REMOTE OBSERVATION OVER TIME (DRONE IN A BOX) – PHASE 1

Task 3 Report- FAA Beyond Visual Line of Sight (BVLOS) Waiver

Prepared by
Bart Bauer, Assistant Director Autonomous Aerial Systems Office (AASO) and
Jeremy Crowley, Director, AASO
University of Montana

Prepared for the
MONTANA DEPARTMENT OF TRANSPORTATION
in cooperation with the
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
Helena, MT 59620-1001

June 21, 2025

Disclaimer Statement

Alternative Format Statement

Table of Contents

List of Figures

I. FAA UAS BVLOS and DiaB Operational and Regulatory Framework

One of the newest technologies in the Unmanned Aerial System (UAS) industry is a Drone in a Box (DiaB). This technology has been embraced by a few local and state law enforcement agencies and state Departments of Transportation (most notably in relation to this project is AKDOT). A DiaB system (Fig. 1), allows for the remote control of a UAS under beyond visual line of sight (BVLOS) operations. According to Federal Aviation Authority (FAA) 14 Code of Federal Regulations (CFR) Part 91, BVLOS is an advanced operation beyond the CFR Part 107 (FAA Certification of Remote UAS Pilot) and requires a waiver.

Figure 1. Two DiaB systems (American Robotics, 2022).

FAA 14 CFR Part 108 is expected to mandate communication links and detect-and-avoid (DAA) and BVLOS certification, as well as move the responsibility of the operations from the individual pilot (as in Part 107) to the organization. Part 108 is also expected to enable routine BVLOS flights without individual waivers by relying on advanced technologies. The notice of proposed rulemaking (NPRM) for part 108 is expected to come out mid-2025 but was not released at the time of the report.

Two executive orders relating to UAS were released in June 2025. One of these addresses Part 108, stating the FAA Administrator must issue a proposed rule enabling BVLOS within 30 days and a final rule withing 240 days. The order requires the FAA to identify performance and safety metrics for BVLOS within 30 days and identify regulatory barriers within 180 days. The other order directs federal agencies to prioritize US-manufactured UAS and publish a Covered Foreign Entity List that identifies companies that pose supply chain risks within 30 days, and to submit proposed rulemaking to secure the US drone supply against foreign exploitation within 90 days (McNabb, 2025).

The companies that manufacture DiaB solutions have been successful in FAA BVLOS waiver applications by incorporating a detect and avoid system (DAA), an on-site weather station, and a camera inside the box in order for the remote pilot in command (PIC) to be able to visually check the aircraft before BVLOS operations. Applicants that have DiaB systems with advanced airspace awareness, detect-and-avoid DAA systems, a proven track record of safe flights, well-developed standard operating procedures (SOPs), and accurate record keeping of pilot training, flight logs, and preventative maintenance are most like to be successful (Karpowicz, 2025).

There are a few organizations that have received FAA waivers for BVLOS (14 CFR Part 107.31), typically under very specific geographical location requirements, with altitude and airspace restrictions, pilot restrictions, daylight restrictions, and with specific UAS that have an airworthiness certificate (FAA, 2024). The FAA also does not allow stacking of waivers, for example, an organization that has a waiver for Flight Over People and a waiver for BVLOS, cannot operate in both BVLOS and Flight Over People simultaneously (Rupprecht, 2024).

According to the FAA, there are 303 entities that have current BVLOS waivers (FAA, 2024). Some of the milestones (The Drone Girl, 2024; FAA, 2025) in BVLOS waiver issuance include:

- Statefarm was the first in the US to be authorized for BVLOS and operations over people (OOP) in January 2019 for catastrophic damage assessments.
- Phoenix Air Unmanned was authorized on in Aug 2023 to conduct aerial photography and inspections below 400’ over sparsely populated areas in pre-planned flight paths operating SwissDrones SVO 50 V2 UAS.
- Zipline was authorized in September 2023 to operate their Sparrow UAS (with preflight safety checks, detect and avoid system, Automatic Dependent Surveillance- Broadcast (ADS-B), acoustic avoidance system, etc.) for package delivery.
- Percepto was authorized in May 2023 to enable their employees to conduct remote BVLOS with their DiaB solution at critical infrastructure sites in the US below 200’ without detect and avoid systems.
- In January 2025 American Robotics received a BVLOS waiver for their DiaB system allowing automated flights over people and moving vehicles. They are required to maintain pilot flight records, pilot training, preventative maintenance schedules, and OEM manuals (Karpowicz, 2025).

Some studies have investigated detect and avoid requirements for BVLOS flights (FAA, 2018). There are UAS interference, security, and communication considerations including radio frequency signal jammers can lead to loss of link, increased power consumption, packet delays and bit errors (FAA, 2016). Requirements and procedures for sUAS BVLOS operations vary by country, and many BVLOS waivers issued have a small detect and avoid system incorporated into the UAS system (Fang et al., 2018). There have been rapid advances in persistent navigation systems and communications systems that are starting to enable highly reliable and autonomous BVLOS operations (Politi et al., 2024).

II. FAA Waiver

The AASO participated in meetings with UAS manufacturers (Censys, Skydio, Vision Aerial) and vendors (Frontier Precision and RDO) and NASA in 2024-2025 to learn from their experiences with FAA DiaB and BVLOS waivers. These meetings combined with AASO’s FAA BVLOS waiver application experience for Lubrecht Experimental Forest enabled us to fully understand the process and requirements for a successful BVLOS waiver. We provided a template for MDT to apply for a BVLOS waiver in Appendix A. The areas that need more information or specific details are highlighted in yellow.

The Autonomous Aerial Systems Office (AASO) applied for a BVLOS waiver for operations at the Lubrecht Experimental Forest in November 2024. This application is included in Appendix B. In February 2025 the FAA provided some guidance and suggestions for additional material to be included in the application. The final waiver was approved in April 2025 and took approximately 150 days total with the additional revisions (Appendix C).

III. Acknowledgements

The authors would like to sincerely thank the Montana Department of Transportation and Technical Panel for their time and effort reviewing the work plan and timeline, providing guidance on the analysis and reports, providing logistical support, and steering the research. Without their help this research would not have been possible.

Technical Panel Members:

Emily Hawley, Research and Project Manager, MDT; Rebecca Ridenour, Research Program Manager, MDT; Mike Kuni, Project Chair, MDT; Paul Hilchen, UAS Manager, MDT; Curtis Buckley, Technical Panel Member, MDT; Lee Grosch, Technical Panel Member, MDT; Justun Juelfs, Technical Panel Member, MDT; Cameron Kloberdanz, Technical Panel Member, MDT; Patrick McCann, Technical Panel Member, MDT; Ethan Ritzen, Technical Panel Member, MDT; Patrick Dryer, Technical Panel Member, AKDOT; Stephanie Brandenberger, Technical Panel Member, FHWA; Raja Nagisetty, Technical Panel Member, Montana Tech

IV. References

American Robotics, 2022. https://www.american-robotics.com/post/ondas-holdings-signs-term-sheet-to-acquire-airobotics. Accessed June 6, 2025.

FAA, 2016. Secure Command and Control Link with Interference Mitigation. [Project]. Federal Aviation Administration. Start date: 8 Aug. 2016. https://rip.trb.org/view/1422582

FAA, 2018. Small UAS detect and avoid requirements necessary for limited BVLOS operations: separation requirements and training. [Project]. Federal Aviation Administration. Start date: 1 Jun. 2018. https://rip.trb.org/view/1562140

FAA, 2023. Unmanned aircraft systems, advanced operations, emergency situations. https://www.faa.gov/uas/advanced_operations/emergency_situations Accessed June 6, 2024.

FAA, 2024. Part 107 waivers issued. https://www.faa.gov/uas/commercial_operators/part_107_waivers/waivers_issued?saa_field_media_file=107.31 Accessed June 6, 2024.

FAA, 2025. FAA Beyond. https://www.faa.gov/uas/programs_partnerships/beyond. Accessed June 12, 2025.

Fang, S., O'Young, S., and Rolland, L., 2018. Development of small UAS beyond-visual-line-of-sight (BVLOS) flight operations: system requirements and procedures. Drones. 2, 13. http://doi:10.3390/drones20200013

Karpowicz, P., 2025. https://www.commercialuavnews.com/public-safety/new-bvlos-waiver-secured-by-american-robotics-defines-a-framework-for-bvlos-operations-under-part-108. Accessed June 6, 2025.

McNabb, M., 2025. https://dronelife.com/2025/06/07/trumps-drone-executive-orders-beyond-the-fact-sheets/. Accessed June 12, 2025.

Politi, E. Purucker, P., Larsen, M., Dos Reis, R., Rajan, R., Penna, S., Boer, J., Rodosthenous, P, Dimitrakopoulos, G., Valamis, I., and Hob, A., 2024. Enabling technologies for the navigation and communication of UAS operating in the context of BVLOS. Electronics. 13, 340. https://doi.org/10.3390/electronics13020340

Rupprecht, J., 2024. Ultimate guide to drone in a box ops (laws, tips, lists, problems, companies) https://jrupprechtlaw.com/drone-in-a-box/ Accessed June 12, 2024.

The Drone Girl, 2023. BVLOS approval: these four drone companies now hold the coveted FAA authorization. https://www.thedronegirl.com/2023/09/29/bvlos-approval-faa/ Accessed June 12, 2024.

V. Appendix A: MDT BVLOS Waiver Application Template

Montana Department of Transportation

CONOPS

For Safe and Effective UAS Operations

Updated: June 28, 2025

MDT CONOPS for Safe and Effective sUAS Operation

II. Operational System Description

- **Aircraft:**
  - **Multirotor:** Capable of vertical takeoff, hovering and multidirectional travel. Utilized for aerial filming, surveying, mapping, environmental monitoring, and inspection in varied terrain. Multirotor aircraft are used for small area mapping and point of interest data collections. Navigation is either automated or manual flight with internal systems to include first-person view, gimbal supported live view, obstacle avoidance sensors, GPS, gyroscope, accelerometer, inertial measurement unit and weather sensors. Flight times are up to 45 minutes, depending on battery load, wind conditions, and payload. Battery strength has a Montana Department of Transportation (MDT) self-imposed mandatory landing value of 25%. Wind speed limitations are 20-25 and 35 knot gusts level flight. Operating temperatures are between -20°C and 40°C (4°F to 104°F). Emergency procedures include: obstacle avoidance sensors, geofencing, low battery warning, communication loss and weather minimums, all will operate automatically, or the PIC will initiate a return to home operation at a PIC defined altitude. Additionally, the PIC has the ability to execute an engine shut off midflight, that will result an aircraft crash. This option is a last resort to sacrifice the aircraft to preserve personnel safety.
    - **Inventory:**
      - TBD
- **Control Stations:** Based around a handheld ruggedized tablet/controller for field use, it serves as the primary interface for mission planning, flight control, and data monitoring. This controller provides a single control point that integrates all functions of flight and monitoring to include controller and aircraft systems. The controller includes a dedicated telemetry link (typically using 2.4 GHz, 6.0 MHZ or 900 MHz) to maintain a stable communication link with the UAS. These frequencies have the capacity to work beyond line of sight and can transmit up to 5 miles. This link provides real-time data such as GPS location, altitude, battery status, and overall flight status. There is an audible and visual alert if aircraft or control systems detect a malfunction or predetermined safety thresholds for altitude, distance, weather and battery levels. Built-in GPS on the controller ensures accurate positional awareness for RTH functionality and helps in maintaining location accuracy during operations. The controller is powered by a rechargeable battery, which provides several hours of continuous use. Physical buttons and touchscreen shortcuts enable quick access to critical functions such as takeoff, landing, RTH, and emergency stop, providing fast response options if an anomaly occurs.
- **Crew Members:** Montana Department of Transportation (MDT) Standard Operating Procedures (SOP) is for a PIC and VO; more complex mission requires more personnel.
  - **Pilot in Command:** Overall authority and accountability for the safe operation of the sUAS and mission success. Conducts pre-flight planning, safety assessments, and ensure compliance with all regulations. Oversee all phases of flight, including launch, mission execution, and recovery. Maintain situational awareness, communicate with VOs and other team members, and make real-time decisions on potential hazards. Execute emergency procedures if necessary and log flight

details post-operation. PIC must maintain a current and Valid FAA Part 107 Remote Pilot Certificate. Minimum of 50 hours of logged sUAS flight time, with at least 10 hours on the specific UAS model. Experience with EVLOS operations or relevant training in extended line-of-sight flight operations is recommended. Familiarity with the operational environment, including airspace traffic, restrictions, terrain, and weather patterns.

- **Visual Observer:** Maintains uninterrupted visual contact with the sUAS to relay information to the PIC regarding aircraft position, altitude and proximity to obstacles or other aircraft and wildlife. Communicate potential hazards and flight status to the PIC in real time. Assist in coordinating handoffs if multiple VOs are stationed at intervals to maintain continuous VLOS if the sUAS travels beyond the direct line of sight of the PIC. Monitors near real time air traffic and aviation radio traffic. Observes and monitors local air traffic in the area and environmental conditions and alert the PIC to any safety issues or deviation from intended sUAS flight parameters. Demonstrated knowledge of communication protocols and emergency response as it pertains to sUAS operations. Awareness of emergency protocols and contingency plans if communication with PIC is disrupted. Familiarity with the specific flight area's geography.

III. Operational Scenarios

- **Define the Operations:** Conduct UAS flights up to 400 ft AGL and 50 ft above structures, for aerial surveying, inspections, and data collection in MDT area of responsibility.
- **Geographic Operating Boundaries:** TBD- Suggest Class G within Montana in sparsely populated areas
- **Operating Characteristics:** TBD- Suggest flight up to 400' above ground level (AGL)
- **Planning and Preparation:**
  - Site Assessment: Identify survey area, boundaries, and potential hazards (e.g., power lines, tree lines).
  - Airspace: Notification and monitoring
    - NOTAMs will be filed 24 hours ahead of time, for all flights utilizing approved COAs.
    - Air traffic will be monitored via aviation radios.
    - Monitoring of near real time air traffic via applications in or around the operating area.
  - Weather Analysis: Assess forecasted conditions to ensure safe operation, with attention to wind speeds, precipitation, and visibility.
  - Flight planning: Automated flight plans generated with Digital Elevation Model (DEM), geofencing for distance, altitude and RTH parameters, to include lost link, battery or system failures.
  - Pre-Flight Checklists: Complete MDT checklists for equipment verification, battery inspection, camera settings, calibration procedures, takeoff and landing sites and emergency procedures.
- **Mission Execution:**
  - Data Collection:
    - Preflight briefing by PIC following MDT check lists and safety protocols.

        - Takeoff and landing sites identified, to include back up location.
        - Fly predefined grid patterns with overlapping waypoints to maximize data coverage, or data collection parameters.
        - Specific Points of Interest: Flights may also be directed to specific points of interest, based on data collection requirements. For example, the sUA could be tasked with collecting imagery or sensor data from rockslides, water bodies, or damaged roadways.
        - Monitor flight telemetry and VO observations to ensure optimal altitude, speed, safety and operating area.
- **Data Processing and Post-Flight Analysis:**
    - Data Transfer: Transfer imagery and flight data to secure storage.
    - Data Verification: Check data in field to ensure completeness and accuracy.
    - Post-Flight: Inspect and service UAS platforms to ensure readiness for future missions in accordance with MDT checklists.
    - Conduct a debrief with all crew members, including VOs, to discuss what went well and any challenges encountered during the flight.
    - Incorporate lessons learned from each operation to refine best practices, hand-off techniques, communication protocols, and emergency procedures.
    - Use feedback to enhance future operations and address any safety or efficiency issues.
    - Document any incidents, equipment malfunctions, or communication issues, and submit a report if an accident or near-miss occurred.
    - Document flight telemetry, data, PIC, VO and relevant flight data.
- **BVLOS Intentions:** Line of sight and beyond line of sight will be conducted with the use of multiple VOs, direct communications and/or equipped with handheld radios to maintain continuous communication with the Pilot in Command (PIC). See attached reference manuals for specific aircraft's detect and avoid capabilities.
    - **Aircraft X:** See attached manual section X for detect and avoid capabilities. Reference (aircraft manual attached). Include capabilities, ranges and limitations
    - **Aircraft X:** See attached manual section X for detect and avoid capabilities. Reference (aircraft manual attached) Include capabilities, ranges and limitations

IIII. Airspace and Ground Considerations

- **Airspace Types and Considerations**: Operational area is in the lower portions of Class G airspace, at or below 400 ft AGL. To ensure compliance, operators will consult **area sectional charts,** additionally using apps with **near real-time air traffic data** will greatly improve safety by providing speed, heading and altitude on manned aircraft operating nearby. The addition of multiple VOs will increase the situational awareness of PIC in the flight area.
    - PIC will immediate descent to below 200 feet AGL or land, upon detection of manned aircraft within a 1-mile radius.
    - Loiter at location and altitude until manned aircraft has exited 1-mile radius flight route.
    - sUAS will RTH if battery or other systems reach minimum safe operational thresholds.

- **Ground Entities**: Area X is a sparsely populated area comprised mostly of managed forest and small open fields, with few buildings and structures. There will be times with increased personnel in area X and sUAS operations will be coordinated in accordance with established MDT, SOP. Increased awareness will be posted to alert non-participant personnel of ongoing UAS operations.
- **National Airspace Users**: Area X, Montana, is in the lower portions of Class G airspace, over a sparsely populated area. Operating area is ~XX miles from airport. This area is under the jurisdiction of Spokane Terminal Radar Approach Control and Salt Lake City Air Route Traffic Control Center. sUAS flights up to 400 ft AGL, with Visual Observers for aerial surveying, and data collection in a sparsely populated, wooded area. Area X, Montana, managed by the MDT.
- **Meteorological Conditions**: Operations are in mountainous terrain and can experience changing conditions. Temperature can range from -36°C and 43°C (-33°F to 110°F). Winter has an average snow fall of ~40 inches. Cloud cover generally increases around October thru June. Winds are usually light around 5-15mph but have been recorded as high as 109 mph in July 2024. Weather extremes can have negative effects on flight performance and battery capacity; flight parameters will be adjusted or missions postponed accordingly. Icing is of particular concern for MDT operations and special consideration, or postponing missions will be implemented when condition are likely to produce icing. sUAS operations will adhere to the MDT SOP for weather and operate within the manufactured guidelines for the perspective aircraft. Adhering to the FAA weather minimums for visibility of 3 statute miles, 1,000 feet above, 500 feet below, and 2,000 feet horizontal of cloud cover. Reduction in visibility will reduce the operational area of the current mission.
- **Automation Level**: Automated flights will be used for mosaic data collection and repeatable flight patterns to include photography, videography and data collection. Flight planning software utilized has aircraft and payload specific data to aid in the estimation of flight times, flight duration limits, flight lines, data collection overlap, altitude changes, geofencing, battery minimums, lost link procedures and RTH altitude and route planning. Autonomous flight plans are uploaded to the aircraft from the controller and the PIC has manual override capacities to pause, cancel, initiate RTH or take over manual control during all portion of the flight. Multirotor aircraft have visual and nonvisual obstacle avoidance system.
- **Pilot/Aircraft Ratio**: PIC to sUAS ratio will not exceed 1:1.
- **Day/Night Operations**: Operations will be primarily daylight hours. Night operations will be rare and additional safeguards will be in place for those limited operations. Night missions will be with sUAS equipped with blinking anti-collision lights visible for at least 3 miles. Operational limits and altitudes will be reduced to maintain visual line of sight. All air traffic mitigations for other sUAS and manned aircraft will remain in place.
- **Crew Safety Plan**: Crew Resource Management ensures that the PIC, VO and bystanders are all protected through proactive risk management, clear communication and structured emergency responses. The PIC will conduct a preflight safety brief to include roles and responsibilities, objectives, operational limits, potential hazards and emergency procedures of all persons involved in the operation. The PIC leads a crew conducted risk assessment based on the P.A.V.E. (Pilot, Aircraft, enVironment, External pressures) framework, identifying factors such as environmental hazards, air traffic

density, and operational area risks. The PIC and VO continuously assess the situation in real-time, noting any changes that could elevate risks, such as weather changes or unexpected bystander encroachment. In situations where quick decision-making is essential (e.g., low battery warning, approaching aircraft), the PIC should consult the VO when possible but remains the final authority on whether to abort or continue the mission. The PIC is responsible for all aspects of the mission, but entire crew will stay updated on weather changes, sun position and other environmental factors that could impact visibility, operational safety or situational awareness. Crew members should assess their own and others' fatigue or stress levels and communicate if they need a break or assistance to prevent degradation of situational awareness. The PIC will monitor or assign a crew member to routinely check the wellness of crew members and be vigilant to fatigue, stress and environmental exposure for heat, cold, dehydration and environmental hazards to crewmembers.

IVI. Community Outreach and Safety

- **Community Outreach Plans**: Promote public safety and awareness regarding sUAS activities and establish clear communication channels to address public questions or concerns. MDT promotes awareness and safety through a variety of sources to the public, to include… Comply with FAA regulations, including filing a Notice to Air Mission (NOTAM) for public awareness in the airspace. Not later than 24 hours prior to all flight plans above 400 feet AGL, a NOTAM will be filed at 1800wxbrief.com using the UAS NOTAM form and specify the aircraft ID, date, time, duration, start and end times, altitude, aircraft type, contact information, COA identifier and operational area. If applicable appropriate ATC will be notified via phone 15 minutes prior to launch and immediately after landing. Flight plans and details can be email to applicable tower manager if requested by ATC.
- **Accident and Incident Reporting**:
    - Accidents will be reported to the FAA within **10 days, through FAADroneZone,** if any of the following occurs:
    - **Serious Injury to Any Person:** An injury requiring hospitalization or that results in a significant injury (e.g., head trauma, broken bones, lacerations needing stitches).
    - **Loss of Consciousness:** If any person loses consciousness due to the accident.
    - **Property Damage of $500 or More:** If the accident causes damage to property (excluding the sUAS itself) valued at $500 or more. This includes both repair or replacement costs of the damaged property.
    - **Accidents will be reported immediately to the National Transportation Safety Board (NTSB) through the Response Operations Center (ROC) at 844-373-9922, if any of the following occurs:**
        - **If any person suffers a fatal injury or serious injury (defined as an injury requiring hospitalization for more than 48 hours, fractures, or other significant trauma).**
        - **Any collision with another aircraft, manned or unmanned.**
        - **The aircraft holds an airworthiness certificate or approval and sustains substantial damage**

- **For these situations, you should notify the NTSB as soon as possible through their official reporting channels to support a timely investigation.**
- PIC will document the following information for Reporting either to FAA or NTSB.
    - Name of owner, and operator of the aircraft.
    - Name of the PIC and VOs.
    - Date and time of the accident.
    - Type, nationality, and registration marks of the aircraft.
    - Speed, altitude, direction of flight, battery percentage.
    - Last point of departure and point of intended landing of the aircraft.
    - Position of the aircraft with reference to some easily defined geographical point.
    - Nature of the accident, the weather and the extent of damage to the aircraft, so far as is known.
    - A description of any explosives, radioactive materials, dangerous articles, or other payload to include sensors carried.

V. Command, Control, and Security

- **Command and Communication Functions**: To ensure safe and efficient sUAS operations within the NAS, command and communication protocols are necessary between sUAS components (aircraft, control station, and observers) and NAS stakeholders (e.g., air traffic control, nearby manned aircraft, and local authorities). These protocols establish structured information flow, enhance situational awareness, and ensure quick, coordinated responses to changes in operational or environmental conditions.
- PIC maintains primary control over the sUAS via the ground control station, utilizing either a direct radio-frequency link or cellular connectivity, depending on operational requirements.
- The ground control station continuously receives real-time telemetry data from the sUAS, including altitude, airspeed, position, battery status, and signal strength.
- Mission planning has built in safety features that automatically initiate a RTH to include: lost link, altitude height violation, geofencing, battery level, system malfunctions and weather limitations.
- The PIC has the ability to switch between autonomous and manual flight modes as well initiate RTH for any reason, i.e., loss of link, low battery, airspace incursion, or exceeded weather limitations. In the event of primary GPS loss, the sUAS can rely on onboard sensors or secondary GPS to maintain stability and support safe recovery.
- The PIC and VOs establish a continuous communication channel (handheld radios, dedicated communication apps or cell phone), allowing VOs to provide real-time updates on surrounding airspace, potential obstacles, and bystander proximity.
- To confirm critical commands or safety alerts, the PIC and VO use a call-and-response protocol to ensure instructions are heard and understood (e.g., “Aircraft at 9 o’clock,” “Roger, aircraft at 3 o’clock”).
- In case of a potential hazard, the VO can issue an emergency “Abort” or “Land Immediately” command, which the PIC will follow as part of established protocols.

- **Communication NAS Stakeholders:** A NOTAM will be filed 24 hours in advance of the operation to notify other airspace users and ATC of the sUAS activity. If applicable appropriate ATC will be notified, 15 minutes prior to launch and immediately after landing, as advised by ATC Manager. Flight plans and details can be emailed to tower if requested by ATC.
- PIC or designated crew will monitor ATC frequencies when operating near controlled airspace, allowing them to receive situational updates or notifications regarding nearby manned aircraft. Additionally, they will monitor near real time air traffic via applications in or around the operating area.
- In the event of a flyaway the PIC will immediately notify ATC and if necessary, nearby manned aircraft or local authorities to alert them to a potential hazard. PIC will communicate the aircrafts last know position, altitude, speed, heading and battery remaining or estimated remaining time of flight.
- **Emergency Procedures**:
    - Fire: If any member of the crew observes fire or smoke coming from the sUAS, the PIC will be informed immediately. The emergency will be announced to the ground crew, which will mobilize to the area of the aircraft. The PIC will assess the situation, land as soon as possible, preferable at the launch site. If it is not possible to reach the launch site, the PIC will land the aircraft at a predetermined alternate site or any open area. A fire extinguisher will be on site for all remote launches.
    - Air Incursions: PIC will immediate descent to below 200 feet AGL upon detection of manned aircraft within a 1-mile radius. Loiter at location and altitude until manned aircraft has exited 1-mile radius flight route. sUAS will RTH if battery or other systems reach minimum safe operational thresholds.
    - PIC Incapacitation: The visual observer or sensor operator will take over operations for immediate landing using the RTH protocol. Medical assistance will be sought immediately.
    - Accident or Incident: Accidents meeting the qualifying criteria will be reported to the FAA within **10 days, through FAADroneZone, and NTSB through the ROC at 844-373-9922. Accidents or incident to sUAS, that do not meet the reporting requirements will be documented and examined by UM AASO personnel and mitigation and safety procedures will be implemented to safeguard further events.**

VI. Extended Visual Line of Sight (EVLOS) Operations

- EVLOS operations allow an sUAS to operate beyond the direct visual line of sight of the PIC by using VOs to maintain continuous situational awareness of the sUAS. EVLOS extends operational reach while keeping safety standards high. The following procedures and considerations are essential for conducting safe and effective EVLOS operations.
- Conduct a thorough analysis of the operational area, focusing on potential obstacles and known airspace risks. Evaluate and confirm that the operation area is within Class E or G airspace or required authorizations are obtained for controlled airspace.

- Conduct viewshed analysis of take-off, landing and operational area to determine possible reduced line of sight due to structures, terrain and vegetation. Position VOs strategically to maintain continuous visual line of sight.
- Position VOs strategically along the planned flight path to ensure continuous observation of the sUAS. Each VO's observation range will overlap with the next, allowing for seamless handoffs. Avoid placing VOs near areas with obstructions that could hinder sightlines, like dense trees or buildings.
- The PIC and VOs establish a continuous communication channel (handheld radios, dedicated communication apps or cell phone), allowing VOs to provide real-time updates on surrounding airspace, potential obstacles, and bystander proximity.
- To confirm critical commands or safety alerts, the PIC and VO use a call-and-response protocol to ensure instructions are heard and understood (e.g., "Aircraft at 9 o'clock," "Roger, aircraft at 3 o'clock").
- In case of a potential hazard, the VO can issue an emergency "Abort" or "Land Immediately" command, which the PIC will follow as part of established protocols.
- Weather conditions will be continuously monitored for reduced operational performance, such as visibility, windspeed, temperature, moisture and other limitations to visibility that may may require an immediate return to a safe landing location.
- VOs will use language for hand-offs, such as "Aircraft in view and within range," "I have eyes on aircraft heading in x direction" to confirm that the next VO has clear sight of the sUAS before responsibility is transferred.
- VOs provide the PIC with pre-determined interval updates (not to exceed 5 min) on the sUAS position, altitude and surrounding environment, noting any approaching obstacles, air traffic or deviation from briefed flight route.
- If a VO loses sight of the sUAS, they will alert the PIC immediately, the PIC should either adjust the flight path to regain visual contact or activate the RTH function.
- If communication is lost with a VO, the PIC should return the sUAS to a safe location or designated holding point until communications are re-established
- VOs will monitor the ground area for any bystanders or wildlife approaching the operational zone. If there is unauthorized enter into the operation area, VOs will communicate this to the PIC, who will then decide to continue as planned, hold, re-route, RTH or cancel the mission until the area is clear.
- Verify that the sUAS home location is accurate and that the RTH is set and functional ensuring the RTH route in not overpopulated areas. Check battery levels and set limits (30%) to allow sufficient time for the sUAS to return safely in case of unexpected conditions.

VII. Summary

This CONOPS for the MDT implements a multi-faceted approach to sUAS operations, emphasizing safety, risk mitigation, and adherence to regulations. By diligently implementing these measures, MDT demonstrates a commitment to conducting safe, responsible, and effective sUAS operations. The key elements of our strategy, include:

- **Comprehensive Pre-flight Procedures:** MDT prioritizes thorough pre-flight planning and preparation, including site assessments, weather analysis, automated flight plans with geofencing, and pre-flight checklists. This meticulous approach helps identify and mitigate potential hazards before flight operations commence.
- **Strategic Crew Management**: Recognizing the importance of human factors, MDT employs a crew safety plan that prioritizes proactive risk management, clear communication, and structured emergency responses. This includes utilizing the P.A.V.E. framework for risk assessments, ensuring continuous communication between the PIC and VOs and establishing clear roles and responsibilities for all crew members.
- **Essential Role of Visual Observers**: VOs are integral to safe sUAS operations, especially in EVLOS scenarios. They provide real-time situational awareness to the PIC, relaying information about the aircraft's position, potential obstacles, and surrounding airspace. Strategic VO positioning, with overlapping observation ranges, ensures continuous visual contact with the sUAS, even beyond the PIC's direct line of sight.
- **Well-Defined Emergency Protocols**: MDT has established detailed protocols for handling various emergencies, including fire, air incursions, PIC incapacitation, and accidents. These procedures emphasize prompt communication, coordinated responses, and adherence to reporting requirements.
- **Multi-Layered Communication Strategy**: MDT employs a combination of communication methods to ensure seamless coordination and situational awareness among crew members and relevant stakeholders. They utilize handheld radios, dedicated communication apps, or cell phones for direct communication between the PIC and VOs. MDT files NOTAMs, monitor ATC frequencies, and maintain communication with the Lubrecht Experimental Forest manager.
- **Respect for Airspace Regulations**: Recognizing the importance of operating safely within the NAS, MDT primarily conducts flights in Class G airspace. They consult FAA sectional charts, utilize apps with near real-time air traffic data and implement procedures to safely managing air incursions.
- **Commitment to Community Outreach**: MDT proactively promotes public safety and awareness regarding sUAS activities through workshops, presentations and lectures. This commitment to transparency and education helps foster understanding and cooperation between MDT and the surrounding community. Proposed area of operation for MDT sUAS operations.

VIII. Part 107 Waiver and Safety Explanation Guidelines and Guiding Questions

Waiver Safety Explanation Guidelines and Guiding Questions.

107.31 Visual Line of Sight Aircraft Operations

We are applying for, extended line of sight operations, to allow an sUAS to operate beyond the direct visual line of sight of the RPIC by using VOs to maintain continuous situational awareness of the sUAS.

1) General

a) Describe how the remote pilot in command (RPIC) will be able to continuously know and determine the position, altitude, and movement of the small Unmanned Aircraft (sUA).
   - The RPIC receives real-time information about the aircraft's position, altitude, airspeed, battery and signal strength through the use of a ground control station. The RPIC will determine if the sUA is detouring from the predetermined flight path and take corrective action. Additionally, the RPIC will know the position, heading and speed of the aircraft through the use of Visual Observers and continuous observation of the aircraft.

b) Describe how the RPIC will ensure the sUA remains in the area of intended operation. How will this be verified?
   - The RPIC will use ground control station defined geofencing for operations to include geographic boundaries as well as high and low altitude limitations. Aircraft failsafe will be preprogramed to return to home if crossing the geofence boundary or in the event of a lost link communications between the sUA and the ground control station. The mission will be briefed to all VO and any deviation from flight area and flight plan will be relayed to the RPIC who will take corrective action and return to home.

c) Describe how the RPIC ensures the operation will not go beyond the capabilities of the command-and-control link. How will that be tested and verified?
   - The RPIC will ensure that the command-and-control ranges of the operation are within the manufacturer's stated capabilities and established ranges for the system. The RPIC will continuously monitor the command-and-control link signal strength through the ground control station. Aircraft failsafe will be preprogramed to return to home in the event of a lost link communications between the sUA and the ground control station. A pre-flight viewshed analysis of the flight area will be conducted at the takeoff and landing sites, as well as the operational area to identify potential signal degradation due to terrain and vegetation. The RPIC will reduce the operational area as needed to maintain a command-and-control link.

d) What is the route of flight? What factors, with regards to the route of flight, will affect command and control, flight over people/moving vehicles/obstructions, etc.?
   - Flights will be conducted at Area X, Montana. All operations are in the lower portions of Class G airspace, over a sparsely populated area with little manned aircraft air traffic. Area X is comprised of forested mountains and small natural meadow. Terrain, and forest obstructions are the primary considerations and will determine the command-and-control limitations and will be reduced as determined by the RPIC. No flights will be conducted from moving vehicles, flights will be altered by the RPIC to avoid direct or sustained flights over people not directly involved in the sUA operations.

e) Does the sUA have a return to home (RTH) function? If so, how does the RPIC ensure the sUA does not overfly people/vehicles or collide with obstructions during the RTH flight?
   - Yes, the sUA does have a RTH function it utilizes pre-programmed parameters, including a defined altitude and route, established during the flight planning stage. The RTH route is set to minimize the risk of overflying people and vehicles, by avoiding roads and structures. The RTH altitude is set to avoid obstructions such as buildings, power lines, and terrain features by a minimum of 100 ft. Visual Observes

will continuously monitor the sUA and relay any potential deviation from safety parameters to the RPIC.

2) Detect and Avoid (DAA)

a) How will the RPIC monitor the airspace surrounding the operation of the sUA to remain well clear of other aircraft?

- The RPIC will file a Notice to Air Missions (NOTAMS) 24 hours before flights at or below 400 AGL at 1800wxbrief.com using the UAS NOTAM form and specify the aircraft ID, date, time, duration, start and end times, altitude, aircraft type, contact information, COA identifier and operational area. During the flight, the RPIC and crew will utilize several tools and procedures for real-time airspace monitoring. The team will monitor the Common Traffic Advisory Frequency (CTAF) for their operational area to stay informed about local aircraft activity. They will also use flight tracking applications that provide near real-time air traffic data, offering insights into the speed, altitude, and heading of nearby manned aircraft. Additionally, multiple visual observers will scan the airspace for any potential aircraft within the vicinity. If an aircraft is detected within a one-mile radius of the sUA, the RPIC will immediately descend the sUA to below 400 feet AGL. The sUA will loiter at that altitude until the aircraft has left the area. If battery levels or other system limitations reach critical thresholds during this maneuver, the RPIC will initiate a return to home (RTH).

b) Will a Detect and Avoid (DAA) system be used with the operation?

1. What type of DAA system is to be used? RADAR / ACOUSTIC / VISUAL?
   - Aircraft X has X system for detect and avoid (Reference X) A Visual DAA protocol will also be used to detect and avoid aircraft in the operating area, utilizing multiple visual observers, ADS-B applications and radio monitoring. The RPIC will monitor air traffic frequencies via radio and utilize ADS-B application to track manned aircraft.
2. Is the DAA system ground based or airborne?
   - DAA system is….
3. Is the DAA system compliant with the Industry Based DAA Performance Standard or a combination of standards?
   - Yes, our protocol, system X has DAA capabilities to include… (Reference manual), utilization of visual observers, ADS-B applications and radio monitoring.
4. If the DAA is ground based, is there adequate low altitude DAA coverage to support the operation?
   - Yes, there is adequate low altitude support for these operations through, visual observers, ADS-B applications and radio monitoring.
5. What is the maximum distance the system is effective in detecting other aircraft?
   - The use of ADS-B applications has nationwide coverage. The radio has a 5-watt output and air traffic communications between 118.00MHZ and 136.975MHZ.
6. Has the DAA system been tested and proven reliable in the desired operating environment?
   - Yes…insert details
7. What is the maximum altitude above ground level the sUA will be flown during this operation?
   - 400 AGL

8. What is the avoidance strategy?
   - If an aircraft is detected within a one-mile radius of the sUA, the RPIC will immediately descend the sUA to below 200 feet AGL or land as appropriate. The sUA will loiter at that altitude until the aircraft has left the area. If battery levels or other system limitations reach critical thresholds during this maneuver, the RPIC will initiate a return to home.
9. If avoidance is automated, what safeguards are there to protect the system from undesired behavior?
   - Fill in details and include reference to section in aircraft manual
10. Describe how the RPIC interfaces with the DAA system to monitor the airspace and manage the DAA operation?
    - The RPIC will……, additionally communicate with visual observers, monitor ADS-B applications and radio monitoring.
11. What is the minimum distance for detection so that the avoidance strategy can be carried out?
    - Outline aircraft X capabilities (Reference). Additionally, one mile is the minimum distance to activate the protocol. RPIC and VOs will monitor radio traffic and ADS-B applications to track aircraft for potential conflicting flight paths, and allow sufficient time for the RPIC to implement the established avoidance protocols, ensuring the safe separation of the sUA from other aircraft.
12. If using an obstruction/shielded DAA concept of operations, what is the shielding criteria?
    - Outline aircraft X capabilities (Reference).

3) Lighting

a) Describe the anti-collision lighting used on the sUA, in order for it to be seen by crewmembers in other aircraft from a distance of at least 1 statute mile (sm) during daytime operations and 3sm if conducting nighttime operations.
   - Green, red and white flashing LED lights visible for 3sm at night and 1sm during the daytime are attached to the sUA.

4) Alerts.

a) Describe how the RPIC will be alerted of a degraded function or failure of the sUAS.
   - The RPIC will be alerted to a degraded function or failure of the sUAS through several methods, including both automatic system alerts and real-time communication from the visual observer. The ground control station receives real-time telemetry data from the sUAS, including altitude, airspeed, position, battery status, and signal strength. This allows the RPIC to monitor the sUAS's performance and identify any anomalies or deviations from the planned flight. Visual observers will be briefed on the mission, flight path and areas of concern prior to launch and will relay information to the RPIC, any concerns or deviation from briefed mission.

b) Will there be an audible and visual alert of the degraded function or failure as required by industry standards?
   - Yes, both audible and visual alert to deviation or degradation.

c) What are the procedures in the event of a degraded function or failure of the sUAS?
   - The RPIC will initiate a RTH manually, also mission planning includes built-in safety features that automatically initiate a RTH in response to several triggers to include lost communications link, altitude or geofence violations, low battery levels, system

malfunctions and exceeding weather limitations. Emergency shut off of the sUA's engines in flight is a final safety procedure to ensure safety of personnel and will cause the sUA to crash.

d) What are the C2 lost link procedures?
- In the event of a lost communication link between the sUA and the ground control station, for more than 15 seconds, automatic or manual RTH is initiated.

5) **Training**

a) Describe how the responsible person will ensure that relevant knowledge is required of all persons participating in the operation.
- The RPIC will conduct a pre-flight safety briefing with all crew members per the MDT established standard operation procedures and checklists. This briefing includes a discussion of roles, responsibilities, qualifications, objectives, operational limits, potential hazards, emergency procedures, and operational area risks. Familiarity with the specific flight area's geography is also required.

b) What training will be required for the operation?
- The RPIC is required to have a current and valid FAA Part 107 Remote Pilot Certificate, have a minimum of 50 hours of logged sUAS flight time, with at least 10 hours on the specific sUAS model being used. Visual observers must demonstrated knowledge of communication protocols and emergency responses related to sUAS operations. They also need to be aware of emergency protocols and contingency plans in case communication with the RPIC is disrupted.

c) How will the training be documented and maintained?
- All flight data, including flight routes, weather conditions, battery performance, VO's, PIC and communication records are kept for 5 years after the completion of the flight. Individual training and qualifications are documented in the same database system and ensured current before operations.

6) **Weather**

a) What are the weather limitations on the sUA to be operated?
- Visibility, precipitation, temperature, windspeed, and altitude are all considered before sUA operations. Visibility minimums are 3 statute miles, 1,000 feet above, 500 feet below, and 2,000 feet horizontally of cloud cover. Any visibly or probable precipitation during schedule operations will be rescheduled. Temperature ranges for our sUAS operations are between -10°C and 40°C (14°F to 104°F) for VTOL aircraft and -20°C and 40°C (4°F to 104°F) for multirotor aircraft. Temperatures close to freezing at takeoff and flight altitudes is of primary concern and will be rescheduled to avoid the potential of icing. sUAS operations have wind speed limitations. Windspeed limitations for VTOL sUA are 15-20 knots during vertical operations and 35 knot gusts during level flight. Multirotor aircraft have a slightly higher limit of 20-25 knots and 35 knot gusts during level flight. Higher altitudes reduce battery and propeller performance due to increased power demands. This can be minimized by the use of high-altitude props and reduce area of coverage per flight. The RPIC will initiate an RTH if weather conditions exceed limitations. If Aircraft X has other limitations list them here.

b) How will you determine the weather conditions at the launch and recovery site as well as along the intended route?

- Weather forecasts from multiple sources will be assessed and reviewed before scheduling a sUA flight. Weather criteria at launch and recovery site will be determined by the RPIC utilizing a handheld weather meter to determine windspeed and temperature.

7) Command and Control

a) Describe the command-and-control link of the sUAS.

- The command-and-control link is via a bi-directional radio link with a range of 10 km (6 mi) in a direct line of sight. The radio link uses multiple frequencies, including 1227.6 MHz, 1561.098 MHz, and 1575.42 MHz.

b) Is the command-and-control link configuration FCC approved? If so, please provide the approval number?

- Yes, FCC ID: provide numbers here, may have to reach out to manufacture for these numbers

107.33 Visual Observer

- We are applying for, extended line of sight operations, and beyond line of sight waiver, to allow an sUAS to operate beyond the direct visual line of sight of the RPIC by using VOs to maintain continuous situational awareness of the sUAS.

1) **Describe how you will account for the communication latency between the Visual Observer(s) (VO) and the Remote Pilot in Command (RPIC).**

a) How will the RPIC and VO(s) communicate with each other if they are not near each other?

- A continuous communication channel will be established between the PIC and VOs using handheld radios, dedicated communication apps, or cell phones. A call-and-response protocol will be used to confirm critical commands or safety alerts. This ensures that instructions are heard and understood by both the PIC and VO. For example, a VO will say "Aircraft headed North of my location" and the PIC would respond "Roger, aircraft headed North from your location." In case of a potential hazard, the VO will issue an emergency "Abort" or "Land Immediately" command, which the PIC will follow as part of established protocols. The RPIC with establish pre-determined interval updates (not to exceed 5 minutes), on the sUAS position, altitude, and surrounding environment. These updates will include any approaching obstacles, air traffic, deviations from the briefed flight route, or all clear.

b) If this communication method fails, how will the RPIC and VO(s) be alerted to the failure?

- The RPIC will check communication during mission events and predetermined intervals (not to exceed 5 minutes), based on area, terrain and sUA.

c) What will the RPIC and VO(s) do if a communication failure occurs?

- If the RPIC cannot contact the VO, or the VO misses an established communications window, the RPIC will attempt to re-establish communication on the backup system and return the sUAS to a safe location or designated holding point until communications are re-established. If the RPIC still cannot reestablish communications with the VO, the RPIC will RTH the sUA.

Insert figures with area of operations as relevant

IX. MDT UAS Risk Assessment for FAA Waiver Request

1. Mission Description
    a. Operation Objective: Conduct UAS flights beyond visual line of sight (BVLOS), below 400 AGL in class G airspace. Utilizing a Drone in a Box (DiaB) system to respond to natural hazards (rockslides, landslides, flooding…) affecting Montana roadways, and interface with the Montana Department of Transportation's traffic Transportation Management Center (TMC).
    b. Location: XXXXX
    c. Area of Operations: XXXXX
2. Risk Analysis Framework the assessment uses a structured approach to identify potential hazards and apply mitigations, and ensure safety of operations categorized by:
    a. Airspace, Altitude, and Aircraft Proximity
    b. Aircraft and Equipment Reliability
    c. Human Factors and Crew Competency
    d. External and Environmental Conditions
3. Risk Assessment Matrix

Severity Index	Likelihood				
	Extremely Improbable (1)	Improbable (2)	Remote (3)	Occasional (4)	Frequent (5)
Catastrophic (5)	5	10	15	20	25
Hazardous (4)	4	8	12	16	20
Major (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5

    a. Airspace, Altitude, and Aircraft Proximity

Risk	Potential Impact	Mitigations	Hazard Category
Encounter with Manned or Unmanned Aircraft	Risk of mid-air collision with low-flying aircraft helicopters, aircraft or agricultural aircraft.	• Use multiple Visual Observers (VOs) with 360-degree visual scanning capability at all flight altitudes. • Maintain continuous contact between VO and PIC with voice, handheld radios and cell phones as	Improbable and Catastrophic 10

		secondary communication methods. • Continuous monitoring of local CTAF (Common Traffic Advisory Frequency) to identify nearby manned aircraft activity. • Monitor flight tracking applications, to identify potential aircraft incursions into flight area of operation. • Use of lighting on UAS, visible for 1 mile during daylight and 3 miles at nighttime for enhanced visibility to other aircraft. • Establish and follow immediate descent, loiter or return to home procedures if manned aircraft is detected within a 1-mile proximity operations.	
Loss of UAS tracking	Loss of tracking of UAS due to weather or terrain. Risk unintentional deviation from planned flight route or area.	• Conduct viewshed analysis of takeoff, landing and operational area loss of line of sight due to structures, terrain and vegetation. • Use of telemetry to accurately track and monitor speed, heading, altitude and health of onboard systems. • Use geofencing and altitude restrictions to	Remote and Minor 6

		limit operational area and set Return to Home (RTH) protocols.	
Extended UAS Command and Control Range	Increased altitude may reduce reliability of control link communication between UAS and PIC.	• Conduct viewshed analysis of takeoff, landing and command locations to reduce signal degradation due to terrain and vegetation. • Verify communication reliability at proposed altitude prior to operation. • Ensure command and control ranges are within the manufacture and established ranges of system. Use geofencing and altitude restrictions to limit operational area and set Return to Home (RTH) protocols. • Monitor telemetry and command signal strength. • Implement RTH automatically if communication link is lost.	Improbable and Minor 4

b. Aircraft and Equipment Risks

Risk	Potential Impact	Mitigations	Hazard Category
Battery and Lift at Higher Altitudes	Risk of reduced battery and prop performance due to increased power demands at higher altitudes.	• Conduct battery endurance tests to ensure operational limits are not exceeded at the proposed altitude.	Improbable and Negligible 2

		• Install high altitude props for operations as outlined in manufacture specification due for altitude or density altitude. • Monitor battery temperature, voltage and capacity via telemetry • Set a conservative battery threshold for initiating return to base 30% remaining power.	
Air Pressure and Temperature Variability	Higher altitude increases exposure to environmental factors that could impact performance mainly wind, temperature.	• Evaluate aircraft specifications to confirm operational limits, including wind resistance and temperature tolerances. • Monitor onboard systems for temperature, wind and battery tolerances. • Monitor real-time weather data and set maximum wind speed thresholds for operational limits.	Remote and Negligible 3

c. Human Factors and Crew Competency

Risk	Potential Impact	Mitigations	Hazard Category
Reduced PIC and VO Situational Awareness	Reduced situational awareness due to increased altitude and difficulty in visually monitoring UAS.	• Brief VOs on communication protocols, especially for altitude-specific operation. • Limit duration of individual VO shifts	Remote and Minor 6

		to reduce eye strain and fatigue. • Rotate VO personnel during operations to maintain optimal alertness and observation capacity. • Establish operation limitations to include breaks or replacement for personnel. • Establish crew position redundancy for all personnel, to include the PIC.	
Communication Lapses	Higher altitude operation increases reliance on real-time communication between the PIC and VOs. Communication lapses could delay reaction times in emergencies.	• Monitor flight tracking applications, to identify potential aircraft incursions into flight area of operation. • Equip all team members with handheld radios and establish a dedicated communication channel. • Establish radio checks at predetermined intervals. Failure of radio check will terminate mission until comms are re-established. • Conduct a pre-flight communication check and emergency drill to verify response protocols. • Uses of cell phones as backup communications.	Remote and Negligible 3

d. Environmental and External Conditions

Risk	Potential Impact	Mitigations	Hazard Category
Flights Over People	Risk of aircraft collision with people and structures	• Alter automated flight plans to eliminate/reduce flights over people. • Post operational notification of UAS flight ops over potential high use areas. • Return to Home routes planned to minimize RTH over people and structures.	Improbable and Major 6
Adverse Weather Conditions	Higher altitudes may encounter unexpected weather shifts, impacting UAS performance.	• Utilize real-time weather monitoring for early warning on changing conditions at all operating altitudes. • Evaluate aircraft specifications to confirm operational limits, including wind resistance and temperature tolerances. • Monitor onboard systems for temperature, wind and battery health. • Set defined weather-related flight thresholds (e.g., max wind speed, precipitation, temperature range). • Postpone or cancel flight ops if weather conditions increase the likely hood of icing potential.	Occasional and Negligible 4
Wildlife Activity	Increased potential for bird strikes or interference from	• Plan operations during times when wildlife activity is	Improbable and Minor

	wildlife at higher altitudes.	minimal (e.g., avoid dawn and dusk). • Brief VOs on increased likelihood of birds in the area, and communication to the PIC. • Establish procedures to immediately descend if wildlife is observed within a close proximity.	4
		•	

4. Emergency Response Plan
    a. Mid-Air Collision Avoidance
        i. Immediate descent to below 200 feet AGL upon detection of manned aircraft within a 1-mile radius.
        ii. Loiter at location and altitude until aircraft has exited 1-mile radius flight route.
        iii. Return to Home as necessary.
    b. Loss of Communication or VLOS
        i. Initiate automated return-to-home (RTH) mode if communication with the PIC is lost.
        ii. Notify airspace authorities if recovery is unsuccessful.
    c. System Malfunctions
        i. In the event of a critical system failure, conduct an immediate descent and emergency landing in a pre-identified safe zone.
        ii. If time and resources are available return-to-home.
    d. Weather-Related Emergency
        i. Return to take off and land immediately if weather conditions deteriorate below the operational minimums.
5. Documentation and Reporting
    a. Follow all established MDT checklists.
    b. Log all flight data, including flight routers, weather conditions, battery performance, VOs, RPIC and communication records. All records are kept for a minimum of 5 years after completion of the flight.
    c. Maintain a post-operation report documenting any anomalies or incidents for submission to the FAA, if necessary.

Conclusion

This risk assessment aims to address safety concerns associated with operations beyond visual line of sight, by implementing monitoring and mitigation protocols, personnel training, and emergency response procedures to ensure safe, compliant UAS operation in accordance with Part 107 waiver requirements.

V. Appendix B: AASO CONOPS and COW Application

Autonomous Aerial Systems Office

University of Montana

CONOPS

For Safe and Effective sUAS Operations

Updated: January 15, 2025

AASO CONOPS for Safe and Effective sUAS Operation

I. Operational System Description

- **Aircraft:**
  - **Vertical Take-Off and Landing (VTOL):** Capable of vertical takeoff, hovering, transition to forward fixed-wing flight, and vertical landing. Utilized for aerial surveying, mapping, environmental monitoring, and inspection in varied terrain. The Wingtra Gen II and the Sentaero 5 are primarily used for mapping. The Sentaero 5 is equipped with Detect-and-Avoid (DAA) technology. Navigation is either automated or manual flight with internal systems to include GPS, gyroscope, accelerometer, inertial measurement unit and weather sensors. Flight times are up to 1 hour, depending on battery load, wind conditions, and payload. Battery strength has a University of Montana self-imposed mandatory landing value of 25%. Wind speed limitations are 15-20 knots during vertical operations and 35 knot gusts during level flight. Operating temperatures are between -10°C and 40°C (14°F to 104°F). Emergency procedures include: geofencing, low battery warning, communication loss and weather minimums, all will include either automatic, or PIC initiated a return to home operation at a PIC defined altitude. Additionally, the PIC has the ability to execute an engine shut off midflight, that will result an aircraft crash. This option is a last resort to sacrifice the aircraft to preserve personnel safety.
    - **Inventory:**
      - Wingtra Gen II, with RGB, Multispectral and LiDAR payloads.
      - Censys Sentaero 5, with RGB, Multispectral, infrared (IR) and LiDAR payloads.
  - **Multirotor:** Capable of vertical takeoff, hovering and multidirectional travel. Utilized for aerial filming, surveying, mapping, environmental monitoring, and inspection in varied terrain. Our multirotor aircraft are used for small area mapping and point of interest data collections. Navigation is either automated or manual flight with internal systems to include first-person view, gimbal supported live view, obstacle avoidance sensors, GPS, gyroscope, accelerometer, inertial measurement unit and weather sensors. Flight times are up to 45 minutes, depending on battery load, wind conditions, and payload. Battery strength has a University of Montana self-imposed mandatory landing value of 25%. Wind speed limitations are 20-25 and 35 knot gusts level flight. Operating temperatures are between -20°C and 40°C (4°F to 104°F). Emergency procedures include: obstacle avoidance sensors, geofencing, low battery warning, communication loss and weather minimums, all will include either automatic, or PIC initiated return to home operation at a PIC defined altitude. Additionally, the PIC has the ability to execute an engine shut off midflight, that will result an aircraft crash. This option is a last resort to sacrifice the aircraft to preserve personnel safety.
    - **Inventory:**
      - Vision Aerial Vector with RGB, multispectral, thermal payloads
      - Skydio
      - DJI Aircraft
        - Phantom 4 Pro

        - Mavic 2 and 3
        - Matrice M-100 and M-600 with RGB, multispec, hyperspectral payloads

- **Control Stations:** Based around a handheld ruggedized tablet/controller for field use, it serves as the primary interface for mission planning, flight control, and data monitoring. This controller provides a single control point that integrates all functions of flight and monitoring to include controller and aircraft systems. The controller includes a dedicated telemetry link (typically using 2.4 GHz, 6.0 MHZ or 900 MHz) to maintain a stable communication link with the UAS. These frequencies work with line of sight and have demonstrated reliability in this type of terrain at greater than 1-mile, when flown under previous UM COA, 2021-WSA-8002-COA. This link provides real-time data such as GPS location, altitude, battery status, and overall flight status. There is an audible and visual alert if aircraft or control systems detect a malfunction or predetermined safety thresholds for altitude, distance, weather and battery levels. Built-in GPS on the controller ensures accurate positional awareness for RTH functionality and helps in maintaining location accuracy during operations. The controller is powered by a rechargeable battery, which provides several hours of continuous use. Physical buttons and touchscreen shortcuts enable quick access to critical functions such as takeoff, landing, RTH, and emergency stop, providing fast response options if an anomaly occurs.
- **Crew Members:** UM Standard Operating Procedures is for a PIC and VO; more complex mission requires more personnel.
    - **Pilot in Command:** Overall authority and accountability for the safe operation of the sUAS and mission success. Conducts pre-flight planning, safety assessments, and ensure compliance with all regulations. Oversee all phases of flight, including launch, mission execution, and recovery. Maintain situational awareness, communicate with VOs and other team members, and make real-time decisions on potential hazards. Execute emergency procedures if necessary and log flight details post-operation. PIC must maintain a current and valid FAA Part 107 Remote Pilot Certificate. Minimum of 50 hours of logged sUAS flight time, with at least 10 hours on the specific UAS model. Experience with EVLOS operations or relevant training in extended line-of-sight flight operations is recommended. Familiarity with the operational environment, including airspace traffic, restrictions, terrain, and weather patterns.
    - **Visual Observer:** Maintains uninterrupted visual contact with the sUAS to relay information to the PIC regarding aircraft position, altitude and proximity to obstacles or other aircraft and wildlife. Communicate potential hazards and flight status to the PIC in real time. Assist in coordinating handoffs if multiple VOs are stationed at intervals to maintain continuous VLOS if the sUAS travels beyond the direct line of sight of the PIC. Monitors near real time air traffic and aviation radio traffic. Observes and monitors local air traffic in the area and environmental conditions and alert the PIC to any safety issues or deviation from intended sUAS flight parameters. Demonstrated knowledge of communication protocols and emergency response as it pertains to sUAS operations. Awareness of emergency protocols and contingency plans if communication with PIC is disrupted. Familiarity with the specific flight area’s geography.

II. Operational Scenarios

- **Define the Operations:** Conduct UAS flights up to 2,000 ft AGL, with daisy chain Visual Observers for aerial surveying, weather observations, sensor testing and data collection in a sparsely populated, and wooded area.
- **Geographic Operating Boundaries:** Lubrecht Experimental Forest, Montana, within a 5-mile radius of point 46.893316, -113.450323. All operations are in the lower portions of Class E and G airspace, over a sparsely populated area with little manned aircraft air traffic. Operating area is ~30 miles East of Missoula Airport, ~114 miles Southwest of Great Falls Airport and ~72 miles Northwest of Helena Airport. This area is under the jurisdiction of Spokane Terminal Radar Approach Control and Salt Lake City Air Route Traffic Control Center. Lubrecht Experimental Forest, Montana, is managed by the W.A. Franke College of Forestry and Conservation at the University of Montana as an outdoor classroom. (Figure 2) Lubrecht Experimental Forest Operation Area (Figure 3) Great Falls Sectional Chart.
- **Operating Characteristics:** Lubrecht is an ideal test area for conducting research to support forestry, agriculture, controlled burns and UAS operations, due to its remote location, sparsely populated area, and limited structures and air traffic.
- **Planning and Preparation:**
  - Site Assessment: Identify survey area, boundaries, and potential hazards (e.g., power lines, tree lines).
  - Airspace: Notification and monitoring
    - NOTAMs will be filed 24 hours ahead of time, for all flights utilizing approved COAs.
    - Air traffic will be monitored via aviation radios.
    - Monitoring of near real time air traffic via applications in or around the operating area.
  - Weather Analysis: Assess forecasted conditions to ensure safe operation, with attention to wind speeds, precipitation, and visibility.
  - Flight planning: Automated flight plans generated with Digital Elevation Model (DEM), geofencing for distance, altitude and RTH parameters, to include lost link, battery or system failures.
  - Pre-Flight Checklists: Complete UM checklists for equipment verification, battery inspection, camera settings, calibration procedures, takeoff and landing sites and emergency procedures.
- **Mission Execution:**
  - Data Collection:
    - Preflight briefing by PIC following UM check lists and safety protocols.
    - Takeoff and landing sites identified, to include back up location.
    - Fly predefined grid patterns with overlapping waypoints to maximize data coverage, or data collection parameters.
    - Specific Points of Interest: Flights may also be directed to specific points of interest within the Lubrecht Experimental Forest, based on the research or data collection requirements. For example, the sUA could be tasked with collecting imagery or sensor data from particular forest stands, water bodies, or other features.

        - Monitor flight telemetry and VO observations to ensure optimal altitude, speed, safety and operating area.
- **Data Processing and Post-Flight Analysis:**
    - Data Transfer: Transfer imagery and flight data to secure storage.
    - Data Verification: Check data in field to ensure completeness and accuracy.
    - Post-Flight: Inspect and service UAS platforms to ensure readiness for future missions in accordance with UM checklists.
    - Conduct a debrief with all crew members, including VOs, to discuss what went well and any challenges encountered during the flight.
    - Incorporate lessons learned from each EVLOS operation to refine hand-off techniques, communication protocols, and emergency procedures.
    - Use feedback to enhance future operations and address any safety or efficiency issues.
    - Document any incidents, equipment malfunctions, or communication issues, and submit a report if an accident or near-miss occurred.
    - Document flight telemetry, data, PIC, VO and relevant flight data.
- **EVLOS Intentions:** Line of sight and extended line of sight will be conducted with the use of multiple VOs, direct communications and/or equipped with handheld radios to maintain continuous communication with the Pilot in Command (PIC).

III. Airspace and Ground Considerations

- **Airspace Types and Considerations**: Operational area is in the lower portions of Class E and G airspace. To ensure compliance, operators will consult **FAA Great Falls sectional charts (**Figure 3**)** Great Falls Sectional Chart**,** additionally using apps with **near real-time** ADS-B **air traffic data** will greatly improve safety by providing speed, heading and altitude on manned aircraft operating nearby. The addition of multiple VOs will increase the situational awareness of PIC in the flight area.
    - PIC will immediate descent to below 400 feet AGL upon detection of manned aircraft within a 1-mile radius.
    - Loiter at location and altitude until manned aircraft has exited 1-mile radius flight route.
    - sUAS will RTH if battery or other systems reach minimum safe operational thresholds.
- **Ground Entities**: Lubrecht is a sparsely populated area comprised mostly of managed forest and small open fields with few buildings and structures to support ongoing management operations. There will be times with increased personnel conducting research and operations on Lubrecht and sUAS operations will be coordinated with onsite managers and team leads to minimize and inform personnel in operational areas.
- **National Airspace Users**: Lubrecht Experimental Forest, Montana, and the surrounding area within a 5-mile radius of point 46.893316, -113.450323 is in the lower portions of Class E and G airspace, over a sparsely populated area with light manned aircraft air traffic. Operating area is ~30 miles East of Missoula Airport, ~114 miles Southwest of Great Falls Airport and ~72 miles Northwest of Helena Airport. This area is under the jurisdiction of Spokane Terminal Radar Approach Control and Salt Lake City Air Route Traffic Control Center. sUAS flights up to 2,000 ft AGL, with daisy chain Visual Observers for aerial surveying, weather observations, sensor testing and data collection in

a sparsely populated, wooded area. Lubrecht Experimental Forest, Montana, managed by the W.A. Franke College of Forestry and Conservation at the University of Montana as an outdoor classroom.

- **Meteorological Conditions**: Operations are in mountainous terrain and can experience changing conditions. Temperature can range from -36°C and 43°C (-33°F to 110°F). Winter has an average snow fall of ~40 inches. Cloud cover generally increases around October thru June. Winds are usually light around 5-15mph but have been recorded as high as 109 mph in July 2024. Weather extremes can have negative effects on flight performance and battery capacity; flight parameters will be adjusted or missions postponed accordingly. Icing is of particular concern for UM operations and special consideration, or postponing missions will be implemented when condition are likely to produce icing. sUAS operations will adhere to the UM SOP for weather and operate within the manufactured guidelines for the perspective aircraft. Adhering to the FAA weather minimums for visibility of 3 statute miles, 1,000 feet above, 500 feet below, and 2,000 feet horizontal of cloud cover. Reduction in visibility will reduce the operational area of the current mission.
- **Automation Level**: Automated flights will be used for orthomosaic data collection and repeatable flight patterns to include photography, videography and sensor collection. Flight planning software utilized has aircraft and payload specific data to aid in the estimation of flight times, flight duration limits, flight lines, data collection overlap, altitude changes, geofencing, battery minimums, lost link procedures and RTH altitude and route planning. Autonomous flight plans are uploaded to the aircraft from the controller and the PIC has manual override capacities to pause, cancel, initiate RTH or take over manual control during all portion of the flight. Multirotor aircraft have visual and nonvisual obstacle avoidance system.
- **Pilot/Aircraft Ratio**: PIC to sUAS ratio will not exceed 1:1.
- **Day/Night Operations**: Operations will be primarily daylight hours. Night operations will be rare, and additional safeguards will be in place for those limited operations. Night missions will be with sUAS equipped with blinking anti-collision lights visible for at least 3 miles. Operational limits and altitudes will be reduced to maintain visual line of sight. All air traffic mitigations for other sUAS and manned aircraft will remain in place.
- **Crew Safety Plan**: Crew Resource Management ensures that the PIC, VO and bystanders are all protected through proactive risk management, clear communication and structured emergency responses. The PIC will conduct a preflight safety brief to include roles and responsibilities, objectives, operational limits, potential hazards and emergency procedures of all persons involved in the operation. The PIC leads a crew conducted risk assessment based on the P.A.V.E. (Pilot, Aircraft, enVironment, External pressures) framework, identifying factors such as environmental hazards, air traffic density, and operational area risks. The PIC and VO continuously assess the situation in real-time, noting any changes that could elevate risks, such as weather changes or unexpected bystander encroachment. In situations where quick decision-making is essential (e.g., low battery warning, approaching aircraft), the PIC should consult the VO when possible but remains the final authority on whether to abort or continue the mission. The PIC is responsible for all aspect of the mission, but the entire crew will stay updated on weather changes, sun position and other environmental factors that could impact visibility, operational safety or situational awareness. Crew members should assess their

own and others' fatigue or stress levels and communicate if they need a break or assistance to prevent degradation of situational awareness. The PIC will monitor or assign a crew member to routinely check the wellness of crew members and be vigilant to fatigue, stress and environmental exposure for heat, cold, dehydration and environmental hazards to crewmembers.

IV. Community Outreach and Safety

- **Community Outreach Plans**: Promote public safety and awareness regarding sUAS activities and establish clear communication channels to address public questions or concerns. As a university we promote awareness and safety through a variety of workshops, presentations and lectors, to students, faculty and community organizations. Comply with FAA regulations, including filing a Notice to Air Mission (NOTAM) for public awareness in the airspace not later than 24 hours prior to all flight plans above 400 feet AGL, a NOTAM will be filed at 1800wxbrief.com using the UAS NOTAM form and specify the aircraft ID, date, time, duration, start and end times, altitude, aircraft type, contact information, COA identifier and operational area. If applicable MSO ATC will be notified via phone (406) 549-2979, 15 minutes prior to launch and immediately after landing, as advised by ATC Manager. Flight plans and details can be emailed to Missoula Tower Manager Christel.Palmer@ serco-na.com if requested by ATC.
- **Accident and Incident Reporting**:
  - Accidents will be reported to the FAA within **10 days, through FAADroneZone,** if any of the following occurs:
  - **Serious Injury to Any Person:** An injury requiring hospitalization or that results in a significant injury (e.g., head trauma, broken bones, lacerations needing stitches).
  - **Loss of Consciousness:** If any person loses consciousness due to the accident.
  - **Property Damage of $500 or More:** If the accident causes damage to property (excluding the sUAS itself) valued at $500 or more. This includes both repair or replacement costs of the damaged property.
  - **Accidents will be reported immediately to the National Transportation Safety Board (NTSB) through the Response Operations Center (ROC) at 844-373-9922, if any of the following occurs:**
    - **If any person suffers a fatal injury or serious injury (defined as an injury requiring hospitalization for more than 48 hours, fractures, or other significant trauma).**
    - **Any collision with another aircraft, manned or unmanned.**
    - **The aircraft holds an airworthiness certificate or approval and sustains substantial damage**
  - **For these situations, you should notify the NTSB as soon as possible through their official reporting channels to support a timely investigation.**
  - PIC will document the following information for Reporting either to FAA or NTSB.
    - Name of owner, and operator of the aircraft.
    - Name of the PIC and VOs.
    - Date and time of the accident.
    - Type, nationality, and registration marks of the aircraft.

- Speed, altitude, direction of flight, battery percentage.
- Last point of departure and point of intended landing of the aircraft.
- Position of the aircraft with reference to some easily defined geographical point.
- Nature of the accident, the weather and the extent of damage to the aircraft, so far as is known.
- A description of any explosives, radioactive materials, dangerous articles, or other payload to include sensors carried.

V. Command, Control, and Security

- **Command and Communication Functions**: To ensure safe and efficient sUAS operations within the NAS, command and communication protocols are necessary between sUAS components (aircraft, control station, and observers) and NAS stakeholders (e.g., air traffic control, nearby manned aircraft, and local authorities). These protocols establish structured information flow, enhance situational awareness, and ensure quick, coordinated responses to changes in operational or environmental conditions.
- PIC maintains primary control over the sUAS via the ground control station, utilizing either a direct radio-frequency link or cellular connectivity, depending on operational requirements.
- The ground control station continuously receives real-time telemetry data from the sUAS, including altitude, airspeed, position, battery status, and signal strength.
- Mission planning has built in safety features that automatically initiate a RTH to include: lost link, altitude height violation, geofencing, battery level, system malfunctions and weather limitations.
- The PIC has the ability to switch between autonomous and manual flight modes as well initiate RTH for any reason, i.e., loss of link, low battery, airspace incursion, or exceeded weather limitations. In the event of primary GPS loss, the sUAS can rely on onboard sensors or secondary GPS to maintain stability and support safe recovery.
- The PIC and VOs establish a continuous communication channel (handheld radios, dedicated communication apps or cell phone), allowing VOs to provide real-time updates on surrounding airspace, potential obstacles, and bystander proximity.
- To confirm critical commands or safety alerts, the PIC and VO use a call-and-response protocol to ensure instructions are heard and understood (e.g., “Aircraft at 9 o’clock,” “Roger, aircraft at 3 o’clock”).
- In case of a potential hazard, the VO can issue an emergency “Abort” or “Land Immediately” command, which the PIC will follow as part of established protocols.
- **Communication NAS Stakeholders:** A NOTAM will be filed 24 hours in advance of the operation to notify other airspace users and ATC of the sUAS activity. If applicable MSO ATC will be notified via phone (406) 549-2979, 15 minutes prior to launch and immediately after landing, as advised by ATC Manager. Flight plans and details can be email to Missoula Tower Manager Christel.Palmer@serco-na.com if requested by ATC.
- PIC or designated crew will monitor ATC frequencies when operating near controlled airspace, allowing them to receive situational updates or notifications regarding nearby

manned aircraft. Additionally, they will monitor near real time air traffic via applications in or around the operating area.

- In the event of a flyaway the PIC will immediately notify ATC and if necessary, nearby manned aircraft or local authorities to alert them to a potential hazard. PIC will communicate the aircrafts last know position, altitude, speed, heading and battery remaining or estimated remaining time of flight.
- **Communication Ground Stakeholders:** All operations will be coordinated and scheduled with the Lubrecht Experimental Forest Manager and flight information disseminated/posted as necessary.
- **Emergency Procedures**:
    - Fire: If any member of the crew observes fire or smoke coming from the sUAS, the PIC will be informed immediately. The emergency will be announced to the ground crew, which will mobilize to the area of the aircraft. The PIC will assess the situation, land as soon as possible, preferably at the launch site. If it is not possible to reach the launch site, the PIC will land the aircraft at a predetermined alternate site or any open area. A fire extinguisher will be on site for all remote launches.
    - Air Incursions: PIC will immediate descent to below 400 feet AGL upon detection of manned aircraft within a 1-mile radius. Loiter at location and altitude until manned aircraft has exited 1-mile radius flight route. sUAS will RTH if battery or other systems reach minimum safe operational thresholds.
    - PIC Incapacitation: The visual observer or sensor operator will take over operations for immediate landing using the RTH protocol. Medical assistance will be sought immediately.
    - Accident or Incident: Accidents meeting the qualifying criteria will be reported to the FAA within **10 days, through FAADroneZone, and NTSB through the ROC at 844-373-9922. Accidents or incident to sUAS, that do not meet the reporting requirements will be documented and examined by UM AASO personnel and mitigation and safety procedures will be implemented to safeguard further events.**

VI. Extended Visual Line of Sight (VLOS) Operations

- EVLOS operations allow an sUAS to operate beyond the direct visual line of sight of the PIC by using VOs to maintain continuous situational awareness of the sUAS. EVLOS extends operational reach while keeping safety standards high. The following procedures and considerations are essential for conducting safe and effective EVLOS operations.
- Conduct a thorough analysis of the operational area, focusing on potential obstacles and known airspace risks. Evaluate and confirm that the operation area is within Class E or G airspace or required authorizations are obtained for controlled airspace.
- Conduct viewshed analysis of take-off, landing and operational area to determine possible reduced line of sight due to structures, terrain and vegetation. Position VOs strategically to maintain continuous visual line of sight.
- Position VOs strategically along the planned flight path to ensure continuous observation of the sUAS. Each VO's observation range will overlap with the next, allowing for

seamless handoffs. Avoid placing VOs near areas with obstructions that could hinder sightlines, like dense trees or buildings.
- The PIC and VOs establish a continuous communication channel (handheld radios, dedicated communication apps or cell phone), allowing VOs to provide real-time updates on surrounding airspace, potential obstacles, and bystander proximity.
- To confirm critical commands or safety alerts, the PIC and VO use a call-and-response protocol to ensure instructions are heard and understood (e.g., “Aircraft at 9 o’clock,” “Roger, aircraft at 3 o’clock”).
- In case of a potential hazard, the VO can issue an emergency “Abort” or “Land Immediately” command, which the PIC will follow as part of established protocols.
- Weather conditions will be continuously monitored for reduced operational performance, such as visibility, windspeed, temperature, moisture and other limitations to visibility that may may require an immediate return to a safe landing location.
- VOs will use language for hand-offs, such as “Aircraft in view and within range,” “I have eyes on aircraft heading in x direction” to confirm that the next VO has clear sight of the sUAS before responsibility is transferred.
- VOs provide the PIC with pre-determined interval updates (not to exceed 5 min) on the sUAS position, altitude and surrounding environment, noting any approaching obstacles, air traffic or deviation from briefed flight route.
- If a VO loses sight of the sUAS, they will alert the PIC immediately, the PIC should either adjust the flight path to regain visual contact or activate the RTH function.
- If communication is lost with a VO, the PIC should return the sUAS to a safe location or designated holding point until communications are re-established
- VOs will monitor the ground area for any bystanders or wildlife approaching the operational zone. If there is unauthorized enter into the operation area, VOs will communicate this to the PIC, who will then decide to continue as planned, hold, re-route, RTH or cancel the mission until the area is clear.
- Verify that the sUAS home location is accurate and that the RTH is set and functional ensuring the RTH route in not over populated areas. Check battery levels and set limits (30%) to allow sufficient time for the sUAS to return safely in case of unexpected conditions.

VII. Summary

This CONOPS for the University of Montana implements a multi-faceted approach to sUAS operations, emphasizing safety, risk mitigation, and adherence to regulations. By diligently implementing these measures, UM demonstrates a commitment to conducting safe, responsible, and effective sUAS operations. The key elements of our strategy, include:
- **Comprehensive Pre-flight Procedures:** UM prioritizes thorough pre-flight planning and preparation, including site assessments, weather analysis, automated flight plans with geofencing, and pre-flight checklists. This meticulous approach helps identify and mitigate potential hazards before flight operations commence.
- **Strategic Crew Management**: Recognizing the importance of human factors, UM employs a crew safety plan that prioritizes proactive risk management, clear communication, and structured emergency responses. This includes utilizing the P.A.V.E. framework for risk assessments, ensuring continuous communication between the PIC and VOs and establishing clear roles and responsibilities for all crew members.

- **Essential Role of Visual Observers**: VOs are integral to safe sUAS operations, especially in EVLOS scenarios. They provide real-time situational awareness to the PIC, relaying information about the aircraft's position, potential obstacles, and surrounding airspace. Strategic VO positioning, with overlapping observation ranges, ensures continuous visual contact with the sUAS, even beyond the PIC's direct line of sight.
- **Well-Defined Emergency Protocols**: UM has established detailed protocols for handling various emergencies, including fire, air incursions, PIC incapacitation, and accidents. These procedures emphasize prompt communication, coordinated responses, and adherence to reporting requirements.
- **Multi-Layered Communication Strategy**: UM employs a combination of communication methods to ensure seamless coordination and situational awareness among crew members and relevant stakeholders. They utilize handheld radios, dedicated communication apps, or cell phones for direct communication between the PIC and VOs. UM files NOTAMs, monitors ATC frequencies, and maintains communication with the Lubrecht Experimental Forest manager.
- **Respect for Airspace Regulations**: Recognizing the importance of operating safely within the NAS, UM primarily conducts flights in Class E and G airspace. They consult FAA sectional charts, utilize apps with near real-time air traffic data and implement procedures to safely managing air incursions.
- **Commitment to Community Outreach**: UM proactively promotes public safety and awareness regarding sUAS activities through workshops, presentations and lectures. This commitment to transparency and education helps foster understanding and cooperation between UM and the surrounding community.

VIII. Figures of Proposed Area of Operation

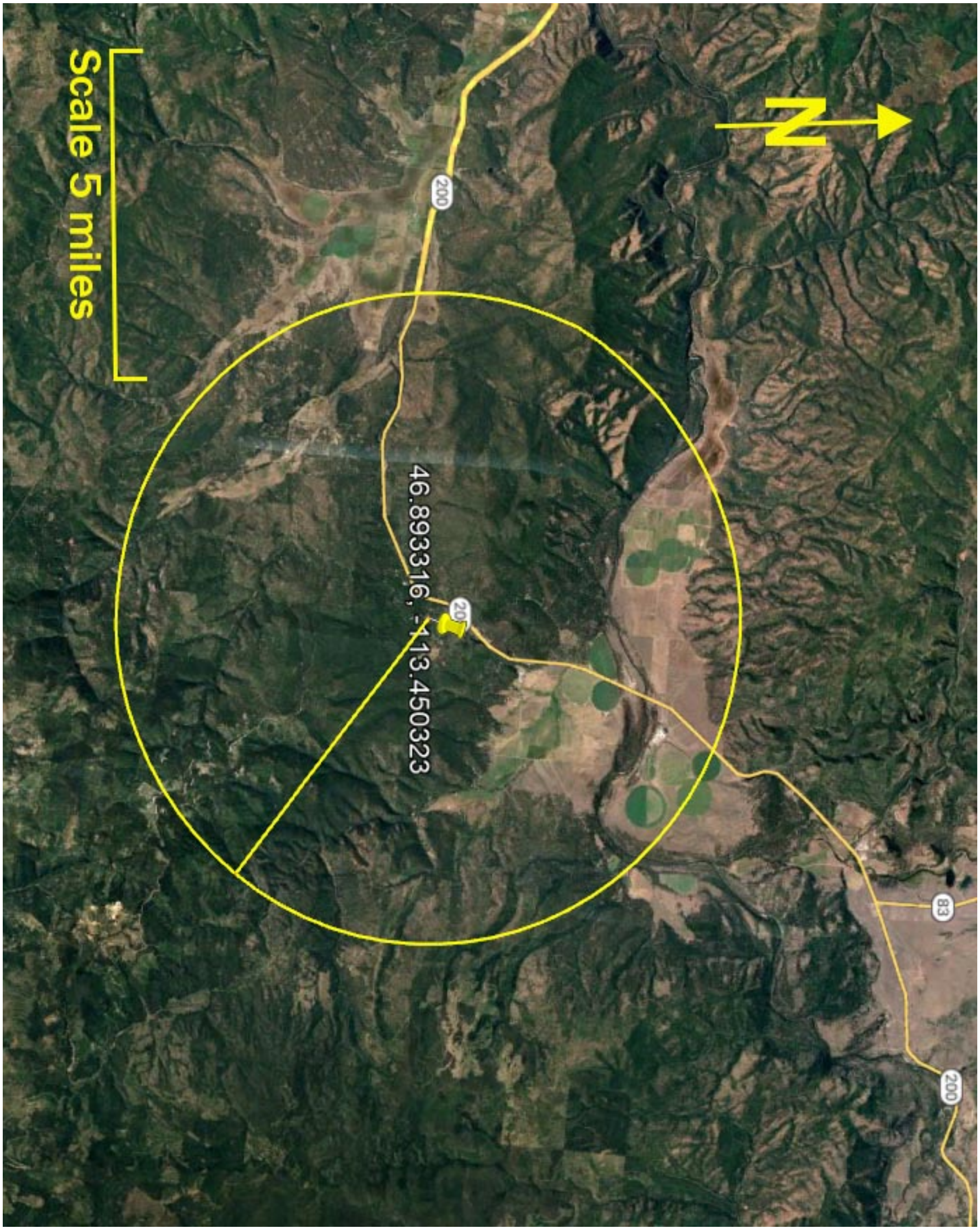


Figure 2: Lubrecht Experimental Forest Operation Area

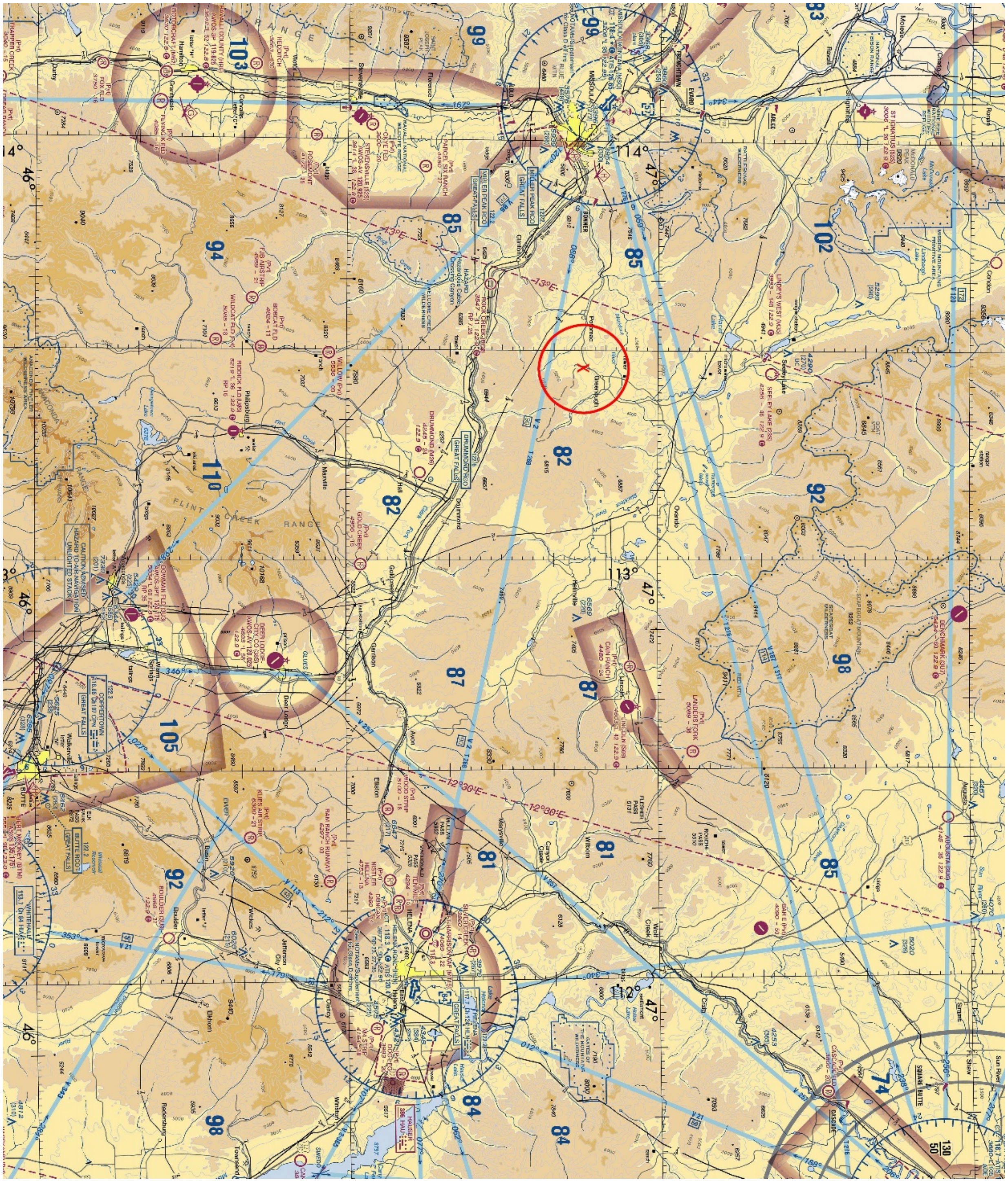


Figure 3: Great Falls Sectional Chart. Lubrecht Experimental Forest Operation Area.

IX. Part 107 Waiver and Safety Explanation Guidelines and Guiding Questions

107.31 Visual Line of Sight Aircraft Operations

We are applying for, extended line of sight operations, to allow an sUAS to operate beyond the direct visual line of sight of the RPIC by using VOs to maintain continuous situational awareness of the sUAS.

8) General

a) Describe how the remote pilot in command (RPIC) will be able to continuously know and determine the position, altitude, and movement of the small Unmanned Aircraft (sUA).
   - The RPIC receives real-time information about the aircraft's position, altitude, airspeed, battery and signal strength through the use of a ground control station. The RPIC will determine if the sUA is detouring from the predetermined flight path and take corrective action. Additionally, the RPIC will know the position, heading and speed of the aircraft through the use of Visual Observers and continuous observation of the aircraft.

b) Describe how the RPIC will ensure the sUA remains in the area of intended operation. How will this be verified?
   - The RPIC will use ground control station defined geofencing for operations to include geographic boundaries as well as high and low altitude limitations. Aircraft failsafe will be preprogramed to return to home if crossing the geofence boundary or in the event of a lost link communications between the sUA and the ground control station. The mission will be briefed to all VO and any deviation from flight area and flight plan will be relayed to the RPIC who will take corrective action and return to home.

c) Describe how the RPIC ensures the operation will not go beyond the capabilities of the command-and-control link. How will that be tested and verified?
   - The RPIC will ensure that the command-and-control ranges of the operation are within the manufacturer's stated capabilities and established ranges for the system. The RPIC will continuously monitor the command-and-control link signal strength through the ground control station. Aircraft failsafe will be preprogramed to return to home in the event of a lost link communications between the sUA and the ground control station. A pre-flight viewshed analysis of the flight area will be conducted at the takeoff and landing sites, as well as the operational area to identify potential signal degradation due to terrain and vegetation. The RPIC will reduce the operational area as needed to maintain a command-and-control link.

d) What is the route of flight? What factors, with regards to the route of flight, will affect command and control, flight over people/moving vehicles/obstructions, etc.?
   - Flights will be conducted at Lubrecht Experimental Forest, Montana, within a 5-mile radius of point 46.893316, -113.450323. All operations are in the lower portions of Class E and G airspace, over a sparsely populated area with little manned aircraft air traffic. Lubrecht is a University of Montana property, comprised of forested mountains and small natural meadow. Terrain, and forest obstructions are the primary considerations and will determine the command-and-control limitations and will be reduced as determined by the RPIC. No flights will be conducted from moving

vehicles and flights will be altered by the RPIC to avoid direct or sustained flights over people not directly involved in the sUA operations.

e) Does the sUA have a return to home (RTH) function? If so, how does the RPIC ensure the sUA does not overfly people/vehicles or collide with obstructions during the RTH flight?
   - Yes, the sUA does have a RTH function it utilizes pre-programmed parameters, including a defined altitude and route, established during the flight planning stage. The RTH route is set to minimize the risk of overflying people and vehicles, by avoiding roads and structures. The RTH altitude is set to avoid obstructions such as buildings, power lines, and terrain features by a minimum of 100 ft. Visual Observes will continuously monitor the sUA and relay any potential deviation from safety parameters to the RPIC.

9) Detect and Avoid (DAA)

a) How will the RPIC monitor the airspace surrounding the operation of the sUA to remain well clear of other aircraft?
   - The RPIC will file a Notice to Air Missions (NOTAM) 24 hours before flights above 400 AGL at 1800wxbrief.com using the UAS NOTAM form, and specify the aircraft ID, date, time, duration, start and end times, altitude, aircraft type, contact information, COA identifier and operational area. During the flight, the RPIC and crew will utilize several tools and procedures for real-time airspace monitoring. The team will monitor the Common Traffic Advisory Frequency (CTAF) for their operational area to stay informed about local aircraft activity. They will also use flight tracking applications that provide near real-time air traffic data, offering insights into the speed, altitude, and heading of nearby manned aircraft. Additionally, multiple visual observers will scan the airspace for any potential aircraft within the vicinity. If an aircraft is detected within a one-mile radius of the sUA, the RPIC will immediately descend the sUA to below 400 feet AGL. The sUA will loiter at that altitude until the aircraft has left the area. If battery levels or other system limitations reach critical thresholds during this maneuver, the RPIC will initiate a return to home (RTH).

b) Will a Detect and Avoid (DAA) system be used with the operation?
   1. What type of DAA system is to be used? RADAR / ACOUSTIC / VISUAL?
      - We do not have a ground based RADAR or acoustic system in place at this time. A Visual DAA protocol will be the primary way of detecting and avoiding aircraft in the operating area, utilizing multiple visual observers, ADS-B applications and radio monitoring. The RPIC will monitor air traffic frequencies via radio and utilize ADS-B application to track manned aircraft.
   2. Is the DAA system ground based or airborne?
      - This detect and avoid protocol emphasizes visual observers, ADS-B applications and radio monitoring.
   3. Is the DAA system compliant with the Industry Based DAA Performance Standard or a combination of standards?
      - No, our protocol, emphasizes visual observers, ADS-B applications and radio monitoring.
   4. If the DAA is ground based, is there adequate low altitude DAA coverage to support the operation?

- Yes, there is adequate low altitude support for these operations through, visual observers, ADS-B applications and radio monitoring.

5. What is the maximum distance the system is effective in detecting other aircraft?
   - The use of ADS-B applications has nationwide coverage. The radio has a 5-watt output and air traffic communications between 118.00MHZ and 136.975MHZ.
6. Has the DAA system been tested and proven reliable in the desired operating environment?
   - Yes, this protocol has been tested and proven reliable while operating under UAS COA 2021-WSA-8002-COA
7. What is the maximum altitude above ground level the sUA will be flown during this operation?
   - 2,000 AGL
8. What is the avoidance strategy?
   - If an aircraft is detected within a one-mile radius of the sUA, the RPIC will immediately descend the sUA to below 400 feet AGL. The sUA will loiter at that altitude until the aircraft has left the area. If battery levels or other system limitations reach critical thresholds during this maneuver, the RPIC will initiate a return to home.
9. If avoidance is automated, what safeguards are there to protect the system from undesired behavior?
   - There are no automated avoidance systems other than a RPIC initiated maneuver.
10. Describe how the RPIC interfaces with the DAA system to monitor the airspace and manage the DAA operation?
    - The RPIC will communicate with visual observers, monitor ADS-B applications and radio monitoring.
11. What is the minimum distance for detection so that the avoidance strategy can be carried out?
    - One mile is the minimum distance to activate the protocol. RPIC and VOs will monitor radio traffic and ADS-B applications to track aircraft for potential conflicting flight paths and allow sufficient time for the RPIC to implement the established avoidance protocols, ensuring the safe separation of the sUA from other aircraft.
12. If using an obstruction/shielded DAA concept of operations, what is the shielding criteria?
    - We are not using any obstruction or shielded structure or features.

10) Lighting

a) Describe the anti-collision lighting used on the sUA, in order for it to be seen by crewmembers in other aircraft from a distance of at least 1 statute mile (sm) during daytime operations and 3sm if conducting nighttime operations.
   - Green, red and white flashing LED lights visible for 3 sm at night and 1 sm during the daytime are attached to the sUA.

11) Alerts.

a) Describe how the RPIC will be alerted of a degraded function or failure of the sUAS.
   - The RPIC will be alerted to a degraded function or failure of the sUAS through several methods, including both automatic system alerts and real-time communication from the visual observer. The ground control station receives real-time telemetry data

from the sUAS, including altitude, airspeed, position, battery status, and signal strength. This allows the RPIC to monitor the sUAS's performance and identify any anomalies or deviations from the planned flight. Visual observers will be briefed on the mission, flight path and areas of concern prior to launch and will relay information to the RPIC, any concerns or deviation from briefed mission.

b) Will there be an audible and visual alert of the degraded function or failure as required by industry standards?
   - Yes, both audible and visual alert to deviation or degradation.

c) What are the procedures in the event of a degraded function or failure of the sUAS?
   - The RPIC will initiate a RTH manually, also mission planning includes built-in safety features that automatically initiate a RTH in response to several triggers to include lost communications link, altitude or geofence violations, low battery levels, system malfunctions and exceeding weather limitations. Emergency shut off of the sUA's engines in flight is a final safety procedure to ensure safety of personnel and will cause the sUA to crash.

d) What are the C2 lost link procedures?
   - In the event of a lost communication link between the sUA and the ground control station, for more than 15 seconds, automatic or manual RTH is initiated.

12) **Training**

a) Describe how the responsible person will ensure that relevant knowledge is required of all persons participating in the operation.
   - The RPIC will conduct a pre-flight safety briefing with all crew members per the UM established standard operation procedures and checklists. This briefing includes a discussion of roles, responsibilities, qualifications, objectives, operational limits, potential hazards, emergency procedures, and operational area risks. Familiarity with the specific flight area's geography is also required.

d) What training will be required for the operation?
   - The RPIC is required to have a current and valid FAA Part 107 Remote Pilot Certificate, have a minimum of 50 hours of logged sUAS flight time, with at least 10 hours on the specific sUAS model being used. Visual observers must demonstrated knowledge of communication protocols and emergency responses related to sUAS operations. They also need to be aware of emergency protocols and contingency plans in case communication with the RPIC is disrupted.

e) How will the training be documented and maintained?
   - All flight data, including flight routes, weather conditions, battery performance, VO's, PIC and communication records are kept for 5 years after the completion of the flight. Individual training and qualifications are documented in the same database system and ensured current before operations.

13) **Weather**

a) What are the weather limitations on the sUA to be operated?
   - Visibility, precipitation, temperature, windspeed, and altitude are all considered before sUA operations. Visibility minimums are 3 statute miles, 1,000 feet above, 500 feet below and 2,000 feet horizontally of cloud cover. Any visibly or probable precipitation during schedule operations will be rescheduled. Temperature ranges for our sUAS operations are between -10°C and 40°C (14°F to 104°F) for VTOL aircraft and -20°C and 40°C (4°F to 104°F) for multirotor aircraft. Temperatures close to

freezing at takeoff and flight altitudes is of primary concern and will be rescheduled to avoid the potential of icing. sUAS operations have wind speed limitations. Windspeed limitations for VTOL sUA are 15-20 knots during vertical operations and 35 knot gusts during level flight. Multirotor aircraft have a slightly higher limit of 20-25 knots and 35 knot gusts during level flight. Higher altitudes reduce battery and propeller performance due to increased power demands. This can be minimized by the use of high-altitude props and reduce area of coverage per flight. The RPIC will initiate an RTH if weather conditions exceed limitations.

c) How will you determine the weather conditions at the launch and recovery site as well as along the intended route?
   - Weather forecasts from multiple sources will be assessed and reviewed before scheduling a sUA flight. Weather criteria at launch and recovery site will be determined by the RPIC utilizing a handheld weather meter to determine windspeed and temperature.

d) How will you comply with 107.51?
   - The RPIC will maintain line of sight of the sUA through the use of overlapping daisy chained visual observers. If a visual observer loses sight of the sUA they will immediately alert the RPIC who will adjust the flight path to regain visual contact or return-to-home and reposition the visual observers. The RPIC will ensure that geofencing is in place for boundaries and altitude prior to mission launch. The RPIC will monitor the ground control station the receives real-time telemetry data from the sUAS, including altitude, airspeed, position, battery status, and signal strength. This allows the RPIC to monitor the sUA's altitude, speed, position, direction and identify any anomalies or deviations from the planned flight.

14) Command and Control

a) Describe the command-and-control link of the sUAS.
   - The command-and-control link is via a bi-directional radio link with a range of 10 km (6 mi) in a direct line of sight. The radio link uses multiple frequencies, including 1227.6 MHz, 1561.098 MHz, and 1575.42 MHz.

b) Is the command-and-control link configuration FCC approved? If so, please provide the approval number?
   - Yes, FCC ID: RYK-WPET236ACNBT, 2AWEB-HALOHNF4W
   -

107.33 Visual Observer

We are applying for, extended line of sight operations, to allow an sUAS to operate beyond the direct visual line of sight of the RPIC by using VOs to maintain continuous situational awareness of the sUAS.

2) **Describe how you will account for the communication latency between the Visual Observer(s) (VO) and the Remote Pilot in Command (RPIC).**

a) How will the RPIC and VO(s) communicate with each other if they are not near each other?
   - A continuous communication channel will be established between the PIC and VOs using handheld radios, dedicated communication apps, or cell phones. A call-and-response protocol will be used to confirm critical commands or safety alerts. This ensures that instructions are heard and understood by both the PIC and VO. For

example, a VO will say "Aircraft headed North of my location" and the PIC would respond "Roger, aircraft headed North or your location." In case of a potential hazard, the VO will issue an emergency "Abort" or "Land Immediately" command, which the PIC will follow as part of established protocols. The RPIC with establish pre-determined interval updates (not to exceed 5 minutes), on the sUAS position, altitude, and surrounding environment. These updates will include any approaching obstacles, air traffic, deviations from the briefed flight route, or all clear.

b) If this communication method fails, how will the RPIC and VO(s) be alerted to the failure?
   - The RPIC will check communication during mission events and predetermined intervals (not to exceed 5 minutes), based on area, terrain and sUA.

c) What will the RPIC and VO(s) do if a communication failure occurs?
   - If the RPIC cannot contact the VO, or the VO misses an established communications window, the RPIC will attempt to re-establish communication on the backup system and return the sUAS to a safe location or designated holding point until communications are re-established. If the RPIC still cannot reestablish communications with the VO, the RPIC will RTH the sUA.

107.51(b) Operating Limitations for Small Unmanned Aircraft: Altitude

We are applying for an altitude waiver to 2,000 AGL, using VOs to maintain continuous situational awareness of the sUAS.

1) **Describe how the small unmanned aircraft (sUA) will not pose a hazard to aircraft, persons on the ground, and others' property when operating at altitudes other than those prescribed in § 107.51(b).**
   - sUAS flights will take place in a sparsely populated area, specifically within a 5-mile radius of the Lubrecht Experimental Forest in Montana. The area is managed forest with few buildings or structures. Flights will be coordinated with Lubrecht on-site managers, and disseminated to onsite personnel, additionally flight times and areas will be posted. Automated flight plans will be altered to eliminate or reduce flights over people, and no sustained flights will occur over people useless they are directly involved in sUA operations. VOs will be vigilant for people in the area and will notify the RPIC who will decide to continue as planned, hold, re-route, RTH or cancel the mission until the area is clear. RTH routes will be planned to minimize the flight path over people and structures. This ensures that if the sUAS needs to return to its home location, it will avoid flying over populated areas. The operating area is in Class E and G airspace with little manned aircraft traffic.

a) How will the Remote Pilot in Command (RPIC) and Visual Observer(s) (VO), if used, see and avoid other aircraft when flying over 400 feet above ground level (AGL)?
   - RPIC and VOs are essential for maintaining situational awareness. The VOs will maintain continuous visual contact with the sUAS and relay information to the RPIC regarding the aircraft's position, altitude, and proximity to obstacles or other aircraft. VOs will be stationed at intervals to maintain continuous visual line of sight. VOs will scan the airspace and communicate potential hazards to the PIC in real time. The

RPIC and VO will monitor near real time air traffic applications as well as aviation radio traffic.

2) **Describe the anti-collision lighting used on the sUA, in order for it to be seen by crewmembers in other aircraft from a distance of at least 1 statute mile (sm) during daytime operations and 3sm if conducting nighttime operations.**
   - Green, red and white flashing LED lights visible for 3sm at night and 1sm during the daytime are attached to the sUA.

   a) Will the sUA be sufficiently visible by crewmembers in other aircraft in the location where the RPIC will operate?
      - Yes, the sUA will be equipped with LED lights visible for 1sm during the daytime. Additional measures are taken to ensure there in no interference with other aircraft. RPIC will monitor air traffic using aviation radios and near real-time air traffic applications. If a manned aircraft is detected within a 1-mile radius, the RPIC will immediately descend to below 400 feet AGL and loiter at that location until the other aircraft has exited the 1-mile radius. The RPIC will RTH if battery or other systems reach minimum safe operational thresholds.

3) **Describe how the RPIC will be able to accurately determine the sUA altitude and direction of flight.**
   a) How will the RPIC know, while keeping eyes on the sUA, the current real-time:
      1) Geographic location,
      2) Altitude (AGL), and
      3) Direction of flight of the sUA

      - The RPIC receives real-time information about the aircraft's position, altitude, airspeed, battery and signal strength through the use of a ground control station. The RPIC will determine if the sUA is detouring from the predetermined flight path and take corrective action. Additionally, the RPIC will know the position, heading and speed of the aircraft through the use of Visual Observers and continuous observation of the aircraft. The RPIC will use ground control station defined geofencing for operations to include geographic boundaries as well as high and low altitude limitations. Aircraft failsafe will be preprogramed to return to home if crossing the geofence boundary or in the event of a lost link communications between the sUA and the ground control station. The RPIC will ensure that the command-and-control ranges of the operation are within the manufacturer's stated capabilities and established ranges for the system. The RPIC will continuously monitor the command-and-control link signal strength through the ground control station. A pre-flight viewshed analysis of the flight area will be conducted at the takeoff and landing sites, as well as the operational area to identify potential signal degradation due to terrain and vegetation. The RPIC will reduce the operational area as needed to maintain a command-and-control link.

   b) How will the RPIC maintain visual line of sight with the sUA (i.e., meet the requirements of § 107.31) at the maximum altitude and distance requested in the waiver application?

      - The RPIC will maintain line of sight of the sUA through the use of overlapping daisy chained visual observers. If a visual observer loses sight of the sUA they will immediately alert the RPIC who will adjust the flight path to regain visual contact or return-to-home and reposition the visual observers. The RPIC will ensure that geofencing is in place for boundaries and altitude prior to mission launch. The RPIC will monitor the ground control station the receives real-time telemetry data from the sUAS, including altitude, airspeed, position, battery status, and signal strength. This allows the RPIC to monitor the sUA's altitude, speed, position, direction and identify any anomalies or deviations from the planned flight.

4) **Describe the area of operations using latitude/longitude, street address, identifiable landmarks, or other maps to include the distance from and direction to the nearest airport (e.g., 4.8 miles SE of XYZ Airport).**
   - Lubrecht Experimental Forest, Montana, within a 5-mile radius of point 46.893316, -113.450323. All operations are in the lower portions of Class E and G airspace, over a sparsely populated area with little manned aircraft air traffic. Operating area is ~30 miles East of Missoula Airport (MSO), ~114 miles Southwest of Great Falls Airport (GTF) and ~72 miles Northwest of Helena Airport (HLN). This area is under the jurisdiction of Spokane Terminal Radar Approach Control and Salt Lake City Air Route Traffic Control Center. Lubrecht Experimental Forest, Montana, is managed by the W.A. Franke College of Forestry and Conservation at the University of Montana as an outdoor classroom. Lubrecht is an ideal test area for conducting research to support forestry, agriculture, controlled burns and UAS operations, due to its remote location, sparsely populated area for people, structures and air traffic.
5) **In addition to filing a NOTAM, describe how the RPIC will communicate/coordinate with Air Traffic Control (ATC) if required by a Special Provision in your Certificate of Waiver and based on the complexity of your operation.**
   - A NOTAM will be filed 24 hours in advance of the operation to notify other airspace users and ATC of the sUAS activity. Prior coordination has already been done with MSO ATC. If applicable MSO ATC will be notified via phone (406) 549-2979, 15 minutes prior to launch and immediately after landing, as advised by ATC Manager. Flight plans and details can be email to Missoula Tower Manager Christel.Palmer@serco-na.com if requested by ATC.

X. AASO FAA Risk Assessment

AASO UAS Risk Assessment for FAA Waiver Request

6. Mission Description
   a. Operation Objective: Conduct UAS flights up to 2,000 AGL, with daisy chain Visual Observers for aerial surveying, weather observations, sensor testing and data collection in a sparsely populated, wooded area.
   b. Location: Lubrecht Experimental Forest, Montana, managed by the W.A. Franke College of Forestry and Conservation at the University of Montana as an outdoor classroom.
   c. Area of Operations: Lubrecht Experimental Forest, Montana, within a 5-mile radius of point 46.893316, -113.450323. All operations are in Class E and G airspace, over a sparsely populated area with little manned aircraft air traffic. Operating area is ~30 miles East of Missoula Airport, ~114 miles Southwest of Great Falls Airport, and ~72 miles Northwest of Helena Airport. This area is under the jurisdiction of Spokane Terminal Radar Approach Control and Salt Lake City Air Route Traffic Control Center.
7. Risk Analysis Framework the assessment uses a structured approach to identify potential hazards and apply mitigations, and ensure safety of operations categorized by:
   a. Airspace, Altitude, and Aircraft Proximity
   b. Aircraft and Equipment Reliability
   c. Human Factors and Crew Competency
   d. External and Environmental Conditions
8. Risk Assessment Matrix

Severity Index	Likelihood				
	Extremely Improbable (1)	Improbable (2)	Remote (3)	Occasional (4)	Frequent (5)
Catastrophic (5)	5	10	15	20	25
Hazardous (4)	4	8	12	16	20
Major (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5

   a. Airspace, Altitude, and Aircraft Proximity

Risk	Potential Impact	Mitigations	Hazard Category

Encounter with Manned or Unmanned Aircraft	Risk of mid-air collision with low-flying aircraft helicopters, aircraft or agricultural aircraft.	• Use multiple Visual Observers (VOs) with 360-degree visual scanning capability at all flight altitudes. • Maintain continuous contact between VO and PIC with voice, handheld radios and cell phones as secondary communication methods. • Continuous monitoring of local CTAF (Common Traffic Advisory Frequency) to identify nearby manned aircraft activity. To include MSO, GTF, HLN. • Monitor flight tracking applications, to identify potential aircraft incursions into flight area of operation. • Use of lighting on UAS, visible for 1 mile during daylight and 3 miles at nighttime for enhanced visibility to other aircraft. • Establish and follow immediate descent, loiter or return to home procedures if manned aircraft is detected within proximity of operations.	Improbable and Catastrophic 10
Loss of VLOS	Loss of visual awareness of UAS due to altitude, weather or	• Position VOs strategically to	Remote and Minor

	terrain. Risk unintentional deviation from planned flight route or area.	maintain continuous visual line of sight. • Conduct viewshed analysis of take-off, landing and operational area loss of line of sight due to structures, terrain and vegetation. • Use of telemetry to accurately track and monitor speed, heading, altitude and health of onboard systems. • Use geofencing and altitude restrictions to limit operational area and set Return to Home (RTH) protocols.	6
Extended UAS Command and Control Range	Increased altitude may reduce reliability of control link communication between UAS and PIC.	• Conduct viewshed analysis of take-off, landing and command locations to reduce signal degradation due to terrain and vegetation. • Verify communication reliability at proposed altitude prior to operation. • Ensure command and control ranges are within the manufacture and established ranges of system. Use geofencing and altitude restrictions to limit operational area and set Return to Home (RTH) protocols.	Improbable and Minor 4

		• Monitor telemetry and command signal strength. • Implement RTH automatically if communication link is lost.	

b. Aircraft and Equipment Risks

Risk	Potential Impact	Mitigations	Hazard Category
Battery and Lift at Higher Altitudes	Risk of reduced battery and prop performance due to increased power demands at higher altitudes.	• Conduct battery endurance tests to ensure operational limits are not exceeded at the proposed altitude. • Install high altitude props for operations as outlined in manufacture specification due for altitude or density altitude. • Monitor battery temperature, voltage and capacity via telemetry • Set a conservative battery threshold for initiating return to base 30% remaining power.	Improbable and Negligible 2
Air Pressure and Temperature Variability	Higher altitude increases exposure to environmental factors that could impact performance mainly wind, temperature.	• Evaluate aircraft specifications to confirm operational limits, including wind resistance and temperature tolerances. • Monitor onboard systems for temperature, wind and battery tolerances.	Remote and Negligible 3

		• Monitor real-time weather data and set maximum wind speed thresholds for operational limits.	

c. Human Factors and Crew Competency

Risk	Potential Impact	Mitigations	Hazard Category
Reduced PIC and VO Situational Awareness	Reduced situational awareness due to increased altitude and difficulty in visually monitoring UAS.	• Employ multiple VO positions strategically to maintain continuous visual line of sight. • Brief VOs on communication protocols, especially for altitude-specific operation. • Limit duration of individual VO shifts to reduce eye strain and fatigue. • Rotate VO personnel during operations to maintain optimal alertness and observation capacity. • Establish operation limitations to include breaks or replacement for personnel. • Establish crew position redundancy for all personnel, to include the PIC.	Remote and Minor 6
Communication Lapses	Higher altitude operation increases reliance on real-time communication between the PIC and VOs. Communication lapses could delay	• Monitor flight tracking applications, to identify potential aircraft incursions into flight area of operation. • Equip all team members with	Remote and Negligible 3

	reaction times in emergencies.	handheld radios and establish a dedicated communication channel. • Establish radio checks at predetermined intervals. Failure of radio check will terminate mission until comms are re-established. • Conduct a pre-flight communication check and emergency drill to verify response protocols. • Uses of cell phones as backup communications.	

d. Environmental and External Conditions

Risk	Potential Impact	Mitigations	Hazard Category
Flights Over People	Risk of aircraft collision with people and structures	• Lubrecht area is a sparsely populated area that is primarily forested. • Alter automated flight plans to eliminate/reduce flights over people especially groups and well-traveled roads. • Post operational notification of UAS flight ops over potential high use areas. • Return to Home routes planned to minimize RTH over people and structures. • VOs will be vigilant to foot traffic in the	Improbable and Major 6

		area and notify the PIC.	
Adverse Weather Conditions	Higher altitudes may encounter unexpected weather shifts, impacting UAS performance.	• Utilize real-time weather monitoring for early warning on changing conditions at all operating altitudes. WXL25 on 162.400 MHz is the closest NOA station with several local research stations on Lubrecht. • Evaluate aircraft specifications to confirm operational limits, including wind resistance and temperature tolerances. • Monitor onboard systems for temperature, wind and battery health. • Set defined weather-related flight thresholds (e.g., max wind speed, precipitation, temperature range). • Postpone or cancel flight ops if weather conditions increase the likely hood of icing potential.	Occasional and Negligible 4
Wildfire or Controlled Burn	May encounter reduced visibility to smoke, unexpected wind shifts, up and downdrafts that impacting UAS performance and LOS.	• Check for TFR or wildfire events in the vicinity of the operating area. Ground all air operations for duration of event. • Data collection in support of prescribed controlled burns on Lubrecht, deconflict	Remote and Major 9

		with area manager, on scene commander and ensure no flight operations are being conducted. • Reduce operational size of data collection. • Monitor flight tracking applications, to identify potential aircraft incursions into flight area of operation. • Increase the number of VO and decrease their spacing.	
Wildlife Activity	Increased potential for bird strikes or interference from wildlife at higher altitudes.	• Plan operations during times when wildlife activity is minimal (e.g., avoid dawn and dusk). • Brief VOs on increased likelihood of birds in the area, and communication to the PIC. • Establish procedures to immediately descend if wildlife is observed within a close proximity.	Improbable and Minor 4

9. Emergency Response Plan
    a. Mid-Air Collision Avoidance
        i. Immediate descent to below 400 feet AGL upon detection of manned aircraft within a 1-mile radius.
        ii. Loiter at location and altitude until aircraft has exited 1-mile radius flight route.
        iii. Return to Home as necessary.
    b. Loss of Communication or VLOS
        i. Initiate automated return-to-home (RTH) mode if communication with the PIC is lost.
        ii. Notify airspace authorities if recovery is unsuccessful.
    c. System Malfunctions

        i. In the event of a critical system failure, conduct an immediate descent and emergency landing in a pre-identified safe zone.
        ii. If time and resources are available return-to-home.
    d. Weather-Related Emergency
        i. Return to take off and land immediately if weather conditions deteriorate below the operational minimums.

10. Documentation and Reporting
    a. Follow all established UM checklists.
    b. Log all flight data, including flight routers, weather conditions, battery performance, VOs, RPIC and communication records. All records are kept for a minimum of 5 years after completion of the flight.
    c. Maintain a post-operation report documenting any anomalies or incidents for submission to the FAA, if necessary.

Conclusion

This risk assessment aims to address safety concerns associated with operations up to 2,000 AGL, with daisy chain Visual Observers, by implementing monitoring and mitigation protocols, personnel training, and emergency response procedures to ensure safe, compliant UAS operation in accordance with Part 107 waiver requirements.

VI. Appendix C: AASO BVLOS Certificate of Waiver

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

CERTIFICATE OF WAIVER

ISSUED TO

AASO
Responsible Party: Bart Bauer
Waiver Number: 107W-2025-00358

ADDRESS

32 Campus Drive
Missoula, MT 59812

This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate, except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED

Small Unmanned Aircraft System (sUAS) operations beyond the visual line of sight of the remote pilot in command (PIC); Small Unmanned Aircraft System (sUAS) operations in which a participating Visual Observer (VO) is not able to see the Unmanned Aircraft (UA); Small Unmanned Aircraft System (sUAS) operations higher than 400 feet above ground level (AGL), when not within a 400 foot radius of a structure.

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE **14 CFR §§ 107.31—Visual line of sight aircraft operation,**
107.33(b) & (c)(2)—Visual observer, and
107.51(b)—Operating limitations for small unmanned aircraft - Altitude

STANDARD PROVISIONS

1. A copy of the application, made for this certificate, shall be attached to and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Administrator of the Federal Aviation Administration or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.
4. This certificate is nontransferable.

NOTE—This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.

SPECIAL PROVISIONS

Special Provisions 1 to 27, inclusive, are set forth on the attached pages.

This Certificate of Waiver is effective from April 16, 2025, to April 15, 2027, and is subject to cancellation at any time upon notice by the Administrator or an authorized representative.

BY DIRECTION OF THE ADMINISTRATOR

Adam Vetter
Tactical Operations Manager
FAA Western Service Center

SPECIAL PROVISIONS ISSUED TO
AASO

General.

The FAA's Flight Standards Service has reviewed your application to ensure compliance with the requirements of 14 CFR § 107.200 and § 107.205. Pursuant to these authorities, the Administrator finds that the proposed sUAS operation can be conducted safely under the provisions of this Certificate of Waiver (Waiver) as listed below because you have established adequate mitigations for risks involved with operating your sUAS in the manner you described. Adherence to the provisions of this Waiver establishes the required level of safety within the national airspace system.

The Administrator may cancel this Waiver at any time. As a general rule, this Waiver may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with any provision listed below is a violation of the terms of this Waiver and will serve as justification for cancellation.

List of Regulations Waived by Section and Title. The following regulations are waived:

> **14 CFR § 107.31**, Visual line of sight aircraft operation, is waived to allow operation of the Small Unmanned Aircraft (sUA) beyond the direct visual line of sight of the remote pilot in command (PIC);
>
> **14 CFR § 107.33(b) & (c)(2)**, Visual observer, is waived to the extent necessary to allow operation of the Small Unmanned Aircraft (sUA) when any Visual Observer (VO) who is participating in the operation may not be able see the unmanned aircraft in the manner specified in § 107.31;
>
> **14 CFR § 107.51(b)**, Operating limitations for small unmanned aircraft - Altitude, is waived to allow sUAS operations higher than 400 feet AGL, not to exceed 2,000 feet AGL.

No part of this Waiver will function as an airspace authorization under 14 CFR § 107.41. The FAA's Air Traffic Organization responds directly to such requests. The FAA LAANC system cannot be used for airspace authorizations for waivered operations.

Common Special Provisions: The Responsible Person is directly responsible for safety of operations conducted under this Waiver and will ensure the Remote Pilot in Command (PIC), manipulator of the controls, and Visual Observers (VO)[1] comply with all provisions of this Waiver.

1. The Responsible Person listed on the Waiver is responsible to the FAA for the safe conduct of the operations. Prior to conducting operations that are the subject of this Waiver, the Responsible Person:
    a. Must ensure the PIC, manipulators of the controls, and VO are informed of the terms and provisions of this Waiver and the strict observance of the terms and provisions herein;
    b. Must ensure the PIC, manipulators of the controls, and VO are informed of, and familiar with, Part 107 regulations; and

[1] Title 14 CFR § 107.3 defines the term "visual observer." Any VO participating in operations conducted under this Waiver must meet the requirements listed in § 107.33 throughout the duration of flight operations.

   c. Evidence of the above (a and b) must be documented and must be presented for inspection upon request from the Administrator or an authorized representative;

2. This Waiver must not be combined with any other waiver(s), authorizations(s), or exemption(s) without specific authorization from the FAA;

3. The FAA has the authority to cancel or delay any or all flight operations if the safety of persons or property on the ground or in the air are in jeopardy, or there is a violation of the terms of this Waiver;

4. A copy of this Waiver must be accessible and available to the PIC at the ground control station during sUAS operations that are the subject of this Waiver;

5. The Responsible Person listed on this Waiver must maintain a current list of pilots by name and remote pilot certificate number used in operations under this Waiver. This list must be presented for inspection upon request from the Administrator or an authorized representative;

6. The Responsible Person listed on this Waiver must maintain a current list of sUA by registration number(s) used in operations under this Waiver. This list must be presented for inspection upon request from the Administrator or an authorized representative;

7. For the purposes of this Waiver, direct participants are the PICs, persons manipulating the controls, VOs, and any persons whose involvement is necessary for safety of the sUAS operation. All other persons are considered non-participants;

8. If a discrepancy exists between the provisions in this Waiver and the waiver application, the Waiver takes precedence and must be followed;

Visual Line of Sight Operations Special Provisions: The PIC may conduct sUAS operations without the ability to see the unmanned aircraft throughout the entire flight, provided:

9. Visual Observers: All operations conducted under this Waiver must use one or more VO as described in the waiver application;

   a. All VOs must receive documented training for their duties and responsibilities to include;
      1) Scanning of the Operational Volume for Air and Ground based intruders;
      2) Communications procedures and phraseology; and
      3) Overall operations conducted under this Waiver;

   b. Sufficient VO(s), defined as the minimum number of VO(s) required to continuously observe at least a 2 statute mile radius of airspace surrounding the sUA in flight, are;
      1) Used to identify any non-participating aircraft prior to their entry into the planned operational area;
      2) Physically located such that the PIC receives sufficient notice to ensure the sUA remains well clear of all other aircraft;
      3) Physically located to notify the PIC of any moving vehicle or human presence that may pose a hazard to the operation;

   c. Communication between the PIC and VO must occur to facilitate, when necessary, for the PIC taking action to maneuver the sUA with sufficient time to;
      1) Give way to all other aircraft in accordance with 14 CFR § 107.37;

2) React to any unforeseen operational or mechanical failure without creating a hazard to other people, other aircraft, or property in the event of a loss of control of the sUA; and
3) Maintain compliance with this Waiver and un-waived provisions of Part 107;

d. If communication between the VO and the PIC will occur by electronic device:
   1) The device must be continuous full-duplex;
   2) The PIC must be able to use the device hands-free; and
   3) There must be a reliable back-up communication method;

10. Remote ID: The sUA must be a standard remote identification unmanned aircraft listed on the FAA-accepted declaration of compliance list (found here: https://uasdoc.faa.gov/), unless otherwise authorized by the Administrator in writing;

11. NOTAM: The Responsible Person must file a Notice to Airmen (NOTAM) no more than 72 hours and no less than 24 hours prior to operating under this Waiver. A NOTAM can be filed by calling 1-877-487-6867 (1-877-4-US-NTMS); and must include the location and/or operating area, altitude, time, nature of the activity, Waiver and/or COA number, PIC name and contact information. The Responsible Person must verify the NOTAM has been issued prior to conducting waivered operations;

12. The Flight Crew for operations under this Waiver must consist of the personnel specified in the waiver application and supporting documentation, in the number and crew specialties as specified;

13. The PIC must be located within the continental United States;

14. Standard Shielding: The sUA must not exceed:

    a. 100 feet above ground level (AGL); or
    b. 100 feet above the height of any object, obstacle (natural or man-made), within a 100-foot radius of the sUA and not to exceed 400 feet AGL; and
    c. Must remain within the confines of the defined operational area detailed in the waiver application; and
    d. Flight operations will be limited to a distance of 2 SM from takeoff location;

15. The PIC must ensure:

    a. Prior to conducting operations under this Waiver, the PIC must perform a documented site survey to:
       1) Identify flight operational area obstacles and boundaries so as to avoid collision with, or damage to property;
       2) Validate C2 signal strength is sufficient for control through the entire route;
       3) Validate suitable launch/recovery site(s); and
       4) Complete and document a Flight Risk Assessment;
    b. Routes are preplanned (using waypoints) prior to flight and aircraft are programmed to automatically follow the route. Manual flights are allowed as necessary;

c. Geofencing is used to confine the Operational Volume (defined as the property lines of the assets or perimeter boundaries of the controlled access area or right of way specified in the waiver application + maximum allowed altitude);

d. Return to Home/Return to Land feature must not allow the sUA to deviate from the defined operational volume;

e. Launch or recovery areas are pre-designated and monitored to keep any human being who are not directly participating in the operation out of the areas prior to, during, and immediately following flight operations;

f. Individuals directly participating in the operation of the sUAS must be easily identifiable visually (e.g., apparel, safety vests); and

g. Non-participant Company personnel inside the operational area are notified of sUA operations;

16. The Responsible Person must ensure:

a. A copy of the waiver application and this Waiver is available to the PIC and all other direct participants prior to and during sUAS operations that are the subject of this Waiver;

b. A copy of the current operations manual required by this Waiver is available to the PIC and all other direct participants prior to and during sUAS operations that are the subject of this Waiver;

c. All operations conducted under this Waiver follow the procedures outlined in the current operations manual. If a discrepancy exists between the provisions in this Waiver and the procedures outlined in the operations manual, the provisions of this Waiver take precedence and must be followed;

d. A documented notification from the operator(s) of the sUAS to any airport, heliport, known agricultural aerial application operation, or aerial military installation within a 3-mile radius of the operating area; and

e. Each PIC who will conduct operations under this Waiver is trained in a manner that addresses the items listed in 14 CFR § 107.49(a) and in a manner that is consistent with how the sUAS will be operated under this Waiver. All training and demonstration for all PICs and VOs must be documented and made available upon request by the Administrator or an authorized representative. Training operations may only be conducted under the standard requirements of Part 107 (without waiver).
The training must include:
1) sUA limitations;
2) sUA programming;
3) sUA operational procedures;
4) Abnormal procedures;
5) Air traffic avoidance procedures;
6) Crew Resource Management;
7) sUA flight training; and
8) Demonstration of sUA ground and flight skills;

17. Operations Manual: The Responsible Person must update or revise the operations manual (aka CONOPs) submitted with the waiver application for changes in the operation. The Responsible Person must track such revisions and present revised documents to the Administrator or an authorized

representative upon request. The Responsible Person must also present revised documents when applying for extension of, or amendment to this Waiver. If any revision to the manual would be contrary to the information provided in the waiver application or obviate a condition or limitation of this Waiver, then the Responsible Person must apply for an amendment to this Waiver;

18. Operations subject to this Waiver must cease as soon as possible in a manner that does not jeopardize the safety of human beings, property or other aircraft, if, at any time:
    a. Safety of human beings or property on the ground, or in the air is in jeopardy;
    b. Any failure to comply with the provisions of this Waiver exists; and
    c. Full-duplex communications cannot be maintained between the PIC and any VO participating in the operation;

19. Lost Link Procedures: If the PIC loses command or control link with the sUA, the sUA must follow a pre-determined route to immediately re-establish command and control link. If command and control link is not immediately re-established and the PIC no longer has the ability to direct the sUAS to ensure compliance with applicable provisions of Part 107, the sUA must follow the loss of command and control procedure as described in the waiver application;

20. Safety Briefing: Prior to operations under this Waiver, all Direct Participants must attend a safety briefing that addresses, at minimum, the following items as applicable:
    a. Designated positions, physical locations, responsibilities, and Crew Resource Management;
    b. Planned flight operating area;
    c. Designated launch and recovery areas;
    d. Verification of geo-fence boundaries;
    e. Verification of return home and land flight profile, and course;
    f. Procedures for avoidance of other aircraft and obstacles;
    g. Procedures for operating under this Waiver;
    h. Land vehicle speed;
    i. Intended flight path;
    j. Abnormal procedures; and
    k. Emergency procedures;

21. Operations conducted under this Waiver may only occur with the make and model sUAS described in the waiver application. Proposed operations of any other manufacturer, make or model of sUAS will require a new waiver application or a request to amend this Waiver;

22. ADS-B out (1090/978 MHz) may not be transmitted from the sUAS when operating pursuant to this Waiver. An ADS-B in Receiver must be operational and monitored during all operations pursuant to this Waiver;

23. Anti-Collision Lighting: The sUA must be equipped and operated with high visibility markings and/or anti-collision lighting to increase the conspicuity of the sUA in order to be seen by crewmembers in other aircraft from a distance of no less than 1 statute mile for daytime operations and 3 statute miles for civil twilight and/or night operations;

24. Ground Control Station (GCS), Control and Communications (C2) System:

    a. Telemetry: The sUAS ground control station must display in real-time the sUA altitude, position, direction of flight, ground speed, C2 signal strength, GPS or navigation system signal condition, battery condition, and sUA distance from the control station as described in the waiver application. This information must be available at all times to the PIC;

    b. Alerting: The PIC must ensure the GCS is configured to audibly and/or visually alert the PIC of degraded system performance, geofence loss of containment, loss of Control Link with the sUA, and intrusion alerts as described in the waiver application;

    c. Emergency Profiles: The PIC must ensure the GCS is configured for automated emergency actions (e.g. RTL/RTH, altitude descend, position hold, etc.) as described in the waiver application; and

    d. Sensors: The PIC must ensure any installed collision/obstacle avoidance sensors are operational;

25. UAS Maintenance: All sUAS operations conducted in accordance with this Waiver must comply with all manufacturer recommendations and limitations for the sUAS:

    a. The Responsible Person must maintain each sUAS and its components in accordance with manufacturer's instructions and recommendations. sUAS maintenance includes scheduled and unscheduled overhaul, repair, inspection, modification, replacement, and system software upgrades of the sUAS and its components necessary for flight;

    b. A log of all maintenance performed must be kept for each aircraft operated under this Waiver. This log must be available to the PIC for review prior to conducting operations that are the subject of this Waiver. Each sUAS maintenance log must be presented to the Administrator when requested. The log must contain the following information for each maintenance activity:

        1) A description (or reference data acceptable to the Administrator) of work performed;
        2) The date of completion of the work performed;
        3) The name of the person who performed the work; and
        4) The signature of the person who performed the work;

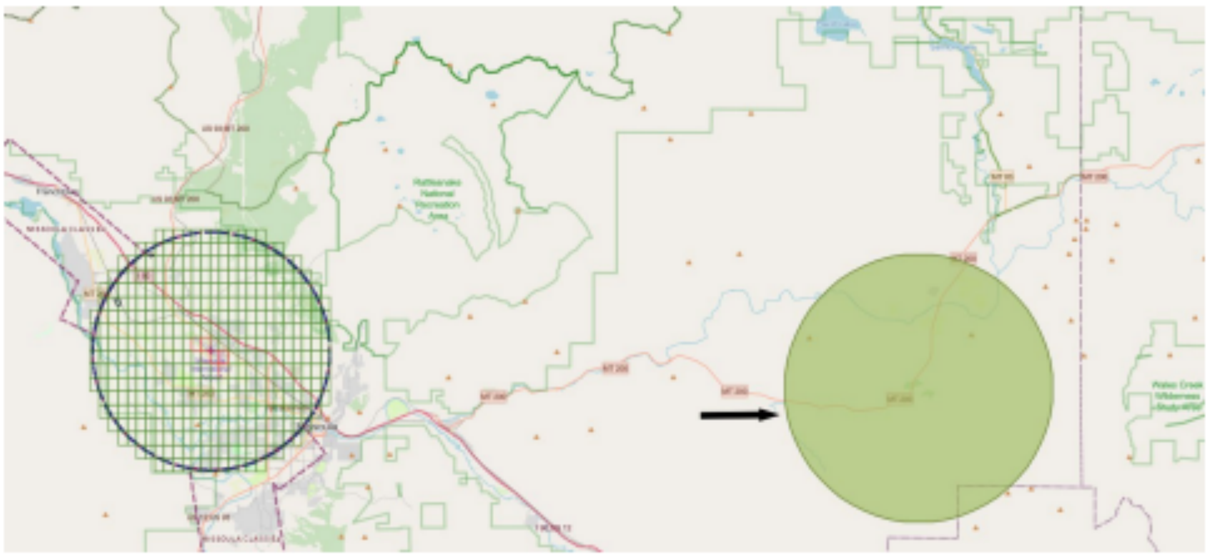
    c. Any sUAS that has undergone maintenance must undergo a functional test flight prior to conducting operations under this Waiver. The functional test flight may only be conducted under the standard requirements of Part 107 (without waiver). A log entry must be made for each functional test flight. The log entry must contain at minimum the:

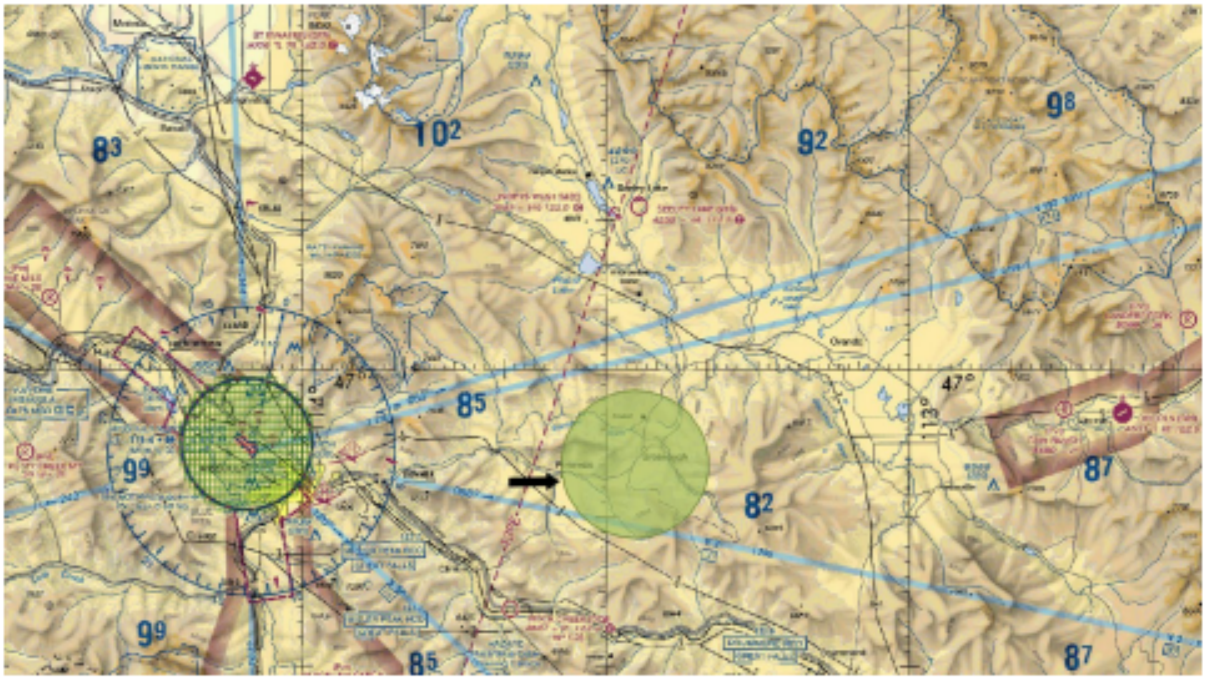
        1) Calendar date;
        2) sUA registration number;
        3) PIC who performed the functional test flight;
        4) Duration of the flight; and
        5) The result of the functional flight test;

26. All emitters used in the sUAS must be in compliance with all applicable FCC regulations and all provisions of the FCC authorization granted for the emitter. A FCC experimental authorization may not be used for sUAS operations under this Waiver; and

27. Operations Area: Operations conducted under this Waiver are limited to the Operations Area described in the waiver application (see description and images below).

Lubrecht Experimental Forest, Montana: 46° 53' 35.937" N, 113° 27' 01.162" W (in Green)
At or Below: 2,000 feet AGL Radius: 5.00 Nautical Miles





Certificate of Waiver Number 107W-2025-00358