ENVIRONMENT, HEALTH & SAFETY
UNIVERSITY OF MICHIGAN

Indoor Operation of Unmanned Aircraft Systems (UAS)

Guideline

Date: 06/30/17
Revision #: 0

Applies To: This Guideline applies to the indoor use of unmanned aircraft systems and unmanned aerial vehicles (hereafter referred to as "UAS") by anyone on the University of Michigan (U-M) Ann Arbor, Flint, and Dearborn campuses, and other U-M properties (e.g. Biological Station, Pellston, MI; Stinchfield Woods, Pinckney, MI; Camp Davis, Jackson, WY). This Guideline also applies to the indoor use of UAS by U-M faculty, students, and staff for U-M sanctioned events off of U-M property.

This Guideline covers UAS flights in both general public spaces (atriums, lobbies, etc.) as well as in controlled classroom and laboratory settings.

The U-M supports the safe use of UAS in the course of research and educational activities and other endeavors in the pursuit of the University's mission. This document provides guidance for the safe indoor operation of UAS on U-M properties and off U-M properties for U-M sanctioned events.

Indoor use of UAS *does not* require an application to the U-M Institutional Autonomous Systems Committee (IASC) or a waiver from Article XV of the Regents' Ordinance provided that:

- The operation is conducted in accordance with the policies and procedures listed in this Guideline
- The Facility Manager/Operating Site Property Manager has granted permission for this operation in accordance with this Guideline

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RESPONSIBILITY

U-M Institutional Autonomous Systems Committee (IASC)

While indoor use of a UAS does not require an application to the IASC or a waiver from Article XV of the Regents' Ordinance, the IASC does reserve the right to review all operations and procedures associated with an indoor UAS mission.

UAS Flight Team

The UAS Flight team consists of the Pilot in Command, the Visual Observer(s), and the Mission Safety Personnel. The roles and responsibilities for each of these important positions is described below.

Pilot in Command (PIC)

- The Pilot of the UAS shall be the PIC and shall have the ultimate responsibility for the safe operation of the UAS.
- The PIC has the final decision on whether to initiate or terminate any flight.
- The PIC will evaluate each mission. It is the PIC's responsibility to recognize risks and refuse all missions that may present unacceptable risks. The PIC's word is final as to whether the flight is safe to conduct.
- The PIC will comply with the Facility Manager/Operating Site Property Manager's request that a mission be terminated if they feel the mission is unsafe.
- Before launch, the PIC must understand the mission request and have all applicable documentation available upon request.

- The PIC must be aware of all hazards associated with the flight zone. These hazards include but are not limited to the building's infrastructure and spectator areas.
- The PIC must keep all UAS operations within the visual line of sight (VLOS).
- The PIC must determine the size classification of the UAS based on the table below:

Group 1	Micro	UAS is less than 1 pound
Group 2	Small	UAS is between 1 pound and 4 pounds
Group 3	Medium	UAS is between 4 pounds and 6.5 pounds
Group 4	Large	UAS is greater than 6.5 pounds

- Qualifications and training:
  - The PIC must safely operate the UAS in all situations. This includes maintaining safe distances from persons and building structures and completing effective evasive and emergency maneuvers when necessary.
  - The PIC must be in a physical and mental condition that will not interfere with the safe operation of the UAS.
  - The PIC must read and be familiar with the contents of this Guideline and the UAS-specific Operator's Manual.

Visual Observer *(Applicable Only for General Public Spaces)*

- The visual observer (VO) will be assigned by the PIC.
- All indoor UAS missions in general public settings require at least one VO to offer a viewpoint that is distinct from the PIC.
- The VO will assist and advise the PIC in maintaining situational awareness and complying with PIC's "see-and-avoid" duties.
- The VO will maintain a view of the flight zone and surrounding areas to identify potential emerging hazards.
- The VO will maintain communication with the PIC at all times.
- Qualifications and training:
  - The VO must have a thorough understanding of all normal, abnormal, and emergency aspects of the UAS and the UAS mission.
  - The VO must understand the safe operation of the UAS in all situations. This includes an understanding of safe distances from persons and structures and how evasive and emergency procedures will be executed.
  - The VO must be briefed by the PIC prior to each flight to ensure a consistent understanding of each mission.
  - The VO must read and be familiar with the contents of this Guideline.

Mission Safety Personnel *(Applicable Only for General Public Spaces)*

- Mission safety personnel will be assigned by the PIC.

- All indoor UAS missions in general public settings must have at least one safety person for off-peak facility operations and a minimum of two safety personnel available during peak facility operations.
- Mission safety personnel will be positioned outside of the flight zone, and will alert the PIC and/or the VO of any potential emerging hazards.
- In the event of building fire alarm or any other type of emergency, mission safety personnel will remove any cones or visible markers to allow egress through the flight zone.
- Mission safety personnel will be familiar with the locations of emergency phones, exits, first aid kits, fire extinguishers, and any other safety equipment deemed necessary for a successful UAS mission.

Facility Manager / Operating Site Property Owner (FM/OSPO)

- The FM/OSPO has authority over the building in which the flight zone is located.
- Indoor UAS missions will only occur with explicit permission of the FM/OSPO.
- The FM/OSPO can revoke this permission at any time, including issuing real-time requests for the PIC to immediately and safely recover or terminate the UAS mission.
- Works with UAS team prior to flight activities to develop a safe flight zone and identify any potential hazards associated with that flight zone.

Principal Investigator (PI) / Department

- The PI / Department will enforce procedures outlined in this Guideline.
- The PI / Department will ensure that staff and students are aware of this Guideline and instructed on the details of implementation.
- The PI / Department will provide the necessary personal protective equipment (PPE) to the UAS flight team prior to any flight activity. The PPE includes, but is not limited to ANSI Z87 approved eye protection, ANSI Z89.1 approved hard hats, and proper reflective vests.

U-M Environment, Health, & Safety (EHS)

- EHS will work with Departments, the UAS team, and the FM/OPSO to provide guidance and assistance to promote a safe indoor UAS mission that complies with all applicable rules and regulations.
- EHS will publish policies and guidance, and provide assistance and training.

PROCEDURES

Checklists have long been valued as the foundation for safe flight activities. Emphasis is placed on the completion of checklists and assessments for the successful completion of each indoor UAS mission.

For the purpose of this Guideline, the procedures for a safe UAS mission are separated into 1) General Public Area UAS Missions and 2) Controlled Area UAS Missions.

General Public Area UAS Mission Procedures

Site Assessment/Preparation

Prior to any indoor UAS event in a general public area, members of the UAS team and the FM/OSPO will collaborate and complete the Indoor UAS Flight Passport (IFliP), located in Appendix A. The successful completion of the IFliP ensures that all individuals involved with an indoor UAS flight are in agreement with the parameters of that mission. **Once the IFliP has been completed, it must be signed by both the PIC and the FM/OSPO before any indoor UAS event**.

The IFliP (Appendix A) is comprised of two components:

1. **Site Hazard Assessment**: Prior to any flight, members of the UAS team and the FM/OSPO will meet and identify the flight zone. All potential hazards associated with this flight zone will be identified. The Site Hazard Assessment is found in the IFliP.
2. **Site Preparation**: After the Site Hazard Assessment has been completed, the UAS team will work with the FM/OSPO to prepare the flight zone. The flight zone preparation will be done in accordance with the IFliP.

Controlled Area UAS Mission Procedures

Site Assessment/Preparation

Indoor UAS missions that occur in a controlled area such as a research laboratory require less oversight. This is based on the idea that this setting 1) is isolated from the general public who may be unsuspecting of the UAS mission and 2) has a permanent demarcated flight zone and is better suited for repetitive UAS missions.

Because of the repetitive nature of UAS flights in research laboratories, a *standing approval* from the FM/OSPO will be in place after the initial completion of the IFliP.

Site Hazard Assessment: Prior to an initial flight in a controlled area, members of the UAS team and the FM/OSPO will meet and identify the flight zone. All potential hazards associated with this flight zone will be identified. The Site Hazard Assessment is found in the IFliP (Appendix A).

Site Preparation: After the Site Hazard Assessment has been completed, the UAS team will work with the FM/OSPO to prepare the flight zone. The flight zone preparation will be done in accordance with the IFliP.

FLIGHT OPERATIONS

A successful indoor UAS mission is contingent upon thorough planning. After gaining indoor flight site approval from the FM/OSPO through the completion of the IFliP, the UAS team can move forward to actual flight operations.

UAS Team PPE and Engineering Control Requirements

Prior to any flight activity, it is imperative that the UAS team understand and implement the required flight zone PPE and engineering controls. The following table summarizes these flight zone PPE and engineering controls based on the UAS Group.

UAS GROUP	HARD HAT REQUIRED IF MAX ALTITUDE EXCEEDS[1]	SAFETY GLASSES REQUIRED?[2]	GENERAL PUBLIC FLIGHT ZONE REFLECTIVE VEST REQUIRED?	CONTROLLED AREA FLIGHT ZONE REFLECTIVE VEST REQUIRED?	TETHER REQUIRED?
1	50 ft	Yes	Yes	No	No
2	20 ft	Yes	Yes	No	No
3	10 ft	Yes	Yes	No	Yes
4	10 ft	Yes	Yes	No	Yes

1. Hard hat must be ANSI Z89.1 approved head protection
2. Safety glasses must be ANSI Z87 approved eye protection

Normal UAS Preflight and Post Flight Activities

Although there are many variables that go into a given UAS flight, there are some basic steps that can be taken to guarantee that the mission is completed as safely as possible.

- **Preflight Activities**: Before each indoor UAS mission, the PIC must perform a preflight inspection of the UAS to ensure that it is in a condition for safe operation. The preflight inspection should be conducted in accordance with the manufacturer's preflight inspection procedures. Additional preflight items that should be completed focus on UAS team roles, contingency plans, and overall flight zone preparedness. A detailed preflight checklist can be found in the Indoor UAS Flight Operations Checklist (Appendix B).
- **Post-flight Activities**: After each indoor UAS mission, steps should be taken to ensure that the UAS is de-energized and stored properly. This post-flight inspection should be conducted in accordance with the manufacturer's procedures. Other potential post-flight activities are described in the Indoor UAS Flight Operations Checklist (Appendix B).

Physical Restraint Flight Operations

- **Tethered Flight**: All Group 3 and Group 4 UAS operations require the use of a tether. The tether must 1) be lightweight enough as to not interrupt the safe operation of the UAS and 2) be strong enough to withstand possible encounters with structures. When conducting a tethered flight, the following guidance must be followed:
  - All tethered operations require at least 4 team members: The PIC, two anchors (who operate the tethers), and a VO.
- **Netted Flight Zone**: Although not required, netting can provide an effective means for demarcating a flight zone. This physical barrier can protect both the public and building structures from an errant UAS maneuver.
  - A netted flight zone would relieve the requirement of having mission safety personnel.

- Propeller guards should be considered when operating within a netted enclosure to decrease the chances of entanglement.

Appropriate and Prohibited Uses

All indoor UAS missions must be completed in a safe and responsible manner.

- Indoor UAS missions shall not monitor or record areas where there is a reasonable expectation of privacy in accordance with accepted social norms. These areas include but are not limited to restrooms, locker rooms, individual residential rooms, changing or dressing rooms, and health treatment rooms.
- Indoor UAS missions shall not monitor or record residential hallways, residential lounges, or the inside of campus daycare facilities.
- Indoor UAS missions shall not monitor or record sensitive institutional or personal information which may be found, for example, on an individual's workspace, on computer or other electronic displays.

Related Documents

U-M documents:

- University of Michigan Regents' Ordinance Article XV
- University of Michigan Research Unmanned Aircraft Systems
- University of Michigan Policy on the Operation of Unmanned Aircraft Systems (UAS)
- University of Michigan Unmanned Aircraft Systems Outdoor Flight Operations Manual
- University of Michigan Unmanned Aircraft Systems On and Off U-M Property: Paths for U-M Approval

Appendices

- Appendix A -- Indoor UAS Flight Passport (IFliP)
- Appendix B -- Indoor UAS Flight Operations Checklist

TECHNICAL SUPPORT: All reference guidelines, regulations, and other documents are available through EHS (647-1143).

Appendix A: Indoor UAS Flight Passport (IFliP)

The Indoor UAS Flight Passport must be completed by UAS team members in collaboration with the FM/OSPO prior to any indoor UAS flight inside of any U-M building or for U-M sanctioned activities in any building off of U-M property. **Once the IFliP has been completed, it must be signed by both the PIC and the FM/OSPO before any flight activity.**

UAS Mission Personnel Information

Department Name:
PI Name:
PIC Name:
VO Name:
Safety Personnel:
FM/OSPO Name:

Site Hazard Assessment (to be completed by UAS team and FM/OSPO)

TASK COMPLETED? Y/N	**ASSESSMENT TASK**	**ASSESSMENT NOTES *(Use IFliP Task Notes Page if Necessary*)**
	UAS team members and FM/OSPO have determined appropriate flight zone as defined in this Guideline	Flight zone location (Building, Room #, etc):
	The flight zone has been determined to not impede egress in the event of building fire or emergency	
	UAS team members and FM/OSPO have identified potential flight zone hazards. These hazards may include, but are not limited to, fire suppression equipment, ceiling fans, display areas, and any other building infrastructure that may present a hazard to a successful mission	List of potential hazards and hazard locations:
	UAS team members and the FM/OSPO have identified a safe battery charging area. This area must be outside of the flight zone and a safe distance away from spectator or public area	Battery charging location:

Site Preparation

TASK COMPLETED? Y/N	SITE PREPARATION TASK	SITE PREPARATION TASK NOTES
	The flight zone (as defined in the Site Hazard Assessment) has been clearly demarcated with cones or other visible markers. The UAS will not fly beyond the demarcated area.	How is flight zone demarcated
	If necessary, physical restraints (i.e. tether or netting) have been implemented	Type of physical restraint used:
	Door signs indicating that a UAS event is in progress have been fixed to all doors leading to flight zone	

Building FM/OSPO Signature **Date**

UAS PIC Signature **Date**

IFliP Task Notes

Flight zone location (Building, Room #, etc.)
List of potential hazards and hazard locations
Battery charging location
How flight zone is demarcated
Type of restraint system in use (if required)

Appendix B: Indoor UAS Flight Operations Checklist

Preflight Activities

☐ Establish and brief personnel on flight zone operations, launch/recovery zones, and the mission plan.

☐ Establish and brief personnel on contingency plans and flight termination procedures. Topics to consider include but are not limited to:

- What to do in the event of a sudden energy depletion.
- What to do if the UAS leaves the visual line of site (VLOS).
- What to do in the event that an unauthorized person walks into the flight zone.
- What to do in the event of a building fire alarm.

☐ Verify that all UAS team members have the correct PPE and engineering controls as outlined in the table below:.

UAS GROUP	HARD HAT REQUIRED IF MAX ALTITUDE EXCEEDS[1]	SAFETY GLASSES REQUIRED?[2]	GENERAL PUBLIC FLIGHT ZONE REFLECTIVE VEST REQUIRED?	CONTROLLED AREA FLIGHT ZONE REFLECTIVE VEST REQUIRED?	TETHER REQUIRED?
1	50 ft	Yes	Yes	No	No
2	20 ft	Yes	Yes	No	No
3	10 ft	Yes	Yes	No	Yes
4	10 ft	Yes	Yes	No	Yes

☐ Ensure that flight zone is free of spectators and hazards.

☐ The PIC has inspected the UAS to ensure that it is in a condition for safe operation. This preflight inspection should be done in accordance with the UAS manufacturer's inspection procedures when available and/or an inspection procedure developed by the UAS operator

Post-Flight Activities

☐ Upon landing UAS, de-energize UAS according to manufacturer's procedures.

☐ Communicate with safety personnel that mission has been completed and that the UAS has been de-energized. Safety personnel will then relay this information to members of the public if necessary.

☐ Complete post-flight activities in accordance with the UAS manufacturer's procedures.

Glossary of Terms

TERMS	DEFINITIONS:
Unmanned Aerial Vehicle and Unmanned Aircraft System (UAS)	An aerial vehicle or system, whether or not capable of carrying cargo, that is operated remotely or that is capable of navigating autonomously (commonly referred to as "drones").
Flight Zone	An area that is reserved for indoor UAS flight activities. The flight zone is clearly demarcated by cones or other visible means to keep people out who are not directly involved with the UAS mission. The flight zone is determined by the Facility Manager/Operating Site Property Owner in collaboration with the UAS team.
Indoor Area	A structure consisting of walls and a roof capable of containing the flight of a UAS.
General Public Area	An area that can be accessible to spectators or people not affiliated with an indoor UAS mission. Examples include, but are not limited to, building atriums and lobbies.
Controlled Area	An area that is not accessible to spectators or the general public. Controlled areas include, but are not limited to, classrooms and research laboratories.
Size Classifications	For the purpose of this Guideline, UAS are classified as follows

Group 1	Micro	less than 1 pound
Group 2	Small	between 1 pound and 4 pounds
Group 3	Medium	between 4 pounds and 6.5 pounds
Group 4	Large	greater than 6.5 pounds

Peak Hours Operations	When a building's doors are unlocked, and the general public can freely enter the building.
Off-Peak Hours Operations	When a building's doors are locked, classes are not in session, and the general public cannot freely enter the building.