

CU Boulder Flight Ops

Multicopter ACS Flight Maneuvers

Flight Maneuvers list

- Normal Takeoff and Climb
- Straight Transects
- Box Pattern
- Circles Around a Point
- Loss of Orientation
- Lost Link Scenario
- Normal Descent and Landing
- Low Fuel/ Low Battery
- Emergency Landing

Note: This presentation only covers the flight maneuvers required by the ACS. There are other ACS testing requirements that should be considered and this presentation should only be used as a supplement to the published ACS.

Normal Takeoff and Climb

- ACS completion requirements:
 - Ability to clear takeoff area.
 - Lift off in stable and safe manner before initialing climb.
 - Maintain directional control and proper wind drift correction throughout the climb (if applicable).
 - Initial climb altitude is suitable for VLOS and safe from obstacles.
- Key Considerations:
 - Understand why a vertical climb is necessary.
 - Ability to determine a safe initial altitude.

2) Upon reaching a safe altitude a directional climb can be made.

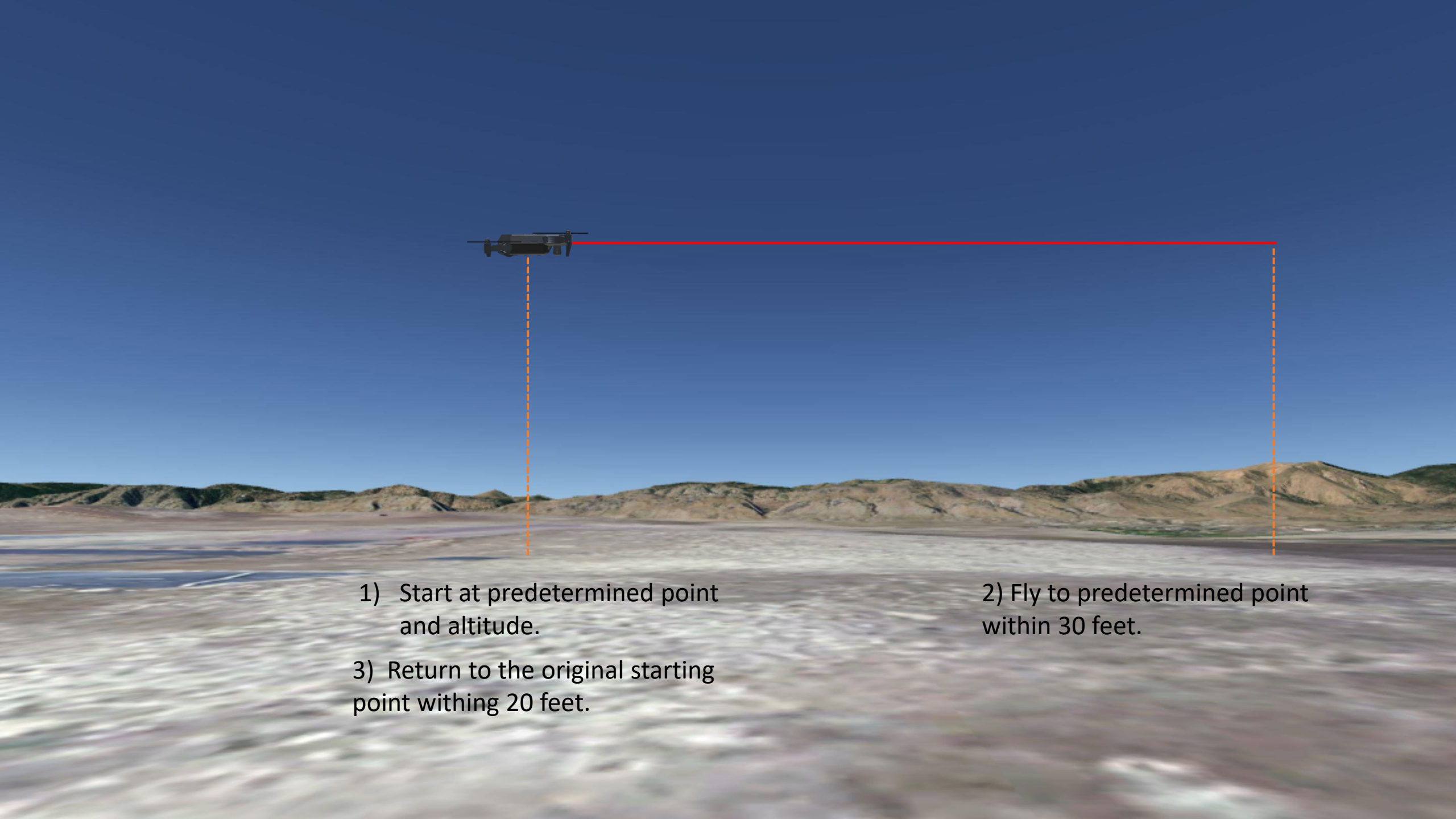
3) Cruise and maneuvers.

1) Initial take off and climb out is stable and direct. No unnecessary movement until safe altitude is reach.




Straight Transects

- ACS completion requirements:
 - Clear the area.
 - Select altitude sufficient for VLOS and obstacle avoidance.
 - Fly to predetermined point within 30 feet without reference to any instruments or displays.
 - Then fly backward with forward facing orientation to original starting point within 20 feet without reference to any instruments or displays.
 - Ability to hold a flight path along the center line of the transect to within +/- 15 feet on either side .
- Key Considerations:
 - Picking a suitable point which is safe and can easily be measured.
 - Judging distance without aid of instrumentation or displays.



- 1) Start at predetermined point and altitude.
- 3) Return to the original starting point withing 20 feet.

- 2) Fly to predetermined point within 30 feet.



1) Start at predetermined point and altitude.


2) Fly to predetermined point within 30 feet.

1.5&2.5) Hold flight path along the center line of the transect to within +/-15 feet on either side .

3) Return to the original starting point withing 20 feet.

Box Pattern

- ACS completion requirements:
 - Clear the area.
 - Select altitude sufficient for VLOS and obstacle avoidance.
 - Fly even box pattern with reference to ground track. Each leg should be the same length to within 20 feet.
 - Each centerline track should be straight to within 20 degrees of starting corner point.
 - Each corner point should be well defined.
- Key Considerations:
 - Clearly define the endpoints of the desired box before beginning the maneuver.
 - Avoid overshoot of each corner point with smooth control inputs.

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- An aerial photograph showing a drone in flight over a large, open field. A red polygon is drawn on the ground, with one vertex at the drone's current position. The field is mostly dry and light-colored, with some darker patches. In the bottom left, there is a paved road and some buildings. The drone is a quadcopter with four propellers.
- 1) Each corner point defined by PIC before the maneuver starts.
 - 2) Pilot can fly to each previously defined point within 20 feet and within 20 degrees of desired line.
 - 3) Each corner point is clearly defined with a controlled stop.
 - 4) Each leg is a consistent length in length.

Circles about a Point

- ACS completion requirements:
 - Clear the area.
 - Select altitude sufficient for VLOS and obstacle avoidance.
 - Select suitable ground reference area for maneuver.
 - Complete one 360-degree orbiting turn around the prespecified point with the longitudinal axis of the UAS pointing towards the center point for the entirety of the turn.
 - Radius of turn around point is prespecified and held within +/-20ft
- Key Considerations:
 - Selection of good center point.
 - Considerations for flying in the “region of reverse command”.
 - Understanding control inputs.



Loss of Orientation

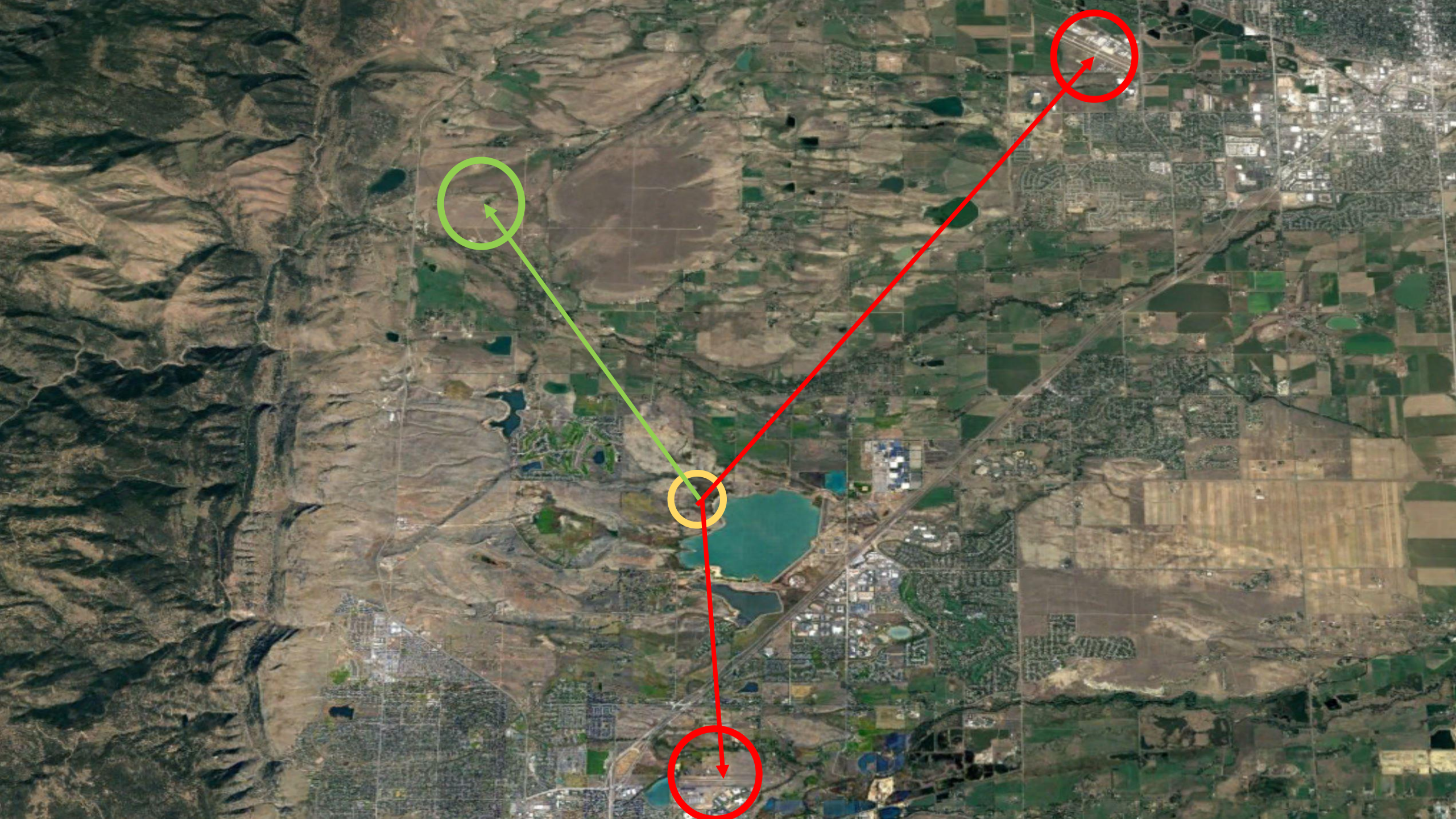
- ACS completion requirements:
 - Ability to determine orientation and return UAS to a predetermined starting point in timely manner.
- Key Considerations:
 - Understand control inputs and effects on UAS.
 - Smooth control inputs and corrections to avoid overcorrecting.



Lost Link Scenario/ Fly Away Event

- ACS completion requirements:
 - Applicant can determine appropriate actions to take during a simulated lost link scenario including knowledge of required information to communication to nearest airport or possible at-risk facility if applicable.
- Key Considerations:
 - Preflight preparation and knowledge of nearby hazards such as airports or communities.
 - Knowledge on UAS specific emergency actions (return to home, EPs, options).
 - Knowledge on applicable reporting requirements to nearby airports or controllers.
 - Knowledge of general ground speed and battery life to determine an effective threat zone.





Normal Descent and Landing

- ACS completion requirements:
 - Proper landing briefing.
 - Maintain safe altitude before final descent to landing zone.
 - Maintain directional control and proper wind drift correction throughout descent.
 - Stable approach down to touchdown.
 - Correct controller inputs when UAS is on the ground.
- Key Considerations:
 - Understand approach profile and reason behind a high altitude approach.
 - Small corrections in descent to landing zone.

3) Stop over desired landing zone.

2) Fly back at altitude with primarily yaw adjustments for course corrections.

4) Commence stable descent with minor correction to land on desired landing zone. (avoiding translational motion as much as possible).

1) Climb to safe return altitude.



Low Fuel / Low Battery

- ACS completion requirements:
 - Determine suitable landing area.
 - Complete emergency checklist or memory items.
 - Get in a position to make an emergency or precautionary emergency landing in a timely manner.
- Key Considerations:
 - This maneuver is typically tested in succession with the emergency landing task.
 - This task focus on returning to above a landing area as quickly as possible which means using a combination of control movements to be efficient in returning.
 - Although this is an emergency it is still recommended to climb to a safe altitude which is required for landing while returning.

Emergency Descent and Landing

- ACS completion requirements:
 - Determine if UAS has ability to land a planned LZ.
 - Quickly return drone to LZ at safe altitude.
 - Execute stabilized but timely descent making minor corrections when necessary.
 - Complete emergency checklist or memory items if applicable.
- Key Considerations:
 - Understand importance in climbing to safe altitude.
 - While flying quickly make minor corrections to avoid major course changes.
 - Judgement of entire situation.

2) Commence a quick but stable descent making minor corrections as needed.

1) Quickly climb to a safe returning altitude while heading back to the landing zone.

