

Grand Forks County Sheriff's Department Unmanned Aircraft Systems Unit

Qube COA Application Attachment



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1.0 System Description

Air Vehicle Type: AeroVironment Qube



1.1 Description of System

The Qube Small Unmanned Aircraft System (SUAS) is a rugged and reliable system that provides immediate, real-time airborne situational awareness for a variety of missions. The system is comprised of a Vertical Takeoff and Landing (VTOL) air vehicle, payload, and associated Ground Control Station (GCS).

The Qube GCS features an intuitive user interface on a touchscreen-tablet computer. The air vehicle's autopilot enables position-hold (using GPS) and altitude-hold (using barometric sensors) throughout the flight. There are no "waypoints" defined by the operator in the operation of the system: instead, the system uses the location where the air vehicle was launched from as the HOME location and as the Loss-of-Link landing location (see Loss of Link section below).

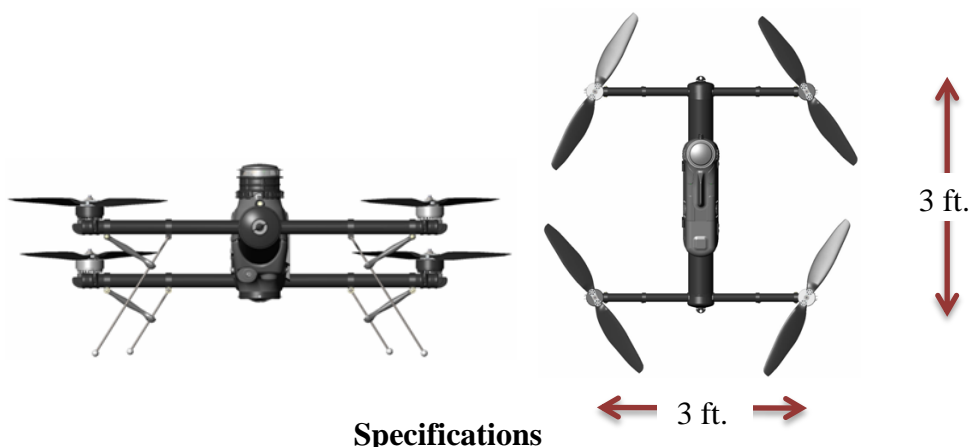
The Qube system also features "Geofencing" and altitude limits as additional safety features. Geofencing prohibits flight of the air vehicle beyond a user-defined radius, centered at the launch location (HOME). Altitude limit prohibits flight of the air vehicle above a user-defined maximum altitude.

The Qube air vehicle can be launched and recovered in minutes without special equipment on unprepared terrain. The air vehicle is battery-powered and has low visual, acoustic, and thermal signatures. The Qube air vehicle flies for up to 40 minutes on a rechargeable Lithium-Ion (Li-ion) battery pack. The standard payload is a single-axis gimbaled payload that includes an electro-optical (EO) camera and a long-wave infrared (LWIR) camera in a single package. The Qube system is typically operated by a two-person team consisting of an operator and an observer.

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Qube incorporates a tailored version of AeroVironment's Digital Data Link (DDL). The DDL provides encoded uplink and downlink on a single frequency.

The Qube air vehicle and GCS both disassemble into simple subcomponents for storage and transportation. The complete air vehicle is contained in single hard shell carrying case. A foam liner supports and protects the components from damage.



Payload	High resolution color & thermal cameras
Range	1 km line-of-sight
Endurance	40 minutes
Operating Altitude (Typical)	0-500 feet AGL
Length	3 ft. (90 cm)
Weight	5.5 lb (2.5 kg)
GCS	Rugged touchscreen tablet with Digital Data Link module

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1.2 Control Station

The Qube Ground Control Station (GCS) includes two major components: a ruggedized tablet computer and RF Unit.

The tablet computer is a rugged computer that features a touchscreen. The Qube GCS application (developed by AeroVironment) is operated from the tablet computer. This application provides the operator with all vehicle management and control functions, and uses the touch screen as the means for operator inputs. The application is designed to allow the operator to use his or her finger for making all control inputs on the touch screen. A stylus or mouse are not required.

The RF Unit is a separate component that houses the ground side transceiver of the Digital Data Link (DDL). The RF Unit is powered by its own external battery and connects to the tablet computer via Ethernet cable. The RF Unit has no operator controls. All RF Unit settings (such as channel selection) are made via the Qube GCS application. The standard configuration of Qube operates on the 2.4 GHz ISM band.

Assembled GCS



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1.3 Communication Systems Description

The system does not provide voice or ATC communication. If ATC or other communication is required, operators must use a separate device such as a hand held radio. Typically the visual observer is co-located with Qube operator (within speaking distance) and there is no need for communication equipment between operator and observer. The operator must provide appropriate equipment when remotely located observers are used for situational awareness and see-and-avoid duties.

A tailored version of AeroVironment's Digital Data Link (DDL) is used for air vehicle command and control. The DDL provides encoded uplink and downlink on a single frequency, and provides several channels/frequencies to allow multiple systems to operate in proximity. The standard configuration of the Qube system operates in the 2.4 GHz ISM band (unlicensed operation)

1.4 Certified TSO Components

Currently the system has no TSO components.

2.0 Qube Air Vehicle Performance Characteristics

Climb Rate:	200 ft/min
Descent Rate:	200 ft/min
Turn Rate:	20 deg/sec
Maximum Cruise Speed:	30 knots
Minimum Cruise Speed:	0 knots
Approach Speed:	0-30 knots
Operating Altitude Maximum	12,500 ft MSL
Operating Altitude Minimum	0 ft AGL
Gross Takeoff Wt:	5.5 lbs

2.1 Launch/Recovery

The Qube air vehicle design allows Vertical Takeoff and Landing (VTOL). Launch and recovery are performed similar to traditional helicopter/VTOL operations. The Qube requires a relatively flat surface that is free of larger obstructions to be used as its launch/recovery location. The Qube requires no launch/recovery support equipment.

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The air vehicle provides a gimbaled camera that is positioned to look straight down below the air vehicle during launch and recovery allowing the operator to view the launch/recovery location.

The system implements a number of safety features for launch and recovery. An automated System Built-In-Test is conducted prior to each flight. Pre-flight and post-flight checklists enable the operator to identify any issues prior to flight. During landing, the air vehicle detects touchdown and automatically shuts off propulsion motors.

3.0 Airworthiness

Currently Qube has no FAA airworthiness certificate or other certificate. The Qube system is manufactured by the World's leading UAS manufacturer. Aerovironment has manufactured more UAS than any other manufacturer. Aerovironment UAS are manufactured to military specifications and each airframe, including the Qube, has undergone rigorous testing to insure airworthiness.

4.0 Procedures

4.1 Lost Link/Mission Procedures

What happens when command link is lost?

If the air vehicle stops receiving commands from the GCS, the air vehicle will begin a pre-determined Loss of Link (LOL) action. The operator can not alter the action to be taken upon entering LOL, and is not required to make any settings or data inputs. The LOL landing location is always the same as the launch location of the air vehicle and cannot be modified by the operator.

During normal operations, the operator determines the height of the highest obstacle in the area of operations (visual estimation). After launch, the air vehicle is initially commanded to an altitude that clears the highest obstacle in the area of operations. The system keeps track of the highest altitude at which the air vehicle has flown during the flight and uses this altitude as a "safe" altitude during LOL.

Upon entering LOL, the air vehicle immediately climbs to the "safe" altitude. Upon reaching safe altitude, the air vehicle proceeds directly to the launch/recovery location that was determined at the beginning of the operation. Upon reaching the launch/recovery location, the air vehicle begins hover descent to touchdown at that location. Automatic touchdown detection is activated causing rotors to stop upon touchdown.

If GPS is not functioning when LOL is entered, or GPS stops functioning at any time during this process, the air vehicle holds pitch and bank attitude for zero airspeed for 30 seconds while awaiting

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return of link. If link is not re-established the air vehicle begins a vertical hover descent to landing at its current location. Automatic touchdown detection is activated causing rotors to stop upon touchdown.

How does air vehicle respond if link is never re-established?

The air vehicle automatically lands by following its pre-determined LOL action (described above).

How does the air vehicle recognize that loss of command link has occurred?

The air vehicle monitors the number of command packets that it receives from the GCS. The air vehicle detects any missing packets. If the air vehicle receives zero packets per second for a pre-determined time, it automatically initiates the LOL action (described above).

How does the operator on the Ground Control Station recognize loss of command link has occurred?

A link health indicator is provided on the GCS controller screen. This provides a continuous display of link quality to the operator. When LOL action begins, a corresponding warning message is displayed on the controller. The operator may recover from LOL and resume normal operation at any time after link is re-established through a deliberate command.

4.2 Lost Communications Procedures

Lost Communications between the Pilot and ATC

Pilot-in-command will immediately attempt to reestablish communications with ATC via an alternate means such as cellular phone. If ATC communications are not re-established within a short period of time, the mission will be terminated and the aircraft recovered.

Lost Communications between the Pilot and Ground Observers

Typically the pilot-in-command (PIC) and observer are collocated at the GCS and in direct contact with each other. Contact with remote observers is usually maintained via radio. If radio communication fails, the observer will immediately attempt an alternate communication method with the PIC such as cellular phone. If PIC-Observer communications are not re-established within a short period of time, the mission will be terminated and the aircraft recovered.

4.3 Emergency Procedures

Normal operator mission planning procedures include consideration of emergencies for each phase of the flight. The system provides continuous air vehicle and GCS status and presents warnings and indications of various emergency conditions. During flight, operators maintain situational awareness and monitor data to notice anomalies as soon as they develop. The system includes a number of

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published predefined Emergency Procedures (EPs) for critical malfunctions. EPs include immediate action items when appropriate. The immediate action items are indicated by underlining and bold face print on the EP checklist. AeroVironment operator training requires that operators must be able to perform these steps without referencing the EP checklist or operator manual.

Published EPs include:

- Loss of Link
- GPS Failure
- Structural or Flight Control Failure
- Extreme Low Air Vehicle Battery
- Propulsion Failure
- Avionics Over temperature
- Motor Controller Over Temperature
- Air Vehicle Battery Over Temperature
- Tablet Controller Failure
- Altitude Hold Failure
- Avoiding Collision With Other Approaching Aircraft

Medical:

If there is a medical emergency with any personnel involved, flight operations will cease and emergency responders will be contacted. Within Grand Forks County, the nearest emergency medical facility is:

Altru Hospital
1200 S. Columbia Rd.
Grand Forks, ND 58201
(701) 780-5000

Preferred method of emergency transportation of injured personnel is law enforcement vehicle or ambulance.

A first aid kit will be present on-site during all UAS operations.

Reporting:

Incident reports will be logged and applicable authorities notified. Any incidents pertaining to the performance of the aircraft or other parts of the system will be reported to the manufacturer.

ATC Notifications:

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In an emergent situation, should it become necessary to contact one or more of the ATC facilities, VHF radio communication via the appropriate frequency shall be the preferred method. In lieu of radio communication, traditional, cell or satellite telephone contact may be made.

ATC Facility	ATC Telephone #	Frequency
Grand Forks AFB (KRDR)	(701) 747-3808	124.90
Grand Forks Airport (KGFK)	(701) 792-4280	118.40
Grand Forks RAPCON	(701) 747-6140	118.10

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