Emergency Procedures Description Attachment

NASA DFRC 2008 Fire Mission
UAS COA Application Attachment

NASA Dryden Flight Research Center (DFRC) has procured from General Atomics – Aeronautical Systems Incorporated, an MQ-9 Reaper aircraft and a Ground Control Station (GCS). DFRC has assigned the number "NASA 870" to the aircraft, registered it as N870NA, and renamed it "Ikhana" (pronounced ee-kah-nah, a Native American word from the Choctaw Nation meaning intelligent, conscious, or aware).

"Track changes" is used in this document to highlight the differences in this attachment between revision A of the 2008 plans, and revision B. Change tracking (and hence "change bars") have been suppressed for editorial and non-philosophical changes.

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The Ikhana UAS is a complex electromechanical aircraft that depends on an engine driven generator to power the avionics and flight controls. In many systems, the aircraft has 2 and 3 levels of redundancy. Despite the redundancy, there are a few failure modes and emergencies that would prevent the aircraft from completing the planned mission.

Specific Predator B (MQ-9) emergency procedures are covered in USAF TO 1Q-9 (M) A-1 and coordinated with the appropriate air traffic control facilities.

This attachment addresses two emergency situations and their constraints that would warrant landing the aircraft as soon as practical. The two emergency situations are: 1. Engine Failure, and 2. Generator Failure.

(b) (3) (A), (b) (3) (B) [redacted]

3. **Additional Constraints** – A normal landing is accomplished via C-band line-of-sight (LOS) communication between the GCS and the aircraft. The GCS is located near the planned takeoff and landing location and near instantaneous command/control of the aircraft is possible. When the aircraft is beyond line-of-sight (BLOS) (also known as over-the-horizon, OTH), the aircraft is controlled via Ku-band satellite link. This link has a time delay inherent to satellite communication systems. Satellite communication time delays during a landing attempt to a BLOS/OTH emergency landing site (ELS) will likely result in a landing that is not "smooth". It is for this reason that ELS are selected to reduce the risk of exposure to the general population and ground assets.

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6.1.4. **Maximum Airspeed** – The aircraft is limited in airspeed by its V_{ne} (never exceed speed), and by the flutter speed of the attached pod/pylon.

6.1.4.1. **Aircraft V_{ne}** – The aircraft V_{ne} is 230 KIAS/249 KTAS. Maximum sustained speed in level flight is in the 140 – 150 KIAS range. Best glide speed is based on aircraft weight and is flown at +2° AOA.

6.1.4.2. **Pod/Pylon flutter speed** – Although the calculated pylon/pod flutter speed is much greater, the 2007 maximum cleared (demonstrated) airspeed for the WSFM pylon/pod is 180 KIAS up to FL180, and the aircraft's V_{ne} above that altitude.

7. **Emergency Landing Sites (ELS)** – NASA DFRC has a desire to attempt to land the aircraft in an emergency situation.

7.1. In an emergency situation, it is desired to attempt to land the aircraft at a suitable landing site, only if this can be accomplished without an unacceptable increase of risk to people.

7.2. **Pre-mission Emergency Landing Site Selection** – Although the NASA DFRC rules for pre-mission selection of an ELS may change, the full set is currently the following:

7.2.1. Verbal FAA HQ UAS restriction: No airfields with an active Commercial or General Aviation presence. Private airfields by definition have a General Aviation presence.

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7.2.2. NASA DFRC restriction: No military airfields unless the controlling authority has been briefed on the aircraft, mission and risks and that authority approves designation as an Emergency landing site for these missions.

7.2.3. NASA DFRC restriction: The DFRC Range Safety Office or local Range Safety Office must analyze each site/airfield and determine acceptable runways, approach corridors, lost link plans and orbit points (as applicable) with respect to surrounding populations.

7.3. **Emergency Landing Sites** (ELS) – Two types of ELS have been defined by NASA DFRC. Primary ELS are those few required to support possible landing attempts in the event of a generator failure. Secondary ELS are those sites where an attempt could be made to land or crash the aircraft in the event of an engine failure where the engine is not able to be restarted. All ELS and approach paths are evaluated by the DFRC Range Safety Office (RSO) and DFRC Operations personnel for desirability and appropriateness. The current set of ELS approved by the DFRC RSO and Operations are available to the pilots and crew in real-time during a flight. The lists will be analyzed and updated as new information becomes available.

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(A),
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7.3.2. Secondary ELS – Because of the limited capability for the aircraft to fly without an operating engine, there are over 280 identified secondary ELS to cover the entire requested COA area. The list of approved sites are maintained as a database and contain several pieces of information about each site, including desirability (landing vs. crash site), location, altitude, length, FRD location, surface type (asphalt, dirt), and contact information for an owner, or the local Sheriff. This list will be modified and updated as new information is developed and received. As a rule, there are no approved agreements to use these sites, but they do comply with the landing site selection process described above. The full list and mission specific lists are available to the pilot and the crew in the GCS in real-time during flights. Reference the following for a graphic description of secondary ELS for each Zone: Figure 2 – Zone A Secondary ELS (Engine out), Figure 3 – Zone B

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Secondary ELS (Engine out), and Figure 4 – Zone C Secondary ELS (Engine out),

Deleted: Figure 3 – Zone B Secondary ELS (Engine out)

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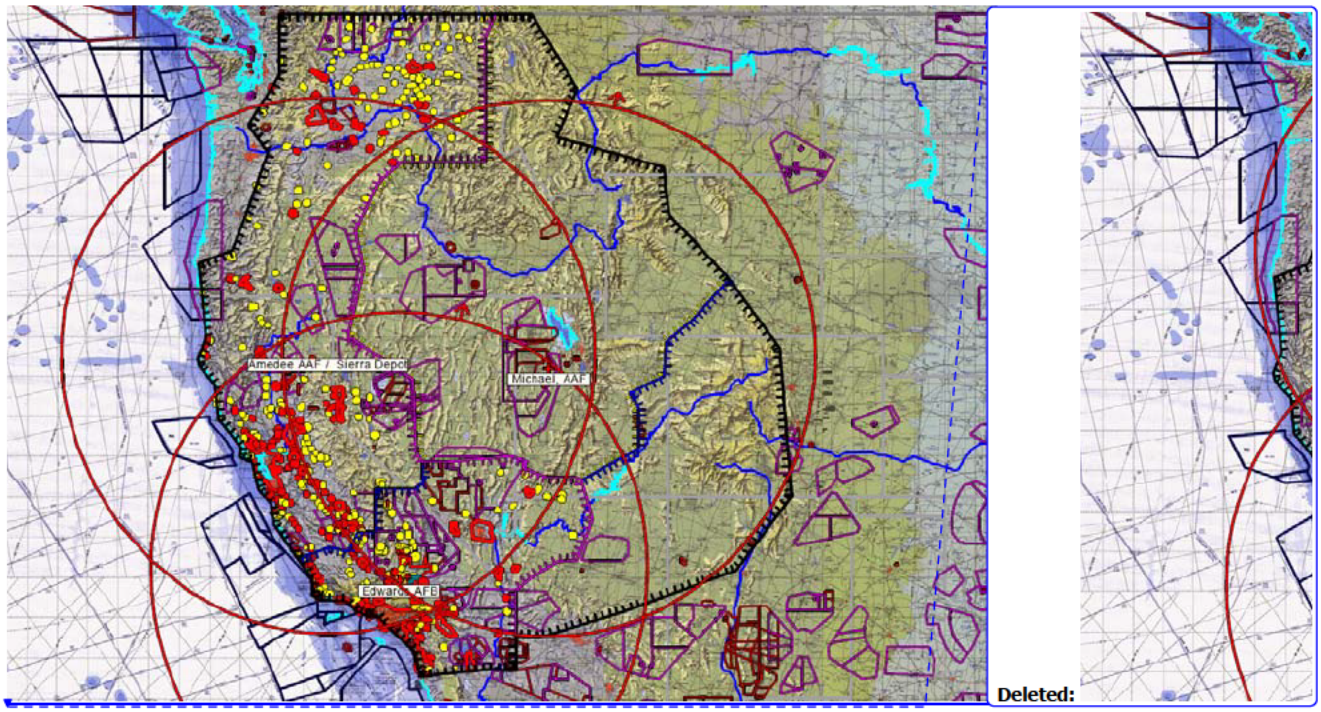

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Figure 1 - 400 nm circles on Primary ELS (Generator Failure)

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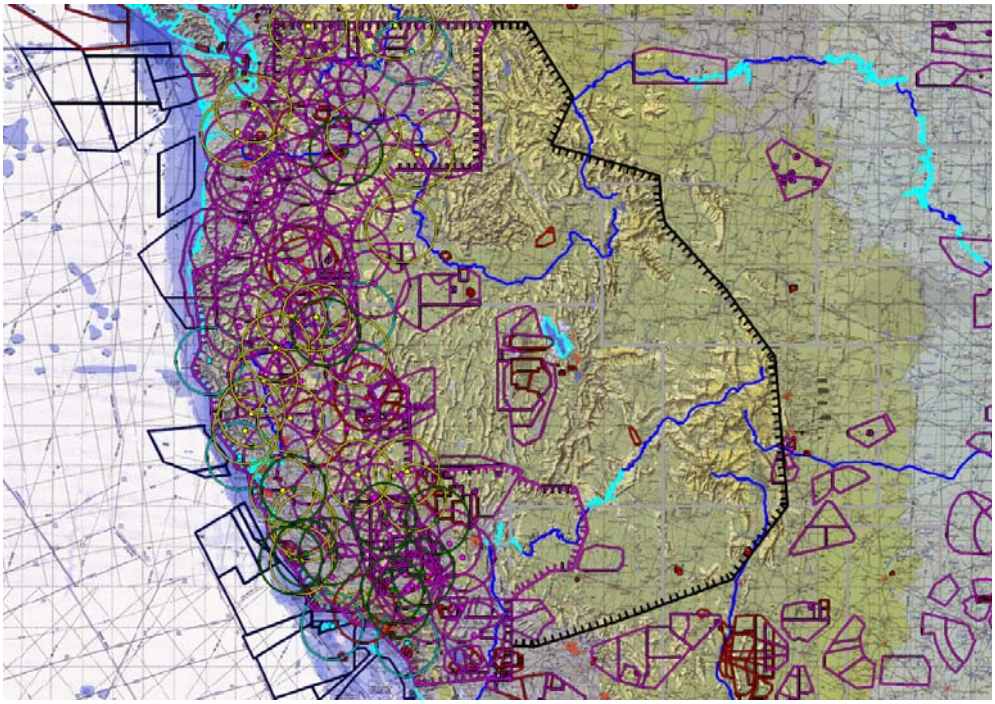

Figure 2 – Zone A Secondary ELS (Engine out)

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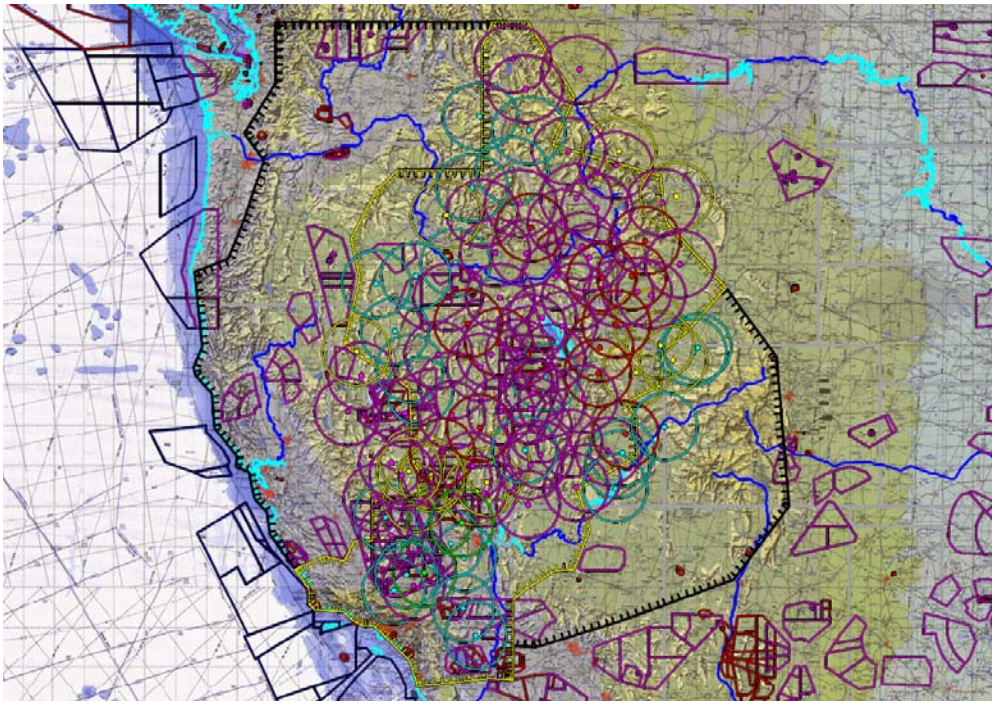

Figure 3 – Zone B Secondary ELS (Engine out)

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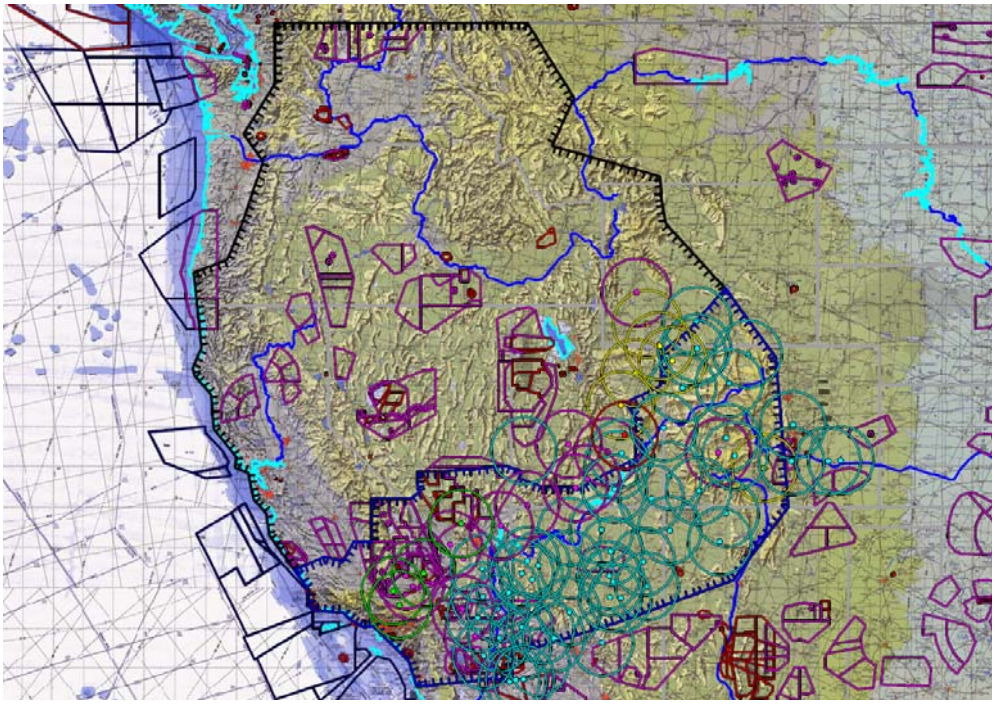

Figure 4 – Zone C Secondary ELS (Engine out)

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