Emergency Procedures

Emergency Procedures for a UAS of this size and weight class are minimal, if for no other reason the systems in the UAS are simple. There are several emergency procedures that can be accounted for and grouped together.

Main Power Loss

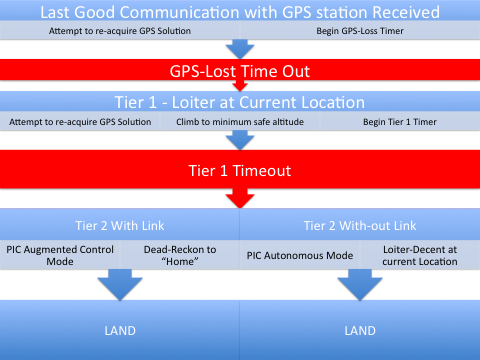
Loss of the main bus power can occur either at the battery junction, disabling engine and flight controls, or at the engine bulkhead, disabling the engine. In the even of total power loss (engine and flight controls), the vehicle follows a ballistic trajectory to the ground. The mitigation technique for this scenario is to minimize energy at impact. Maximum allowable speed while powered will not exceed 23 m/s, and maximum altitude to 300 meters, restricting the ballistic envelope. Additionally all flights are over uninhabited wetlands, so property damage and human injury are extremely unlikely. This is the only emergency situation where the airplane has no further recovery method.

Loss of the main bus at the engine will result in a controlled landing at an emergency decision site. The UAS will continue with communications Link and flight controls. The PIC will immediately turn the UAS towards the HOME position. The UAS is designed as a glider, and thus has a glide slope of approximately 11/1. This means that even at the worst case scenario for a normal flight-plan (1 mile out (1609m) and 150 m of altitude), the airplane will be able to glide unpowered back to the HOME position where a suitable landing site can be selected.

GPS Loss

Loss of GPS solution or GPS communication is the second-most troublesome procedure. Loss of GPS will result in the loss of a navigation solution, and autonomous function will be moderately-inhibited. The GPS-LOSS scenario is a two tiered recovery approach. Upon GPS-LOSS timeout, the UAS will immediately enter a loiter orbit in an attempt to reacquire signal. If after 15 seconds GPS is not reacquired, the UAS will enter tier two. At any time in tier one or two, the operator can take over with augmented control and utilize its onboard magnetometer to navigate back to the “HOME” Waypoint through dead-reckoning. Additionally the UAS is required to remain within line of sight, and the OBSERVER will call out UAS position and movement back to the PIC. Once the UAS is close enough to resolve orientation (<400m), the PIC can engage manual control and perform a manual landing at the pre-decided optimal landing site.

If a cascade of failures has occurred and LOST-LINK has also occurred, during tier two the UAS will enter into a loiter land procedure; descending in a loiter while reducing speed until contact with the ground at flair speed. During this decent the UAS is still in controlled flight and at touchdown the forward speed should not exceeded 11 m/s with the propeller off, minimizing damage to anything the UAS may come in contact with. Again, the UAS operates over unpopulated areas and mostly over water, therefore this type of landing should result in no property damage or personal injury.



Lost Link

-See the LOST LINK document on LOST LINK emergency procedures.

Manned Aircraft Encroachment

In any event that a manned aircraft approaches the UAS flight zone, the PIC will immediately return the UAS to the HOME waypoint, while manually over-riding the Altitude to the lowest allowable predefined for the flight zone. The lowest allowable altitude is 50 ft above the tallest obstacle in the flight zone, which gives 450 ft of vertical separation from a manned aircraft, which should always keep 500ft of vertical separation from obstacles in the flight zone.

Other Scenarios

Remaining emergency procedures can be grouped based on PIC response. Any scenario in which the UAS still has positive control will result in the PIC bringing the UAS back to the “HOME” waypoint. Depending on the level of failure, the PIC will then either enter a Spiral-Land procedure or a standard Loiter-Land. Depending on the degradation of the level of autonomy, the PIC will issue commands in the following order: Autonomous-Control, Augmented-Control (MANUAL or ALTITUDE mode), or Direct (Pilot in Control) Control. Any scenario in which is UAS does not have positive control, the PIC will switch to Direct Control, regain positive control, or attempt to land the UAS at its current location.