LOST LINK/MISSION PROCEDURES (Piccolo II Autopilot)

Summary: These procedures outline actions to be taken in the event the UAV loses control link communications with the Ground Control Station (GCS). For these purposes, the term "link" shall refer to the radio link between UAV autopilot and GCS.

Case 1. Loss of Link During Launch
Description:
        A typical flight will have the UAV take off under radio control by the Pilot-in-Command (PIC). Upon reaching stable flight, the PIC will activate the switch on the R/C transmitter to enable the UAV autopilot, beginning autonomous flight.
        A **loss of link during launch** would be if the PIC could not enable the UAV autopilot and begin autonomous flight.
Action:
        In the event of a loss of link during launch, the PIC and spotter will take these actions:
1. PIC will activate switch again to attempt to enable autopilot. Spotter/Assistant will observe the Piccolo GCS to determine if PIC/CIC indicator changes to CIC. If not successful, then:
2. PIC will climb to 200 ft altitude (AGL) and circle, attempting again to activate autopilot. If not successful, then:
3. PIC will switch off autopilot on transmitter, announces "Landing," enters a left hand landing pattern and lands the UAV into the wind.

Case 2. Loss of Link During Autonomous Flight
Description:
        After launch, a typical autonomous flight will have the UAV climb to altitude, fly a pre-programmed route, return to a point above the launch site and descend to 200 feet AGL, where it will land under radio control by the Pilot-in-Command (PIC).
        A **loss of link during Autonomous Flight** would be if the radio link failed or was obstructed, temporarily or totally, while the UAV was flying its pre-programmed route.
Action:
        The UAV does not require the RF link while flying autonomously. The link is used by the UAV to transmit position and airframe data to the GCS, and by the GCS to the UAV for in-flight changes to its pre-programmed flight. If the link is lost, the UAV will end its flight in the return-to-origin mode and auto-land.
        In the short-distance flights planned (furthest distance from UAV to GCS would be less than one mile), communications will be line-of-sight. It is unlikely that if the RF link would be lost. If it was lost and it was necessary to recall or reposition the UAV in an emergency (e.g. manned aircraft entered UAV flight area), then:
1. PIC and/or assistant would immediately switch from the omni-directional vertical antenna to the high-gain, directional yagi antenna. This antenna has an additional 13 dB gain, and would provide 200X more RF signal between the UAV and GCS, re-establishing the RF link. If this did not restore the link, then:
2. PIC and assistant will observe the UAV to determine if it is following the return-too-origin profile. During this time, they will continue attempting to take over by manual radio control. If this is not possible, all personnel will continue to observe the UAV to determine if it is likely to

pose a hazard. If it appears to be heading out of the AO, the Pilot assistant or other designated team member will notify the airport towers, notifying them of the problem. In addition:
3. If this should occur when another aircraft is visible PIC will attempt to contact the intruding aircraft on Guard frequency.

       Note that at the time of this application, there has not been a total failure recorded of the RF link in a UAV with the Piccolo autopilot.

Case 3. Loss of Link During Recovery
Description:
       A typical recovery will have the UAV descend to 200 ft AGL in a large spiral, whereupon the PIC will switch off autopilot on transmitter, announce "Landing," enter the landing pattern and land the UAV.

       A **loss of link during recovery** would be if the PIC could not turn off the UAV autopilot and assume control under manual R/C flight.
Action:
       In the event of a loss of link during recovery and the UAV remains in autonomous control (CIC), the PIC and spotter will take these actions:
1. PIC will activate switch again to attempt to turn off the autopilot. Spotter/Assistant will observe GCS to determine if PIC/CIC indicator changes to PIC. If not successful, then:
2. PIC and spotter will observe that UAV is using its pre-programmed autonomous landing (auto-land) profile. This will cause the UAV to enter a landing pattern, and land into the wind at a shallow, programmed descent angle. This is a feature of the Piccolo autopilot, but is not typically used in favor of the additional control and more precise landing obtained with PIC landing.

Reporting Lost Link to ATC
       In the event of a lost link, the UAS pilot will immediately notify Atlanta Air Route Traffic Control Center (ZTL ARTCC) at (770) 210-7622, state pilot intentions, and comply with the following provisions:
- The UA lost link mission will not transit or orbit over populated areas.
- Lost link programmed procedures will avoid unexpected turn-around and/or altitude changes and will provide sufficient time to communicate and coordinate with ATC.
- Lost link orbit points shall not coincide with the centerline of Victor airways.

Preventive Measures
       In addition to the thorough pre-flight inspection procedures that will be used to ensure the UAV is airworthy, the Piccolo II autopilot features a "Lost Link/Lost Comms" procedure. In the instance of communication between UAV and GCS being lost for more than 5 seconds, the UAV will return to the "home" waypoint and circle. This will enable the pilot and GCS operator to re-establish comms.

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