Standard Operating Procedures for UAS at CSU Channel Islands

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Channel Islands
CALIFORNIA STATE UNIVERSITY

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Operating UAS on Campus Requires Prior Approval

Pursuant to University Policy on Unmanned Systems (AA.01.005), any individual or group wanting to fly UAS on the property of CSU Channel Islands must obtain prior written approval from the University's UAS Board.

Information for applying for permission to fly UAS on campus property can be found online at http://www.csuci.edu/rsp/uas/.

This document does not describe this application process or limitations that the UAS Board has put on UAS operations on campus. Rather, this document describes the standard operating procedures that employees and students are expected to follow when operating UAS on campus or as representatives of the University.

Crew Training Requirements

Crewmember Positions

Observer (OBS)

Initial qualification of the OBS will begin with the successful completion of FAA Aviation Ground School. The student will then need to complete 30 minutes of flight time in an OBS roll. After the completion of the mandatory 30 minutes of flight time, a check ride may be administered by a qualified instructor. The check ride will consist of a full preflight, launch and recovery and will evaluate the student's knowledge of procedures and responsibilities as well as their ability to perform the OBS duties. Once a student OBS has passed their check ride, they may be designated as an OBS by the CSUCI Unmanned Systems Board.

Mission Commander (MC)

Only qualified Observers will be allowed to begin MC training. The student will then need to complete a familiarization flight and a separate evaluation flight performing the duties of an MC while under instruction before he or she may be designated as a MC by the CSUCI Unmanned Systems Board.

Air Vehicle Operator (AVO)

Initial AVO qualification training will be conducted by an instructor designated by the CSUCI Unmanned Systems Board. Student AVO's must successfully complete a certified FAA Aviation Ground School before the first flight of an unmanned aircraft (does not include simulators). A minimum of 10 simulator hours and 30 minutes of flight time will be required for each AVO. At least 5 hours of simulator time must be completed before taking the controls on a flight event. After satisfying the minimum requirements under the guidance of a qualified instructor and deemed ready to progress by that instructor, a student will be required to pass a check ride. The check ride will consist of a full preflight,

launch and recovery while under the evaluation of a qualified instructor. Students will be evaluated on their knowledge of:

- the unmanned aircraft system
- preflight procedures
- site safety procedures
- emergency procedures and protocols
- crew resource management

Students should be able to demonstrate positive control of the aircraft and be able to take off and land within a specified space. Final designation as an AVO will be at the discretion of the CSUCI Unmanned Systems Board.

Pilot in Command (PIC)

The PIC must be a sufficiently experienced AVO that is qualified in the aircraft he or she is signing for. The PIC must be designated in writing by the CUSCI Unmanned Systems Board prior to signing for any aircraft.

Ground Crew

- Ground Crew personnel shall attend a Maintenance Training course taught by a CSUCI qualified instructor. The course will cover:
- System setup
- Compass Calibration
- Computer Interface
- Replacement parts
- Propeller Safety
- Shop Safety
- Software Updates
- Records Management

Once the course is complete, a practical demonstration of the topics listed above shall be completed under the supervision of a qualified instructor. Final designation as a Ground Crew member will be at the discretion of the CSUCI Unmanned Systems Board.

Ground Crew Chief

The Ground Crew Chief must be a sufficiently experienced Ground Crew member experienced in the aircraft system to be worked on. Ground Crew Chief designations will be given at the discretion of the CSUCI Unmanned Systems Board.

Visual Observers

Summary: This describes the visual surveillance plan used for the Iris+ UAS.

Description: For the purpose of see-and-avoid, visual observers must be utilized at all times. The Air Vehicle Operator (AVO) and Observer will ensure there is a safe operating distance between manned and unmanned aircraft at all times. Since all flights will occur below 320' AGL, it is unlikely that air traffic will be sharing the same airspace. The Observer will maintain visual line-of-sight contact with the aircraft to ensure the area is clear.

CI Park Observer Responsibilities:

- The Observer shall ensure the required site safety equipment is readily accessible prior to starting engines.
- The Observer shall be stationed next to the AVO and assist in clearing the hazard area of any personnel prior to starting engines.
- During flight, the Observer shall assist the AVO by advising of any personnel on the ground, any air traffic, and clear out any personnel in the event of an emergency.

Launch and Recovery

Summary: The 3D Robotics Iris+ uses a vertical takeoff and landing system controlled by either an RC controller or autonomously using autopilot and GPS.

Takeoff:

Prior to starting engines:

- The Air Vehicle Operator (AVO) shall ensure that the aircraft has been thoroughly inspected and is in a good flying condition.
- The AVO shall verify that an altitude limit of 320 feet Above Ground Level (AGL) and a range limit of 980 feet is loaded into the aircraft parameters.
- The AVO shall check local weather for high winds (20kts or greater) and storms in the area. Operations will be terminated if weather conditions do not meet minimum requirements of:
- Wind speed less than 20kts
- Visual Meteorological Conditions (VMC)
- The AVO shall ensure an Observer is posted.
- The Observer shall ensure the required site safety equipment is readily accessible.
- The AVO shall ensure that personnel are at least 20 feet away and that all checklists are complete.
- The Observer shall notify Camarillo Tower / Santa Rosa Island National Park Service Personnel of the commencement of UAS flight activities and at the conclusion of flight activities as well as provide the tower with a good contact number in case of an emergency.

After engine start:

- All personnel not involved in flying shall remain at least 20ft away from flight personnel and the aircraft.
- Once the throttle is engaged beyond 50%, the aircraft will begin to lift off the ground.
- During flight, the observer shall assist the AVO by advising of any personnel on the ground, any air traffic, and clear out any personnel in the event of an emergency.

Recovery:

When ready to land, the AVO may choose to either:

- Activate the LAND switch - This switch, when activated tells the aircraft to land at its current position.
- Activate the Return to Launch (RTL) switch - This switch is programed to make the aircraft return to the launch point automatically and land.
- Land the aircraft manually using the throttle
- If in AUTO mode, the aircraft will land at the pre-programmed position

Prior to initiating the landing sequence, the AVO will ensure that non-flight crew personnel are at least 20 feet away and the landing area is clear of hazards. After landing, the engines will be shut down by the AVO and the battery will be disconnected.

Lost Communication Procedures

Summary: These procedures outline the actions to be taken in the event the Air Vehicle Operator (AVO) or Observer loses radio communication.

- In the event that VHF radio contact is lost between the AVO and Air Traffic Control (ATC), the AVO will use a cell phone to contact Camarillo Tower. If operating on Santa Rosa Island, the AVO will land the aircraft and a runner will be sent back to the National Park Service Headquarters building to get new radios and re-establish radio communication. Flight operations will cease until radio communication can be re-established.
- The AVO and Observer will generally be within a few feet of each other and in constant vocal communication throughout the flight. In the event that the AVO and Observer are unable to communicate with each other, the flight will be stopped and the aircraft will be brought back to land.

Lost Link / Mission Procedures

Summary: These procedures outline actions to be taken in the event a flight crew encounters a loss of link between the RC controller and the aircraft or a loss of GPS signal. The causal factors of each of these situations will be thoroughly investigated and remediated prior to any subsequent flight attempts. Each of these occurrences will be recorded and the data will be provided to the FAA. The Iris+ Controller monitors both the connection strength with the aircraft as well as GPS signal strength. Should either appear to be degraded, the aircraft will be brought back to land, and the situation will be investigated.

- **Lost Link** – If the aircraft loses contact with the RC transmitter, it will land automatically, indicated by a blinking yellow status LED. If it loses RC signal during a mission, it will return to the launch point before landing. The Air Vehicle Operator (AVO) will notify personnel in the area of the situation and the Observer will ensure the landing zone is clear.
- **Loss of GPS** – If the aircraft loses GPS signal in a flight mode that requires GPS (loiter, auto, return-to-launch, guided), it will land automatically, indicated by a blinking blue and yellow status LED and a high-high-high-low tone. The AVO will notify personnel in the area of the situation and the Observer will ensure the landing zone is clear.

Mission Procedures:

CI Park:

- All flight operations shall remain within the limits of Cam Park as depicted in Figure 1.
- Operators shall not intentionally overfly personnel.
- Flying is not allowed over the barn, parking lot, pit areas, or the access road depicted in Figure 1.
- Aircraft shall not exceed 320ft AGL.

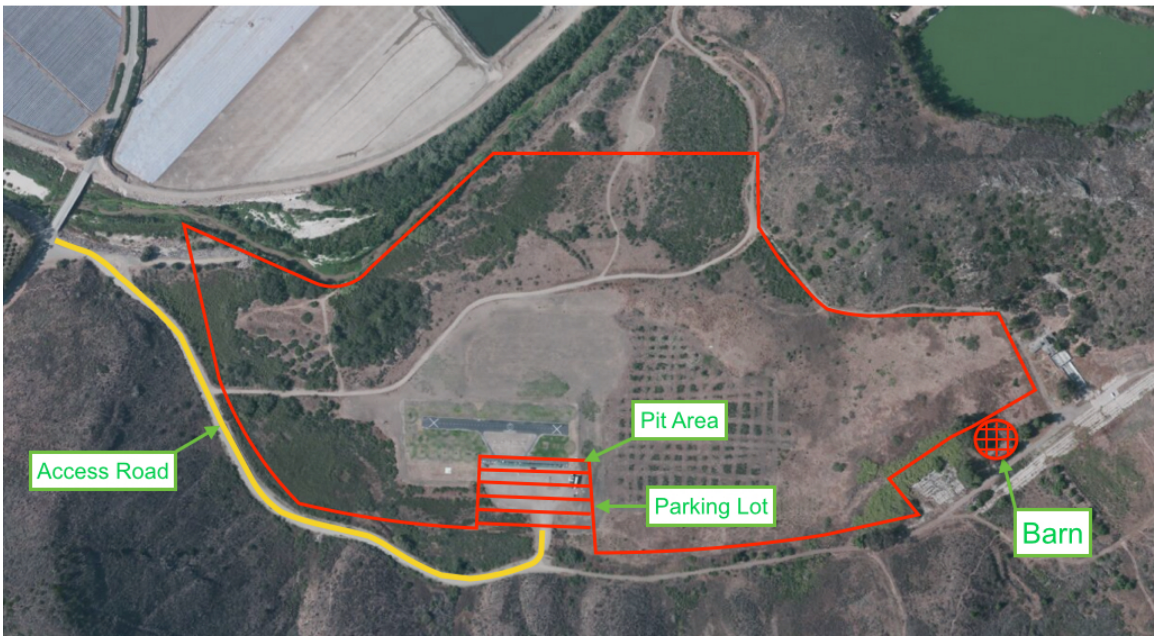

Figure 1: CI Park Operating Area

SYSTEM DESCRIPTION – Aircraft Description

3D Robotics Iris+

Description: The 3D Robotics Iris+ is a small unmanned quadcopter used for aerial imaging. It uses an open-source autopilot capable of managing all phases of flight as well as confining the aircraft to a pre-loaded geographical area (geo-fencing) using GPS. With a weight of less than 5 lbs, this aircraft is easily maneuvered and controlled. The maximum flight time is 22 minutes but varies greatly with payload and wind conditions.

Specifications:

Autopilot:	Pixhawk v2.4.5
Firmware:	ArduCopter 3.2
GPS:	3DR uBlox GPS with Compass (LEA-6H module, 5 Hz update)
Telemetry radio:	3DR Radio Telemetry v2 (915 MHz or 433 MHz)
Motors:	950 kV
Frame type:	V
Propellers:	9.5 x 4.5 T-Motor multirotor self-tightening counterclockwise (2)
	9.5 x 4.5 T-Motor multirotor self-tightening clockwise (2)
Battery:	3S 5.1 Ah 8C lithium polymer
Low battery voltage:	10.5 V
Maximum voltage:	12.6 V
Battery cell limit:	3S
Battery weight: 320 g	
Weight with battery:	1282 g
Height: 100 mm	
Motor-to-motor:	550 mm
Payload capacity:	400 g (.8 lbs)
Radio range:	up to 1 km (.6 miles)
Flight time:	16-22 minutes*

*Flight time varies with payload, wind conditions, elevation, temperature, humidity, flying style, and pilot skill. Listed flight time applies to elevations less than 2,000 ft above sea level.

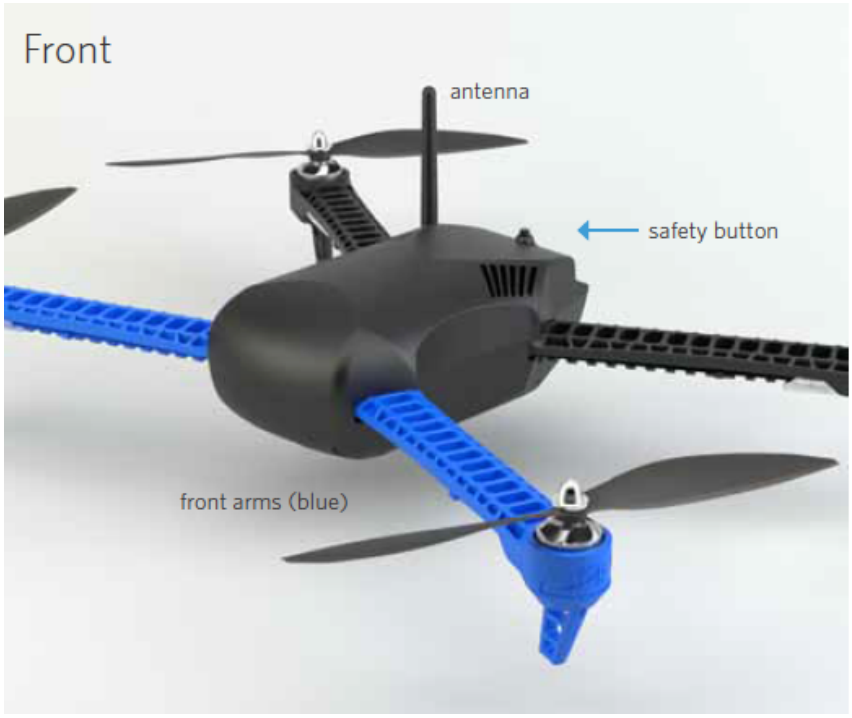

Figure 1: Iris+ Front View

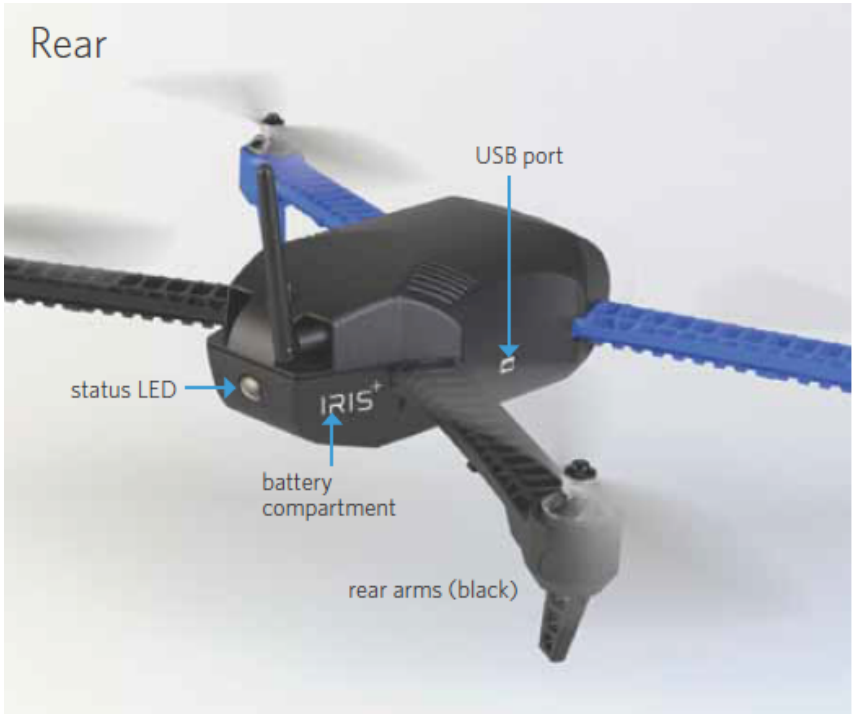

Figure 2: Iris+ Rear View

Parts

Controller
your direct link to IRIS

Ground station radio
with USB and Android adapters

Battery kit
battery, guard bag, and charger
with international travel adapters

Propellers and tool kit
four propellers with propeller tool and
small, medium, and large hex keys
(1.5 mm, 2 mm, and 3 mm)

Tall legs
Switch to tall legs to use IRIS with the Tarot
Gimbal or for extra clearance on landing.

Use the small (1.5 mm) hex
key to loosen the set screw
in the bottom of the leg.

Slide out the leg to remove it, and replace with the tall leg.
Tighten the set screw until it sits flush with the surface.
Do not tighten the screw beyond this point.

Figure 3: List of Parts

SYSTEM DESCRIPTION – Communication System

Summary: This describes the communication system used by the flight crew the Iris+ UAS.

Description:

- **Crew Coordination** – The flight crew will communicate via verbal responses. If the distance becomes too great for face to face communications, the crew will use handheld radios.
- **Communication with ATC (Cam Park)** – Communication with Air Traffic Control (ATC) will be accomplished primarily by Cellular Telephone. Prior to each flight period, the crew will notify Camarillo Tower of their intention to initiate UAS flight activities, the duration of the flight event, and a primary and secondary contact number to be reached at in the event of an emergency.
- **Communication with National Park Service (NPS) Personnel (Santa Rosa Island)** – Communication with NPS personnel will be accomplished primarily by range radio. Prior to each flight period, the crew will check out range radios at the NPS Headquarters building. After arriving at the operating area, the crew will test the radios by contacting NPS personnel. The crew will then notifying them of their intention to initiate UAS flight activities and the duration of the flight event in case of an emergency.

SYSTEM DESCRIPTION – Control Station

Summary: This system uses the 3D Robotics Iris+ Controller to operate the aircraft.

Description: The 3D Robotics Iris+ Controller operates on the 915 MHz frequency and has three flight modes of operations (Standard, Loiter, and Automatic).

Controller Functions:

- Standard – This mode provides the operator an altitude hold function but does not use GPS to maintain position.
- Loiter – This mode provides the operator with both an altitude hold function as well as GPS aided position hold.
- Auto – This mode allows GPS waypoints to be programmed into the autopilot. When AUTO is selected the aircraft will automatically fly the series of waypoints and land.
- Gimbal Control – This TILT knob allows the operator to control the angle of the camera in flight.
- Land (CH 7) – This switch, when activated tells the aircraft to land at its current position.
- Return to Launch (RTL) – This switch is programed to make the aircraft return to the launch point automatically and land.
- Geofence – This function is programmed into the autopilot prior to flight and allows a virtual safety fence to be created. This safety fence restricts the aircraft to within 980 ft of the launch point and under 320 ft in altitude.

Controller Data: The controller provides the operator with a variety of data in flight including:

- GPS status
- Connection strength
- Altitude
- Speed
- Distance from launch point
- Flight time
- Current flight mode
- GPS signal strength
- Flight battery level
- Flight battery mAh consumed since armed
- Current Latitude and Longitude
- Controller battery level

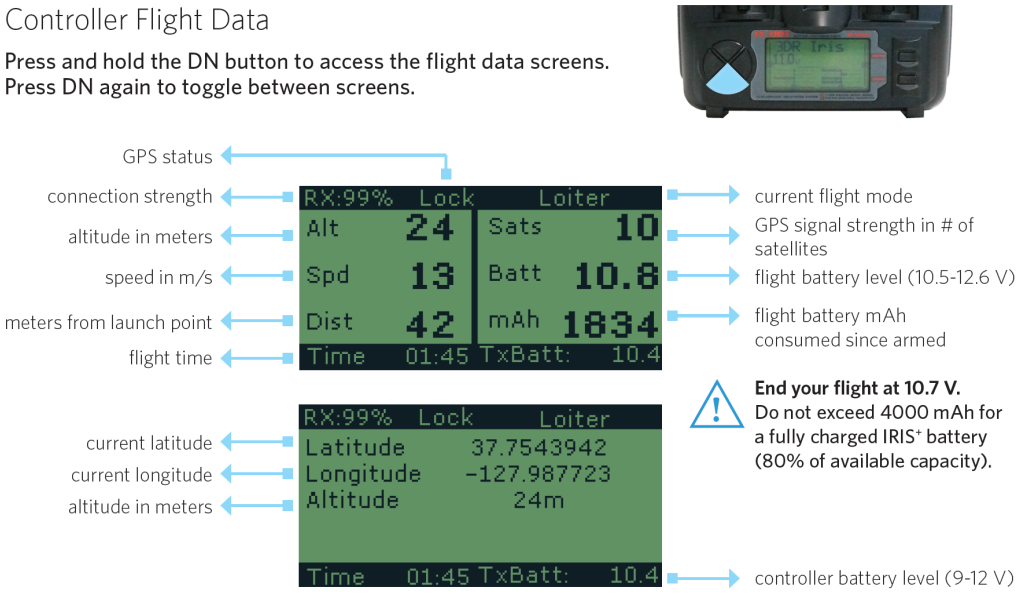

Figure 1: Iris+ Controller Data

CI Park Operating Area:

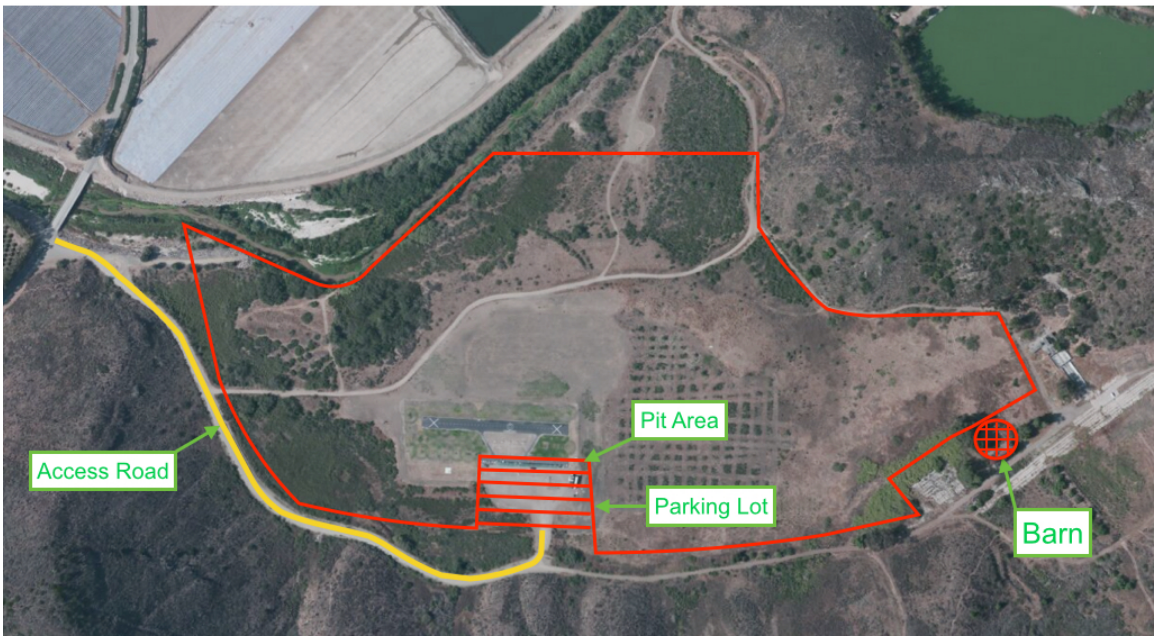

Figure 1: Cam Park Operating Area

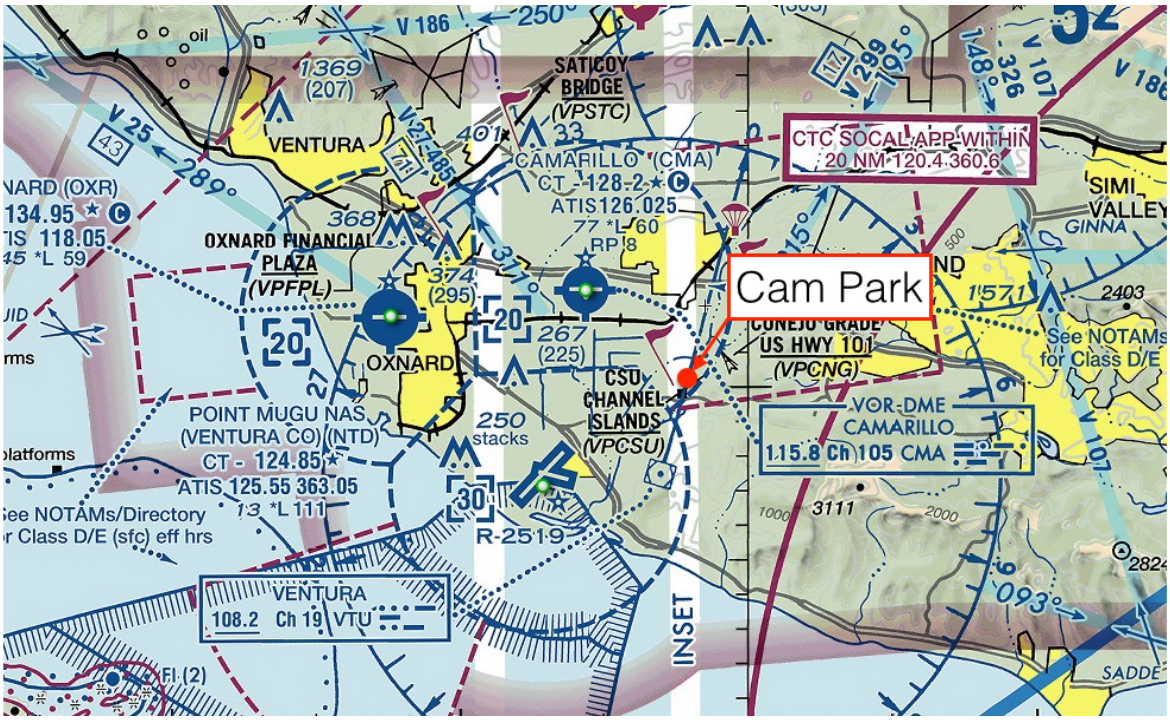

Figure 2: Cam Park Nav Chart

CI Park Iris+ Standard Operating Procedures

Site Safety

1. Anytime aircraft are being operated at the site, the following shall be on hand and readily accessible:
    a. Water source
    b. Fire extinguisher
    c. Cell phone capable of calling 911
    d. Shovel
    e. First aid kit
    f. Fire proof box
    g. Protective gloves
2. If a fire breaks out on site and it cannot be safely handled using onsite methods, evacuate the area immediately and call 911.

Launch and Landing Procedures

1. Pre-launch inspections shall be conducted before flight and include a ground based test of the antenna link status for proper communications. Any discrepancies in the link status shall be addressed and fixed prior to a launch attempt.
2. Prior to starting engines:
    a. The PIC shall ensure that the aircraft has been thoroughly inspected and is in a good flying condition.
    b. The PIC shall verify that an altitude limit of 400ft Above Ground Level (AGL) and a range of 1500ft is loaded into the aircraft parameters.
    c. The PIC shall check local weather for high winds and storms in the area.
    d. The PIC shall ensure an MC/OBS is posted.
    e. The OBS shall ensure the required site safety equipment listed in 1.a is readily accessible.
    f. The PIC shall ensure that personnel are at least 10 feet away and that all checklists are complete.
    g. The MC shall notify Camarillo Tower of the commencement of UAS flight activities and at the conclusion of flight activities as well as provide the tower with a good contact number in case of an emergency.
3. All personnel not involved in flying shall remain behind the white safety line.

Flight Operations

1. All flight operations shall remain within the limits of Cam Park as depicted in Figure 1.

2. Operators shall not intentionally overfly personnel.
3. Flying is not allowed over the barn, parking lot, pit areas, or the access road depicted in Figure 1.
4. Aircraft shall not exceed 400ft AGL.
5. The number of aircraft airborne at the same time shall not exceed 1 per PIC.

Observer Responsibilities

1. The observer shall assist the AVO in clearing the hazard area of any personnel prior to starting engines.
2. During flight, the observer shall assist the AVO by advising of any personnel on the ground, any air traffic, and clear out any personnel in the event of an emergency.

MC Responsibilities

1. The MC shall ensure adequate cell phone coverage prior to flight operations.
2. In the event of an emergency, the MC shall note:
    a. Time of incident
    b. Aircraft Tail Number
    c. Names of aircrew involved
    d. Weather conditions
    e. Location
3. For any emergency listed below, the MC shall contact Jason Miller (660-234-5028 or 805-437-8898) when it is practicable to do so.

4. Emergency Procedures

5. Lost Link – If the aircraft loses contact with the RC transmitter, it will land automatically, indicated by a blinking yellow status LED. If it loses RC signal during a mission, it will return to the launch point before landing. The AVO will notify personnel in the area of the situation and the MC/OBS will ensure the landing zone is clear.
6. Loss of GPS – If the aircraft loses GPS signal in a flight mode that requires GPS (loiter, auto, return-to-launch, guided), it will land automatically, indicated by a blinking blue and yellow status LED and a high-high-high-low tone. The AVO will notify personnel in the area of the situation and the MC/OBS will ensure the landing zone is clear.
7. Low Battery – If the battery reaches 25% charge, the aircraft will land automatically, indicated by a blinking yellow status LED and a quick repeating tone. If the battery runs low during a mission, the drone will return to the launch point before landing. The AVO will notify personnel in the area of the situation and the MC/OBS will ensure the landing zone is clear.
8. Engine Out – In the event of an engine out, the AVO shall notify any personnel near the aircraft at the time as well as cut power to the remaining engines. The AVO and Observer will then proceed out to the crash site with a fire extinguisher, a pair of protective gloves and a fire proof box.

If a fire has started, attempt to put out the fire with the fire extinguisher if it is safe to do so. If the fire has spread beyond control with a fire extinguisher, evacuate to a safe area immediately and call 911.

After the fire is out, or if there was no fire at all, the battery shall be inspected for integrity. If the battery is intact and it is safe to do so, the aircraft may be removed from the site and brought back to the home base. If the battery shows any signs of leakage, bulging, or smoking, the battery shall be handled with protective gloves and placed in a fireproof box for transport and disposal.

9. Fly Away – In the rare event of an uncontrolled fly away, the AVO should make every attempt to regain control of the aircraft while the MC notifies Camarillo tower of the approximate altitude, direction, and battery time remaining.

During any event where the aircraft is displaying unusual activity, or is in an emergency situation, always be ready to switch to stabilize mode and land the aircraft manually to prevent an unsafe situation.

Important Contact Info

10. Emergency – Dial 911
11. Campus Police (Non-emergency) – (805) 437-8444
12. Jason Miller – (660) 234-5028
13. Camarillo Tower – (805) 388-9730

SYSTEM DESCRIPTION – Certified TSO Components

Summary: There are no certified TSO components used in the 3D Robotics Iris+ UAS being tested as part of this COA application.