

Aircraft Type and Model Description

NASA DFRC Ikhana Local Area 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 and renamed it “Ikhana” (pronounced ee-kah-nah, a Native American word from the Choctaw Nation meaning intelligent, conscious, or aware).

In general, the aircraft is standard unmanned MQ-9 aircraft with a few differences. First, Ikhana has no weapon systems installed. Second, the MQ-9 Flight Manual indicates the standard NAV configuration is 3 EGI (Honeywell H-764 embedded GPS/INS units), but Ikhana is configured with 1 EGI (Honeywell H764), 3 GPS (Novatel OEM4-G2 boards), and 3 INS (Honeywell HG1700 units). Third, the aircraft has some additional wiring and instrumentation systems to support NASA science research activities.

1. **UAS System** – The Ikhana system can potentially have 3 components: (a) The Ikhana aircraft, (b) a “Launch and Recovery Element (LRE)” GCS, and (c) a Mission Control Element (MCE) GCS. Generally, the Ikhana GCS will act as the LRE and the MCE, and consequently, there will only be 2 components (aircraft and GCS).

1.1. **Ikhana (MQ-9) aircraft** – General Atomics Aeronautical Systems Inc., Rancho Bernardo, California manufactures the Ikhana (MQ-9) aircraft. The aircraft are designed to be flown by a pilot or in an autonomous mode. Autonomous pre-planned responses may be overridden from the ground control station at the discretion of the pilot.

1.2. **GCS** – The GCS functions as the aircraft cockpit. A single GCS is planned for use as the LRE and MCE. See Figure 1. The GCS can control the aircraft either within line of sight (LOS) or over the horizon (OTH) via a combination of satellite relay and terrestrial communications. Control of an aircraft may be passed between ground control stations at any time during the mission.

1.2.1. **Launch and Recovery Element (LRE)** – An LRE will be used for launching and recovering the aircraft. After launching an aircraft the LRE will handoff control to the MCE to perform the specific mission. The LRE operators will communicate with airspace management authorities until handoff. LRE voice communications with ATC are provided by a single ARC-210 UHF/VHF voice radio relay through the aircraft with telephone communications available as backup.

1.2.2. (b) (3) (A), (b) (3) (B)



(b) (3) (A), (b) (3) (B)

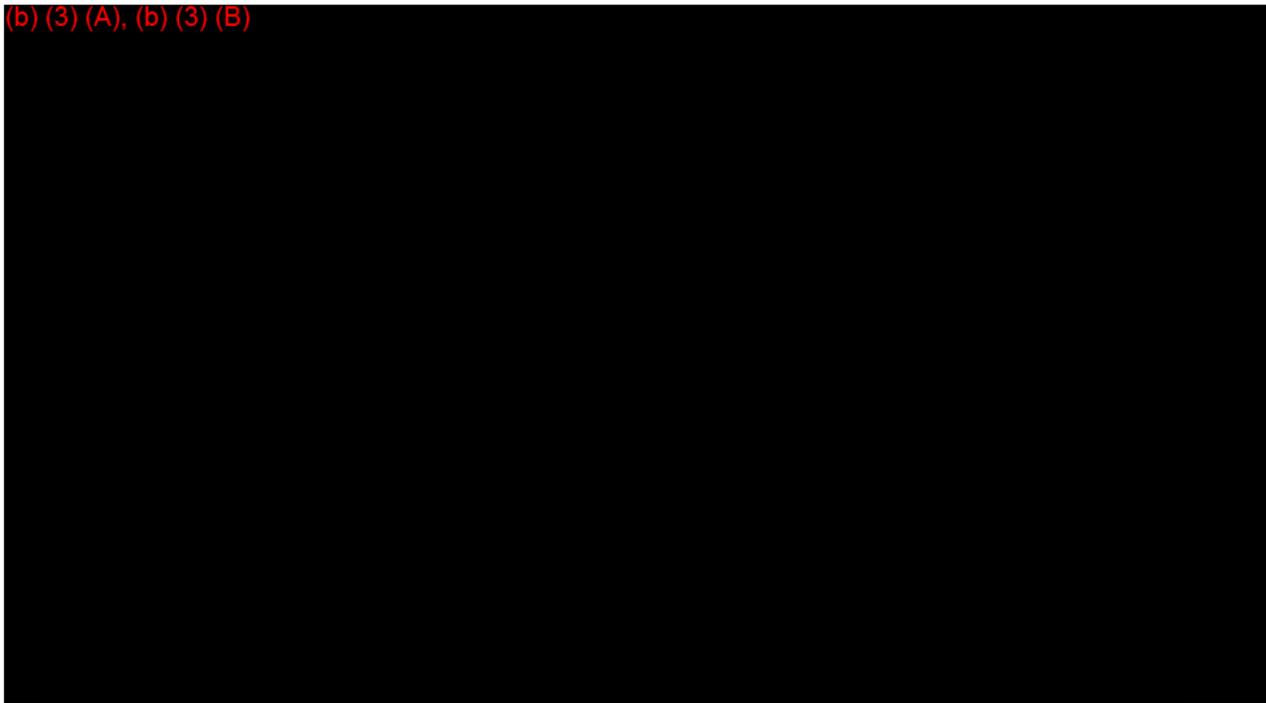
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(b) (3) (A), (b) (3) (B)

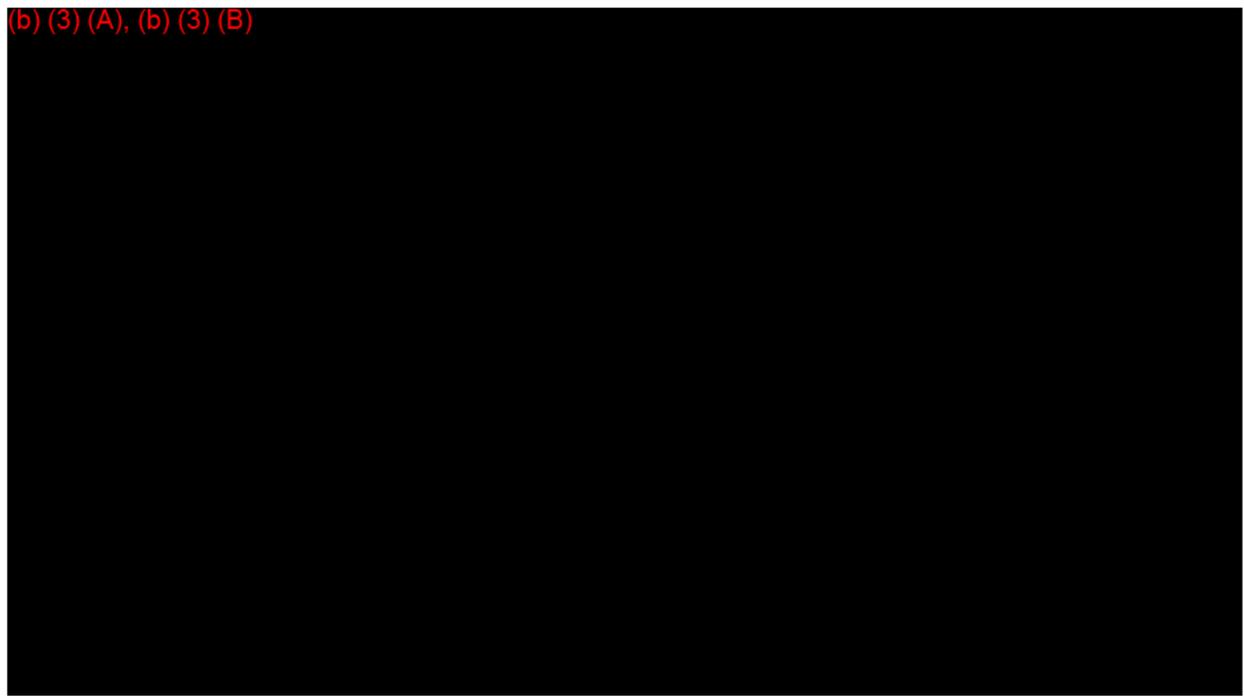
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(b) (3) (A), (b) (3) (B)

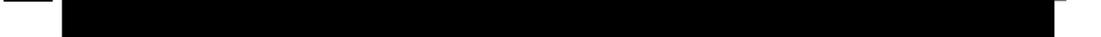
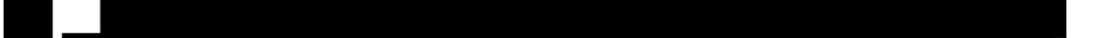
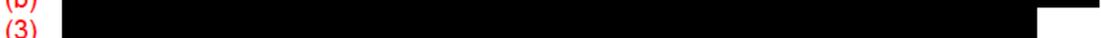
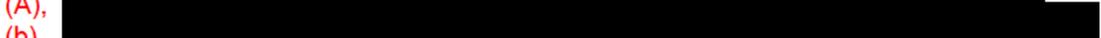
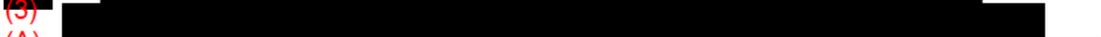
(b) (3) (A), (b) (3) (B)



(b) (3) (A), (b) (3) (B)



(b)
(3)
(A),
(b)
(3)
(B)



(b) (3) (A), (b) (3) (B)

2.4. (b) (3) (A), (b) (3) (B)

2.5. **Lighting** – The Ikhana aircraft is equipped with standard aircraft position lights and anti-collision strobe lights. All external lighting can be controlled by the pilot from the GCS.

2.6. (b) (3) (A), (b) (3) (B)

2.7. **GCS Situational Displays** – In the GCS, there are 3 basic types of displays available to the pilot in the GCS. The first type is a navigational map (“tracker display”) that shows real-time aircraft position (from downlink telemetry). The pilot can select any of several maps for this display. The second type is the “heads-up display” (HUD) that shows real-time aircraft telemetry (rate of climb, altitude, heading, etc) displayed over a pilot selected camera view on the aircraft. The third type is system/subsystem monitoring displays. These displays can be selected by flight crew members to show digital and/or chart recorder style aircraft information to investigate potential aircraft anomalies in-flight.

2.8. (b) (3) (A), (b) (3) (B)

this mode is a backup mode that is not expected to take control of the aircraft.

- 3.1.2.1. **Preprogrammed Autonomous Lost Link Mission** – The MQ-9 has the capability to fly a preprogrammed set of waypoints and actions in the event that it loses all command and control inputs from the GCS/pilot. This is generally referred to as the “lost link” mission. The “actions” include autonomous changes to transponder codes (such as 7600), altitudes, airspeed, etc. This backup mode is designed to ensure that the aircraft performs a predictable mission profile in the event of lost link. For a typical mission, the pilot inputs an appropriate lost link mission prior to the flight. During the flight, the pilot updates the “entry point” into the lost link mission. The pilot has the full capability to delete, update, and modify the lost link mission during a flight. The mission is designed provide a predictable return to base (RTB) function to the aircraft. At the end of the lost link mission, it is anticipated that the GCS LOS command and control system would be able to take control of the aircraft for landing. At the end of the lost link mission, if the GCS LOS command and control system is not able to take control of the aircraft, the aircraft will eventually run out of fuel and contact the ground in a predetermined and preprogrammed area. The predetermined and preprogrammed area is specifically selected by DFRC Range Safety to protect the public from danger in this scenario. For operating in the Local Area, this predetermined and preprogrammed area is within the R-2508/R-2515 SUA complex, or immediately adjacent to Gray Butte Field (04CA) or El Mirage (99CL) airports.
- 3.1.2.2. **Preprogrammed Autonomous Mission** – This type of mission is a variation of the directly controlled preprogrammed mission. The preprogrammed mission has an attribute that can designate legs or waypoints to be “lost link OK”. Using this attribute, the pilot can define a preprogrammed mission (or portion of a mission) that will executed, even if the aircraft loses the command and control link from the GCS. This capability is utilized when transferring aircraft control from one GCS to another.