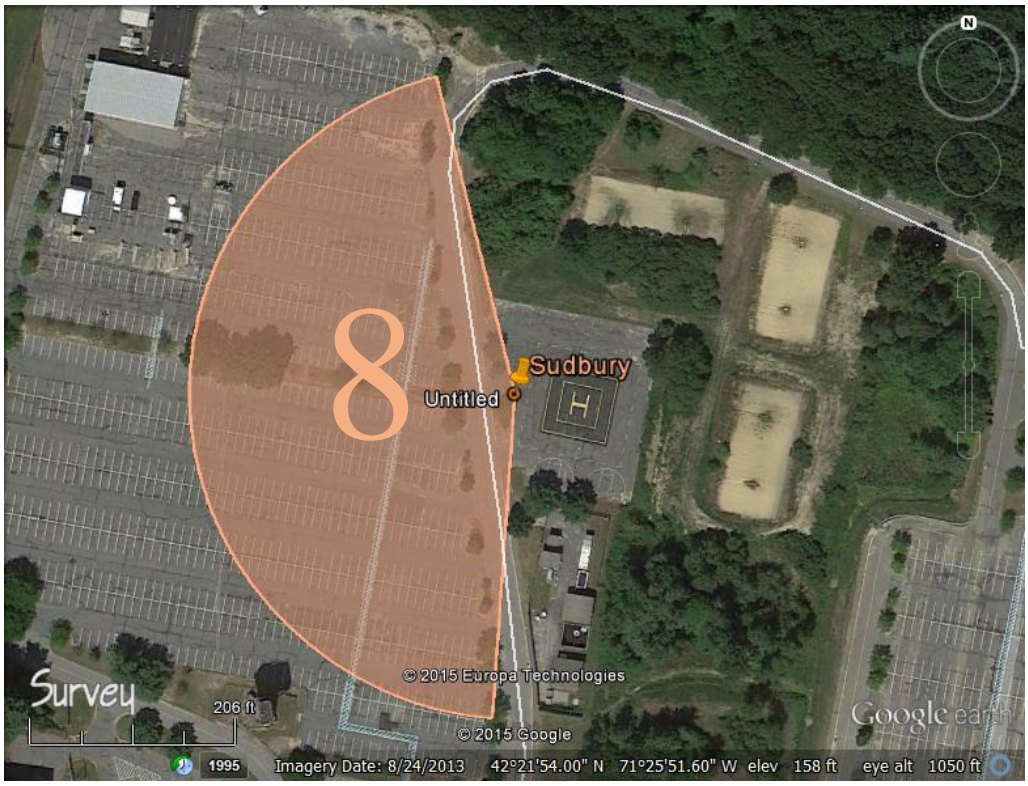



*Figure 5. Sudbury location, showing a potential flight pattern*

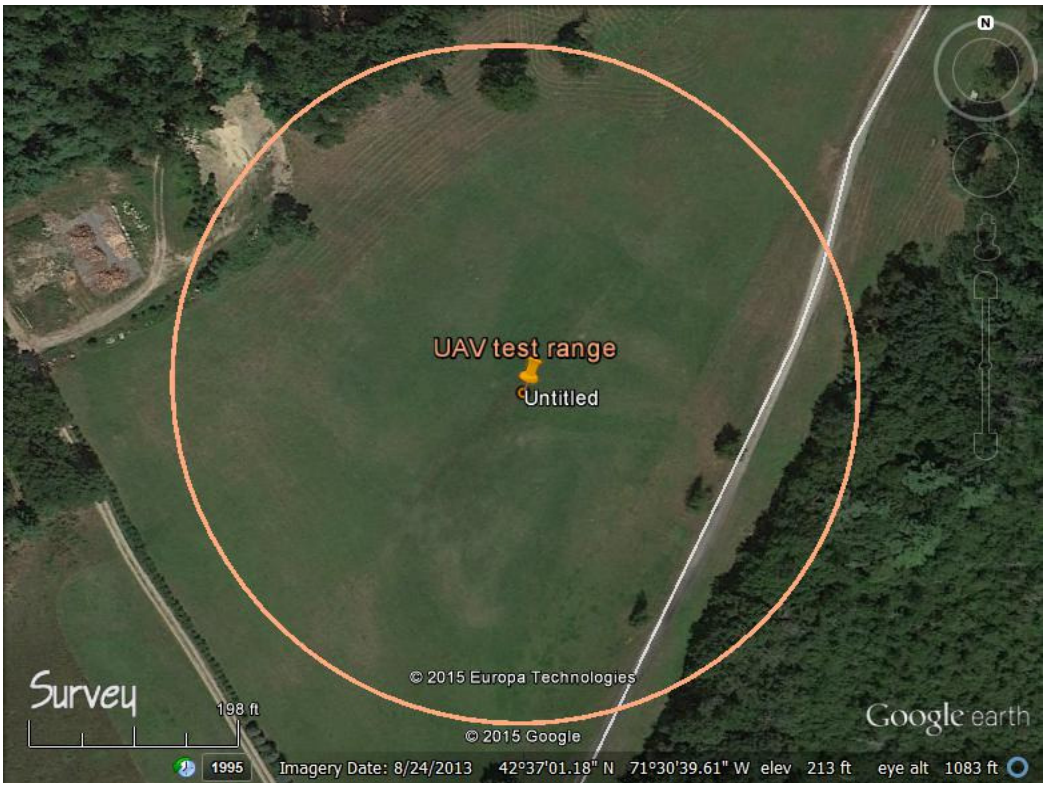



*Figure 6. UAV test range*

c. Associated potential hazards
Pelham: None.
Raytheon HQ: None
MDC: None
Sudbury: None
UAV test range: None

d. Proximity to populated areas - The area of operations will be limited to the open spaces in the sites selected. Operations will be controlled by a licensed pilot, and the operations will avoid any buildings. This is essential not only for the safety of flight and the people in the buildings, but any flight near a building could interfere with the radio experimentation that is the purpose of the flight.

***I.*** **Proximity of any Airports**

Site-by-site assessment of airport proximity:
Pelham Site – the Pelham site is near the Steck Farm Airport, which does not appear to have a runway, although there do appear to be some bi-planes parked at the farm, and they may use the field as their runway.

Raytheon HQ – about 4.5 miles from the headquarters location, to the northeast and in the Merrimack River is the Merrimack Valley Seaplane Base. There are no other airports or heliports nearby.

MDC – no nearby airports. There is a "digital heliport" within about 2 miles, but on closer inspection, it does not appear to be a heliport at all, since there are no markings for use by aircraft in the parking lot.

Sudbury – Nearby airports: there is an old airstrip is nestled in the woods about 1.5 miles from the Sudbury location, but it appears to be in disrepair and not used. Also, the Marlboro Airport is approximately 5 miles from this test site. It is a public airport with one runway that averages about 37 flights per day.

UAV Test Range – the only aircraft facility within five miles of the UAV test range is the Nashoba Community Hospital Heliport. The next nearest airport is Pepperell Airport which is between 7 and 8 miles away from the UAV test range. Pepperell is a private airport, used largely for sky diving activities. While the airport is open to general aviation, not commercial, and pilots must call first to use the airport.

Summary Analysis: After review of the nearby airports, and given the height limitation of the UAV flights (400 feet or less) there is no anticipated concern that any UAV operations will pose a hazard to any airport or flight operations.

**J. Operation in Visual line-of-sight in accordance with Section 333(b)(1)**

The operations will operate with visual line of sight. The UAV will never be out of sight of the operator. Because the area of operations will have a radius of 100 meters, with the expectation that the UAV will hover more than it will fly, the UAV is expected to be much closer to the operator than 100 meters. The areas selected for operation, as shown in figures 2-6, are open areas with no obstacles or obstructions to view. These areas were selected both for the safety of flight characteristics, but also because open areas are required for the testing to be effective. Figures 3, 4, and 5 also include overlays which show the possible flight paths of the UAV at those test sites. The UAV operations will be limited to oval (race track) paths or figure eight paths, to keep the UAV in a discrete area away from any obstacles, buildings, or people. Further, these flight paths are ideally designed for the radar development operations that are the purpose of the UAV flights.

The pilot in command of the UAV will maintain visual contact with the UAV as well as having control of the RC controller to direct flight. Finally, the pilot in command will have the ability to trigger the "home" command if at any point safety requires it.

**K. Procedures for pre-flight safety risk assessment to comply with 14 CFR Section 91.7(b)**

The pilot, along with the UAV team, will conduct a pre-flight safety risk assessment prior to any operations. The procedures will include:

Checking and monitoring weather conditions every 15 minutes the day of flight to ensure that wind conditions will not allow loss of control to the UAV.

Checking visibility to ensure that the minimum visibility will be maintained throughout each 15 minute scheduled flight.

Inspecting the chosen flight area for obstacles, people, or valuable property. Adjusting the flight area to avoid any obstacles or people to ensure the safety of all.

Prior to each flight, the flight area will be cordoned off with signs posted that a flight is in progress and that people should avoid the area. This will protect any Raytheon staff from inadvertently entering the area during a flight, thereby minimizing any chance of risk to humans.

Further, to ensure the airworthiness of the aircraft, the pilot will conduct all of the pre-flight safety checks and inspections listed in the AMA manual – see Attachment A – and in the aircraft user manual – See *Figure 1*, above – before every flight.

Raytheon's proposed testing would equip the hexacopter with a simulated radar transmitter and fly the hexacopter in specifically designated areas, below 400 feet, to allow work on advancement of the radar system.

The central radar, where system development is taking place is located at: Pelham, New Hampshire - Site0: 42.737013°, -71.354670°, 412 ft AMSL

The operations would be conducted by a specialized team of operators who are expert in use of the hexacopter as well as very familiar with the FAA's requirements for see and avoid procedures with regard to any and all other aircraft operating in the nearby National Air Space.

**5. How would this request benefit the public as a whole:**

The proposed operations will deliver a high quality technology to potential US government customers at a rapid rate and economical cost. This benefits the public by delivering advanced technology rapidly that will enhance national security. Further, the use of commercial off the shelf components as a platform for developing the radar system will save tax payer dollars over development of a customized UAV as the platform for the radar simulator. Further, there is no harm to the public from the proposed operation. The goal is to use this UAV as part of a research experiment, not as a device for hire.

The whole purpose of the operation is to use the UAV as a platform that will advance the development of a radar system. Testing of this UAV is not the reason for this request. The experimentation is devoted to radar system development. Advances in the radio system will prove fruitful for Raytheon's DOD customers.

**6. Reasons why this exemption will not adversely affect safety or how this exemption will provide safety at least equivalent to the existing rule:**

The proposed operations will be conducted by a licensed pilot who is very familiar with the FAA's rules on UAS operations.

Use will be limited to the greatest extent possible, and the burden on the national air space will be as low as possible, since flight operations will only take place to advance the science of the radar. The primary locations for this testing are on Raytheon plant sites, and not at publicly available spaces. The areas selected, as described above, are fenced off from the public and only personnel with proper authority are allowed on site. With the low altitude of flight, there is no chance of any interference with any aircraft or other UAVs.

Further, testing will only be conducted sporadically, in good weather conditions, and by personnel who are experienced with the need to protect the national air space using see and avoid techniques.

The operations will be conducted by a certificated airman with many years of experience as a pilot. His experience in conducting pre-flight and post-flight inspections will prove invaluable to ensuring that the flight operations are conducted in compliance with all procedures. Further, his experience will also prove invaluable in ensuring that the flight operations will be conducted in accordance with the proper diligence and care.

This level of experience and attention to proper procedure is essential to ensuring Raytheon's compliance with the FAA's regulations. Since these aircraft are otherwise flown by amateurs for recreational purposes, in

areas which may not be controlled, the proposed exemption will provide safety at least equivalent to the existing rule.

7. **Summary:**

Raytheon is seeking an exemption from the FAA for the use of a commercial-off-the-shelf UAV to speed the development of advanced defense technologies. The use of the UAV will allow for rapid prototyping of a radar system and speed the troubleshooting of various technical issues by using a remote synthetic target generation that will test the radar performance.

The exemption request seeks authorization for use of the DJI S900 Hexacopter to carry the target generator. The FAA's current regulations preclude a business from using an amateur UAV in their business operations. Because the aircraft does not yet have an airworthiness certificate, this petition seeks to waive various FAA regulations regarding the use of certificated aircraft. However, the key to the testing is that Raytheon will be using a UAV that is widely available to amateur users, and Raytheon will be using the UAV in highly controlled environments and with stringent safety protocols.

Raytheon will utilize the experience of a licensed pilot to command the operations of the aircraft. The aircraft will operate below 400 feet in altitude. The aircraft in question has a homing feature which will ensure that it never loses power far from its starting point and which ensures that it will not fly out of range of the controller.

Operations will be limited to visual line of sight, with an emphasis on see-and-avoid procedures being followed.

Flights will be sporadic and limited to 15 minutes at a time, not constant, and certainly not daily. Furthermore, the UAV will only be in use during the workday, not at night nor on the weekends.

Grant of this Petition for Exemption is in the public interest because it will advance the radar science through the use of innovative technology, at a lower cost to the public and at a quicker pace that is important for our nation's security. Further, the proposed operations, which include command by a trained pilot, do not pose a greater risk to the public than operations already taking place by amateurs.

This Petition does not seek an exemption for use of the UAV for hire. It is simply a highly efficient tool for advanced development of a radar technology which is important to the US Department of Defense.

**Conclusion:**

For the foregoing reasons, Raytheon IDS respectfully requests that the FAA grant this Petition for Exemption to allow it to operate a UAV platform for the rapid and cost-effective development of its radar system. Raytheon IDS will take all precautions to protect the national airspace, as described above. Should you have any questions or need further information, please contact me.

This request is vital to our national security. Thank you very much for your consideration.

Sincerely,

Karen Dyberg

Karen Dyberg
Spectrum Manager
Raytheon Integrated Defense Systems

## GUIDELINES FOR LARGE MODEL AIRPLANE INSPECTIONS

No one can predict equipment failure or pilot error in the flying of radio controlled airplane. However, if the following preliminary precautions are met, equipment and structural failures can be minimized.

Whether you are the owner of a LMA or an appointed LMA Inspector, you will evaluate every aspect of the airplane awaiting certification.

The following is considered the criteria for certification of Large Model Airplane:

### *Check List for Preflight Inspection*

1. UN-ASSEMBLED INSPECTION

1.1 WING GROUP

( ) Fuselage attachment points
( ) Strut attachment points
( ) Rigging wire attachment points
( ) Servo mounting
( ) Pushrods/cables and actuating links
( ) Control horns
( ) Control surface hinges and area around hinges
( ) Undercarriage integrity and attachment points
( ) Structural integrity overall
( ) Covering integrity

1.2 FUSELAGE GROUP

( ) Wing attachment points
( ) Undercarriage integrity and attachment points
( ) Servo mounting
( ) Pushrods/cables and actuating links
( ) Control horns
( ) Control surface hinges and area around hinges
( ) Fin and rudder assembly
( ) Horizontal stabilizer assembly
( ) Bracing/strut attachment points
( ) Structural integrity overall
( ) Covering integrity

### 1.3 ENGINE(S)

*( ) Propeller secure and undamaged
*( ) Spinner secure and clear of propeller blades
*( ) Engine mounting and accessories secure
*( ) Cowling attachment
*( ) Magneto switch functioning and OFF
*( ) External servicing points (fuel, plus, etc.)

### 1.4 RADIO EQUIPMENT

( ) Receiver installation
( ) Battery installation
( ) Antenna installation
( ) Switch installation
( ) Wiring and plugs clean, undamaged and secure

## 2. ASSEMBLED INSPECTION

### 2.1 GENERAL

( ) First ensure that all components fit together correctly, and that no undue strain is needed to achieve proper alignment.

### 2.2 RIGHT WING

( ) No non-design twists or warps
( ) Wing tips true
( ) Wing leading edge
( ) Struts and rigging secure
( ) Attachment to fuselage
( ) Undercarriage attachment
( ) Alignment of control surfaces

### 2.3 FUSELAGE AND TAIL GROUP

( ) Horizontal stabilizer attachment
( ) Fin and rudder attachment
( ) Struts and bracing secure
( ) Alignment of tail group with respect to wing
( ) Alignment of control surfaces
( ) Tail wheel assembly
( ) Canopy

2.4 LEFT WING

( ) No non-design twists or warps
( ) Wing tips true
( ) Wing leading edge
( ) Struts and rigging secure
( ) Attachment to fuselage
( ) Undercarriage attachment
( ) Alignment of control surfaces

2.5 MISCELLANEOUS

( ) Center of gravity
*( ) Correct movement and centering of all control surfaces
*( ) Battery charge, fuel, air pressure all sufficient

2.6 CHECKS WITH ENGINE(S) RUNNING

*( ) Airplane secure before start (tied down preferred)
*( ) Engine performance and reliability
*( ) Propeller and spinner balance
*( ) Minimal airplane vibration
*( ) Radio reliability
*( ) Radio range check

The above check list is to be completed by the owner of a LMA or an appointed inspector prior to test flights. All items are to be marked “N/A” if not applicable, checked if passed, or left blank pending re-inspection if failed.

The Check List is subsequently used by the operator of the airplane:

(a) Once at the beginning of a flying session (all items)
(b) Before every flight (items marked with an * only)

## PREFLIGHT CHECKOUT TEST
(Should be completed prior to each flight)

CONTROL SYSTEM:

( ) Perform a range check with your radio. Use the recommended range check distances as described by the radio manufacturer as a minimum test range requirement. Perform the range check, without the engine operating, to the maximum range achievable without control degradation.

( ) Run a similar check with the engine operating at power levels from idle to maximum power. If there is range degradation with an operating engine there is an issue with ignition noise and/or a vibration induced problem. Do not fly until this is resolved. ANY reduction in range means a loss in signal/noise ratio and a chance of control loss in flight.

The engine off/engine on test should be conducted prior to each flying session since degradation of shielding and spark plugs with usage is a historical fact.

( ) Check servo operating for erratic performance, especially with the engine(s) operating. Be sure they operate smoothly throughout the entire control range. Apply hand load to surfaces while being moved by transmitter action to check for non-flexing of control cables/rods.

( ) Transmitter battery life MUST have been previously established by a discharge test, prior to first flight.

( ) Keep a daily record of transmitted "ON" time.

( ) Check the state of charge of the flight battery packs, UNDER LOAD, just prior to each flight. Flight battery packs MUST have been previously checked for design capacity prior to first flight.

( ) Check the function of the fail-safe system by turning off the transmitter and observing the results.

VEHICLE:

Thoroughly inspect the airplane and components for assembly and for structural integrity.

( ) Inspect the wing and tail assembly for signs of structural failure.

( ) Examine all control surface hinging for design integrity.

( ) Examine servo mounting and retention screws or bolts.

( ) Examine all push rods and keepers.

( ) Be SURE there is no looseness or slop in the control components.

( ) Check the mounting provision for tightness and security of all components that are removable for transporting to and from the flying site.

( ) Inspect fuselage for signs of potential failure or damage during previous flights or transporting.

( ) Check servo installation and be sure the servo arm retention screws are tight.

( ) Inspect receiver/servo wiring for integrity and see that all plugs connecting the components are taped or in some way protected from vibrating apart. Include battery pack plugs.

( ) Check to see that receiver antenna(s) are routed away from servos. Vertical orientation of antenna is preferred.

( ) Check for NO STRAIN on antenna/receiver connection.

( ) Examine landing gear mounting and function. (retract/steering)

( ) Examine fuel tank(s) installation for adequate support, isolation from vibration and ZERO leakage. Special care must be given to gasoline systems in view of the increased fire hazards involved.

ENGINES:

( ) Inspect mounting for looseness, cracks or evidence of degradation.

( ) Check for loose bolts, muffler looseness, routing and integrity of ignition wiring, etc.

( ) Check propeller(s) and installation for tightness. Propellers must have the edges rounded to prevent hand cuts on starting. Always use a glove or engine starter.

( ) Check spinner(s) for tightness or cracks. (Loss of a spinner and/or propeller in flight can quickly generate a panic situation).

( ) Inspect cowl area for loose nuts and bolts.

ENGINE RUN-UPS:

( ) Exercise extreme caution when starting and operating engines. A starter is preferred to avoid hazards to the hands or body.

Securely restrain the vehicle. Do not allow ANYONE to be positioned in the plane of rotation of the propeller(s).

The use of safety glasses is encouraged. Avoid loose clothing, transmitter straps, etc. that might engage the propeller.

( ) Always have a FIRE EXTINGUISHER available when operating gasoline engines.

( ) Start the engine(s) and check for proper idle.

( ) Be sure that the engine(s) operates at desired top end R.P.M. and does not sag with prolonged running, from inadequate cooling.

PILOT STANDARDS:

The inspector will review the pilot's skill level at the same time as the model's qualification flight.

Safe operation is a mixture of several ingredients: design, construction, pre-flight check-out and the pilot. A proficient pilot can often avoid a disaster when power failure, partial loss of control or many other incidents occur. The larger the airplane is, the more it will fly like a full-scale airplane than smaller models. Control and engine(s) response are quite different from smaller airplane.

The following constitutes the standards for pilots of airplanes in the LMA-2 classification:

( ) At least five years background in model design, construction, and/or piloting of radio controlled model airplane.

( ) Has demonstrated successful flying experience of LARGE heavy models in excess of 40 pounds.

( ) A demonstrated ability to recognize stall and loss of aerodynamic control.