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## VOLUME 16 UNMANNED AIRCRAFT SYSTEMS

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### CHAPTER 4 OPERATIONAL REQUIREMENTS AND APPROVAL

#### Section 5 General Operational Requirements

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16-4-5-1 GENERAL APPLICABILITY AND REQUIREMENTS. This section applies to Unmanned Aircraft Systems (UAS) operations conducted in the National Airspace System (NAS) other than in active restricted and warning areas designated for aviation use or approved prohibited areas. The Federal Aviation Administration (FAA) requires aircraft to operate safely among all users of the NAS, including non-cooperative aircraft (e.g., aircraft operated without a transponder), and other airborne operations not reliably identifiable by air traffic control (ATC) radar (e.g., balloons, gliders, parachutists). Unless otherwise specifically authorized, UAS operators must use observers, either airborne or ground-based, to comply with Title 14 of the Code of Federal Regulations (14 CFR) part 107 and part 91 requirements.

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16-4-5-3 RISK MITIGATION. While considerable work is ongoing to develop a certifiable detect, sense, and avoid system (DSA) as an alternative method of compliance (AMOC) with the “see-and-avoid” aspect of part 91, § 91.113, no current solution exists. (At a high level, DSA can be defined as: Detect-is something there? Sense-is it a threat/target? Avoid-maneuver to miss.) As a result, compliance with the see-and-avoid requirement and navigational awareness (a subset of situational awareness) are primary concerns in UAS operational approvals leading to imposition of AMOC. Risk mitigation for these two issues is normally based on the use of observers or other methods of maintaining flight separation and collision avoidance or “segregation”; however, they may also include other concepts or systems that an operator/applicant may propose for FAA review. The FAA only approves UAS flight operations that can be conducted at an Acceptable Level of Safety (ALoS). Refer to the current editions of:

- Advisory Circular (AC) 120-92, Safety Management Systems for Aviation Service Providers.

- FAA Order VS 8000.367, Aviation Safety (AVS) Safety Management System Requirements.

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- FAA Order 8000.368, Flight Standards Service Oversight.

- FAA Order 8000.369, Safety Management System.

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- FAA Order VS 8000.370, Aviation Safety (AVS) Safety Policy.

- FAA Order 8040.4, Safety Risk Management Policy.

NOTE: Risk mitigations that depend on the establishment of new types and categories of airspace are extremely difficult and time consuming. The NAS is established and configured through a rigorous regulatory process. Risk mitigations that result in the prohibition of the public's right to transit airspace will require a very long lead time with no guarantee that they will be approved.

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A. See-and-Avoid Strategies. It is the operator/applicant's responsibility to mitigate risk and ensure that the remote pilot in command (PIC), person manipulating the controls, and visual observer (VO) are able to see-and-avoid other aircraft and property when operating the UA.

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B. Risk Mitigation Responsibility. It is the operator/applicant's responsibility to demonstrate that the risk of injury to persons or property along the flight path is appropriately mitigated. Aircraft with performance characteristics that impede, delay, or divert other normal air traffic operations may be restricted in their operations. It is the responsibility of the aviation safety inspector (ASI) to assess these risks and consider them when developing work programs. The Flight Standards District Office (FSDO) should create work programs based on the areas of highest risk levels consistent with the FAA guidance on risk-based decision making to control

risk to the lowest acceptable levels.

#### 16-4-5-5 SYSTEM CONSIDERATIONS FOR UAS.

A. Traffic Alert and Collision Avoidance Systems (TCAS). The use of TCAS by UAS has not been validated as an acceptable alternative for see-and-avoid requirements, and is not an approved means of mitigation for UAS see-and-avoid requirements or strategies.

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B. Automatic Dependent Surveillance-Broadcast (ADS-B). A precise satellite-based surveillance system. ADS-B OUT uses Global Positioning Satellite (GPS) technology to determine an aircraft's location, airspeed, and other data, and broadcasts that information to a network of ground stations, which relay the data to ATC displays and to nearby aircraft equipped to receive the data via ADS-B IN.

C. Onboard Cameras/Sensors. Although onboard cameras and sensors positioned to observe targets on the ground have demonstrated some capability, their use in detecting airborne operations for the purpose of segregation is still quite limited. To date, these types of systems have not been approved as a sole mitigation in the see-and-avoid risk assessment.

D. Use of Equipment in Lieu of VOs.

1) Any equipment proposed for use on UAS to accomplish the function of see-and-avoid in lieu of VOs must:

a) Be certified as an aircraft system and equipment using standards, requirements, and processes commensurate with installation of equipment in aircraft by a recognized airworthiness authority.

b) Meet the requirements of 14 CFR part 25, § 25.1309, or equivalent process, for any UAS installation, regardless of its size, performance, or maximum takeoff weight (MTOW).

NOTE: For other equipment that is not proposed for use in meeting see-and-avoid requirements, 14 CFR part 23, § 23.1309, or an equivalent process, should be used.

2) It is the responsibility of the operator/applicant to show that the contemplated standards, requirements, and processes meet an ALoS.

E. Radar and Other Sensors. If the operator/applicant utilizes special types of radar systems or other sensors to mitigate risk, they must provide supporting data which demonstrates the following can be accomplished safely:

- 1) Both cooperative and non-cooperative traffic can be detected and tracked to ensure appropriate separation and collision avoidance.
- 2) The proposed system can effectively mitigate a potential collision.
- 3) Operators are suitably trained and equipped to use them effectively.
- 4) Procedures are in place for the PIC to effectively use the data.

F. Lost Link Points (LLP).

- 1) LLPs are defined as a point, or sequence of points, where the aircraft will proceed and hold at a specified altitude, for a specified period of time, in the event the command-and-control link to the aircraft is lost. The aircraft utilize high levels of automation to hold, or loiter, at the LLP until the control link with the aircraft is restored or the specified time elapses. If the time period elapses, the aircraft may autoland, proceed to another LLP in an attempt to regain the control link, or proceed to a Flight Termination Point (FTP) for flight termination. LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is reestablished or fuel exhaustion occurs.
- 2) For areas where multiple or concurrent UAS operations are authorized in the same operational area, a segregation plan must be in place in the event of a simultaneous lost link scenario. The deconfliction plan may include altitude offsets and horizontal separation by using independent LLPs whenever possible.

G. Flight Termination System (FTS). It is highly desirable that all UAS have system redundancies and independent functionality to ensure the overall safety and predictability of the system. UAS that lack these characteristics may be required to have an FTS whose architecture and activation are independent of the UAS system and can be activated automatically or manually by the UAS PIC to safeguard the public.

H. Spectrum Authorization.

- 1) Every UAS operator must have the appropriate National Telecommunications and Information Administration (NTIA) or Federal Communications Commission (FCC) authorization/approval to transmit on the radio frequencies (RF) used for UAS uplink and downlink of control, telemetry, and payload information.
- 2) Non-Federal public agencies, such as universities and state/local law enforcement, and all civil UAS operators generally require a license from the FCC as authorization to transmit on frequencies other than those in the unlicensed bands (900 megahertz (MHz), 2.4 gigahertz (GHz), and 5.8 GHz). This generally will be in the form of an experimental radio license or a special temporary authority (STA) issued by the FCC. Non-Federal public agencies and civil UAS

operators that operate systems using frequencies assigned to the Federal government (e.g., the Department of Defense (DOD)) must demonstrate they have the proper authorization through FCC-issued documentation.

3) DOD agencies will typically demonstrate UAS spectrum authorization through an STA issued by the NTIA or a frequency assignment in the NTIA-administered Government Master File (GMF). Authorizations issued under Title 47 of the Code of Federal Regulations (47 CFR) part 300, in the NTIA Manual, Chapter 7, paragraph 7.11, Use of Frequencies by Certain Experimental Stations, are not appropriate for UAS operations.

4) Federal public agencies other than the DOD, such as the National Aeronautics and Space Administration (NASA), the U.S. Coast Guard (USCG), and the U.S. Customs and Border Protection (USCBP), also need an STA issued by NTIA or a frequency assignment in the NTIA-administered GMF. This is especially important for systems designed to operate on frequencies assigned to the DOD.

16-4-5-7 OPERATIONAL REQUIREMENTS FOR UAS. Unless operating in an active restricted or warning area designated for aviation use, or approved prohibited areas, UAS operations must adhere to the following requirements.

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A. Observer Requirement. Model aircraft and part 107 operations do not normally require the use of VOs. If the UAS operation authorization requires a VO, visual flight rules (VFR) operations may be authorized utilizing either ground-based or airborne VOs on board a dedicated chase aircraft. A VO must be positioned to assist the PIC to exercise the see-and-avoid responsibilities required by §§ 91.111 and 91.113, by scanning the area around the aircraft for potentially conflicting traffic and assisting the PIC with navigational awareness.

1) VOs must:

a) Assist the PIC in not allowing the aircraft to operate beyond the Visual Line of Sight (VLOS) limit.

b) Be able to see the aircraft and the surrounding airspace sufficiently to assist the PIC with:

- Determining the unmanned aircraft's (UA) proximity to all aviation activities and other hazards (e.g., terrain, weather, and structures);

- Exercising effective control of the UA;

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- Complying with §§ 91.111 and 91.113; and
  - Preventing the UA from creating a collision hazard.
- c) Inform the PIC before losing sufficient visual contact with the UA or previously sighted collision hazard. This distance is predicated on the observer's normal vision.

NOTE: Normal vision may include use of corrective lenses, spectacles, and contact lenses as necessary.

2) Because of field of view (FOV) and distortion issues with aids to vision such as binoculars, field glasses, night-vision devices, or telephoto lenses, these are allowed only for augmentation of the observer's visual capability; they cannot be used as the primary means of visual contact. When using other aids to vision, VOs must use caution to ensure the aircraft remains within normal VLOS of the observer. These aids to vision are not to be confused with corrective lenses or contact lenses, which do not alter the FOV or distort vision.

3) The responsibility of ensuring the safety of flight and adequate visual range coverage to avoid any potential collisions remains with the PIC. The PIC for each UAS operation must identify a location from which the observer will perform his/her duties. This location will be selected to afford the best available view of the entire area within which the operation is to be conducted.

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4) Daisy-chaining of observers to increase operational distance is not normally approved; however, an operator or applicant may provide a safety case for daisy-chaining in accordance with Volume 16, Chapter 4, Section 3, by demonstrating an acceptable level of risk to the NAS.

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5) A good practice for observer(s) is to be in place 30 minutes prior to night operations to ensure dark adaptation.

#### B. ATC Communications Requirements.

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1) Model aircraft and part 107 operations do not normally require radio equipage. If the UAS operation authorization requires radio equipage the UAS pilot must establish and maintain direct two-way radio communication with appropriate ATC facilities anytime:

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- a) The aircraft is being operated in Class A or D airspace (under § 91.135 or 91.129) or, when required, in Class E and G airspace (under § 91.127 or 91.126).
- b) The aircraft is being operated under instrument flight rules (IFR).

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- c) It is stipulated under the requirements of any issued FAA waiver or authorizations.
- 2) It is preferred that communications between the UAS pilot and ATC be established through onboard radio equipment to provide a voice relay; however, for IFR flight this method of transmission is required.

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C. Intercommunications Requirements. Any VO, sensor operator, or other person charged with providing see-and-avoid assistance must have immediate communication with the UAS PIC. If a chase aircraft is being utilized, immediate communication between the chase aircraft and the UAS PIC is required at all times. If the UAS PIC is in communication with ATC, monitoring of the ATC frequency by all UAS crewmembers (pilots, observers, and chase pilots) is recommended for shared situational and navigational awareness. However, unless it is approved for others to do so, the UAS PIC is the only crewmember that will communicate with ATC.

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D. Electronic Devices. The use of electronic devices (including cell phones) is not permitted other than for mission-required usage. Use of electronic devices must not interfere with the UAS systems. The use of electronic devices (including cell phones) is not authorized for primary communication with ATC unless authorized by a Certificate of Waiver or Authorization (COA), or Special Airworthiness Certificate operating limitations.

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E. Dropping Objects/Expendable Stores or Hazardous Materials (hazmat). Carriage of hazmat is prohibited under part 107. Objects may be dropped from UAs operating in accordance with part 107, § 107.23 if they do not create an undue hazard to persons or property. For operations other than part 107, if the intended UAS operation includes the carriage, dropping, or spraying

of aircraft stores outside of active restricted or warning area airspace designated for aviation use, or approved prohibited areas, the operator/applicant must ensure that specific approval is listed in the COA (or Special Airworthiness Certificate operating limitations), all operational risks have been sufficiently mitigated as required by part 91 or part 107, and the hazmat requirements in Title 49 of the Code of Federal Regulations (49 CFR) have been met, if hazmat will be carried. The operator/applicant must provide to the FAA acceptable procedures for hung stores and loss of control link while carrying stores. A similar case must be made for hazmat carried aboard the aircraft and, if approved, will be listed in the special provision section of the COA, or Special Airworthiness Certificate operating limitations.

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F. Flight Over Congested Areas. Part 107 prohibits operations over non-participants. UAS operations over non-participants may be approved under the terms of a waiver, conditions of an exemption, where the level of airworthiness allows, or in emergency or national disaster relief situations if the proposed mitigation strategies are found to be acceptable.

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G. Aviation Event/Air Show. An operator is required to provide a safety case in accordance with Volume 16, Chapter 4 that demonstrates an ALoS and must receive a separate aviation event/air show waiver in accordance with this order.

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H. Flight Over Heavily Trafficked Roads or Open-Air Assembly of People. UAS operations must avoid these areas, except where the level of airworthiness allows. If flight in these areas is required, the operator/applicant is required to support proposed mitigations with system safety cases that indicate the operations can be conducted safely. Additionally, it is the operator/applicant's responsibility to demonstrate that risk of injury to persons or property along the flightpath has been mitigated to an acceptable level. UAS with performance characteristics that impede, delay, or divert other air traffic operations may be restricted in their operations. Refer to AC 120-92 and Order 8000.369.

I. Day/Night Operations.

1) Day Operations. UAS operations outside of Class A airspace, active restricted or warning areas designated for aviation use, or approved prohibited areas, will be conducted during daylight hours unless otherwise authorized.

2) Night Operations.

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a) Night operations may be considered if the operator/applicant provides a safety case and sufficient mitigation to avoid collision hazards at night. Refer to § 107.29 for night operations.

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b) UAS night operations are those operations that occur between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time. (This is equal to approximately 30 minutes after sunset until 30 minutes before sunrise, except in Alaska.) Remote pilots and observers should be in place 30 minutes prior to night operations to ensure dark adaptation.

J. Flights Below Class A Airspace. All UAS operations outside of active restricted/warning/Sensitive Security Information (SSI) airspace designated for aviation use, or approved prohibited areas must be conducted in visual meteorological conditions (VMC) if using ground or airborne VOs. In addition, the following weather requirements apply:

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1) If on IFR flight, remain clear of clouds. This requirement does not relieve the PIC from following the ATC clearance. According to part 107, § 107.19, the PIC retains responsibility for, and is the final authority as to, the operation of that aircraft.

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2) If on a visual flight, maintain § 107.51 cloud clearances.

a) Special VFR is not permitted.

b) For chase aircraft, no less than 5 statute miles (sm) in-flight visibility.

K. Automation in UAS Operations. Although it is possible to have a completely manual (direct pilot intervention) UAS, the majority of UAS utilize high levels of automation to a certain degree. Only those UAS which have the capability of direct pilot intervention will be allowed in the NAS outside of active restricted or warning areas designated for aviation use, or approved prohibited areas. Because the pilot may be technically considered out-of-the-loop in a lost link scenario, this restriction does not apply to UAS operating under lost link.

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L. Crew Resource Management (CRM). UAS crewmembers must be CRM knowledgeable. Refer to the current edition of AC 120-51, Crew Resource Management Training, for best practices in UAS operations. The PIC of a UAS must ensure no activities other than those duties required for safe flight operation are performed. No UAS crewmember may engage in any activities unrelated to those required for safe operation of the UAS during critical phases of

flight such as launch/takeoff and landing/recovery.

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M. Sterile Cockpit. Operators are encouraged to comply with the current edition of AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers, or the FAA-recognized equivalent, for ensuring the PIC implements sterile cockpit procedures. During critical phases of flight, including all ground operations, takeoff, and landing, and all other flight operations in which safety or mission accomplishment might be compromised by distractions, no crewmember may perform any duties not required for the safe operation of the aircraft. No crewmember may engage in, nor may any PIC permit, any activity during a critical phase of flight which could distract any crewmember from the performance of his or her duties or interfere in any way with the proper conduct of those duties.

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N. Operating Under IFR. (Public Aircraft Operators) Reserved.

O. Chase Aircraft Operations. The chase aircraft:

- 1) Must remain at a safe distance from the UA to ensure collision avoidance if a malfunction occurs.
- 2) Must remain close enough to the UA to provide visual detection of any conflicting aircraft and advise the PIC of the situation.
- 3) Must remain within radio control range of the UA to maintain appropriate signal coverage for flight control or activation of the FTS, for all operations when the UA is being flown by a pilot in the chase aircraft.
- 4) May be required to have communication with appropriate ATC facilities based on the operator's application or mission profile.

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- 5) Is not required by FAA in active restricted airspace designated for aviation use, or approved prohibited airspace.
- 6) Is not required for Optionally Piloted Aircraft (OPA) if a qualified VO is on board.
- 7) Is not required in Class A airspace unless stipulated in the COA or Special Airworthiness Certificate operating limitations.
- 8) Operations must be conducted in accordance with the special provisions listed in the

approved COA or Special Airworthiness Certificate operating limitations.

9) Must maintain 5 sm in-flight visibility restrictions.

10) Pilot/observer:

a) Will not concurrently perform either observer or UAS pilot duties along with chase pilot duties unless otherwise authorized.

b) Must maintain direct voice communication with the UAS pilot.

11) Pilots operating as a formation flight will immediately notify ATC if they are using a nonstandard formation. Nonstandard formations must be preapproved by ATC. Operators will adhere to the current edition of FAA Order JO 7610.4, Special Operations, as applicable. See Volume 16, Chapter 1, Section 2, for definitions of standard and nonstandard formations.

12) Operations will not be conducted in instrument meteorological conditions (IMC).

13) Operations will be thoroughly planned and briefed.

14) During a lost link situation, the pilot must be notified immediately along with ATC. The chase pilot will report to ATC that the UA is performing lost link procedures as planned or if deviations are occurring.

15) Pilot will ensure safe separation with the UA, and immediately notify ATC and the UA PIC during loss of visual contact with the UA by both the chase pilot and observer, when such contact cannot be promptly reestablished. The UA PIC will either execute lost link procedures to facilitate a rejoin, recover the UA, or terminate the flight as appropriate.

P. Airspace Considerations by Airspace Designation.

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NOTE: UAS operating in airspace designated as Reduced Vertical Separation Minimum (RVSM) airspace must comply with § 91.180. The following guidance does not apply to part 107 operations. UAS operating under part 107 must comply with § 107.41 operation in certain airspace.

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1) Class A. Observers are not normally required in Class A. All UAS must be operating under IFR and on an instrument flight plan.

2) Class B. UAS operations are currently not authorized. Class B airspace contains terminal

areas with the highest density of manned aircraft in the NAS. On a case-by-case basis, the FAA may consider exceptional circumstances. For public aircraft, a letter of agreement (LOA) between the affected ATC facility and the operator describing UAS segregation procedures is required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class B operations.

3) Class C (and All Airspace from the Surface Upward to 10,000 Feet Mean Sea Level (MSL) Within 30 NM of an Airport Listed in Part 91 Appendix D, Section 1). UAS operations approved for Class C must comply with §§ 91.130 and 91.215. Requests for operations without this equipment will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. For public aircraft, an LOA between the affected ATC facility and the operator describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class C operations.

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4) Class D. Requests for approval will be handled on a case-by-case basis and may be approved if sufficiently mitigated. UAS operations approved for Class D must comply with § 91.129. For public aircraft, an LOA between the affected ATC facility and the operator describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class D operations.

5) Class E. If there is an operating ATC tower, Class D rules may apply. UAS operations approved for Class E must comply with § 91.127. For public aircraft, an LOA between the affected ATC facility and the operator describing UAS segregation procedures may be required. For civil aircraft, segregation procedures should be incorporated into the operating limitations. UAS operations must not impede, delay, or divert other Class E operations.

6) Class G. UAS operations approved for Class G must comply with § 91.126.

Q. ATC Visual Approach Clearances. The UAS PIC must not accept a visual approach clearance, an instruction to follow another aircraft by visual means, or a clearance to maintain visual separation from another aircraft.

R. In-Flight Emergencies.

1) The PIC will notify ATC of any in-flight emergency or aircraft accident as soon as practical.

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2) The PIC will notify ATC of any loss of control link as soon as practical. Loss-of-control link

scenarios may be handled by ATC as a reportable incident.

16-4-5-9 through 16-4-5-23 RESERVED.