NOTICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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National Policy

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SUBJ: Unmanned Aircraft Systems (UAS) Operational Approval

1. Purpose of this Notice. This notice provides policies necessary for reviewing and evaluating the safety and interoperability of proposed Unmanned Aircraft Systems (UAS) flight operations conducted within the United States (U.S.) National Airspace System (NAS) for the Aviation Safety (AVS) Flight Standards Service (AFS), UAS Integration Office (AFS-80), when assessing applications for a Certificate of Waiver or Authorization (COA) or special airworthiness certificate.

2. Audience. This notice applies to AFS divisions at the Federal Aviation Administration (FAA) Washington headquarters (HQ) and regional field offices.

3. Where You Can Find This Notice. You can find this notice on the MyFAA Web site at https://employees.faa.gov/tools_resources/orders_notices/. Inspectors can access this notice through the Flight Standards Information Management System (FSIMS) at http://fsims.avs.faa.gov. Air carriers and operators can find this notice on the FAA's Web site at: http://fsims.faa.gov. This notice is available to proponents and the public at http://www.faa.gov/regulations_policies/orders_notices.

4. Background.

a. UAS Operations. UAS operations have increased dramatically in both the public and private sectors. This proliferation has introduced greater exposure and elevated risk to the safety of operations within the NAS. This growth in UAS operations has increased the number of applications for operational approvals and increased demand on the FAA to process them. For these activities, the development of a notice is required for the FAA to use when evaluating applications for COAs and special airworthiness certificates.

b. Policy. Policy identifies Unmanned Aircraft (UA) as "aircraft" flown by a "pilot" regardless of where the pilot is located. Aircraft and pilots must demonstrate compliance with applicable sections of Title 14 of the Code of Federal Regulations (14 CFR) to operate in the NAS. However, UA are not compliant with certain sections of 14 CFR. For instance, the absence of an onboard pilot means that the "see-and-avoid" provisions of 14 CFR part 91, § 91.113, cannot be satisfied. Without an onboard pilot, there is a significant reliance on the command and control link, and a greater emphasis on the loss of functionality associated with lost link. Furthermore, for air traffic control (ATC) operations requiring visual means of maintaining

in-flight separation, the lack of an onboard pilot does not permit ATC to issue all of the standard clearances or instructions available under the current edition of FAA Order 7110.65, Air Traffic Control. Consequently, to ensure an equivalent level of safety, UAS flight operations require an alternative method of compliance (AMOC) or risk control to address their "see-and-avoid" impediments to safety of flight, and any problems they may generate for ATC. In the future, permanent and consistent methods of compliance will be needed for UAS operations in the NAS without the need for waivers or exemptions.

5. Consensus Opinion. This notice is subject to continuous review, will be updated when appropriate, is not meant as a substitute for any regulatory process, and was jointly developed by and reflects the consensus opinion of:

- Flight Technologies and Procedures Division (AFS-400);
- UAS Integration Office (AFS-80) and the ATO component of AFS-80; and
- Aircraft Certification Service, Production & Airworthiness Branch (AIR-240).

Note: In general, and as a minimum, proponents must observe all applicable regulations of 14 CFR parts 61 and 91. This notice identifies acceptable AMOC with the regulations when evaluating requests for approval of proposed UAS operations. Refer to the following Web site for a listing of regulations: http://www.faa.gov/regulations_policies/faa_regulations/.

6. Discussion. This notice represents the culmination of input from government agencies, industry, and user stakeholders along with best practices and procedures that have been used by FAA in prior approvals for UAS applications for COAs or special airworthiness certificates. The material presented in this notice represents the process and procedures necessary for approving applications for UAS flight operations. However, because of the uniqueness of various UAS flight operations, each application must be evaluated on its own technical merits, including operational risk management (RM) planning. Each application may require unique authorizations or limitations directly related to the specific needs or capabilities of the UAS and/or the proposed specific mission and operating location.

7. Applicability and Approval Process Criteria. The applicability and process to be used in UAS operational approval are dependent on whether the proposed UAS operation within the territorial airspace of the United States (the airspace above the contiguous United States, Alaska, Hawaii, U.S. territories, and U.S. territorial waters) is defined as public or civil (see 14 CFR part 1, § 1.1 and Public Law 110-181, "The National Defense Authorization Act of 2008"). UAS operations outside the territorial airspace of the U.S. will be classified as either state or civil operations in accordance with international law. A public operation is one that is intrinsically governmental in nature (i.e., Federal, State, and local agencies). Proponents requesting approval of public aircraft operations by UAS will use the COA application process. In contrast, proponents for civil operations approval will use the special airworthiness certificate process. Part 91, § 91.319(a)(2) specifically prohibits operation of an aircraft that has an experimental certificate from "carrying persons or property for compensation or hire."

a. Coordination and Approval. Regardless of the process for the authorization approval, COA applications for UAS flight operation approvals will be coordinated through the ATO component of AFS-80 and AVS. Special airworthiness certificates will be coordinated through the Aircraft Certification (AIR-240) staff as well as the ATO and AFS component of AFS-80 for final approval and disposition.

b. Applicability and Methods of Authorization. Operational policy in this notice applies to both public and civil operations and certain state aircraft operations.

(1) Applicability. These procedures are applicable for all operations in the contiguous United States, Alaska, Hawaii, U.S. territories, and international airspace in the Flight Information Regions (FIR) delegated to the United States where the FAA is the Air Traffic Service (ATS) provider. These procedures do not apply to the territorial airspace of another sovereign country that lies within FIRs delegated to the United States where the FAA is the ATS provider, except by agreement with that country, or airspace in FIRs delegated to other countries. All UAS proponents, operators, and pilots must observe all applicable regulations of 14 CFR.

(a) In general, specific authorization to conduct UAS operations in the NAS outside of active Restricted and Warning Areas designated for aviation use, or approved Prohibited Areas, must be requested by the proponent. Airspace inside buildings or structures is not considered to be part of the NAS and is not regulated. (Refer to the current edition of Order JO 7400.8, Air Traffic Organization Policy.)

(b) This notice and the processes prescribed do not apply to hobbyists and amateur model aircraft users when operating unmanned systems for sport and recreation. Those individuals should seek policy under the current edition of Advisory Circular (AC) 91-57, Model Aircraft Operating Standards. AC 91-57 is not to be used as a basis of approval for operation of any other aircraft, including by Federal, State, and local governments, commercial entities, or law enforcement.

(c) This notice and the processes prescribed also do not apply to UAS operations in FAA-controlled international airspace by an agency of, or a contractor to, the Federal government when those operations are appropriately designated as State aircraft operations and are operated under “due regard” rules and procedures established by the Federal agency responsible for the operation. The designation of flight operations as State aircraft operations normally are made in coordination with the U.S. Department of State. This notice and the processes prescribed do, however, apply where the responsible Federal agency either has not established a formal set of rules and procedures for “due regard” operations, or is not operating the UAS under “due regard” rules and procedures in FAA-controlled international airspace. This notice and the processes prescribed also apply to all UAS operations by an agency of, or a contractor to, the Federal government that transit through U.S. territorial airspace en route to or from international airspace. See Appendix F, UAS COA Requirement. The “due regard” option is not available for state aircraft operations transiting through U.S. territorial airspace en route to or from international airspace.

(d) Oceanic Operations Within Warning Areas. UAS operations contained within Warning Areas are handled in the same manner as those operations conducted in active Restricted and approved Prohibited areas; that is, neither specific FAA approval nor observers or chase aircraft are required by the FAA.

(e) The only public aircraft that can fly under "due regard" are U.S. government aircraft designated as State aircraft.

(2) Methods. The two methods of approval are the issuance of either a COA for public aircraft operations or a special airworthiness certificate for civil operations. In the case of public aircraft operations, the operating entity applying to conduct the UAS operation must comply with its own processes, policies, and standards in the following areas, in addition to complying with all applicable safety provisions in all other parts of 14 CFR:

- Pilot certification,
- Crew certification,
- Recent pilot experience (or, currency),
- Medical certificates, and
- Airworthiness of public UAS.

Note: If no established public entity processes, policies, or standards exist, it is highly recommended that the public agency/department apply the specifics outlined in this notice and comply with the provisions of 14 CFR applicable to civil UAS operations.

8. COA for Public Operations.

a. Applications. Applications for a COA are only accepted from entities that intend to conduct public aircraft operations. An application may be referred to the FAA Office of the Chief Counsel (AGC-200) for determination of the status of a proponent as a government entity under the public aircraft statute. The duration of COAs complies with the time limitations specified under the current edition of FAA Order 7210.3, Facility Operation and Administration. COAs may be issued for a lesser duration if requested or deemed appropriate. COAs are not required for operations conducted within active Restricted or Warning Area airspace designated for aviation use, or approved Prohibited Areas with permission from the appropriate authority or using agency of that airspace. (Refer to the current edition of Order JO 7400.8, Special Use Airspace.)

b. Approving and Reviewing Authority. AFS-80 is responsible for determining whether the proponents' proposed UAS operations can be conducted safely and responsibly in the NAS, and that they comply with all COA limitations and provisions.

(1) In accordance with FAA Order 7210.3, "As a general rule, a waiver or authorization should be canceled when it is no longer required or there is an abuse of its provisions or unforeseen safety factors develop. Failure to comply with the waiver or authorization is cause for cancellation."

(2) The FAA has the authority to suspend or cancel the COA, or to delay any activities if there is a violation of the terms in the COA, or if the safety of persons or property on the ground or in the air is determined to be in jeopardy. That may include, but is not limited to:

- Incidents or accidents occurring during UAS operations in the NAS;
- Habitual noncompliance with administrative requirements, such as failure to provide the FAA with monthly reports on the number of flights, pilot duty time, or unusual equipment malfunctions (e.g., a malfunction or failure of ground control station (GCS) flight control hardware or software (other than loss of control link); a power plant failure or malfunction; a deviation from any provision contained in the COA);
- Deviations from ATC instructions, operational, or coordination issues; and
- Events of intermittent or persistent lost-link as described in the COA or events determined to pose as a risk to the safety of the NAS.

(3) COA suspensions and cancellations are not automatic. Whenever possible, a documented conversation, between the FAA and the proponent, will happen before the suspension/cancellation is issued. Timely and transparent responses to accidents, deviations, and similar safety-related events are expected.

c. Accident and Incident Notification and Investigation. The current edition of FAA Order 8020.11C, Aircraft Accident and Incident Notification, Investigation, and Reporting, and Title 49 of the Code of Federal Regulations (49 CFR) part 830, outlines reporting procedures for accidents and incidents involving civil aircraft and certain public aircraft. All accidents and incidents involving fatalities, injuries, property damage, and fly-away by civil aircraft and those public aircraft subject to part 830 require FAA notification within 24 hours. No additional flights by those aircraft under this COA are allowed before notification. An immediate investigation is required, and when requested to do so, UAS proponents are expected to provide copies of written aircraft accident/incident reports to AFS-80 for review. In accordance with 49 CFR part 1520, § 1520.5, reports will not be released outside of government channels without originator permission.

d. General COA Process. The ATO component of AFS-80 is responsible for the COA process. Applications can be made two ways:

(1) On the Internet using the UAS COA Online System at https://ioeaaa.faa.gov. The UAS COA Online System requires a user name and password; a support desk phone number and e-mail address is provided to assist with obtaining an account.

(2) Using FAA Form 7711-2, Application for Certificate of Waiver or Authorization, available online at http://www.faa.gov/documentLibrary/media/form/faa7711-2.pdf. The completed form can be mailed to: FAA Headquarters, Unmanned Aircraft Systems Integration Office, 490 L’Enfant Plaza SW, Suite 3200, Washington, DC 20024. Mail submittal may encounter significant delay due to current U.S. Postal Service security screening procedures in place.

e. Operational Review. Prior to issuance of a COA, air traffic specialist components of AFS-80 conduct an operational validation that addresses ATC processes. Next, an aviation safety inspector (ASI) evaluates each application to determine if risks to the NAS associated with the operation have been acceptably mitigated. Both the ASI and ATC requirements are merged into the final COA.

f. Safety Risk Management (SRM) Process. ASIs and other FAA personnel use SRM principles outlined in the current edition of AC 120-92, Safety Management Systems for Aviation Service Providers, to maintain or improve the safety of the NAS by identifying safety risks, hazards, and mitigations associated with proposed UAS operations. When deemed appropriate, Safety Risk Management Documents (SRMD) are created through SRM reviews of specific operations or of risks associated with UAS operations in various classes of airspace. SRM reviews may result in the incorporation of additional mitigations or controls into all or some COAs.

g. National Security Considerations. When appropriate levels of Department of Defense (DOD) or Department of Homeland Security (DHS) declare a UAS operation to be a matter of national security, the FAA may approve an application for a COA which, under normal circumstances, might not otherwise conform to the guidelines set forth in this notice. In this case, national security may override risk mitigation requirements. Such requests to the FAA Administrator will originate from an equivalent level of authority from the proponent's parent organization.

h. Special COA.

(1) National Disaster COA. Due to the unpredictability of national disasters, a National Disaster COA is issued in two parts. In part 1 of the COA, AFS-80 completes an evaluation, excluding the location of the disaster. All known information is inserted into a template and signed by appropriate FAA authority. Once the specific location is identified, this information, along with the specific operation, is inserted into part 2 of the COA in the form of an attachment. Part 2 of the COA must then be signed by appropriate FAA authority, which completes and establishes a valid COA.

(2) Emergency COA. An emergency UAS COA may be considered when all of the following conditions apply:

(a) A situation exists that is defined as a condition of distress or urgency, where there is, or that has, the extreme possibility of loss of life, and

(b) The proponent has determined that manned flight operations cannot be conducted efficiently, and

(c) The proposed UAS is operating under a current approved COA for a different purpose or location.

Note: Requests for UAS COAs that fall outside of these parameters will be processed through the normal online COA application process. Emergency UAS COAs will not be considered for:

- Demonstration flights,
- Flights to test capabilities,
- Training,
- Flights in Class B Airspace, or
- Flights over populated areas, unless a suitable mitigation strategy is proposed and found to be acceptable.

9. Special Airworthiness Certificate for Civil UAS Applicants.

a. Airworthiness Determination. Civil applicants may apply for a special airworthiness certificate from the FAA. The proponent is required to submit the requisite data to support a determination that the aircraft and its systems, including the control station (CS), are designed, built, and maintained in a safe and airworthy condition.

b. Special Airworthiness Certificate Issuance. Special airworthiness certificates are typically issued to proponents wishing to conduct UAS research and development (R&D), crew training, and market surveys under 14 CFR part 21, § 21.191. Special airworthiness certificates are issued in accordance with FAA Order 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft, current edition. Refer to Order 8130.34 for in-depth information on special airworthiness certificates.

c. Proponents with both a COA and Special Airworthiness Certification. In cases where a proponent has been issued a special airworthiness certificate, and is concurrently eligible to operate a corresponding UAS on a COA as a public aircraft operation, the proponent must elect, prior to each flight, which authority is to be used to conduct the flight. The use of both a special airworthiness certificate and a COA on a single flight is not permitted.

d. General Process for Civil UAS Operations. For civil UAS operations, the Aircraft Certification Service, Production and Airworthiness Division (AIR-200) at FAA HQ, is responsible for the issuance of special airworthiness certificates according to FAA Order 8130.34. The issuance of a special airworthiness certificate is coordinated with AIR-200, AFS-80 and the ATO component of AFS-80, and AVS at the HQ and regional levels. A thorough review is conducted by the FAA to evaluate the system's airworthiness and operational specifications. In addition, the FAA reviews and accepts mitigations developed by the proponent to meet acceptable standards of safety.

10. UAS Airworthiness. All UAS must be in an airworthy condition to conduct flight operations in the NAS. An "airworthy condition for UAS subject to a COA" means that the UAS meets the applicable standards and requirements of its operating agency and is capable of operating in compliance with the applicable requirements in 14 CFR part 91. The FAA recognizes that some of the requirements can differ from those for manned aircraft and appropriate changes can be defined. As with airworthiness standards, maintenance technician requirements will be addressed as part of the review process.

a. Public Aircraft Proponents. The proponent must provide an airworthiness statement specifying compliance with the proponent's applicable airworthiness criteria. Airworthiness statements must be provided on agency letterhead and include:

- The date the statement is effective,
- A signature of the responsible certifying authority within the agency,
- A point of contact (POC), and
- Any warnings/limitations.

(1) Airworthiness statements are generally written for one UAS. If more than one UAS model is included on a single airworthiness statement, each UAS will be listed and specific information for each UAS will be included in the statement. Airworthiness statements with an expiration date must remain current for the duration of the COA including extensions. If a new airworthiness statement is issued during the period the COA is active, a copy of the airworthiness certificate must be provided to AFS-80.

(2) Examples of acceptable policy/criteria include, but are not limited to:

- Department of Defense (DOD) Handbook, MIL-HDBK 516B, Airworthiness Certification Criteria;
- Air Force Policy Directive (AFPD) 62-6, USAF Aircraft Airworthiness Certification;
- Army Regulations (AR) 70-62, Airworthiness Qualification of Aircraft Systems; or
- Naval Air Systems Command Instruction, NAVAIRINST 13034.1 series, Flight Clearance Policy for Air Vehicles and Aircraft Systems.

b. Civil Aircraft Proponents. Approvals for civil applications using the special airworthiness certificate process receive their airworthiness certification from the FAA.

c. Continued Airworthiness.

(1) Public Aircraft. Proponents for UAS used in public aircraft operations should follow their own agency's procedures and guidelines to maintain continued airworthiness at a level which ensures they continue to operate the aircraft safely.

(2) Civil Aircraft. Proponents for civil UAS operational approvals must address continued airworthiness procedures as part of their application. Civil UAS should be maintained and must conform to the same airworthiness standards defined in 14 CFR parts under which UAS are intended to be operated. It is highly recommended that all proponents provide the following information:

- A Continuing Airworthiness Program,
- A maintenance training program,
- Any unique skill sets or maintenance practices relating to their aircraft and/or aircraft operations that may be outside the current scope and practices of manned aviation, and
- A process to report any applicable data relating to the operation and maintenance of the UAS.

d. Database and Recordkeeping. All information received from UAS proponents aids the FAA in establishing a database for the existing UAS types and operations. This data is critical to our development of future certification criteria for both systems and pilots. It expedites the regulatory process for UAS and allows the FAA to have historical data from which to base current and future UAS policy. Accurate recordkeeping is essential in assuring positive operational and quality airworthiness control. In accordance with 49 CFR § 1520.5, reports will not be released outside of government channels without originator permission.

11. Flight Operations of a UAS.

a. Applicability and Requirements. This notice applies to UAS operations conducted in the NAS other than in active Restricted and Warning Areas designated for aviation use or approved Prohibited Areas. The 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 ATC radar (e.g., balloons, gliders, parachutists). Unless otherwise specifically authorized, UAS operators must use observers, either airborne or ground-based, to comply with 14 CFR part 91 requirements.

b. Risk Mitigation. While considerable work is ongoing to develop a certifiable detect, sense, and avoid system as an AMOC with the see-and-avoid aspect of §§ 91.113 and 91.115, no current solution exists. As a result, compliance with the see-and-avoid requirement and navigational 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 a proponent may propose for FAA review. The FAA only approves UAS flight operations that can be conducted at an acceptable level of safety. Refer to the current editions of AC 120-92 and FAA Order 8000.369, Safety Management System Guidance.

> **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.

(1) Proponents proposing see-and-avoid strategies in lieu of visual observers (VOs) are required to support proposed mitigations with system safety cases which indicate the operations can be conducted safely. Acceptable system safety cases must include a hazard analysis, risk assessment, and other appropriate documentation that identifies the level of risk.

(2) It is the proponent’s responsibility to demonstrate that the risk of injury to persons or property along the flightpath is appropriately mitigated. Aircraft with performance characteristics that impede, delay, or divert other normal air traffic operations may be restricted in their operations.

12. 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.

b. 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.

c. 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:

- 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, and
- 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.

Note: For other equipment that is not proposed for use in meeting see-and-avoid requirements, § 23.1309, or equivalent process, should be used.

(2) It is the responsibility of the proponent to show that the contemplated standards, requirements, and processes meet an equivalent level of safety.

d. Radar and Other Sensors. If special types of radar systems or other sensors are utilized to mitigate risk, the proponent must provide supporting data which demonstrates the following can be accomplished safely:

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

e. Lost Link Procedures. There are many acceptable approaches to satisfy lost link requirements. The intent of any lost link procedure is to ensure airborne operations remain predictable. Proponents will comply with the UAS lost link procedures as specified in the COA.

Note: Lost link is not considered fly-away. Refer to definitions in Appendix A.

(1) Unless otherwise authorized, lost link solutions must comply with the last ATC clearance (if ATC clearance is required), for a period of time sufficient for ATC to ensure conflict resolution without loss of required separation.

(2) Lost link procedures are pre-coordinated by AFS-80 with the appropriate ATC facility and included in the COA. They include, at a minimum, lost link route of flight, transponder use, lost link orbit points, communications procedures, and pre-planned flight termination points (FTP) or other contingency planning measures in the event recovery of the UAS is not feasible.

(3) If lost link occurs within a Restricted Area, Warning Area, or Class A airspace, or lost link procedure takes aircraft into one of these areas, the aircraft will not exit that airspace, unless otherwise authorized, until link is re-established. All exceptions will be submitted as part of the COA application to AFS-80 for review.

(4) Unless otherwise authorized, lost link procedures will conform to the Contingency Planning Limitations in Appendix E and in general, include the following:

- Limiting of UAS operations to operations over water or sparsely populated areas over the ground to transit to another Restricted Area, Warning Area, or to a pre-planned lost link orbit point within visual line-of-sight to re-establish link. (The UAS lost link procedure will not transit over fixed structures on the water.)
- Lost link programmed procedures will avoid unexpected turn-around and/or altitude changes and will provide sufficient time to communicate and coordinate with ATC.
- Lost link orbit points will not be contained within any published holding area, airway, Jet route, T route, or other area navigation (RNAV) published route.

(5) If the link is not re-established within a pre-determined time as defined by the FAA-approved COA, the aircraft may:

- Autoland; however, the aircraft will not exit the Restricted Area or Warning Area in accordance with subparagraph 12.e.(3) above,
- Proceed to another lost link point (LLP) in an attempt to regain communication link, or
- Proceed to an FTP or the location specified in other contingency planning measures for flight termination.

Note: LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established or fuel exhaustion occurs.

- UAS without auto-land capability will proceed to a pre-planned FTP or other acceptable contingency planning option prior to fuel exhaustion.

(6) Refer to Appendix E for more Contingency Planning Limitations.

f. 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 system redundancies may be required to have an independent FTS that can be activated manually by the UAS PIC to safeguard the public.

g. Spectrum Authorization.

(1) Every UAS proponent 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 proponents 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 proponents that operate systems using frequencies assigned to the Federal government (e.g., the 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 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 DOD, such as National Aeronautics and Space Administration (NASA), U.S. Coast Guard (USCG), and 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 DOD.

13. 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.

a. Observer Requirement. Visual flight rules (VFR) UAS operations may be authorized utilizing either ground-based or airborne VOs onboard a dedicated chase aircraft. A VO must be positioned to assist the PIC, to exercise the see-and-avoid responsibilities required by §§ 91.111, 91.113, and 91.115 by scanning the area around the aircraft for potentially conflicting traffic and assisting the PIC with navigational awareness.

(1) VOs:

(a) Must assist the PIC in not allowing the aircraft to operate beyond the visual line-of-sight limit, and

(b) Must be able to see the aircraft and the surrounding airspace sufficiently to assist the PIC with:

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

- Exercising effective control of the UA, and
- Complying with §§ 91.111, 91.113, and 91.115, and
- Preventing the UA from creating a collision hazard, and

(c) Must 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. Corrective lenses, spectacles, and contact lenses are permitted.

(2) Because of field of view 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 visual line-of-sight of the observer. These aids to vision are not to be confused with corrective lenses or contact lenses, which do not alter the field of view 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.

(4) Daisy-chaining of observers to increase operational distance is not normally approved; however, a proponent may provide a safety case for daisy-chaining in accordance with paragraph 16 by demonstrating an acceptable level of risk to the NAS.

(5) Observer(s) must be in place 30 minutes prior to night operations to ensure dark adaptation. Refer to subparagraph 13.i.(2)(b) for night operations information.

b. ATC Communications Requirements.

(1) The UAS pilot must establish and maintain direct two-way radio communication with appropriate ATC facilities anytime:

- 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). See subparagraph 13.q.(2) and (3) for operations in Class B or C airspace; or
- The aircraft is being operated under instrument flight rules (IFR); or
- It is stipulated under the provisions of any issued COA or Special Airworthiness Certificate.

(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.

c. Inter-Communications Requirements. Any VO, sensor operator, or other person charged with providing see-and-avoid assistance must have immediate communication with the UAS pilot. If a chase aircraft is being utilized, immediate communication between the chase aircraft and the UAS pilot is required at all times. If the UAS pilot is in communication with ATC, monitoring of the ATC frequency by all UAS crew members (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 or the supplemental pilots are the only crewmembers that will communicate with ATC.

d. Electronic Devices. The use of electronic devices (including cell phones) other than for UAS flight- and mission-required usage is governed by § 91.21, which ensures these devices do not interfere with the UAS systems. The use of electronic devices (including cell phones) is not authorized for primary communication with ATC unless authorized under the Special Provisions of the COA.

e. Dropping Objects/Expendable Stores or Hazardous Materials. 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 proponent must ensure that specific approval is listed in the special provisions, the operational risks have been sufficiently mitigated as required by 14 CFR § 91.15, and that the hazardous material requirements in 49 CFR have been met. Acceptable procedures for hung stores and loss of control link while carrying stores must be provided to the FAA. A similar case must be made for hazardous materials carried aboard the aircraft and, if approved, will be listed in the special provision section of the COA.

f. Flight Over Populated Areas. Routine UAS operations are prohibited over urban or populated areas, except where the level of airworthiness allows. UAS operations may be approved in emergency or national disaster relief situations if the proposed mitigation strategies are found to be acceptable. See Appendix A for definition of populated or urban area.

g. Air Shows. A proponent is required to provide a safety case in accordance with paragraph 16 that demonstrates an acceptable level of risk and must receive a separate Air Show Waiver in accordance with FAA Order 8900.1, Flight Standards Information Management System (FSIMS).

h. Flight Over Heavily Trafficked Roads or Open-Air Assembly of People. UAS operations must avoid these areas, except where level of airworthiness allows. If flight in these areas is required, the proponent is required to support proposed mitigations with system safety cases that indicate the operations can be conducted safely. Acceptable system safety cases must include information located in paragraph 16. Additionally, it is the proponent’s responsibility to demonstrate that risk of injury to persons or property along the flightpath has been mitigated. 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 FAA Order 8000.369, current editions.

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.

(a) Night operations may be considered if the proponent provides a safety case and sufficient mitigation to avoid collision hazards at night.

(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. (Note: this is equal to approximately 30 minutes after sunset until 30 minutes before sunrise, except in Alaska.) External pilots and observers must 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:

- If on IFR flight, remain clear of clouds. This requirement does not relieve the PIC from following the ATC clearance. According to § 91.3, the PIC retains responsibility for, and is the final authority as to the operation of that aircraft.
- If on VFR flight, maintain § 91.155 VFR cloud clearances, except in Class G airspace, where Class E airspace visibility requirements must be applied, but not less than 3 statute miles (SM) in-flight visibility.
- Special VFR is not permitted.
- For chase aircraft, 5 SM in-flight visibility.

k. Autonomous Operations. Although it is possible to have a completely manual (direct pilot intervention) UAS, the majority of UAS are autonomous 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.

l. Operations from Off-Airport Locations. In most cases, an off-airport location should be situated no closer than 5 nautical miles (NM) from any airport or heliport. The operational areas, including the launch and recovery zones, should be free from obstructions; reasonable efforts should be made to keep operations away from structures.

m. Crew Resource Management (CRM). Proponents must train all UAS crewmembers in CRM. The current edition of FAA AC 120-51, Crew Resource Management Training, or an FAA-recognized equivalent applies to UAS operations. Proponents must implement the recommended training and procedures included in AC 120-51, or in an FAA-recognized

equivalent. 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.

n. Sterile Cockpit. Proponents must 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 involving taxi (movement of an airplane under its own power on the surface of an airport), 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/her duties or interfere in any way with the proper conduct of those duties.

o. Operating Under IFR. While operating on an instrument flight plan, the following must exist, be completed, or be complied with:

(1) The PIC must hold a current instrument rating or an FAA-recognized equivalent.

(2) The aircraft's airworthiness signature statement for flight release (not airworthiness document) must include IFR flight and indicate that all equipment required for IFR operations is certified and working (including pitot-static and transponder checks).

(3) Applicable navigation database and charts are current and available to the UAS pilot.

(4) An IFR flight plan is filed.

(5) An ATC clearance has been obtained and all clearances must be followed.

(6) Direct two-way radio communication between the UAS pilot and ATC is established and maintained. (A communication relay through the aircraft may be required.)

(7) Alternate communication capabilities with ATC for the purpose of lost link and/or lost communication are designated and operational during all phases of flight.

(8) The UAS is equipped with a certified operating mode C (mode S preferred) transponder.

(9) ATC radar services are obtained throughout the portion of the flight in Class A airspace whenever possible (overwater non-radar operations may be allowed in the special provisions section).

(10) All operations outside of Class A airspace and active Restricted, Prohibited, Warning Areas, or SSI airspace designated for aviation use, must remain clear of clouds. If operating under IFR, to comply with this provision, the PIC must have an ATC clearance to deviate.

According to § 91.3, the PIC retains responsibility for, and is the final authority as to, the operation of that aircraft.

(11) VOs are not required in Class A airspace unless stipulated in the COA.

p. Chase Aircraft Operations. The chase aircraft:

(1) Must remain at a safe distance from UA to ensure collision avoidance if a malfunction occurs, and

(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, in the case of pilot operation from the chase aircraft, to maintain appropriate signal coverage for flight control or activation of the FTS.

(4) May be required to have communication with appropriate ATC facilities based on the proponent's application or mission profile.

(5) Is not required by FAA in active Restricted or Warning Area 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.

(8) Operations must be conducted in accordance with the Special Provisions listed in the approved COA.

(9) Must maintain 5 SM in-flight visibility restrictions.

(10) Pilot/observer:

- Will not concurrently perform either observer or UAS pilot duties along with chase pilot duties unless otherwise authorized.
- 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 non-standard formation. Non-standard formations must be pre-approved by ATC. Proponents adhere to the current edition of Order JO 7610.4, Special Operations, as applicable. Refer to Appendix A for definitions of standard and non-standard formations.

(12) Operations will not be conducted in IMC.

(13) Operations will be thoroughly planned and briefed.

(14) Pilot, during a lost link situation, 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 re-established. The UA PIC will either execute lost link procedures to facilitate a rejoin, recover the UA, or terminate the flight as appropriate.

q. Airspace Considerations by Airspace Designation.

Note: UAS operating in airspace designated as reduced vertical separation minimum (RVSM) airspace must comply with § 91.180.

(1) Class A. Observers are not normally required in Class A. All UAS must be operating under IFR and on an instrument flight plan. UAS operations approved for Class A must comply with § 91.135.

(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 proponent 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 airspace within 30 NM of an airport listed in Appendix D, section 1, § 91.215). 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 proponent 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.

(4) Class D. Requests for approval will be handled on a case-by-case basis and may be approved if sufficiently mitigated and a safety case has been established. UAS operations approved for Class D must comply with § 91.129. For public aircraft, an LOA between the affected ATC facility and the proponent 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 proponent 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.

r. 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.

s. In-Flight Emergencies.

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

14. Contingency Planning Limitations. See Appendix E.

15. Personnel Qualifications. This paragraph addresses the qualifications of all UAS flightcrew members, observers, maintainers, and other personnel as appropriate. All references to a pilot certificate or FAA written examination refer to an FAA-issued private pilot certificate, higher certification, or an FAA-recognized equivalent.

a. UAS Pilot Qualifications. The FAA is focused on ensuring that UAS pilots have an appropriate level of understanding of 14 CFR applicable to the airspace where UAS operate. UAS pilots are responsible for controlling their aircraft to the same standards as the pilot of a manned aircraft. Civil UAS pilots may be required to have instruction by an FAA-certificated flight instructor.

b. UAS General Operational Requirements. The following operational restrictions apply to all UAS pilots:

- One PIC must be designated at all times.
- The PIC of an aircraft is directly responsible for, and is the final authority of the operation of that aircraft.
- Pilots must not perform crew duties for more than one UAS at a time.
- Pilots are not allowed to perform concurrent duties both as the pilot and the VO. In the case of OPA, the airborne pilot may assume the role of PIC at all times, but will only be the observer when the OPA is operated by the CS pilot.
- Unless undergoing initial qualification training, pilots must be qualified on the aircraft being flown.
- Only one PIC per aircraft is authorized, and the PIC must be in a position to assume control of the aircraft.

c. PIC.

(1) The designated PIC:

- Has been designated as PIC before or during the flight.
- Is responsible for the UAS flight operation as described under § 91.3, or FAA-recognized equivalent.
- Is responsible for determining whether the UAS is in condition for safe flight.

- Must land as soon as safely practical when any condition occurs that causes operations to be unsafe.
- May be augmented by supplemental pilots; however, the PIC retains complete and overall responsibility of the flight, regardless of who may be piloting the aircraft.
- Has the ability to assume the duties of an internal or an external UAS pilot at any point during the flight.
- May rotate duties as necessary to fulfill operational requirements.
- Operating under a public agency, must have a thorough knowledge of the COA issued to the organization and must retain a copy to reference during flight.
- Must be trained and qualified on the specific UAS for the conduct of the flight.
- May assume the duties of VO or PIC, if piloting an OPA when the OPA is being utilized as a UAS and being flown by the CS pilot.

(2) PIC Rating Requirements. Rating requirements for the UAS PIC depend on the type of operation conducted; they fall into two categories:

- Operations that require at least a private pilot certificate or FAA-recognized equivalent, or
- Operations that do not require at least a private pilot certificate or FAA-recognized equivalent.

(a) The requirement for the PIC to hold a pilot certificate or FAA-recognized equivalent is based on various factors including:

- The location of the planned operations,
- The mission profile,
- The size of the aircraft, and
- Whether or not the operation is conducted within or beyond visual line-of-sight.

(b) The PIC must hold, at a minimum, an FAA private pilot certificate or FAA-recognized equivalent for all operations listed below:

- Flight in Class A, B, C, D, E, and G (400 feet above ground level (AGL)) airspace.
- IFR (must have instrument rating) operations.
- Night operations.
- At joint use or public airfields.
- Requiring a chase aircraft.
- At any time the FAA has determined the need, based on the UAS characteristics, mission profile, or other operational parameters.

(c) Operations without a pilot certificate may be allowed when all of the following conditions are met:

- The PIC has successfully completed, at a minimum, FAA private pilot ground instruction and passed the FAA Private Pilot written examination or FAA-recognized equivalents. (Airman Test Reports are valid for the 24 calendar-month period preceding the month the exam was completed, at which time the instruction and written examination must be repeated.)
- Operations are during daylight hours.
- The operation is conducted in a sparsely populated location.
- Operations are approved and conducted solely within visual line-of-sight in Class G airspace.
- Visual line-of-sight operations are conducted no further than ½ NM laterally from the UAS pilot and at an altitude of no more than 400 feet AGL at all times. Refer to Appendix A for the visual line-of-sight definition.
- Operations are conducted no closer than 5 NM from any FAA-designated airport or heliport other than the airport from which the aircraft is operating.
- The operation is conducted from a privately owned airfield, military installation, or off-airport location.

(3) PIC Recent Flight Experience (Currency). The proponent must provide documentation showing the pilots maintain an appropriate level of recent pilot experience in the UAS being operated, or in an FAA-certified simulator. At a minimum, the PIC must conduct three takeoffs (launch) and three landings (recovery) in the specific UAS within the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations); or as prescribed by the proponent's accepted recurrent training and currency program.

(a) For those operations that require a certificated pilot, the PIC, to exercise the privileges of his certificate, must have flight reviews and maintain recent pilot experience in manned aircraft per 14 CFR part 61, as appropriate; or FAA-accepted equivalent.

(b) For flights approved for night operations, the PIC must conduct three takeoffs (launch) and three landings (recovery) each, in the specific UAS at night, to a full stop in the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations).

(c) For operations approved for night or IFR, the PIC must maintain recent pilot experience per § 61.57 or FAA-accepted equivalent as applicable.

(4) PIC Medical. The PIC must maintain, at a minimum, a valid FAA second-class medical certificate issued under 14 CFR part 67 or the FAA-recognized equivalent. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate listed in § 61.23.

(5) Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(6) PIC Training.

(a) In addition to the training required for a pilot certificate, UAS PICs must have the following additional training (or FAA-recognized equivalent):

- Including normal, abnormal, and emergency procedures in all specific details of the UAS being operated,
- Manufacturer-specific training,
- Demonstrated proficiency, and
- Testing in the UAS being operated.

(b) Proponents must maintain individual training records of all UAS personnel. All training and testing will be documented in the individual's training record by the instructor and initialed by the trainee.

d. Supplemental Pilots. Supplemental pilots are those pilots assigned UAS flight duty to augment the PIC. It is common for proponents to have both an internal and an external UAS pilot. The supplemental pilot can assume either of these positions.

(1) Ratings. Supplemental pilots must have, at a minimum, successfully completed private pilot ground school and passed the written test or FAA-recognized equivalents. The ground school written test results are valid for two years from the date of completion, at which time the instruction and written examination must be repeated. If a supplemental pilot assumes the role of PIC, he/she must comply with the PIC rating, currency, medical, and training requirements listed above in subparagraph 15c.

(2) Recent Pilot Experience. The proponent must provide a process that ensures that pilots maintain an appropriate level of recent pilot experience for the position they are assigned in the UAS being operated.

(3) Medical. Supplemental pilots must maintain, at a minimum, a valid FAA second-class medical certificate issued under part 67 or the FAA-recognized equivalent. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate, according to § 61.23. Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(4) Training.

(a) UAS supplemental pilots must have:

- Training in all specific details of the UAS being operated, including normal, abnormal, and emergency procedures;
- Manufacturer-specific training (or FAA-recognized equivalent);
- Demonstrated proficiency and successful testing in the UAS being operated.

(b) Proponents must maintain individual training records for all UAS personnel. All training must be documented by the instructor and initialed by the trainee.

e. UAS Observer Qualifications. All observers must have an understanding of Federal aviation regulations applicable to the airspace where the UAS will operate. Observers are considered crewmembers. Observers must not perform crew duties for more than one UAS at a time. Observers are not allowed to perform concurrent duties both as UAS pilot and observer.

(1) Medical. All observers must have a valid FAA second-class medical certificate issued under part 67; an FAA-recognized equivalent is an acceptable means of demonstrating compliance with this requirement. The second-class medical certificate expires at the end of the last day of the 12th month after the month of the date of the examination shown on the medical certificate. Section 91.17 or FAA-recognized equivalent applies to all UAS crewmembers.

(2) Training. Observers must complete sufficient training to communicate to the pilot any information required to remain clear of conflicting traffic, terrain, and obstructions, maintain proper cloud clearances, and provide navigational awareness. This training, at a minimum, must include knowledge of:

(a) Their responsibility to assist pilots in complying with the requirements of 14 CFR:

- § 91.111, Operating Near Other Aircraft;
- § 91.113, Right-of-Way Rules: Except Water Operations;
- § 91.115, Right-of-Way Rules: Water Operations; and
- § 91.155, Basic VFR Weather Minimums;

(b) Air traffic and radio communications, including the use of approved ATC/pilot phraseology; and

(c) Appropriate sections of the Aeronautical Information Manual (AIM).

f. UAS Maintenance Personnel Qualifications.

(1) Maintenance Ratings. Will be established as more data is collected and a regulatory guideline is developed.

(2) Recent Maintenance Experience. It is suggested that proponents follow applicable guidelines of 14 CFR part 65, § 65.83, as appropriate, until final UAS regulatory guidelines are available.

(3) Maintenance Medical Requirements. At a minimum, the requirements of § 91.17 or FAA-recognized equivalent must be met. No additional medical requirements have been defined at this time.

(4) Maintenance Training. It is highly recommended that a proponent of a UAS submit a training program. This requirement will be further defined as more data is collected and the regulatory process affects these guidelines.

g. Other UAS Personnel Qualifications. Ancillary personnel such as systems operators or mission specialists must be thoroughly familiar with and possess operational experience of the equipment being utilized. If the systems being utilized are for observation and detection of other aircraft for collision avoidance purposes, personnel must be thoroughly trained on collision avoidance procedures and techniques and have direct communication with the UAS pilot, observer, and other applicable personnel.

16. AMOC. This notice defines certain limitations and procedures to conduct UAS operations, but each application is evaluated on its own technical merit based on its own set of operational parameters and proposed operational profiles, mitigations, and systems. When a proponent desires to deviate from these limitations and procedures, an AMOC that includes a safety case (recommended format provided in Appendix D), must be submitted for approval. For a proponent to make an acceptable safety case, information must be provided that outlines all hazards and risks associated with the requested AMOC. In addition, the proponent must provide a description of the methods and procedures or equipment for mitigating each hazard and risk. As such, deviations and AMOC may differ from the information presented in this notice. Therefore, if the proponent provides an acceptable safety case with sufficient data that supports the proposal, the AMOC will be considered and evaluated for approval.

a. Safety Case Information. The proponent should include at a minimum:

(1) A thorough description of the environment in which the aircraft will operate;

(2) Criteria for categorizing hazards (e.g., severity and likelihood);

(3) A detailed airworthiness description of the affected items associated with the proposed AMOC, which includes, as a minimum:

- Certification status of components and systems, or statement of airworthiness for public aircraft,
- Reliability data,
- Redundant systems,
- Failure modes and effects, including system response to loss of control link, and
- An airworthiness determination (for COA proponents only);

(4) Capabilities of the aircraft;

(5) Flight data;

(6) Accident data;

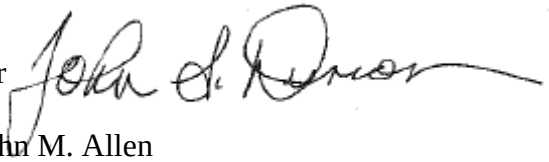
(7) Emergency procedures; and

(8) Pilot/crew roles and responsibilities.

b. Sample Safety Case. Appendix D represents the FAA's approach to documenting the process used for hazard identification and risk mitigation. It is provided as an example for proponents to use when developing and documenting a safety case. In addition to these

guidelines, other government and industry methods similar to the FAA's approach to developing a safety case also provide acceptable hazard analysis tools. These include Preliminary Hazard Analysis, Operational Safety Assessment, Comparative Safety Assessment, and Fault Hazard Analysis. See Appendix D for a complete list.

17. Disposition. We will incorporate the information in this notice into FAA Order 8900.1 before this notice expires. Direct questions concerning the information in this notice to the Unmanned Aircraft Systems Integration Office, AFS-80, at 202-385-4835.

for 

John M. Allen
Director, Flight Standards Service

APPENDIX A. DEFINITIONS

1. Aircraft. A device used or intended to be used for flight in the air, including unmanned aircraft (UA).

2. Airworthiness [UAS]. A condition in which the unmanned aircraft system (UAS) (including the aircraft, airframe, engine, propeller, accessories, appliances, and control station (CS)) conforms to its type certificate, if applicable, and is in condition for safe operation.

3. Airworthiness Certification. Process and aircraft qualification for civil UAS proponents to obtain a special airworthiness certificate.

4. Airworthiness Statement. Document required from public UAS proponents during a Certificate of Waiver or Authorization (COA) application process which confirms aircraft airworthiness.

5. Certificate of Waiver or Authorization (COA). An FAA grant of approval for a specific operation. The authorization to operate a UAS in the National Airspace System (NAS) as a public aircraft outside of Restricted, Warning, or Prohibited areas approved for aviation activities.

6. Chase Aircraft. A manned aircraft that carries its own pilot-in-command (PIC) and a separate qualified VO flying in proximity to a UA.

7. Civil Aircraft. Aircraft other than public aircraft.

8. Cooperative Aircraft. Aircraft that have an electronic means of identification (i.e., a transponder or ADS-B transceiver) aboard in operation.

9. Crewmember [UAS]. In addition to the crewmembers identified in 14 CFR part 1, a UAS flightcrew member includes pilots, sensor/payload operators, and VOs, but may include other persons as appropriate or required to ensure safe operation of the aircraft.

10. Crew Resource Management (CRM). The effective use of all available resources including human, hardware, and information resources.

11. Daisy-Chaining. Aviation jargon for the use of multiple, successive observers to extend the flight of a UA beyond the direct visual line-of-sight of any other PIC or VO.

12. Experimental Certificate. A type of special airworthiness certificate issued for the purposes of research and development (R&D), crew training, exhibition, and market survey as defined in 14 CFR part 21, § 21.191(a), (c), and (f). Note: According to § 91.319(a)(2), experimental aircraft may not be used for carrying persons or property for compensation or hire.

a. R&D Aircraft. Aircraft testing new design concepts, equipment, installations, operating techniques, or uses for aircraft. Any unmanned aircraft system (UAS), including an Optionally Piloted Aircraft (OPA) is eligible for an experimental certificate under this purpose. Operations

may be conducted by the proponent only as a matter of research or to determine whether an idea warrants further development.

b. Crew Training. Crew training is limited to the number of flight crews required by the proponent to conduct experimental aircraft operations.

c. Market Survey. Aircraft may be used for the purposes of conducting market surveys, sales demonstrations, and customer crew training of the manufacturer's customers as provided in part 21, § 21.195.

13. External Pilot. A UAS pilot who flies from outside a CS shelter with direct visual contact with the aircraft.

14. FAA-Recognized Equivalent. An FAA recognition that a public agency may exercise its own internal processes regarding airworthiness and pilot, aircrew, and maintenance personnel certification and training; furthermore, the agency has determined that its UAS is capable of safe operation in the National Airspace System (NAS) when conducting public aircraft operations under Title 49 of the United States Code (49 U.S.C.) §§ 40102(a)(41) and 40125.

15. Fly-Away. An interruption or loss of the control link, or when the pilot is unable to effect control of the aircraft and, as a result, the UA is not operating in a predicable or planned manner.

16. Formation.

a. Non-standard formation. A formation operating under any of the following conditions:

- When the flight leader has requested and ATC has approved other than standard formation dimensions;
- When operating within an authorized block altitude or under the provisions of a letter of agreement (LOA);
- When the operations are conducted in airspace specifically designed for a special activity.

b. Standard formation. A formation in which proximity of no more than 1 NM laterally or longitudinally and within 100 feet vertically from the flight leader is maintained by each wingman or UA.

17. Inspection. The routine performance of inspection tasks at prescribed intervals. The inspection must ensure the airworthiness of an aircraft up to and including its overhaul or life limits.

18. Internal Pilot. A UAS pilot who flies from inside a CS shelter without direct visual contact with the aircraft.

19. Lost Link. An interruption or loss of the control link, or when the pilot is unable to effect control of the aircraft and, as a result, the UA will perform a predictable or planned maneuver. Loss of command and control link between CS and aircraft. There are two types of links:

- An uplink which transmits command instructions to the aircraft, and
- A downlink which transmits the status of the aircraft and provides situational awareness to the pilot.

20. Missile. A non-recoverable, powered, guided munition that travels through the air or space.

- Ballistic missiles follow a ballistic trajectory.
- Cruise missiles generate lift.
- Guided missiles are launched from a ship or aircraft and serve as a self-contained precision bomb.

21. Non-Cooperative Aircraft. Aircraft that do not have an electronic means of identification (e.g., a transponder) aboard or that have inoperative equipment because of malfunction or deliberate action.

22. Non-Standard Formation. See Formation.

23. Observer. A trained person who assists a UAS pilot in the duties associated with collision avoidance and navigational awareness through electronic or visual means. (Collision avoidance includes, but is not limited to, avoidance of other traffic, clouds, obstructions, terrain and navigational awareness.) A visual observer (VO) is a trained person who assists the UAS pilot by visual means in the duties associated with collision avoidance. A VO includes the OPA pilot when the OPA is being operated as a UAS.

24. Off-Airport. Any location used to launch or recover aircraft that is not considered an airport (e.g., an open field).

25. Optionally Piloted Aircraft (OPA). An aircraft that can conduct operations as a traditional aircraft with a pilot aboard the aircraft, and can also operate as a UAS when the aircraft is operated and controlled by the CS pilot, allowing the pilot aboard the aircraft to become a qualified observer and remain a PIC. OPA operating as a UAS must meet UAS guidance requirements.

26. Pilot Duty Period. The period beginning when a flightcrew member is required to report for duty, with the intention of conducting a flight, and ending when the aircraft is parked after the last flight. It includes the period of time before a flight or between flights that a pilot is working without an intervening rest period.

27. Pilot-in-Command (PIC)-[UAS]. The person who has final authority and responsibility for the operation and safety of flight, has been designated as PIC before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the PIC as described by 14 CFR part 91, § 91.3 apply to the UA PIC. The PIC position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight. Note: The PIC can only be the PIC for one aircraft at a time. For OPA, PIC must meet UAS guidance requirements for training, pilot licensing, and medical requirements when operating OPA as a UAS.

28. Populated or Urban Areas. Areas depicted in yellow on a Visual Flight Rules (VFR) sectional chart or as determined from other sources.

29. Proponent. A person or agency making an application for a Certificate of Waiver or Authorization (COA).

30. Public Aircraft. An aircraft operated by a governmental entity (including Federal, State, or local governments, and the U.S. Department of Defense (DOD) and its military branches) for certain purposes as described in 49 U.S.C. §§ 40102(a)(41) and 40125. Public aircraft status is determined on an operation by operation basis. See 14 CFR part 1, § 1.1 for a complete definition of a public aircraft.

31. Public Operator. An operator that is classified as government and/or otherwise qualifies for public aircraft operation under 49 U.S.C. §§ 40102(a)(41) and 40125. Not all flights by a public aircraft operator qualify as a public aircraft operation under the statute. Public aircraft operation status is not automatic for flights conducted by a government entity or a contractor to a government entity.

32. Rocket. A powered, unguided munitions (DOD); or an aircraft propelled by ejected expanding gases generated in the engine from self-contained propellants and not dependent on the intake of outside substances. It includes any part which becomes separated during the operation (14 CFR).

33. Safety Risk Management (SRM). A formalized, proactive approach to system safety. SRM is a methodology that ensures hazards are identified, risks are analyzed, assessed, and prioritized; and results are documented for FAA decision-makers to transfer, eliminate, accept, or mitigate risk.

34. Scheduled Maintenance (Routine). The performance of maintenance tasks at prescribed intervals.

35. Segregation. Setting apart from other air traffic operations in the NAS. Segregation is not synonymous with required air traffic separation standards. Therefore, segregation does not prescribe or mandate criteria such as vertical, lateral, or longitudinal distances.

36. Shells. Munitions that are fired from a gun whether guided or not.

37. Smart Bomb. Precision-guided munitions.

38. Standard formation. See formation.

39. Supplemental Pilot. Pilots assigned UAS flight duties to augment the PIC. It is common for proponents to have both an internal and an external UAS pilot. The supplemental pilot can assume either of these positions. The supplemental pilot may also assume duties of the PIC if the specified qualifications are met.

40. Torpedoes. Powered munitions that travel through water.

41. Unmanned Aircraft (UA). A device used or intended to be used for flight in the air that has no onboard pilot. This devise excludes missiles, weapons, or exploding warheads, but includes all classes of airplanes, helicopters, airships, and powered-lift aircraft without an onboard pilot. UA do not include traditional balloons (see 14 CFR part 101), rockets, tethered aircraft and un-powered gliders.

42. Unmanned Aircraft System (UAS). A UA and its associated elements related to safe operations, which may include CSs (ground, ship, or air-based), control links, support equipment, payloads, flight termination systems (FTS), and launch/recovery equipment.

43. Unscheduled Maintenance (Non-Routine). The performance of maintenance tasks when mechanical irregularities occur.

44. Visual Line-of-Sight. Unaided (corrective lenses and/or sunglasses exempted) visual contact between a PIC or a VO and a UAS sufficient to maintain safe operational control of the aircraft, know its location, and be able to scan the airspace in which it is operating to see and avoid other air traffic or objects aloft or on the ground.

APPENDIX B. ACRONYMS

AC	Advisory Circular
AFPD	Air Force Policy Directive
AFS	Flight Standards Service
AGC	Chief Counsel
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AMOC	Alternative Means of Compliance
AR	Army Regulations
ASI	Aviation Safety Inspector
ATCAA	Air Traffic Control Assigned Airspace
ATCSCC	Air Traffic Control System Command Center
ATO	Air Traffic Organization
ATS	Air Traffic Service
AVS	Aviation Safety
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulations
COA	Certificate of Waiver or Authorization
CRM	Crew Resource Management
CS	Control Station
DCP	Divert/Contingency Points
DHS	Department of Homeland Security
DOD	Department of Defense
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FIR	Flight Information Regions
FL	Flight Level
FSIMS	Flight Standards Information Management System
FTP	Flight Termination Point
FTS	Flight Termination System
GCS	Ground Control Station
GHz	Gigahertz
GMF	Government Master File
HQ	Washington Headquarters
IFR	Instrument Flight Rules
LLP	Lost Link Points
LOA	Letter of Agreement
MHz	Megahertz
MSL	Mean Sea Level
NAS	National Airspace System
NASA	National Aeronautics And Space Administration
NAVAIRINST	Naval Air Systems Command Instruction
NM	Nautical Mile
NTIA	National Telecommunications And Information Administration

OPA	Optionally Piloted Aircraft
PIC	Pilot in Command
POC	Point of Contact
R&D	Research and Development
RF	Radio Frequency
RM	Risk Management
RNAV	Area Navigation
RTB	Return to Base
RVSM	Reduced Vertical Separation Minimum
SM	Statute Mile
SRM	Safety Risk Management
SRMD	Safety Risk Management Document
SSI	Sensitive Security Information
STA	Special Temporary Authority
TAS	Traffic Advisory Systems
TC	Type Certificate
TCAS	Traffic Alert and Collision Avoidance Systems
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
U.S.	United States
USC	United States Code
USCBP	U.S. Customs and Border Protection
USCG	U.S. Coast Guard
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VO	Visual Observer

APPENDIX C. RELATED REGULATIONS AND PUBLICATIONS

1. Title 14 of the Code of Federal Regulations (CFR).

a. Part 1, Definitions and Abbreviations.

b. Part 21, Certification Procedures for Products and Parts.

- Section 21.191, Experimental certificates.
- Section 21.193, Experimental certificates: general.
- Section 21.195, Experimental certificates: Aircraft to be used for market surveys, sales demonstrations, and customer crew training.
- Section 21.197, Special flight permits.
- Section 21.199, Issue of special flight permits.

c. Part 23, § 23.1309, Equipment, Systems, and Installations.

d. Part 25, § 25.1309, Equipment, Systems, and Installations.

e. Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors.

- Section 61.23, Medical Certificates: Requirement and Duration.
- Section 61.56, Flight Review.
- Section 61.57, Recent Flight Experience: Pilot in Command.
- Section 61.58, Pilot-in-Command Proficiency Check: Operation of an Aircraft that Requires more than one Pilot Flight Crewmember or is Turbojet-Powered.

f. Part 65, § 65.83, Recent Experience Requirements.

g. Part 67, Medical Standards and Certification.

h. Part 91, General Operating and Flight Rules.

- Section 91.3, Responsibility and Authority of the Pilot in Command.
- Section 91.13, Careless or Reckless Operation.
- Section 91.15, Dropping Objects.
- Section 91.17, Alcohol or Drugs.
- Section 91.21, Portable Electronic Devices.
- Section 91.111, Operating Near Other Aircraft.
- Section 91.113, Right-of-Way Rules: Except Water Operations.
- Section 91.115, Right-of-Way Rules: Water Operations.
- Section 91.126, Operating on or in the Vicinity of an Airport in Class G Airspace.
- Section 91.127, Operating on or in the Vicinity of an Airport in Class E Airspace.
- Section 91.129, Operations in Class D Airspace.
- Section 91.130, Operations in Class C Airspace.
- Section 91.135, Operations in Class A Airspace.
- Section 91.155, Basic VFR Weather Minimums.

- Section 91.157, Special VFR Weather Minimums.
- Section 91.180, Operations within Airspace Designated as Reduced Vertical Separation Minimum Airspace.
- Section 91.203, Civil Aircraft: Certifications Required.
- Section 91.215, ATC Transponder and Altitude Reporting Equipment and Use.
- Section 91.319, Aircraft having Experimental Certificates: Operating Limitations.

2. Title 49 of the Code of Federal Regulations (CFR).

a. Chapter I, Subchapter C, Hazardous Materials Regulations.

b. Chapter VIII, Part 830, Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft, and Preservation of Aircraft Wreckage, Mail, Cargo, and Records.

c. Chapter XII, Part 1520, § 1520.5, Sensitive Security Information.

3. Related Publications (current editions).

4. Advisory Circulars (AC).

- AC 00-1.1, Government Aircraft Operations.
- AC 91-57, Model Aircraft Operating Standards.
- AC 120-51, Crew Resource Management Training.
- AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers.
- AC 120-92, Introduction to Safety Management Systems for Air Operators.

5. FAA Notices. N JO 7210.766, Unmanned Aircraft Operations in the National Airspace System (NAS).

6. FAA Orders.

- JO 1000.37, Air Traffic Organization Safety Management System.
- JO 7110.65, Air Traffic Control.
- JO 7210.3, Facility Operation and Administration.
- JO 7400.8, Special Use Airspace.
- JO 7610.4, Special Operations.
- 8000.369, Safety Management System Guidance.
- 8020.11C, Aircraft Accident and Incident Notification, Investigation, and Reporting.
- 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft.
- 8900.1, Flight Standards Information Management System.

7. Other Documents.

- Title 47 CFR Part 300, National Telecommunications and Information Administration (NTIA) Manual, Chapter 7.11, Use of Frequencies by Certain Experimental Stations.
- Title 49 United States Code (49 U.S.C.) §§ 40102(a)(41), Definitions.

- FAA Air Traffic Organization (ATO) Safety Management System Manual.
- Memorandum of Agreement Concerning the Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System (DOD-FAA MoA, September 24, 2007).
- Convention on International Civil Aviation (“Chicago Convention”). 7 December 1944, 61 Stat. 1180, 15 U.N.T.S. 295.

APPENDIX D. SAFETY CASE FORMAT

1. Signature Page. Include the following information on the signature page:

- Title: A clear and concise description of the proposed method for AMOC;
- Originator Information: Originator's name, organization, contact information, etc.;
- Safety Risk Management Document (SRMD) Information: Safety Case submission date, revision number, etc.

2. Executive Summary. The summary should give a general description of the proposed AMOC, including a list of the hazards with associated risk level (high, medium, low) and their corresponding initial and predicted residual risk. Include a high level system description, a summary of how the Safety Case was developed, and what process/method was used to move through the risk assessment process.

3. Introduction. Provide a brief reasoning/rationale for the initiative. The scope of the proposed AMOC, whether it is more complex or far-reaching, will determine the need for increased scope and detail of the analysis to be performed.

4. Section 1. Current System/System Baseline. Provide a description of the current system or existing procedures as well as the corresponding (operational) system states. If the proposal entails a procedural change, describe the current procedure and its operational environment. If the current system or procedure is unique and has challenges associated with its unique situation, be sure to delineate.

5. Section 2. Proposed Change. Provide a description of the proposed change/procedure, identifying which safety parameters are involved.

6. Section 3. Safety Risk Management (SRM) Planning and Impacted Organizations. Prior to initiation of the safety analysis, SRM planning is necessary. It is essential to select the appropriate SRM participants, identify the SRM Panel, schedule milestones, and assign tasks and responsibilities. With regard to the organizations that are impacted by the change, describe the method used for collaboration between those organizations during the identification, mitigation, tracking, and monitoring of hazards associated with the change.

7. Section 4. Assumptions. If in the process of developing a procedure to validate an AMOC, any assumptions are made to make the evaluation of the change more manageable, clearly define and document them in this section.

8. Section 5. Phase 1: System Description. The description of the system/procedure, its operational environment, the people involved/affected by the change/procedure, and the equipment required to accommodate the proposal must be provided.

9. Section 6. Phase 2: Identified Hazards. The SRM Panel identifies hazards as a collaborative effort. The tool(s) and technique(s) used to identify hazards should be specified and discussed. The identified hazards are documented as well as their corresponding causes, the corresponding system states considered and the consequent potential outcome. It is important to realize that while identification of the worst credible outcome and the system state in which the worst

credible outcome occurs is required, system states with less severe outcomes should not be ignored.

10. Section 7. Phase 3 & 4: Risk Analysis & Risks Assessed. Describe the process used to analyze the risks associated with the identified hazards. Specify what type of data was used to determine the likelihood of risk occurrence (e.g., quantitative or qualitative) as well as the sources of the data. A risk matrix should provide an illustration of the predicted initial/current risk(s) associated with the identified hazards.

11. Section 8. Phase 5: Treatment of Risks/Mitigation of Hazards. If the existing controls and mitigations do not acceptably mitigate the hazards, then additional recommended safety requirements should be identified. An explanation of how the recommended safety requirements are expected to reduce the initial/current risk to an acceptable predicted residual risk level should be included. Low-risk hazards may still warrant recommended safety requirements.

12. Section 9. Tracking and Monitoring of Hazards. Once the proposal has been approved and implemented, tracking of hazards and verification of the effectiveness of mitigation controls throughout the lifecycle of the system or change are required. Also, the methodology for this tracking and monitoring should be outlined.

13. Appendices.

a. Documents Related to the SRMD. Include a list of documents (orders, directives, regulations, handbooks, and manuals) that pertain to the proposed change, which have been consulted in the development of the proposed change and the corresponding safety analysis.

b. Hazard Identification Tools. Provide information on the different tool(s), method(s), and technique(s) used during the safety analysis. (See Figure D-1, for a chart listing acceptable hazard analysis tools and techniques.)

c. Hazard Analysis and Risk Matrix. Depending on the analyses necessary, there might be one or more appendices with analyses. A risk matrix reflecting the initial and predicted residual risks should also be included.

d. Glossary. Include any acronyms and definitions for any terms you listed in the Safety Case.

Figure D-1. Acceptable Hazard Analysis Tools and Techniques

This chart from the ATO Safety Management System Manual, available on the Internet, displays acceptable hazard analysis tools for developing safety cases.

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Table 3.1: Selection of Hazard Identification and Analysis Tools and Techniques

Tool or Technique	Summary Description	Page in Appendix G
Preliminary Hazard Analysis (PHA)	The PHA provides an initial overview of the hazards present in the overall flow of the operation. It provides a hazard assessment that is broad, but usually not deep.	G-1
Operational Safety Assessment (OSA)	The OSA is a development tool based on the assessment of hazard severity. It establishes how safety requirements are to be allocated between air and ground components and how performance and interoperability requirements might be influenced.	G-3
Comparative Safety Assessment (CSA)	The CSA provides management with a listing of all of the hazards associated with a change, along with a risk assessment for each alternative hazard combination that is considered. It is used to rank the options for decision-making purposes. The CSA's broad scope is an excellent way to identify issues that may require more detailed hazard identification tools.	G-5
Fault Hazard Analysis (FHA)	The FHA is a deductive method of analysis that personnel can use exclusively as a qualitative analysis or, if desired, can expand to a quantitative one. The FHA requires a detailed investigation of the subsystems to determine component hazard modes, causes of these hazards, and resultant effects on the subsystem and its operation.	G-8
Failure Mode and Effect Analysis (FMEA)	The FMEA determines the results or effects of sub-element failures on a system operation and classifies each potential failure according to its severity.	G-9
Failure Modes, Effects, and Criticality Analysis (FMECA)	The FMECA is an essential function in design from concept through development. To be effective, the FMECA is iterative to correspond with the nature of the design process itself. The FMECA identifies component and sub-system failure modes, including the impact of human error; evaluates the results of the failure modes; determines rates and probability; and demonstrates compliance with safety requirements.	G-9
What-If Analysis	The What-If Analysis methodology identifies hazards, hazardous situations, or specific accident events that could produce an undesirable consequence. One can use the What-If Analysis as a brainstorming method.	G-10
Scenario Analysis	The Scenario Analysis identifies and corrects potentially hazardous situations by postulating accident scenarios in cases where it is credible and physically logical.	G-12
Change Analysis	The Change Analysis analyzes the hazard implications of either planned or incremental changes (e.g., operation, equipment, or procedure).	G-13
Cause-Consequence Analysis	The Cause-Consequence Analysis combines the bottom-up and top-down analysis techniques of Event Trees and Fault Trees. The result is the development of potential complex accident scenarios.	G-15

Figure D-1. Acceptable Hazard Analysis Tools and Techniques, continued

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Tool or Technique	Summary Description	Page in Appendix G
Hazard and Operability Tool (HAZOP)	A group uses the HAZOP to analyze hazards of completely new operations and to review the significance of all of the ways that a process element can malfunction or be incorrectly operated. The technique is essentially a structured brainstorming using specific guide words.	G-17
Interface Analysis	One uses the Interface Analysis to discover the hazardous linkages between interfacing systems.	G-18
Accident/Incident Analysis	The Accident/Incident Analysis uses data on recorded hazardous events. One groups these events in various ways according to a pre-established criterion, usually a common cause or outcome. One then identifies the groupings as hazards.	G-19
Job Safety Analysis (JSA)	One uses this technique to assess in detail the safety considerations in a single job or task..	G-20
Energy Trace and Barrier Analysis (ETBA)	The ETBA is highly structured. It documents all energy sources in system. One identifies the energy sources as hazards. One identifies the barrier between the energy sources and the operators, maintainers, and other systems as mitigations.	G-21
Fault Tree Analysis (FTA)	An FTA is a graphical design technique that can provide an alternative to block diagrams. It is a top-down, deductive approach structured in terms of events. One models faults in terms of failures, anomalies, malfunctions, and human errors.	G-22
Management Oversight and Risk Tree (MORT)	One uses the MORT technique to systematically analyze hazards to examine and determine detailed information about the process and accident contributors.	G-24
Human Error Analysis (HEA)	HEA, in a system context, involves assessing each human-machine interface point, decision, or action for the potential for human error to adversely impact system performance or safety of the system and its users. There are a variety of methodologies for conducting these analyses.	G-26
Job Task Analyses (JTA)	The foundation of the performance of HEA is a task analysis, which describes each human task/sub-task within a system in terms of the perceptual (information intake), cognitive (information processing and decision making), and manual (motor) behaviors required of an operator, maintainer, or support person. It should also identify the skills and information required to complete the tasks; equipment requirements; the task setting; time and accuracy requirements; and the probable human errors and consequences of these errors. There are several tools and techniques for performing task analyses, depending on the level of analysis needed.	G-28

APPENDIX E. CONTINGENCY PLANNING LIMITATIONS

1. Point Identification. The proponent must submit contingency plans that address emergency recovery or flight termination of the unmanned aircraft (UA) in the event of unrecoverable system failure. These procedures will normally include Lost Link Points (LLP), Divert/Contingency Points (DCP) and Flight Termination Points (FTP) for each operation. LLPs and DCPs must be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart (or similar format). FTPs or other accepted contingency planning measures must also be submitted in Lat/Long format along with a graphic representation plotted on an aviation sectional chart, or other graphic representation acceptable to the FAA. The FAA accepts the LLPs, DCPs, FTPs, and other contingency planning measures submitted by the proponent, but does not approve them. When conditions preclude the use of FTPs, the proponent must submit other contingency planning options for consideration and acceptance. At least one LLP, DCP, and FTP (or an acceptable alternative contingency planning measure) is required for each operation. The proponent must furnish this data with the initial Certification of Waiver or Authorization (COA) application. Any subsequent changes or modifications to this data must be provided to the Unmanned Aircraft Systems (UAS) Integration Office (AFS-80) for review and consideration no later than 30 days prior to proposed flight operations.

2. Risk Mitigation Plans. For all operations, the proponent must develop detailed plans to mitigate the risk of collision with other aircraft and the risk posed to persons and property on the ground in the event the UAS experiences a lost link, needs to divert, or the flight needs to be terminated. The proponent must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, Navigational Aids (NAVAIDS), and congested areas. In the event of a contingency divert or flight termination, the use of a chase aircraft is preferred when the UAS is operated outside of Restricted or Warning Areas. If time permits, the proponent should make every attempt to utilize a chase aircraft to monitor the aircraft to a DCP or to the FTP. In the event of a contingency divert or flight termination, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

a. LLP Procedures.

(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 will autonomously hold, or loiter, at the LLP until the communication 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 communication link, or proceed to an FTP for flight termination. LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established 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.

b. DCP Procedures.

(1) A DCP is defined as an alternate landing/recovery site to be used in the event of an abnormal condition that requires a precautionary landing. Each DCP must incorporate the means of communication with air traffic control (ATC) throughout the descent and landing (unless otherwise specified in the Special Provisions) as well as a plan for ground operations and securing/parking the aircraft on the ground. This includes the availability of control stations (CS) capable of launch/recovery, communication equipment, and an adequate power source to operate all required equipment.

(2) For local operations, the DCP specified will normally be the airport/facility used for launch and recovery; however, the proponent may specify additional DCPs as alternates.

(3) For transit and/or mission operations that are being conducted in Class A airspace or Class E airspace above flight level (FL) 600, DCPs will be identified during the flight to be no further than one hour of flight time at any given time, taking into consideration altitude, winds, fuel consumption, and other factors. If it is not possible to define DCPs along the entire flight plan route, the proponent must identify qualified FTPs along the entire route and be prepared to execute flight termination at one of the specified FTPs if a return to base (RTB) is not possible.

(4) It is preferred that specified DCPs are non-joint use military airfields, other government-owned airfields, or private-use airfields. However, the proponent may designate any suitable airfield for review and consideration.

c. Flight Termination Procedures.

(1) Flight termination is the intentional and deliberate process of performing controlled flight into terrain (CFIT). Flight termination must be executed in the event that all contingencies have been exhausted and further flight of the aircraft cannot be safely achieved or other potential hazards exist that require immediate discontinuation of flight. FTPs or alternative contingency planning measures must be located within power-off glide distance of the aircraft during all phases of flight and must be submitted for review and acceptance. The proponent must ensure sufficient FTPs or other contingency plan measures are defined to accommodate flight termination at any given point along the route of flight. The location of these points is based on the assumption of an unrecoverable system failure and must take into consideration altitude, winds, and other factors.

(2) Unless otherwise authorized, FTPs must be located in sparsely populated areas. Except for on- or near-airport operations, FTPs will be located no closer than five nautical miles (NM) from any airport, heliport, airfield, NAVAID, airway, populated area, major roadway, oil rig, power plant, or any other infrastructure. For offshore locations, the proponent must refer to appropriate United States Coast Guard (USCG) charts and other publications to avoid maritime obstructions, shipping lanes, and other hazards. Populated areas are defined as those areas depicted in yellow on a Visual Flight Rules (VFR) sectional chart or as determined from other sources.

(a) It is preferred that flight termination occurs in Restricted or Warning Areas, government-owned land, or offshore locations that are restricted from routine civil use. However, the proponent may designate any suitable location for review and consideration.

(b) The proponent is required to survey all designated areas prior to their use as an FTP. All FTPs will be reviewed for suitability on a routine and periodic basis, not to exceed six months. The proponent assumes full risk and all liability associated with the selection and use of any designated FTP.

(c) It is desirable that the proponent receive prior permission from the land owner or using agency prior to designation of this area as an FTP. The proponent should clearly communicate the purpose and intent of the FTP.

(d) For each FTP, plans must incorporate the means of communication with ATC throughout the descent as well as a plan for retrieval/recovery of the aircraft.

(e) Contingency planning must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDS, and congested areas to the maximum extent possible.

(f) In the event of a contingency divert or flight termination, if time permits, the use of a chase aircraft is preferred when the UA is operated outside of Restricted or Warning Areas.

(g) In the event of a contingency divert or flight termination or other approved contingency measures, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

APPENDIX F. UAS COA REQUIREMENT FLOWCHART