Program Letter for Desert Hawk III UAS for an Experimental Certificate

Registered Owner Name: Lockheed Martin Mission Systems & Sensors **Registered Owner Address:** 1801 State Route 17C Owego, NY 13827 **Aircraft Description:** **Desert Hawk III UAS** **Aircraft Registration:** N3001D (Experimental)	**Aircraft Builder:** Lockheed Martin Mission Systems & Sensors **Year Manufactured:** 2011 **Aircraft Serial Number:** AV-0569 (Experimental) **Aircraft Model Designation:** Desert Hawk III **Engine Model:** Neu 1905 – electric motor **Propeller Model:** Aeronaut CAM 13x6.5

1. Overview of Project. The applicant must provide a general explanation and overview of the project, indicating any past flight history or experience for consideration. The applicant must provide enough detail for the FAA to understand the program's purpose and need for an experimental certificate for a UAS or OPA, including the following:

a. **Definition of the Experimental Purpose.** Provide a definition of the experimental purpose(s) under which the aircraft is to be operated (14 CFR § 21.191, Experimental certificates).

The Desert Hawk III UAS activity is in support of engineering research and development for enhancements to operating capabilities, verification of design changes implemented within the hardware or software for operating the Desert Hawk III. Several development activities are underway related to alternate payload modules, longer endurance batteries, as well as refinement to the autopilot module that will be supported by experimental operations. As these configurations are available they will be reviewed with the FAA for inclusion under the experimental approval. The initial approval configuration aligns with the production aircraft.

The Desert Hawk II UAS will also be used for crew training of personnel in the operation of the Desert Hawk III. This training will involve operation and checkout of personnel for currency requirements on operating the Desert Hawk III UAS as well as training additional personnel in the operation of the UAS while under the supervision of trained operators.

The Desert Hawk III will also be used in support of Market Research in performing demonstrations of capabilities for potential customers in support of determining fit of the Desert Hawk or for identifying enhancement opportunities to meet potential customer needs.

b. Description of the Purpose/Scope of the Experimental Program. Provide a description of the purpose/scope of the experimental program for each experimental purpose sought (§ 21.193(b) and (d), Experimental certificates: General).

The scope of the test activity associated with the build of the Desert Hawk UAV is to perform operational verification checks associated with the UAV. These checks verify the proper operation of the UAV including installation and operation of the autopilot, communication system and payload interfaces. Specifically, the testing is geared toward verifying the following items:

- *Ability to properly load and execute a mission plan*
- *Ability to successfully launch the UAV*
- *Verify dynamic performance of installed GPS receiver to acquire and track satellites*
- *Verify the ability to establish and maintain an orbit*
- *Verify communication data link performance*
- *Verify landing performance*
- *Observe proper flight characteristics during the test flight*

Flight test operations will utilize profiles similar to the production flight test needs to support initial verification flight test activities related to system enhancements.

c. Reserved.

2. Definition of Flight Areas. Provide a definition of the area(s) in which the experimental flights will be conducted. Include the following:

a. The areas over which the flights are requested to be conducted and the address of base operation (§ 21.193(d)(3)).

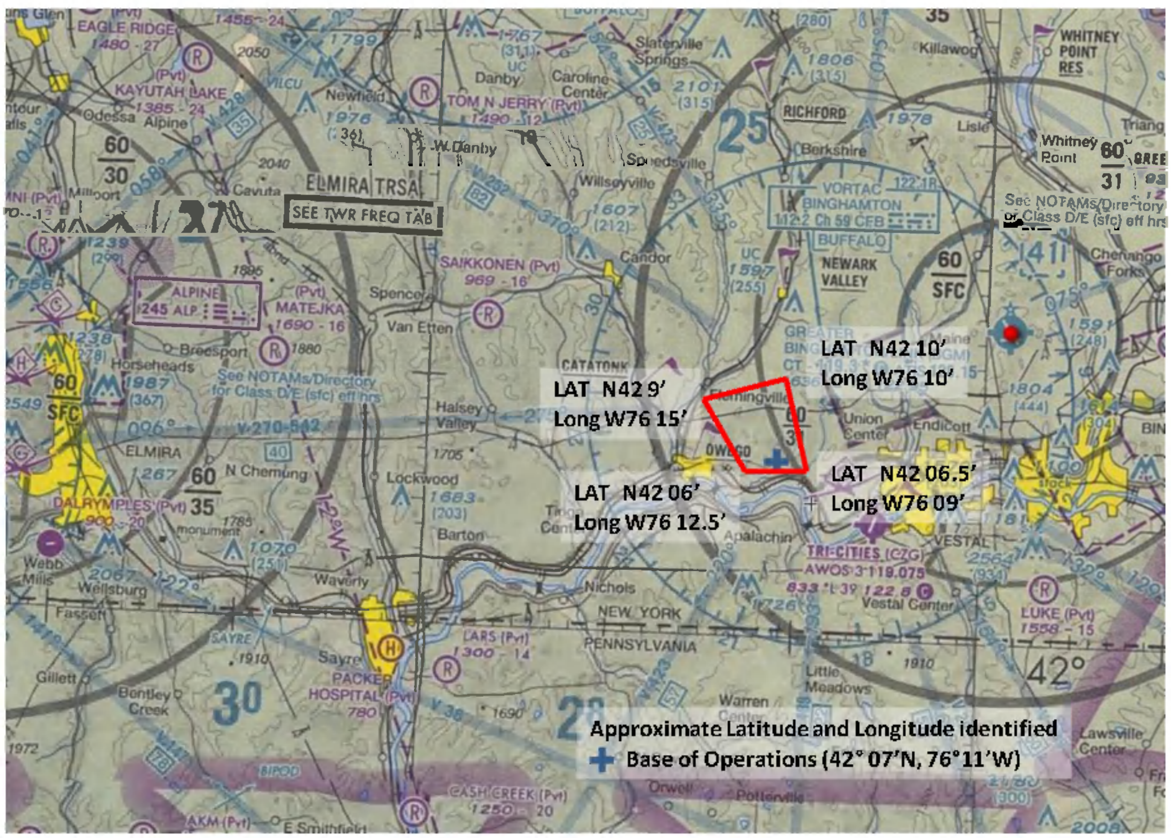
The area of operation is defined by the flight areas shown in section 2b. This area includes a base of operations on Lockheed Martin leased property to support launch and recovery operations at approximately N42°07' / W76°11'. This area will be used for both experimental and production flight testing.

b. The proposed flight test area using latitude and longitude on an aeronautical chart or aerial photograph. For example, if the perimeter of the proposed flight test area is in the shape of a rectangle, the latitude and longitude of the corners must be stated. The distance of each leg of the perimeter must be stated.

The proposed operating area for the Desert Hawk III test activity is identified as follows:

> *The proposed operating area for the Desert Hawk III operations is in a rectangular area north of the Lockheed Martin Owego facility bounded by a southern line from Lat N42 06', Lon W76 12.5' running generally eastward for approximately 2.6 nm to Lat 42 06.5', Lon W76 09'. Then running in a northerly direction for approximately 3.6 nm to Lat N42 10', W 76 10'. Then running in a westerly direction approximately 3.8 nm to Lat N42 09', Lon W76 15', returning in a southerly direction approximately 3.5 nm to the starting point at Lat N42 06', Lon W76 12.5'. Within this area the operating base location would be roughly N42 7', W 76 11'. Operating altitude within this region would be up to a maximum of 1000 ft AGL.*

Mission plans will be generated to support the test activity in this area. Mission plans will account for an approximately 1Km buffer distances from area boundaries to allow operators to terminate any flights prior to the UAV departing from this defined airspace.



c. Airspeed, altitude, number of flight hours, number of flights, and program duration for each test flight area.

The Desert Hawk has a maximum airspeed of 44 Kts, and cruise airspeed of 32 Kts. Test flights will be less than 1,000 ft AGL. The maximum flight endurance of *the Desert Hawk is approximately 90 minutes. Experimental flights will vary in duration but typically would not exceed 60 minutes. The quantity and frequency of experimental flights will be dependent on the nature of the testing being done and will be coordinated with any production flight test activity.*

d. Class of airspace to be used.

Class E.

e. Whether minimum fuel requirements of 14 CFR § 91.151, Fuel requirements for flight in VFR conditions, will be met.

The Desert Hawk is an electrically driven UAV based on an installed battery, minimum fuel is not applicable.

f. Whether flight testing will include payload testing, if the operation is for flight testing. If so, briefly describe the payload and its operation.

Flight testing may involve the verification of installed payload modules for the Desert Hawk. The data stream for these modules is included in the data telemetry stream associated with UAV control and monitoring. The payloads for Desert Hawk III are electro-optical or infra-red sensor units that provide video feedback to the ground station. The ground station has the ability to steer the on board sensor camera to maintain video on an area of interest. Several different payload modules are currently available, with potential for future payloads to be part of the experimental test configuration..

g. Considerations that need to be taken into account regarding payloads.

Desert Hawk payloads are installed in an integral module for the UAV. The UAV provides power and data link support for transmitting data from the payload to the ground station.

h. Whether the aircraft will perform any aerobatic maneuvers.

Aerobatic maneuvers are not part of the planned testing for the Desert Hawk UAV.

i. Flight rules and weather conditions, for example, VFR and visual meteorological conditions (VMC).

Desert Hawk flight testing will be conducted under VFR and VMC conditions, and will maintain LOS communication and operation of the UAV.

3. Aircraft Configuration. Attach three-view drawings or three-view dimensioned photographs of the aircraft (see § 21.193(b)(4)). Describe any ground support equipment (power carts, air carts, towing equipment, etc) required for aircraft operations. Describe UAS configuration, including the control station. Include a description of aircraft/system performance characteristics including the following:

a. Wing span. *59.1 in.*

b. Length. *37.5 in.*

c. Powerplant. *500 watt electric DC Brushless Motor*

d. Maximum gross takeoff weight. *8 lbs.*

e. Fuel capacity. *N/A*

f. Payload capacity. *2 lbs.*

g. Maximum altitude. *17,000 ft*

h. Endurance. *90 minutes maximum*

i. Maximum airspeed. *44 Kts.*

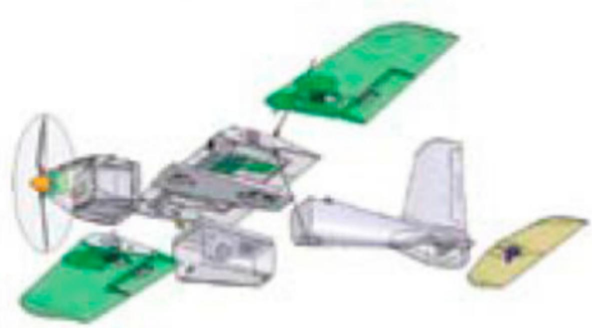
j. Control/data frequencies.

Desert Hawk uses separate uplink and downlink frequencies. For uplink data transmittal, two separate bands, each with 6 selectable channels, can be used. For downlink data, three separate bands, each offering 8 selectable channels, are available for use. Desert Hawk does not require a power car, air

k. Guidance and navigation control.

Desert Hawk III UAS incorporates an advanced autopilot system with integrated GPS, which provides precise navigation, station keeping and easy aircraft re-tasking. The autopilot and embedded navigation system integrated with the intuitive and easily operated and lightweight GCS allow operators without flight experience to easily plan and execute autonomous missions. The Desert Hawk UAV contains a GPS receiver module and three rate gyros to support guidance and navigation control. Altitude and airspeed are provided by a pitot static sensor system. The aircraft relies on its advanced auto pilot for both the pre-programmed and real-time changes to its flight path. In the event of lost link with the aircraft, the aircraft will fly a pre-programmed flight path and recovery route while attempts to re-establish link are made. If link is not re-established, the aircraft will recover autonomously in accordance with its programmed lost link procedures at a preselected lost link landing site.

Desert Hawk III UAS Description



Desert Hawk III Air Vehicle

Desert Hawk III airframe, weighs only six pounds, and is foam and carbon based with a Kevlar-coated shell for enhanced durability. It is capable of carrying a two-pound payload. DHIII is powered by a quiet electric motor and can remain *airborne for up to 90 minutes. Upon recovery, the rechargeable battery or modular plug and play imagers can quickly be swapped out and the aircraft can be re-launched within five minutes. DHIII disassembles into seven sections and can be transported in a backpack or small carry case. The system is completely man portable, offers modular multi-mission imaging sensors, and can be operated by one person, though a two-person team is optimum. The air vehicle is hand launched and, aided by GPS, accurately recovers via a skid-landing on all terrain.*

Desert Hawk III UAS provides a live video feed via an RF link to both the GCS and the optional Remote Video Terminal (RVT). The Desert Hawk III is sensor centric. The operator focuses on controlling the sensor rather than "flying" the air vehicle.

The portable Ground Control Station (GCS) consists of six primary components: a DC Power Distribution Box (PDB), Fully-Ruggedized Computer, Digital Video Recorder/Monitor (DVR), integrated Data/Video Communications Box (D/V Comms Box), and omni-directional uplink and downlink antennas. A single operator has the ability to control both the air vehicle operation (fully autonomous or manual control) and imager payloads. Additionally, sensor information may be displayed on the computer in addition to the digital Recorder/Monitor. The MiniDV provides the capability to record payload imagery with overlaid META data and distributes digital data via firewire interface at the GCS for external recording or distribution device.

Note: 3-view drawings for the Desert Hawk UAV are included in the Safety Checklist information.

4. Inspection **and Maintenance Part 91, (General Operating and Flight Rules) Subpart E, (Maintenance, Preventive Maintenance, and Alterations).**

a. Description of the Program. Describe the inspection and maintenance program that will be used to maintain the aircraft and related systems, including ground stations and/or other support systems.

Desert Hawk aircraft are maintained following the procedures for inspections and minor repairs included in the Desert Hawk III Operations Manual. Significant maintenance and repair activity is accomplished following the Desert Hawk III Advanced Maintenance Manual. Any maintenance activities needed beyond the items covered in these two manuals are covered by refurbishment of the Desert Hawk III by Lockheed Martin.

b. Required Documentation. Provide a copy of the flight manual, if applicable; current weight and balance report; and equipment list.

The following documents are provided:

Desert Hawk III Operations Manual

5. Pilot Qualification (14 CFR §§ 61.3, Requirement for certificates, ratings, and authorizations, and 61.5, Certificates and ratings issued under this part).

a. Pilot Qualifications. Describe the qualifications for each pilot.

All pilots and observers need to have completed FAA required training for pilots or observer training in addition to completing Lockheed Martin training regarding the operation of the Desert Hawk III UAV and training related to operation within the defined test area for the Desert Hawk UAV.

b. Pilot Certifications. Pilots must be qualified/certificated in the appropriate category of aircraft, that is, rotorcraft, powered lift, and airplane.

Pilots for the Desert Hawk UAS will be qualified/certified in the Airplane Category. For operation within the NAS, pilots will meet the pilot requirements of 8130.34B.

c. Pilot Training. Describe the internal training program to qualify pilots.

All pilots and observers complete a Lockheed Martin training program to support operating and testing of the Desert Hawk UAV. This training includes the following:

- *Overview, System Setup and Teardown, Major Component Details*
- *System Operation, Software & Mission Planning*
- *Demonstration Flights*
- *Simulated Mission Instruction, Launch Procedures*
- *Field Setup*
- *Launch (Throwing) Practice*
- *Student Flights under supervision*
- *U-Drive operation*

Pilots and observers will also be trained in the operation within the defined airspace for the UAS test activity, including the following:

- *Rules and responsibilities for operating near other aircraft (91.111)*
- *Right-of-Way Rules (91.113)*
- *VFR Weather Minimums (91.155)*
- *Communication with air traffic control*

Students demonstrate proficiency in the following elements as part of the training for flight certification conducted by Lockheed Martin:

- *AVACS – ensures users can operationally set up and check the UAV for airworthiness*
- *Launch Wizard – users can properly prepare the UAV for flight and launch*
- *GCS SW Preparation - users can properly use DTED and imagery for unknown areas and zone overlays*
- *Proper Mission Planning – ensure correct software execution, ensure safe flight plans are prepared, situational awareness is maintained for the flying area, identify proper launch and recovery areas*

- *Ability to edit a mission in flight – proficiency demonstrated in re-tasking*
- *ATL/Recovery Proficiency – demonstrates competency to land the UAV within specified landing zone within 50 meters*
- *Properly Operate Payload – demonstrates understanding capability of different modes and usage, recording payload imagery*
- *Unplanned Event Correction – handling of contingencies*
- *Range Awareness – understanding the operational concept (CONOPS) for operating in the test range (aviate, navigate, communicate)*

d. Supplemental Pilots. Describe whether supplemental pilots will be used for the operation. Describe how supplemental pilots will be used. Describe the company's internal training program for supplemental pilots. Describe company procedures and requirements for maintaining currency and conducting a flight review for supplemental pilots.

Supplemental pilots are not part of the Desert Hawk III operations.

e. Qualifications and Training of Observers. Describe the qualifications and training of observers. Observer training is required for observers to communicate to the pilot any instructions required to remain clear of conflicting traffic. Acceptable observer training as a minimum must include, but is not limited to, knowledge about the following—

(1) The rules and responsibilities described in §§ 91.111 (Operating near other aircraft), 91.113 (Right-of-way rules: Except water operations), and 91.155 (Basic VFR weather minimums);

(2) Air traffic and radio communications, including the use of approved ATC/pilot phraseology; and

(3) Appropriate sections of the *Aeronautical Information Manual*.

Observers will receive the same training as described above for pilots. . For operation within the NAS, observers will meet the observer requirements of 8130.34B by the observer training that is provided by Lockheed Martin as part of the Desert Hawk operator training program.

6. Aircraft Registration and Identification Marking (14 CFR Part 45). All UAS are required to be registered and identified with the registration number. Aircraft must be marked in accordance with part 45 or alternative marking approval issued by AIR-200.

Marking in accordance with part 45 is not supported by the nature of the UAV but will be marked in a manner agreed with AIR-200.

7. ATC Transponder and Altitude Reporting System Equipment and Use (§ 91.215, ATC transponder and altitude reporting equipment and use). Describe the aircraft altitude reporting system.

Desert Hawk does not include a Transponder and Altitude Reporting System.

8. Method for See-and-Avoid (§ 91.113). Describe in what manner, or by what means, the requirement to see-and-avoid other aircraft will be met. Describe the expected performance of the chase plane.

The operation of the Desert Hawk aircraft will be within sight of the ground operator to support monitoring the aircraft for other aircraft. Desert Hawk does not utilize a chase aircraft to support see-and-avoid.

9. **Safety Risk Management.** Provide a safety checklist that identifies and analyzes the hazards of UAS operations described in the program letter. (See a sample safety checklist in appendix D to this order.) Additional information is available by contacting the FAA Aviation Safety Inspector.

Refer to the Desert Hawk Safety Checklist.

10. **System Configuration.** Provide a description of the aircraft system configuration and all onboard and ground-based equipment.

The aircraft design consists of seven assembled modules to allow for quick assembly and disassembly of the aircraft and ease of transport in the field. The wingtips and tail are removable from the centre wing section for compact storage, and if damaged are interchangeable. The centre wing section is designed to allow the user to quickly install or remove interchangeable plug and play imager payloads.

The airframe, which weighs only six pounds, is foam and carbon based with a Kevlar-coated shell for enhanced durability. It is capable of carrying a two-pound payload. DHIII is powered by a quiet electric motor. DHIII disassembles into seven sections and can be transported in a backpack or small carry case.

The Plug and Play Payload *Second generation (G2) color EO and IR turret payloads offer full 360-degree coverage in pan and 170 degrees in tilt. First generation (G1) color and black and white EO imagers in a two-axis stabilized turret, the turret has clip-in trays that can host two imagers of choice with different focal lengths. The G1 IR imager is roll stabilized and steerable from -60° to 15° on the port side.*

The portable Ground Control Station (GCS) consists of six primary components: a DC Power Distribution Box (PDB), Fully-Ruggedized Computer, Digital Video Recorder/Monitor (DVR), integrated Data/Video Communications Box (D/V Comms Box), and omni-directional uplink and downlink antennas. Additionally, sensor information may be displayed on the computer in addition to the digital Recorder/Monitor when operating the GCS in an opened case configuration. The MiniDV provides the capability to record payload imagery with overlaid META data and distributes digital data via firewire interface at the GCS for an external recording or distribution device.

The portable Remote Viewing Terminal (RVT) consists of three primary components: a Small Viewing Computer, Video Communications Box and antenna assembly. The RVT allows another user to remotely view payload imager information available to the GSC operators while performing an operation or mission independent of the GCS hardware.

11. System Safety—Flight Termination and Lost Link. Describe/explain the expectation of aircraft flight if fuel is starved. Describe/explain aircraft lost link and emergency recovery procedures. Provide an explanation of the flight termination system in detail.

The Desert Hawk motor is battery powered. Battery power is monitored by the system and provides the operator alerts as the battery becomes depleted.

Loss of Communication in Flight

Indications of lost or intermittent communications are identified by pop-up warnings. Other indicators of weak uplink are slow response to user inputs and failure to sync missions. Link signal strength is indicated on the GCS. Sustained loss of signal will activate the Loss of Signal Mission.

Loss of Signal Mission

The Loss of Signal Mission is to return to and orbit the launch point. If there is a loss of communication for greater than five minutes, the UAV will proceed to the primary mission landing pattern and land.

Restoring the communications at any time will cause the UAV to descend to programmed altitudes without user inputs. However, the UAV will not deviate from the Loss of Signal Mission until re-tasked by the user.

Flight Termination

The Desert Hawk III does not include a flight termination system. The user can command the flight to terminate at any point by commanding an immediate landing.

12. Command and Control. Provide a description of the system and/or procedures for command and control of the UAS.

Desert Hawk III utilizes a fully autonomous flight system. The Desert Hawk III UAS incorporates an advanced autopilot system with integrated GPS, which provides precise navigation, station keeping and easy aircraft re-tasking. . The autopilot and embedded navigation system integrate with the intuitive and easily operated lightweight GCS that allows operators without flight experience to easily plan and execute autonomous missions.

Prior to launching the Desert Hawk UAV, the planned operational mission is loaded to the UAV via data link communications. Following launch the UAV will execute the planned mission unless the ground station operator uploads a new mission, or takes direct control of the UAV operation vial input control commands.

An extremely useful mission override is the "Orbit Here Now!" command. By simply selecting this override and clicking on a location on the map, the UAV will divert immediately to that commanded point and begin to orbit at the default altitude. The original autonomous mission can be reactivated at any time with "Cancel Override" or GOTO a primary mission waypoint.

13. **Control Stations.** Provide a description of the ground/airborne stations used to control the UAS.

The GCS consists of six primary components: power data bus (PDB), rugged laptop computer, monitor, MiniDV recorder, comms box, and antenna suite.

The Desert Hawk communication subsystem receives a serial data stream from the GCS computer, and feeds it to the uplink transmitter. The communication subsystem also receives a video stream (with audio sideband) from the downlink receiver, splits it into separate video and audio signals, and feeds them to the video processor.

The video processor receives video and audio from the communication subsystem (during normal operations) or from the MiniDV (during playback).

The PDB encases the DC battery interface, video digitizer, 15 volt computer power supply, 9.5 volt MiniDV power supply, USB hub, and interface cable. The PDB also supplies power to a fan located directly under the computer

The computer *is a ruggedized laptop computer using an Intel Pentium® CPU. The computer includes a daylight-readable touch screen display, and an integrated GPS receiver. The computer uses the Microsoft Windows® XP operating system. Interchangeable DVD-RW and floppy disk drives provide input and output capability for the computer.*

The MiniDV video recorder records the analog video and audio (telemetry) streams transmitted down from the UAV and supports post mission playback.

The monitor is a daylight-readable, color liquid crystal display (LCD) in a rugged case.

The GCS antenna suite consists of two antennas for the GCS, an uplink transmit antenna, and a downlink receive antenna assembly. These antennas attach solidly to the side of the comms box when in use.

The GCS laptop provides a main control screen to support the operation and monitoring of the Desert Hawk UAV. This screen supports a map overlay of terrain data, depicts mission route plan information, and provides the UAV operator situation awareness of the UAV condition and flight state. The control screen also provides user controls to allow the operator to provide command inputs to the UAV to change altitude, airspeed, and heading.

The GCS application on the laptop computer utilizes the graphical user interface (GUI) including mission planning and UAV monitors, telemetry calculations, and 2-way communication with the aircraft, and also controls the video processor and the communications system.

14. **Control Frequencies**. Provide a description/listing of the frequencies used to control the UAS.

Desert Hawk uses separate uplink and downlink frequencies. For uplink data transmittal, two separate bands, each with 6 selectable channels, can be used. For downlink data, three separate bands, each offering 8 selectable channels, are available for use. Specifics related to the control frequencies of the Desert Hawk III.

are included in the Safety Checklist. Specific frequencies used are covered via frequency authorizations with the FCC.