Lost Link/ Mission Procedures

The UAV has a series of mission parameters which are physically loaded into its memory prior to flight. These parameters define the locations of emergency runways, lost link plans, and timing and safety limits used by the aircraft in the event of lost link or lost navigation situations. Although configurable in flight, these parameters are typically designed for a given launch and recovery site and are configured for the anticipated flight environment missions.

The ScanEagle follows an autonomous lost-uplink procedure if communications from the GCS fail. This procedure ends in a belly-landing at a specified location (*shown in table below*) if communications are not reestablished. Many elements of the procedure are configurable. For purposes of this COA submission, the aircraft will be preprogrammed to return to the center of a specified ROZ until communications are reacquired or the preprogrammed, 20 minute "wait at home" timer expires. If the "wait at home" timer expires and communication has not been reestablished, the aircraft will execute a belly landing at the Belly Landing/Engine-Out Recovery location, following the preprogrammed parameters. All lost-link procedure will be approved by the Airspace Manager, Range Control, as part of the mission checklist to ensure protection of airspace and de-confliction from other operations over ISR Group Range Services property and published daily via an Airspace Utilization Order.

ScanEagle Lost-Link Procedure

1. The lost-link procedure begins after the 10 second link timeout timer has expired without the ScanEagle receiving any messages from the ground. The aircraft then flies at a safe airspeed, holds its altitude, and starts a periodic reset of its communication channels.

2. GCS/PIC notifies all Observers both ground and airborne (Chase Aircraft) about the issue and drives checklist procedures to coordinate actions accordingly.

3. After the 10-second timer expires, the ScanEagle will fly directly to the nearest waypoint in the abort flight plan that is not further from home than the aircraft's current position. From that location, the UA will fly to either Waypoint 95 or 96 and enter the Lost Link Waypoint Entry and enter into a 20-minute holding pattern.

4. Once established in the 20-minutue holding pattern, the ScanEagle climbs for a designated period of time towards the highest of 3 altitudes: its current altitude, a safe altitude, or the calculated for line-of-sight communications with the GCS. Each of these altitudes is programmed prior to flight for mitigation of existing airspace boundaries. Observers are stationed at recovery point and send reports as cued by GCS/PIC as to aircraft location and attitude.

5. After reaching the home holding pattern, the aircraft waits for the 20 minute "wait at home" timer to allow the ground crew to reestablish communications and/or secure the landing area.

6. GCS/PIC calls local ATC/FSS (KMKL: Tower- 127.15/249.95; CTAF- 127.15; UNICOM-122.95; JACKSON RCO 122.2 122.65 127.15 (JACKSON RADIO)) and/or ZME ARTCC (134.65/316.15) as required, and Guard Freq's (KSNH: CTAF/UNICOM 122.8) of landing operations per established launch/recovery communication procedures. If radio contact not capable, call 1-800-WX-BRIEF to contact FSS and have information relayed to ZME and other concerned parties.

7. If communications have still not been reestablished, the ScanEagle selects an appropriate approach and touchdown point on the pre-selected ditch point for a belly landing. This ditching selection considers the current winds as measured by the aircraft, and the location previously programmed into memory.

8. Observers monitor aircraft as it completes landing evolution and send reports of positive recovery to GCS/PIC. GCS/PIC advises ACT/FSS/Local traffic of completion of recovery ops.

Lost-Link Scenarios

Using the graphic below, the lost link sequence would be as follows. Assume that the Scan Eagle was in ROZ 4, which is southwest from the LRS, and the UA goes lost link. After 10 seconds, the lost link procedure will begin with the UA maintaining its current altitude, airspeed, and flight-planned routing.

Each of these altitudes is approved by the Mission Coordinator and programmed prior to flight for mitigation of existing airspace boundaries. After 10 seconds in lost-link, the Scan Eagle will fly directly to the nearest waypoint in the abort flight plan. In this scenario, coming from the west, the Scan Eagle (ScanEagle 0) is depicted in the blue circle with the green (UA) box at its current commanded location. From there, the UA will proceed to either waypoint "96" or "95", depending on proximity to each, and begin the 20 minute holding pattern. The holding pattern is depicted as the blue, left-turn rectangle labeled as Points 96, 97, 94, and 95. Once established in the holding pattern, the ScanEagle will then climb toward the highest of three altitudes: its current altitude, a safe altitude, or the calculated for line-of-sight communications with the GCS.

Once the 20-minute timer expires, the ScanEagle will fly to the Emergency Recovery runway location and either fly a straight-in approach or enter the downwind based on existing aircraft-measured wind data.

In the event of a simultaneous lost-link event (See FIGURE 2.), the Airspace Manager and each aircraft PIC will ensure that a minimum 500' vertical separation is maintained between aircraft through pre-programmed lost-link algorithms. Example would be the spoke aircraft climbing to a minimum of 2500' AGL as the safe altitude before attempting a climb to the calculated line-of-sight communications altitude. The Hub aircraft will behave as detailed above, not exceed 2000' AGL and complete its recovery via the Emergency Recovery location after the 20 minute "wait at home" expires. The spoke aircraft will be programmed for a 50 minute "wait at home" to allow 30 minutes for emergency recovery crews to clear the runway after the first aircraft's arrival. Communication among team members is crucial with Visual Observers maintaining constant contact with the aircraft and relaying performance to the GCSs and PICs communicating anticipated aircraft actions to Airspace Manager, observers and corresponding GCS(s). Recovery crews will relay runway conditions to team members and advise when runway is clear.

If there is a single-system lost link event, the functioning aircraft will remain within its designated ROZ until a minimum of 500' vertical separation can be achieved beneath the lost-link aircraft. At that time, the functioning aircraft will recover under the "wait at home" holding pattern to the LRS and engage the SkyHook.

Belly Landing/Engine-Out Recovery Location

Figure 1 is a snapshot from a ScanEagle laptop simulation; this depicts the location the proposed UAS activities would occur. In this snapshot you can see the locations of the Launch/Recovery Site (LRS), and the Belly Landing/Engine Out Recovery location (in RED), and all pre-programmed flight plan waypoints the aircraft navigates by. The aircraft can be pre-programmed to auto-land at this purpose-built location if there are any complications with normal flight activity.

As an added benefit, these built-in simulation capabilities allow operators to continually be tested with simulated potential failures on their ability to utilize the Belly Landing, Engine-Out and Lost-Link Recovery protocols prior to actual flight events at ISR Range Services facilities.

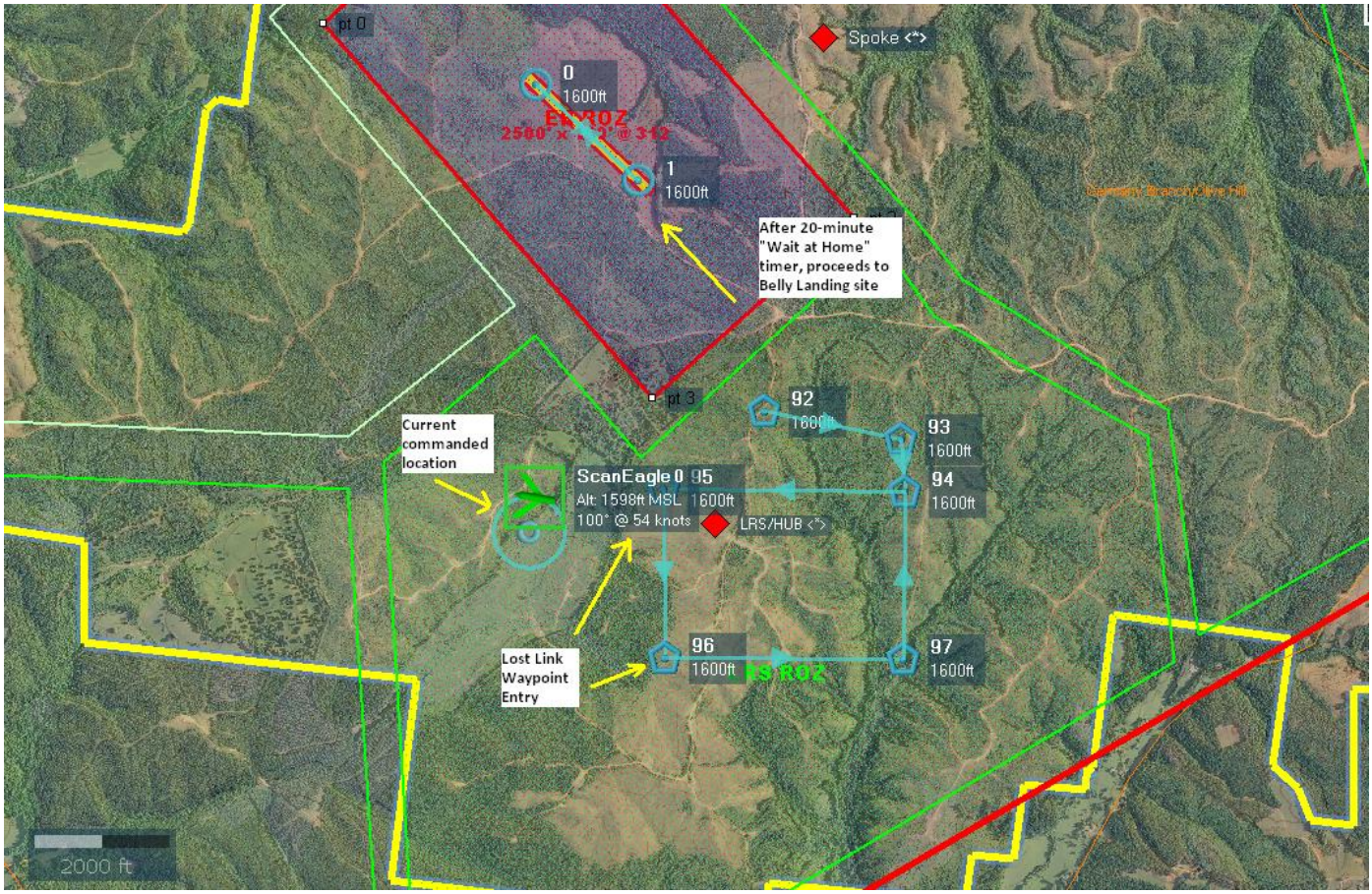

FIGURE 1. Belly Landing/Engine Out location and Lost Link routes.

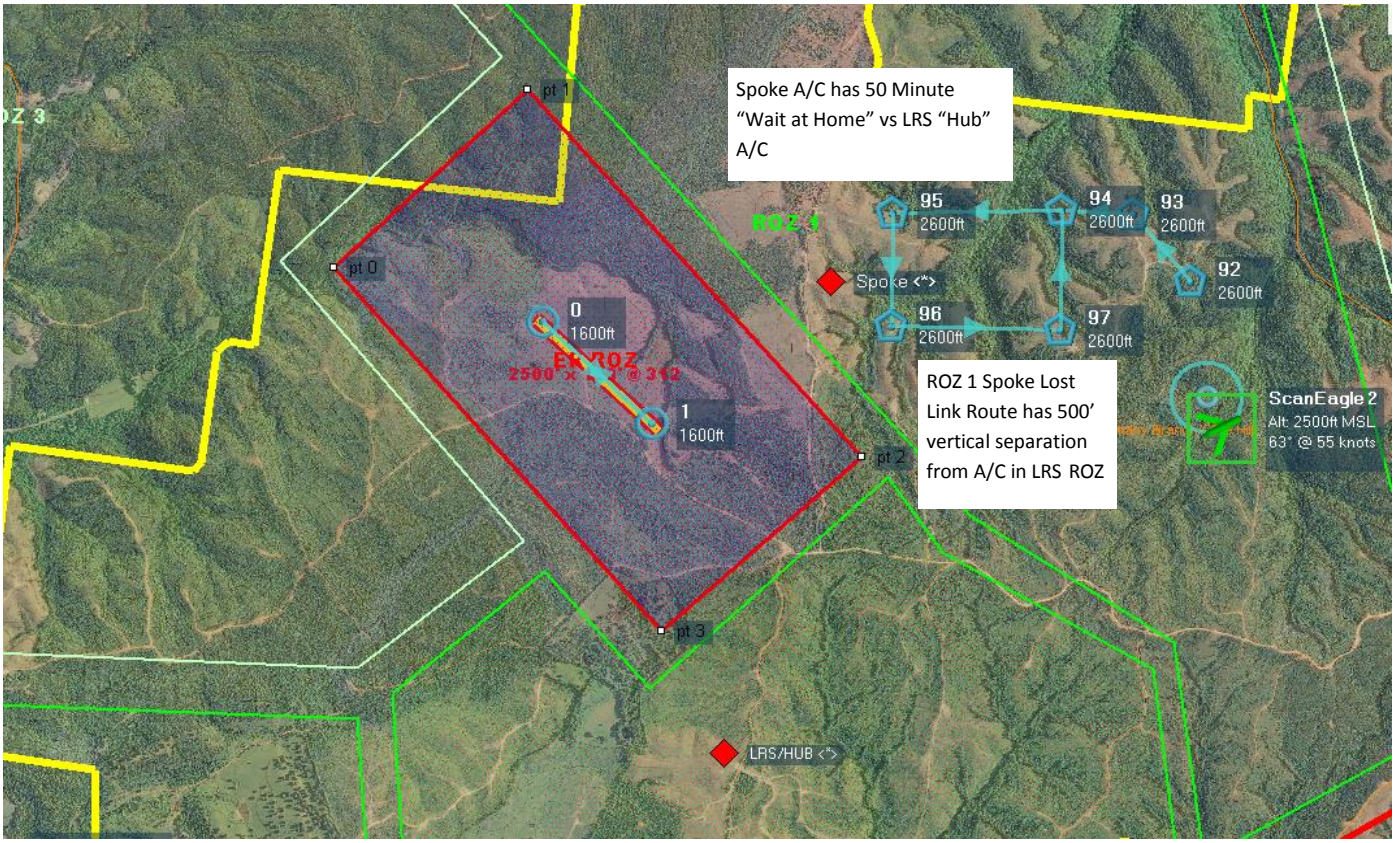

FIGURE 2. Spoke Lost Link route, shown in proximity of LRS and Belly Landing/Engine Out.