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Standard Practice for Seeking Approval for Extended Visual Line of Sight (EVLOS) or Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations[1]

This standard is issued under the fixed designation F3196; 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 Compliance with this practice is recommended as one means of seeking approval from a civil aviation authority (CAA) to operate a small unmanned aircraft system (sUAS) to fly extended visual line of sight (EVLOS) or beyond visual line of sight (BVLOS), or both. Any regulatory application of this practice to sUAS and other unmanned aircraft systems (UASs) is at the discretion of the appropriate CAA.

1.2 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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]

NOTE 1—For requirements in these standards that are specified to be adequate, the applicant/proponent shall propose and obtain approval of the specifics of that requirement from the CAA.

F2908 Specification for Aircraft Flight Manual (AFM) for a Small Unmanned Aircraft System (sUAS)

F2909 Practice for Maintenance and Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS)

F2911 Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)

F3002 Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)

F3003 Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)

F3005 Specification for Batteries for Use in Small Unmanned Aircraft Systems (sUAS)

F3178 Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)

F3201 Practice for Ensuring Dependability of Software Used in Unmanned Aircraft Systems (UAS)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *applicant/proponent, n*—the person or organization responsible for seeking the approval to operate or the person or organization operating an sUAS, or both. The applicant/proponent may be one of the following entities:

3.1.1.1 *manufacturer, n*—the person or organization who causes production of a product or article. A manufacturer may also be an operator.

3.1.1.2 *operator, n*—the person or organization that applies for CAA approval to operate an sUAS or who seeks operational approval for types of flight operations prohibited by a CAA for that sUAS.

3.1.1.3 *original equipment manufacturer, OEM, n*—the person or organization who first produced that particular product or article. An OEM may also be an operator.

3.1.2 *beyond visual line of sight, BVLOS*—operation when the individual(s) (for example, pilot or VO) responsible for controlling the flight of the sUA cannot maintain direct unaided (other than with the use of spectacles/contacts lenses or sunglasses, or both) visual contact with the sUA other aircraft, terrain, or obstacles to determine whether the sUA endangers life or property or both.

3.1.2.1 *Discussion*—Technological means may be used for determining the sUA's movement relative to intruding aircraft, obstacles, and terrain; observe the airspace for other air traffic or hazards; and determine whether the sUA endangers life or property or both.

3.1.3 *command and control (C2) link(s), n*—radio-frequency link(s) between the control station and the unmanned aircraft

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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.

(UA), also known as the control and non-payload communications (CNPC) link(s).

3.1.4 *control station, n*—interface used by the Remote Pilot in Command (RPIC) or pilot to control the flight path of the sUA.

3.1.5 *crew member, n*—person charged with duties essential to the operation of an sUAS during a flight duty period.

3.1.6 *extended visual line of sight, EVLOS*—operation when the sUA cannot be seen by the individuals responsible for see-and-avoid with unaided (other than spectacles/contacts lenses or sunglasses, or both) vision but where the location of the sUA is known through technological means.

3.1.6.1 *Discussion*—Either the RPIC or, alternatively, the VO: can use said technological means for determining the location of the sUA to determine its movement relative to intruding aircraft, obstacles, or terrain; observe the airspace for other air traffic or hazards; and determine whether the sUA endangers life or property or both. To further clarify, technology means can be used to determine the position of the sUAS but the RPIC or the VO must be able to see the area the sUAS is known to be in so as to execute the required see-and-avoid function.

3.1.7 *fly-away, n*—flight outside of operational boundaries (altitude/airspeed/lateral limits) as the result of a failure, interruption, or degradation of the control element or onboard systems, or both.

3.1.8 *fly-away protection system, n*—system that will safely recover the sUA, or keep the sUA within the intended operational area, in the event of a fly-away as defined in 3.1.7.

3.1.9 *licensed band, n*—any frequency or range of frequencies in which transmission requires permission from a governing body (for example, the U.S. Federal Communications Commission).

3.1.10 *lost link, n*—occurrence in which the control station has lost the ability to maintain positive control of the sUA because of the degradation, loss, or interruption of the C2 link for longer than deemed safe depending on the circumstances.

3.1.11 *pilot, n*—the RPIC or person other than the RPIC who is controlling the flight of an sUA under the supervision of the RPIC.

3.1.12 *positive control, n*—condition in which commanded changes in the sUA flight path result in expected and sufficient maneuver(s) within an expected period of time.

3.1.13 *remote pilot in command, RPIC, n*—person who is directly responsible for and is the final authority as to the operation of the sUAS; has been designated as remote pilot in command before or during the flight of an sUAS; and holds the appropriate CAA certificate for the conduct of the flight.

3.1.14 *see-and-avoid, v*—use of the visual capability of a person to identify intruding aircraft so that the sUA can be maneuvered and the safe conduct of the flight can be maintained.

3.1.15 *sense-and-avoid, v*—use of a sensor system to identify intruding aircraft so that the sUA can be maneuvered and the safe conduct of the flight can be maintained.

3.1.16 *shall versus should versus may, v*—use of the word "shall" means that a procedure or statement is mandatory and must be followed to comply with this practice, "should" means recommended, and "may" means optional at the discretion of the applicant/proponent.

3.1.16.1 *Discussion*—"Shall" statements are requirements and they include sufficient detail needed to define compliance (for example, threshold values, test methods, oversight, and reference to other standards). "Should" statements are provided as guidance towards the overall goal of improving safety and could include only subjective statements. "Should" statements also represent parameters that could be used in safety evaluations or could lead to development of future requirements, or both. "May" statements are provided to clarify acceptability of a specific item or practice and offer options for satisfying requirements.

3.1.17 *small unmanned aircraft, sUA, n*—unmanned aircraft weighing less than 55 lb (25 kg) on takeoff, including everything that is on board or otherwise attached to the aircraft.

3.1.18 *small unmanned aircraft system, sUAS, n*—small unmanned aircraft and its associated elements (including communication links and the components that control the sUA) that are required for the safe and efficient operation of the sUA in a national airspace system.

3.1.19 *unmanned aircraft, UA, n*—aircraft operated without the possibility of direct human intervention from within or on the aircraft.

3.1.20 *visual line of sight, VLOS, n*—with vision that is unaided other than by corrective lenses or sunglasses, or both, the pilot or visual observer shall be able to see the sUA throughout the entire flight to determine its movement relative to intruding aircraft, obstacles, terrain; observe the airspace for other air traffic or hazards; and determine whether the sUA endangers life or property or both.

3.1.21 *visual observer, VO, n*—person who is designated by the RPIC to assist the RPIC or the pilot, or both, to see the sUAS throughout the entire flight to determine its movement relative to intruding aircraft, obstacles, terrain; observe the airspace for other air traffic or hazards; and determine whether the sUA endangers life or property or both.

3.2 *Acronyms:*

3.2.1 *AFM*—aicraft flight manual.

3.2.2 *BVLOS*—beyond visual line of sight.

3.2.3 *CAA*—civil aviation authority.

3.2.4 *C2*—command and control.

3.2.5 *CNPC*—control and non-payload communications.

3.2.6 *CONOPS*—concept of operations.

3.2.7 *EVLOS*—extended visual line of sight.

3.2.8 *OEM*—original aircraft manufacturer.

3.2.9 *ORA*—operational risk assessment.

3.2.10 *RPIC*—remote pilot in command.

3.2.11 *SDO*—standards development organization.

3.2.12 *sUAS*—small unmanned aircraft system.

3.2.13 *sUA*—small unmanned aircraft.

3.2.14 *UA*—unmanned aircraft.

3.2.15 *UAS*—unmanned aircraft system.

3.2.16 *VLOS*—visual line of sight.

3.2.17 *VO*—visual observer.

4. Significance and Use

4.1 This practice is written for all sUAS seeking permission to operate EVLOS or BVLOS, or both, in airspace authorized by a CAA.

4.2 It is assumed that the maximum weight, altitude, and airspeed of an sUAS will be specified by a CAA. However, unless otherwise specified by a nation's CAA, this practice applies to sUA that:

4.2.1 Have a maximum takeoff gross weight of less than 55 lb (25 kg), including everything that is on board or otherwise attached to the aircraft, and

4.2.2 Are remotely piloted (that is, flown without the possibility of direct human intervention from within or on the aircraft).

5. Procedure

5.1 The following steps are recommended to seek operational approval to fly an sUAS at EVLOS or BVLOS, or both. Details of each step are provided in the following paragraphs:

5.1.1 If required by the CAA, the applicant/proponent shall define the sUA system. See Section 6 for minimum requirements.

5.1.2 The applicant/proponent shall define the CONOPS. See Section 7 for minimum requirements.

5.1.3 The applicant/proponent shall perform an ORA for the total system and a proposed CONOPS which identifies proposed mitigation strategies including technology, design characteristics, training, operational requirements/limitations or procedures, or combinations thereof, for the identified hazards. See Sections 7 and 8 for minimum requirements.

5.1.4 If required to do so by the CAA, the applicant/proponent shall present results of 5.1.1 – 5.1.3 to the CAA and then refine them until it is jointly determined that risks associated with system design and the proposed operation are acceptable.

5.1.5 If required to do so by the CAA, the applicant/proponent shall work with the CAA or CAA-approved test organizations, or both, to verify that the final system and mitigation strategies meet the agreed-to requirements.

5.1.6 The operator shall obtain approval to operate from the CAA.

6. System Requirements

6.1 If required to do so by the CAA, the operational and airworthiness design requirements in the current versions of the following standards shall, at a minimum, be complied with by any sUAS flown EVLOS or BVLOS, or both. These requirements are necessary but may not be sufficient for all EVLOS or BVLOS operations, or both. Depending on the system and CONOPS proposed by the applicant/proponent, additional risk mitigations for the sUAS (see Section 8) may be required to ensure an acceptable level of risk.

F2908	Specification for Aircraft Flight Manual (AFM) for a Small Unmanned Aircraft System (sUAS)
F2909	Practice for Maintenance and Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS)
F2911	Practice for Production Acceptance of a Small Unmanned Aircraft System (sUAS)
F3002	Specification for Design of the Command and Control System for Small Unmanned Aircraft System (sUAS)
F3003	Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)
F3005	Specification for Batteries for Use in Small Unmanned Aircraft Systems
F3201	Practice for Ensuring Dependability of Software Used in an sUAS
	Standard for training of pilots and visual observers of sUAS published by a SDO. See Related Materials section for ASTM Work Item on this topic.
	Standard for sUAS operations over people published by a SDO—Only required if EVLOS or BVLOS operations or both are proposed to be flown over people. See Related Materials section for ASTM Work Item on this topic.
	Standard for design, construction, and verification of a fixed wing sUAS published by a SDO. See Related Materials section for ASTM Work Item on this topic.
	Standard for design, construction, and verification of a vertical takeoff and landing sUAS published by a SDO. See Related Materials section for ASTM Work Item on this topic.

7. Operational Risk Assessment (ORA) and Concept of Operation (CONOPS)

7.1 An ORA and CONOPS shall be completed by the applicant/proponent in accordance with Practice F3178 for Operational Risk Assessment (ORA) for an sUAS.

7.2 In addition to any hazards identified in the above published ORA standard for an sUAS, hazards specific to either EVLOS or BVLOS operations shall also be included in the ORA.

8. Risk Mitigation Strategies

8.1 Since it is anticipated that each system and CONOPS will vary considerably, specific risk mitigation strategies and details shall be proposed by the applicant/proponent to the CAA for the hazards identified in the ORA. Examples of various types of potential risk mitigation strategies follow. Note that these potential risk mitigation strategies are options that could be proposed to the CAA for consideration—they are not requirements. As more details on acceptable risk mitigation strategies become available, these may be included in future standards or appendixes to this practice.

8.1.1 *Examples of Design or sUAS Characteristics, or Both:*

8.1.1.1 For EVLOS operations, use an onboard telemetry system or other effective means of determining location and, where applicable, altitude, speed, heading, and ground track (either ground based or onboard the sUA) that ensures the RPIC or VO, or both, know the location of the sUA so that they can maintain situation awareness (that is, traffic, terrain, obstacles, and weather) of the airspace in which the sUA operation is being conducted. This allows the VO, in conjunction with the RPIC, to perform the see-and-avoid function for EVLOS operations.

8.1.1.2 For BVLOS operations, use an onboard telemetry system that ensures the RPIC knows the location and, where applicable, altitude, speed, heading, and ground track of sUA sufficiently adequate so that situation awareness (that is, traffic, terrain, obstacles, and weather) of the airspace in which the

sUAS operation is being conducted can be maintained without seeing it with direct unaided vision for BVLOS operations.

8.1.1.3 Use of system redundancy or reliability testing, or both, to minimize system failures or degradations, or both. Testing, together with design characteristics or design analysis, or both, shall demonstrate an acceptable level of safety.

8.1.1.4 Use of C2 system design or characteristics, or both, (for example, frequency hopping, multiple radios, redundant C2 systems, licensed or unlicensed commercially available spectrum, or both, and aviation-protected spectrum) in order to minimize loss, interruption, or degradation of C2 link.

8.1.1.5 Incorporate onboard safety systems that assure emergency recovery of the sUA or flight termination in the event of unrecoverable system failure.

8.1.1.6 For sUAS that use adaptive or complex algorithms, comply with standard for safely bounding flight behavior of UAS containing adaptive or complex algorithms published by a SDO. See Related Materials section for ASTM Work Item on this topic.

8.1.2 *Examples of System Architecture Risk Mitigations:*

8.1.2.1 Use an off-board system (not part of the sUA) that ensures either the RPIC or the VO knows the location of sUA (without necessarily seeing it with unaided vision) so that either the RPIC or the VO can perform the see-and-avoid function for EVLOS.

8.1.2.2 Use a ground-based sense-and-avoid system for BVLOS operations.

8.1.2.3 Use a sUA-based sense-and-avoid system for BVLOS operations.

8.1.3 *Examples of Operational Requirements/ Characteristics/Limitations:*

8.1.3.1 Conduct flights in airspace/altitude blocks where the risk of the sUA colliding with manned or unmanned aircraft, obstructions, or terrain is deemed acceptable by the CAA.

8.1.3.2 Only conduct flights over areas where the risk to people and property on the ground is deemed acceptable by the CAA.

8.1.3.3 Have additional training for RPIC, VOs, and other critical crew members specified in a standard published by a SDO. See Related Materials section for ASTM Work Item on this topic.

9. Keywords

9.1 BVLOS; CONOPS; EVLOS; ORA; small unmanned aircraft; small unmanned aircraft system; sUA; sUAS

RELATED MATERIAL

WK29229 Practice for Training of Pilots and Visual Observers for Small Unmanned Aircraft Systems (sUAS)

WK52089 Specification for Operations over People of Small Unmanned Aircraft Systems (sUAS)

WK52962 Specification for Design, Construction, and Verification of Fixed Wing Small Unmanned Aircraft Systems (sUAS)

WK53964 Specification for Design Construction of a Vertical Takeoff and Landing Small Unmanned Aircraft System (sUAS)

WK53043 Methods to Safely Bound Flight Behavior of Unmanned Aircraft Systems (UAS) Containing Adaptive or Complex Algorithms