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Standard Practice for Unmanned Aircraft System (UAS) Visual Range Flight Operations[1]

This standard is issued under the fixed designation F2500; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice prescribes guidelines that govern the visual flight operation of unmanned aircraft systems in civil airspace in order to provide for the safe integration of unmanned aircraft flight operations with manned aircraft flight operations.

1.2 This practice applies to those operations conducted for civil purposes other than sport or recreation that remain within the visual range of the pilot in command (see Terminology F2395 for a definition of "visual range").

1.3 This practice complies with the known rules, regulations, and public law available at the time of its publication. Should any conflict with a rule, regulation, or public law arise, the user must comply with rule and should notify ASTM of the conflict.

1.4 *This practice only prescribes accepted methods for visual range flight operation of unmanned aircraft systems.*

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2395 Terminology for Unmanned Aircraft Systems

2.2 *Federal Regulations:*[3]

14 CFR Part 43

14 CFR Part 71

14 CFR Part 73

14 CFR Part 91

14 CFR Part 93

14 CFR Part 99

AFS800HB, 8700.1, FSGA 94-12 Procedures Drug/Alcohol Testing, Joint Flight Standards Information Bulletin for Air Transportation (FSAT), General Aviation (FSGA), and Airworthiness (FSAW), FSAT 94-18, FSGA 94-12, and FSAW 94-50, Procedures for Reporting of Alcohol or Drug Test Results and Refusals to Submit to Testing by Flight Crewmembers to CAMI, November 18, 1994

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *mile(s)—in this document*, "mile" refers to nautical miles.

4. Summary of Practice

4.1 This practice prescribes additional methods for safe, visual range flight operations of unmanned aircraft systems, including flight procedures, aircraft system requirements, pilot license or certificate requirements, maintenance requirements, and special flight operations.

5. Significance and Use

5.1 Safe operation of the unmanned aircraft is of the primary importance to the unmanned aircraft industry and for successful integration of unmanned aircraft with manned aircraft in civil airspace. Operators and pilots-in-command of unmanned aircraft systems shall comply with applicable Federal Aviation Regulations (14 CFR Part 43, 14 CFR Part 71, 14 CFR Part 73, 14 CFR Part 91, 14 CFR Part 93, and 14 CFR Part 99). This standard includes the minimum additional methods that should be followed by unmanned aircraft system operators, including pilots-in-command, on every visual range flight to ensure the safe operation of the aircraft and safety of people and property in the air and on the ground. This visual range flight operation standard shall be used in conjunction with appropriate unmanned aircraft system airworthiness and pilot qualification standards.

6. General Methods

6.1 *Applicability:*

[1] This practice is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.02 on Flight Operations.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

6.1.1 This standard prescribes methods governing the operation of unmanned aircraft systems operating within visual range of the pilot-in-command.

6.1.2 This standard is intended for visual range flight operations of unmanned aircraft systems for other than sport or recreation.

6.2 *Pilot Qualifications:*

6.2.1 The pilot in command of a UAS operating under this standard shall have an approved[4] license or certificate with the appropriate ratings and limitations for that UAS.

6.3 *Responsibility and Authority of the Pilot in Command:*

6.3.1 The pilot-in-command of an UAS is directly responsible for, and is the final authority as to, the safe operation of that aircraft.

6.3.2 In an in-flight emergency requiring immediate action, the pilot-in-command may deviate from any guideline of this standard, or applicable Civil Aviation Authority (CAA) regulations, to the extent required in order to meet the conditions of that emergency and shall, when applicable, advise the appropriate airspace controlling agency of his/her intentions or actions as soon as possible once the conditions of the emergency are satisfied and further deviation is no longer necessary.

6.3.3 Each pilot-in-command that deviates from a regulation under 6.3.2 shall, upon request of the Administrator or representative, send a written report of the deviation to the Administrator.

6.3.4 Deviations under 6.3.2 shall always minimize the risk to people or property, even if the choice increases the risk to the UAS.[5]

6.4 *UAS Airworthiness:*

6.4.1 The pilot-in-command of the UAS is responsible for determining whether that aircraft and associated systems are in condition for safe flight. The pilot-in-command shall discontinue the flight when unairworthy conditions occur.

6.4.2 The operator will ensure the UAS conforms to an approved airworthiness standard, or an airworthiness certificate, and is appropriately registered for use.

6.5 *Careless or Reckless Operation:*

6.5.1 No person may operate an aircraft in a careless or reckless manner so as to endanger life or property of another.

6.6 *Dropping Objects:*

6.6.1 No pilot-in-command of a UAS may allow any object to be dropped from that aircraft in flight that creates a hazard to persons or property. However, this section does not prohibit the dropping of any object if reasonable precautions are taken to avoid injury or damage to persons or property. The pilot-in-command shall ensure the drop area remains clear throughout the operation.

6.6.2 The operator of a UAS must take all reasonable precautions to prevent the inadvertent release of the objects.

6.7 *Alcohol and Drugs*—No person may act or attempt to act as pilot-in-command of a UAS:

6.7.1 Within 8 h after the consumption of any alcoholic beverage,

6.7.2 While under the influence of alcohol,

6.7.3 While using any drug or medication that affects the person's faculties in any way contrary to safety, or

6.7.4 While having 0.04 % by weight or more alcohol in the blood. (See AFS800HB, 8700.1, FSGA 94-12.)

7. Flight Guidelines

7.1 *Preflight Action*—Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. This information shall include (at a minimum):

7.1.1 Appropriate weather observations, reports, or forecasts, or a combination thereof, for the operating area and expected duration of the flight,

7.1.2 Proximity to airports and airspace defined in 7.7-7.12 of this standard,

7.1.3 Location of emergency landing areas,

7.1.4 Maintenance and inspection records,

7.1.5 Pilot Operating Handbooks,

7.1.6 All applicable notices to airmen (NOTAMs) as published by the CAA for the duration of the flight operations,

7.1.7 Conduct the UAS pre-flight inspection IAW the pilot's operating handbook, and

7.1.8 Verify the absence of electromagnetic interference in the operating area in the planned frequency range.

7.2 *Night Operation*—Night operations require that:

7.2.1 The pilot-in-command of the UAS is rated for night operations, and

7.2.2 The UAS is configured and properly lighted for night operation.

7.3 *Operating Near Other Aircraft*—No UAS may operate so close to another aircraft, manned or unmanned, so as to create a collision hazard. No UAS may operate in formation flight except by arrangement with the pilot-in-command of each aircraft in the formation.

7.4 *Right-of-Way*—The pilot-in-command shall follow the right of way rules given in 14 CFR Part 91.113. When there is doubt, always maneuver to avoid a collision.

7.5 *Minimum Safe Altitudes:*

7.5.1 Except when necessary for takeoff and landing, UAS operations are to be conducted at altitudes that permit the pilot-in-command to conduct an emergency landing without undue hazard to persons or property.

7.5.2 When determining safe separation from obstacles during the operation, the pilot shall consider his vehicle size, weight, and speed when determining the safe distance from people and property that are not associated with the operation.

7.6 *Maximum Altitudes*—Visual range flight operations normally remain within Class G airspace. Pilots shall not operate the aircraft at an altitude where they can no longer provide visual collision avoidance.

[4] In this standard, "approved" means approved by the administrator CAA, his designated representative, or by an organization recognized by the CAA to do so.

[5] For example, in the event of an engine failure, the UAS pilot may choose to perform the emergency landing in a rough field or trees rather than land on a highway with traffic present.

7.7 *Operating On or In the Vicinity of an Airport in Class G Airspace:*

7.7.1 Operations on an airport in Class G airspace are prohibited without approval of that airport's authority/management.

7.7.2 Operations within 3 miles from center of a public airport in Class G airspace are prohibited without notification and approval of that airport's authority/management.

7.7.3 Operations within 1 mile from center of a charted, private airport in Class G airspace shall make a reasonable effort to notify the owner prior to the operation.

7.7.4 The operator shall publish a NOTAM or post a notice at the airfield concerning the operation.

7.8 *Controlled Airspace*—Operations, under this standard, within Class A, B, C, D, and E airspace are prohibited without prior approval of the controlling authority.

7.9 *Special Use Airspace:*

7.9.1 Operations within prohibited areas, restricted areas, national security areas, and warning areas are prohibited without prior approval of the using or controlling authority as appropriate.

7.9.2 Operations within active military operating areas, military training routes, alert areas, or controlled firing areas are allowed, but the pilot should exercise extreme caution. When possible, schedule UAS operations to coincide with minimal levels of activity, or contact the controlling agency for traffic advisories.

7.10 *Temporary Flight Restrictions*—UAS operations shall observe all temporary flight restrictions designated in CAA NOTAMs. Operations are prohibited without prior approval of the controlling authority.

7.11 *Special Flight Rules Areas*—Operations within airspace designated as special flight rules areas are prohibited without prior approval of the controlling authority.

7.12 *Air Defense Identification Zones*—Operations into, within or out of air defense identification zones are prohibited without prior approval of the controlling authority.

7.13 *Fuel/Energy Requirements*—UAS operators shall not plan to fly with less than 15 % of total endurance for either propulsion or control systems.

7.14 *Visibility Minimums*—Obstructions to visibility include but are not limited to weather, buildings, and ground environment such as trees and hills. These variables can affect the operation in several unanticipated ways and precludes establishing a numerical requirement. This requires the pilot to evaluate each flight independently. Visual range flight operations require sufficient visibility for the pilot-in-command to maintain control of the UAS at all times, establish required minimum safe altitude of the UAS, maintain required clearance with all aircraft and obstacles, and remain clear of clouds.

7.15 *Flight Logs*—The operator shall maintain the flight logs for the UAS. These may include aircraft, control system, pilot, or operator logbooks, or a combination thereof. At a minimum, the operator shall record date, aircraft identification, total flight time, number of landings, flight description, incidents or mishaps, maintenance discrepancies, and pilot's name. See Appendix X1 for an example logbook format. The logbook may be in electronic format and must be available to inspect upon request of an inspector or representative of the governing body.

7.16 *Pilot Operating Handbook*—Operators under this standard shall have, and reference, a Pilot Operating Handbook for the UAS system. Operators are responsible for the quality of materials and construction under this standard. Operators who construct more than 51 % of their UAS may provide their own Pilot Operating Handbook.

8. Equipment and Documentation Requirements

8.1 *Equipment Requirements*—The following equipment requirements are based on an operational necessity and may or may not be part of the UA or addressed in the UAS airworthiness documentation. They are included here for operational safety.

8.1.1 A UAS operating under this standard must have an instrument(s) which will provide the pilot in command with an indication(s) of remaining UAS endurance.

8.1.2 Operations above 400 ft above ground level (AGL) require an altitude measuring device and an automatic altitude hold function.

8.2 *Documentation Required*—Anyone operating a UAS under this standard shall maintain documentation that the UAS meets approved airworthiness standards and that the pilot is appropriately trained and qualified.

9. Special Flight Operations

9.1 *Training*—UAS flight training performed under this standard shall be conducted at an approved flying facility or over an appropriate, sparsely populated area.

9.2 *Flight Test*—UAS airworthiness flight testing, including maintenance check flights, performed under this standard shall be conducted over sparsely populated areas.

10. Maintenance

10.1 *Operation After Maintenance, Preventive Maintenance, Rebuilding or Alterations:*

10.1.1 The operator will assure that work is performed by people authorized to do the work and documented in the appropriate logs.

10.1.2 Any action affecting airworthiness shall require a maintenance check flight prior to resuming for-hire operations.

10.2 *Inspections*—The operator must comply with the periodic inspection requirements listed in the appropriate maintenance manuals. The inspection may be conducted by the builder or a maintenance technician qualified on that type of UAS. The inspector shall use the inspection checklist approved in the UAS' airworthiness records. An inspection log shall be maintained and kept with the UAS.

10.3 *Maintenance Records*—Maintenance records shall be maintained and kept with the UAS. The records shall at least contain the name of the mechanic, the certificate or other authorization of the mechanic, the maintenance action or the discrepancy and corrective action, and the date of completion.

The mechanic shall sign the log to indicate completion in accordance with the aircraft manuals.

10.4 *Transfer of Records*—Maintenance and inspection records must be transferred to any new operator of the UAS, if that UAS is to be used in for-hire applications. Flight log information must also be passed such that the new operator knows the total flight time accrued and any incidents that might affect airworthiness. Any aircraft deemed un-repairable must have logs so noted before transfer or discarding.

11. Keywords

11.1 flight; operation; UAS; visual range

ANNEX

(Mandatory Information)

A1. SAMPLE OPERATIONS CHECKLISTS

A1.1 *Flight Operation Checklists* —Flight operations checklists are typically separated into six phases of flight checks which are Pre-Flight, Control Systems Check, Before Take Off, In-Flight Operations, Landing, and Post-Flight Operations. Any checklist will vary based on the complexity of the specific UAS. This sample is provided for guidance only.

A1.1.1 *Pre-Flight:*

A1.1.1.1 Before the first flight of the day, all transmitter, on-board aircraft, and camera batteries are fully charged. Review appropriate maintenance logs.

A1.1.1.2 Check all control surfaces, that is, rudder, elevator and ailerons for signs of damage, loose hinges, and overall condition.

A1.1.1.3 Check the control linkages are secure and the condition of the control horns and brackets.

A1.1.1.4 Check the wing to make sure it is in good structural condition and properly secured and aligned to the airframe.

(1) Check the motor/engine and mounting system to make sure it is firmly attached to the airframe.

A1.1.1.5 Check the propeller for chips, cracks, looseness and any deformation.

A1.1.1.6 Check the landing gear for strut damage, secure attachment to the airframe, and the wheels are in good shape and rotate freely.

A1.1.1.7 Check that the servos are firmly attached to the airframe and all receiver connections are secure.

A1.1.1.8 Check all electrical connections making sure they are plugged in and secured to the airframe.

A1.1.1.9 Check that the payload equipment and mounting system are secure and operational.

A1.1.1.10 Perform an overall visual check of the aircraft prior to arming any power systems.

A1.1.1.11 Repair or replace any part found to be unairworthy in the pre-flight prior to take-off.

A1.1.2 *Control Systems Check:*

A1.1.2.1 Make every effort to assure that no one is using your radio's frequency in the vicinity before turning on your transmitter.

A1.1.2.2 Make sure that all of your body parts, clothing, other obstructions, and bystanders are well away from any propeller and its arc before turning power on to any systems. Make sure the aircraft is secure and will not move if the motor was suddenly powered up.

A1.1.2.3 Outloud—"CLEAR PROP."

A1.1.2.4 Turn on the transmitter. If it displays information such as aircraft memory and battery voltage, be sure these numbers are correct.

A1.1.2.5 Make sure that the throttle stick on the transmitter is in the power off position.

A1.1.2.6 Connect the battery or turn on the power switch to the aircraft, or both.

A1.1.2.7 Turn the transmitter off. If the control surfaces are moving about, someone else is on your frequency or there is another interference source close enough to abort the flight.

A1.1.2.8 Turn the transmitter back on if the control surfaces were normal.

A1.1.2.9 Check for proper operation of control surfaces.

A1.1.2.10 Elevator stick back—elevator up, stick forward—elevator down.

A1.1.2.11 Looking from behind the aircraft: Rudder stick left—rudder left, stick right—rudder right.

A1.1.2.12 Looking from behind the aircraft: Aileron stick left—left aileron up, right aileron down. Aileron stick right—right aileron up and left aileron down.

A1.1.2.13 Make sure that all servos are steady and not chattering or making any other abnormal noise when in operation or idle.

A1.1.2.14 Check the motor/engine for proper operation. Firmly secure the aircraft and gradually increase the throttle to full power and back down to idle—checking for lack of thrust, vibration or other possible anomalies. Check that the motor stops completely when the throttle stick is at the power off position, and the prop brake (if activated) is working properly.

A1.1.2.15 Payload equipment power is on. Check to make sure the triggering device is working correctly.

A1.1.2.16 Follow the recommended procedures as outlined in your radio transmitter/receiver owners manual for the proper field range test.

A1.1.3 *Before Take Off:*

A1.1.3.1 Transmitter antenna is fully extended.

A1.1.3.2 Transmitter trim settings in proper position.

A1.1.3.3 Receiver antenna is fully extended.

A1.1.3.4 Check that the take off area is clear of obstructions and people.

A1.1.3.5 Double check wind direction and review potential emergency landing areas.

A1.1.3.6 Set flight timer alarm.

A1.1.3.7 Outloud—"TAKE OFF."

A1.1.3.8 Launch aircraft.

A1.1.4 *In-Flight:*

A1.1.4.1 Climb to a safe altitude and check control systems away from potential hazards. Reset trims if necessary.

A1.1.4.2 Keep aircraft at a safe operating distance from people and buildings.

A1.1.4.3 If aircraft must be flown over buildings or people, make every effort to minimize that time.

A1.1.4.4 Continually scan the flight and ground areas for potential hazards.

A1.1.5 *Landing:*

A1.1.5.1 Check the control systems and make sure the trims are set that if necessary, an emergency abort of the landing can be made.

A1.1.5.2 Scan landing area for potential obstruction hazards and recheck wind conditions.

A1.1.5.3 Outloud—"LANDING."

A1.1.5.4 Always be prepared to go around.

A1.1.5.5 Carefully land the aircraft away from obstructions and people.

A1.1.6 *Post-Flight:*

A1.1.6.1 Turn the power off to the aircraft or disconnect the batteries, or both.

A1.1.6.2 Turn off the transmitter.

A1.1.6.3 Turn the power off to the payload equipment.

A1.1.6.4 Visually check aircraft for signs of damage or excessive wear, or both.

A1.1.6.5 Remove the batteries.

A1.1.6.6 Secure the aircraft.

APPENDIX

(Nonmandatory Information)

X1. SAMPLE FLIGHT AND MAINTENANCE LOGS

X1.1 Fig. X1.1 shows an example of a flight log. This particular log also requires the use of an aircraft Maintenance Log (see Fig. X1.2).

X1.2 Fig. X1.2 shows an example of a maintenance log. This particular log also requires the use of a Pilot's Log (see Fig. X1.1).

Crew Member	Date	Aircraft	Function	Type	Start Time	End Time	Total Time	Launch Quantity	Landing Quantity	Comments (Location, other crew, weather, etc.)

Experience Summary	Brought Fwd		
Type	Hours	Launch	Landing
Autonomous (A)			
Ground (G)			
Launch System (L)			
Manual (M)			
Simulator (S)			

	Hours This Page	Quantity This Page		Total Experience		
		Launch	Landing	Hours	Launch	Landing
Autonomous (A)						
Ground (G)						
Launch System (L)						
Manual (M)						
Simulator (S)						

UAV System Experience Logbook

Chief Controller Signature on page completion

FIG. X1.1 Sample Pilot Flight Log

Date	Aircraft	Avionics	Airframe	Engine	Archive	Wing Mount	xTE->CM	zTE->CM
Descriptions						Checklists		
Aircraft Modifications since last flight:						Checks	Initials	Date
						Before Flight		
						Engine		
					Initials:	Avionics		
Flight Objectives:						Mid Bay		
						Assembly		
						Met Ground Check		
						Runway		
					Initials:	Start		
Flight Notes:						After Flight		
						Gndbase		
						Aircraft		
						Meteorological Ground Check		
						Reference	Left Wing	Right Wing
						P	P	P
						T	T	T
						U	U	U
					Initials:		#	#
Maintenance Comments:					Oil	Fuel	Gross	Flight
					Start	S	S	S
					End	E	E	E
					Change	C	C	C
					Hours	Avionics	Airframe	Engine
					This flight			
					TTIS			
					TSO			
				Initials:	Total Cycles			

FIG. X1.2 Sample Maintenance Log