Attachment D

Mutual Aid Box Alarm Systems
Unmanned Aircraft Systems Program (UAS)

UAS Operational Application Guidelines - General

PURPOSE

The purpose of this document is to provide general guidelines on operating a UAS at an incident or event. These guidelines shall coincide with the MABAS-IL UAS Flight Operations and Deployment Policy and shall not supersede the AHJ. The document will be broken down into various tasks. A specific operation may use one or many of these tasks.

SCOPE

The document will offer non-compulsory guidance to facilitate the safe and successful completion of a number of objectives, goals, and tasks instrumental to an effective deployment of UAS assets. Many of these tasks may need to be completed over a series of flights, dependent on the nature of the incident and number of units responding.

FLIGHT OPERATIONS AREA

The following is list of guidelines that should be utilized when establishing the area of operation. The flight operations area should be specifically reserved for the UAS operation and supporting personnel, vehicles and equipment. The takeoff and landing area should be a smaller subdivision of the flight operations area, reserved only for launch and landing of the UAS, as well as routine ground handling operations.

Flight operations area guidelines

- The flight operations areas should be clearly marked when practicable to prevent the entry of nonparticipating persons.
- The ideal flight operations area should be as large is as practicable, but at minimum should be a quadrangle measuring 2,500 square feet (50ft x 50ft).
- If possible, all vehicles and ground support equipment should be kept to one side of the flight operations area, while the other side contains the landing and takeoff zone.
- All persons in the flight operations area should readback announcements or instructions by any flight crew member to ensure they have been communicated effectively.

Takeoff and landing area guidelines

- The landing and takeoff area should be a minimum of 20ft by 20ft and 10ft away from any vehicle or other obstruction.
- The landing and takeoff zone should be unobstructed vertically.
- After sunset, use red scene lighting for the takeoff and landing area, whenever practicable.
- Establish at least one emergency landing zone in an area that will not create additional hazards.

TAKEOFF

The following is a list of guidelines that should be used when taking off.

1. Any crewmember should verbally declare their entry to the takeoff and landing area by announcing "*entering the active*" to all in the flight operations area.
2. When placing the aircraft in the takeoff zone, the aircraft's heading should be aligned with the wind direction. (e.g. wind out of 360°, aircraft should face north.)
3. Crewmembers should verbally declare when they power on the aircraft by announcing "*power*" to all in the flight operations area.

4. While any person is approaching the UAS, while its under power, the Remote Pilot in Command (RPIC) should hold the controls so as to avoid any inadvertent manipulation of the UAS.
5. The Remote Pilot in Command (RPIC) should announce when starting the rotation of the aircraft rotors by stating "*Clear Prop*" to all in the flight operations area.
6. The RPIC should announce when the UAS aircraft is taking off by stating "*taking off*" to all in the flight operations area.
7. Before taking off, the Remote Pilot in Command (RPIC) should position themselves behind the aircraft so that both the pilot and aircraft are pointing in the same direction.
8. Depending on the flight characteristics of the aircraft, during windy conditions, the Remote Pilot in Command (RPIC) may need to apply appropriate wind correction inputs
9. During takeoff, the Remote Pilot in Command (RPIC) should hover the aircraft at a practical altitude to ensure flight controls are functional before climbing out. While hovering, perform a flight controls check to make sure the aircraft is performing as expected before starting your flight mission. This should include:
    - Climb and descend
    - Pitch forward and backwards
    - Roll left and roll right
    - Yaw left and yaw right
    - If equipped, the Remote Pilot in Command (RPIC) should test the GPS lock by disabling position hold momentarily to let the aircraft drift a few feet then re-enabling position hold to ensure the GPS is providing input to the flight controller.

AVIATION RADIO COMMUNICATION PROCEDURES

All aviation radio communications follow a standardized protocol that will be expected by nonparticipating pilots and ATC. It is strongly recommended that MABAS flight crews become familiar with, and use the communication phraseology and techniques that are specified in the Aeronautical Information Manual, Chapter 4, Section 2 when communicating on any VHF Airband frequency.

MINIMUM OBSTACLES CLEARANCE ALTITUDE (MOCA)

Before the start of any mission, the minimum obstacle clearance altitude (MOCA) should be determined. This is the minimum altitude required to safely traverse between any two points in a defined area of operation with adequate clearance from terrestrial obstructions. Utilize the following steps to determine the MOCA:

NOTE: This procedure will only provide a reliable and repeatable MOCA altitude when a visual sensor zoomed to 1x is used. DO NOT attempt this procedure with the live feed from a thermal, multispectral or other payload.

1. Orient the camera gimbal level with the horizon (90-degree between nadir and zenith).
2. If the camera is equipped with a zoomable lens, ensure the lens is set to 1x zoom.
3. Identify the obstacle that appears the tallest in the flight operations area.
4. Set the heading of the aircraft such that the obstacle appears in the center of the camera feed horizontally.
5. From the landing and takeoff zone, ascend vertically until the obstacle crosses the astronomical horizon. (The astronomical horizon is the point at which the ground and sky appear to meet in the distance.)
6. Once this altitude is achieved, scan the live view for any other obstructions protruding above the horizon.
    - If an obstruction is seen, continue to ascend until that obstruction is just below the center of the live view.
7. Perform eight 45-degree yaws to the right. As you make each yaw, stop and scan the live view.
    - If an obstruction is seen protruding above the horizon, continue to ascend until that obstruction is just below the center of the live view.

8. Once a full 360-degree scan has been performed add 20ft to the drone's AGL altitude. This value will be your minimum obstacle clearance altitude (MOCA).
9. Document the MOCA value and if the aircraft is equipped with a return to home feature, set the return to home altitude no lower than the MOCA altitude.

The determination of the MOCA altitude for a particular location can be done before an incident or event as part of a UAS pre-planning exercise for the particular area the UAS will be operating in. Use extreme caution in congested areas, as the construction or modification of towers, buildings, antennas and aerial cables may cause MOCA to change over time.

TRAVERSING BETWEEN POINTS

Typically, most mission objectives will not be in the immediate area of the flight operations area and will require traversing from the takeoff area, to the objective and back multiple times throughout the deployment. When traversing between two points that are not in proximity, the Remote Pilot in Command (RPIC) should:

1. Fly the UAS no lower than the applicable MOCA altitude between the origin and destination.
2. Determine safe flight corridors. These corridors should have minimal obstructions and ground hazards such as ground personnel in the area or structures to allow ample room for the UAS to make an emergency or precautionary landing if necessary. Exercise caution to avoid transient overflight of nonparticipating persons and moving vehicles and vessels. Avoid loitering over structures and infrastructure longer than necessary to complete the needs of the mission. This may also mean that transit to the mission area may not be in a straight line from the flight operations area due to hazards on the ground.
3. Exercise caution to avoid any smoke, gas clouds, or convection currents which may pose a hazard to the operation of the UAS or interrupt the line of sight of the Remote Pilot in Command (RPIC).

OVERWATCH

The majority of UAS missions will involve providing data to enhance the situational awareness of the incident or event. This will frequently involve the following methodology.

Stationary hover (Loiter)

The stationary hover is where an aircraft hovers or loiters in a particular spot for an extended period of time. This may be useful when monitoring ground activities at an incident or event. The following guidelines should be followed while performing the stationary hover maneuver.

- The Remote Pilot in Command (RPIC) shall maintain VLOS at all times.
- Roughly every 10 minutes add gentle input to each primary flight control (yaw, roll, pitch, throttle) to make sure the aircraft is responding appropriately.
- The Remote Pilot in Command (RPIC) may descend below the minimum obstacle clearance altitude (MOCA), if it is safe, necessary, and in the best interest of the mission objective. However, the Remote Pilot in Command (RPIC) should return to the minimum obstacle clearance altitude (MOCA) as soon as practicable, and before moving the aircraft to another point.

Point of interest

The point of interest maneuver has similar intent to the stationary hover but provides a continual 360-degree view of the incident or event. The maneuver is performed by flying the aircraft in a slow circle while focusing the camera or sensor on an intended point of interest. The following guidelines should be observed while flying this maneuver:

- Do not fly below the MOCA altitude unless the RPIC has confirmed that the lower altitude and flight path is clear of any obstructions. This should only be conducted by a pilot who has sufficient knowledge and skill to make this assessment accurately.
- The Remote Pilot in Command (RPIC) may fly the POI maneuver aircraft manually or utilize an automated point of interest flight mode if the aircraft is equipped with it. It is strongly recommended that flights below the minimum obstacle clearance altitude (MOCA) be flown manually.

- The Remote Pilot in Command (RPIC) shall ensure no portion of the Point of Interest path extends beyond VLOS.
- On termination of the Point of Interest flight maneuver, return the aircraft to the minimum obstacle clearance altitude (MOCA).

LANDING

When landing the aircraft under the following conditions, the following guidelines should be adhered to:

1. Verbally declare your intent to return to base and land the aircraft by declaring "*returning to base*" and state your altitude to others in the flight operations area.
    - The UAS should always return to the takeoff and landing area with sufficient battery charge remaining to loiter or divert in the event the landing area is obstructed or congested. Sufficient charge remaining should provide the aircraft with 5 minutes of reserve power once the landing area is reached, at the minimum obstacle clearance altitude (MOCA).
        - If the aircraft's fuel or battery level is at the minimum amount required to return home without engaging the failsafe, verbally declare "*(aircraft call sign/designator) returning to base*", bingo fuel and state your altitude. All other landing and takeoff operations should be ceased, and the landing zone cleared for the incoming aircraft.
    - If the aircraft requires an emergency landing, the Remote Pilot in Command (RPIC) should verbally declare "*UAS (aircraft call sign / designator) declaring an emergency, returning to base*" and state your altitude, general location and direction of flight. All other landing and take-off operations should be stopped, and the landing zone cleared for the incoming aircraft.
        - If, due to the nature of the emergency the Remote Pilot in Command (RPIC) cannot safely return the aircraft to landing area, the Remote Pilot in Command (RPIC) should make an immediate descent and landing wherever is safe and practical.
2. When the aircraft is just outside the flight operations area, hover and hold the aircraft at the minimum obstacle clearance altitude (MOCA) determine that the landing zone is clear of obstructions and personnel, then verbally declare "*landing*" to everyone in the flight operations area. Then land the aircraft when safe to do so.
3. If an aircraft receives landing priority due to fuel exhaustion or other emergency, other aircraft or flight crew should immediately clear the landing area to allow the distressed UAS to land without delay.
4. Once the aircraft is on the ground, the Remote Pilot in Command (RPIC) should stop the rotors and verbally declare "*landed and disarmed*".
5. When retrieving the aircraft, the Remote Pilot in Command (RPIC) or crew member should verbally declare "*retrieving the aircraft*".

RELAYING INFORMATION TO INCIDENT COMMAND

One of the most critical functions a UAS can provide is real-time situational awareness to command during an incident. The following guidelines should be utilized to relay data and communicate with incident command.

- First, determine from incident command the need for live data, and what pertinent decisions will be made based on information captured by the UAS.
- Next, design a strategy by which the flight captures the pertinent data required by the incident commander.
- If possible, designate someone who has completed requisite training and has sufficient experience to assume the role of UAS Technical Specialist to maintain a single point of contact between incident command and the UAS team. This will prevent any unnecessary distractions for crewmembers, improve situational awareness and maintain an effective command structure. Provide a method independent of the Remote Pilot in Command (RPIC) or sensor operator's instrumentation for incident command to view the data from the UAS in real time. (Reference equipment recommendations.)

DATA HANDLING

The following guidelines should be observed while handling the data from a UAS. These guidelines will not supersede AHJ policies, or any state local or federal law, policy, ordinance or directive.

- Each SD card should either be marked on the card or logged when it is inserted into an aircraft to indicate the sensor and aircraft in which the card was used.
- When retrieving the SD card, it should be logged and put into a case that can clearly identify which card slot it is stored in. The slot should be logged as well.

ORHTOMOSAIC MAPPING

Creating orthomosaic maps is valuable for pre-planning, situational awareness, surveying damage, and coordinating response efforts.

- To create an orthomosaic map, the UAS team will need access to software designed specifically for photogrammetry. Simple image editors will not suffice.
- All imagery should be collected with a minimum 75% overlap in the X and Y axis. In areas with high uniformity between images (dense vegetation, concrete, water) the overlap should be increased.
- Pilots should use a flight automation application designed for photogrammetry to eliminate human-introduced inconsistency.