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Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems¹

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1. Scope

1.1 This specification establishes the standard practice for the maintenance and continued airworthiness of a lightweight unmanned aircraft system (UAS).

1.2 At a minimum, a UAS is defined as a system composed of the unmanned aircraft and all required subsystems, control station, all required crew members, command and control (C2) links, and any required launch and recovery equipment.

1.3 The intended use for this specification is for civil aviation authority (CAA), self-, or third-party determinations of continued airworthiness for UAS. This specification provides the core requirements for continued airworthiness of lightweight UAS or for certain CAA operational approvals using risk-based categories, or both. Additional requirements are envisioned to address the requirements for expanded operations and characteristics not addressed by this specification.

1.4 This specification is intended to support aircraft development in accordance with Specifications F2910, F3002, F3005, and F3298.

1.5 This specification is intended to support UAS operations. It is assumed that the risk of UAS will vary based on concept of operations, environment, and other variables. The fact that there are no human beings onboard the UAS may reduce or eliminate some hazards and risks.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*²

F2908 Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)

F2910 Specification for Design and Construction of a Small Unmanned Aircraft System (sUAS)

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

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

F3298 Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems (UAS)

2.2 *Federal Standard:*³

14 CFR Part 107 Small Unmanned Aircraft Systems

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *airframe, n*—fuselage, booms, nacelles, cowlings, fairings, airfoil surfaces (including rotors, but excluding propellers and rotating airfoils of engines), and landing gear of an aircraft, and their accessories and controls.

3.1.2 *airworthiness, n*—condition in which the unmanned aircraft system (UAS) (including the aircraft, airframe, engine, propeller, accessories, appliances, firmware, software, and control station elements) conforms to its design intent, including as defined by the type certificate (TC), if applicable, and is in condition for safe operation.

3.1.3 *civil aviation authority, CAA, n*—government regulatory agency that governs aircraft, airmen, and operations.

3.1.3.1 *Discussion*—In the United States, this is the Federal Aviation Administration (FAA).

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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 U.S. Government Publishing Office, 732 N. Capitol St., NW, Washington, DC 20401, <http://www.gpo.gov>.

3.1.4 *command and control (C2) link(s)*, *n*—safety critical radio frequency (RF) link(s) between the control station (CS) and the unmanned aircraft (UA).

3.1.5 *control station, CS*, *n*—ground-, air-, or marine-based interface used by the remote pilot or the person manipulating the controls to control the flight path of the UA.

3.1.6 *fail-safe system*, *n*—safety feature that, in the event of a specific type of failure, inherently responds in a way that will cause no undo hazards to people, the environment, or equipment.

3.1.7 *flight control system, FCS*, *n*—composed of system components that are necessary to control the aircraft in flight.

3.1.8 *flight-critical system*, *n*—system that, should it fail, the UA would no longer be in a condition for safe operations likely resulting in loss of control.

3.1.9 *flight manual, FM*, *n*—manual describing the operation of the aircraft and includes any limitations; normal, abnormal, and emergency procedures; and provides specific facts, information, or instructions, or combinations thereof, about a particular aircraft and the operation of that aircraft.

3.1.10 *flight manual supplement, FMS*, *n*—document that provides supplemental information for equipment that is not part of the basic aircraft and included in the main flight manual.

3.1.11 *flight termination system, FTS*, *n*—consists of the components of a UA that provide the ability to command an end to that vehicle’s flight in an acceptable manner.

3.1.12 *inspection*, *n*—technique based on visual or dimensional examination of an element; inspection is generally nondestructive, limited in its disruption to the system, and may typically include the use of sight, hearing, smell, and touch, simple physical manipulation, mechanical and electrical gauging, and measurement, and no stimuli (tests) are necessary.

3.1.13 *inspection programs*, *n*—provide guidance in the “when, what” is inspected—unscheduled and scheduled inspection intervals for determining aircraft system conditions.

3.1.14 *lightweight UAS*, *n*—as defined in Specification **F3298**.

3.1.15 *maintenance*, *n*—UAS maintenance means inspection, overhaul, repair, preservation, and the replacement of parts and system software upgrades of the UAS and its components necessary for continued safe flight operations.

3.1.16 *maintenance programs*, *n*—provide guidance in the “what, when, and how” maintenance actions that take place related to unscheduled inspections (that is, result of damage), overhaul, and scheduled part replacement (life limited), and so forth.

3.1.16.1 *Discussion*—In regard to maintenance programs versus inspection programs, maintenance personnel should not confuse an inspection program with the elements that make up a more extensive maintenance program. An inspection program will only capture a list of scheduled inspections, whereas a maintenance program will encompass many elements including inspections, overhaul requirements, repair schemes, and the scheduled replacement of parts.

3.1.17 *manufacturer*, *n*—person or organization who causes production of a product or article.

3.1.17.1 *Discussion*—A manufacturer can also be an owner/operator.

3.1.18 *operator*, *n*—person or organization granted UAS operational approval by a CAA.

3.1.19 *original equipment manufacturer, OEM*, *n*—person or organization who first produced that product or article.

3.1.19.1 *Discussion*—An OEM may also be an operator.

3.1.20 *payload*, *n*—any instrument, mechanism, equipment, part, apparatus, appurtenance, or accessory, including communications equipment, that is installed in or attached to the aircraft; is not used or intended to be used in operating or controlling an aircraft in flight; and is not part of an airframe, engine, or propeller.

3.1.21 *periodic inspections*, *n*—periodic inspections procedures shall be used to ensure the UAS components/subsystems that cannot be verified during preflight inspections, if any, are in a condition for safe operation.

3.1.21.1 *Discussion*—Periodic inspections should occur at an interval that can identify component/subsystem degradation before failure.

3.1.22 *preflight inspections*, *n*—preflight inspections procedures shall determine before each flight that the UAS is in a condition for safe operation and encompass visual or functional checks, or both, as defined by the unmanned aircraft flight manual (UFM), unmanned aircraft maintenance manual (UMM), or a supporting maintenance and inspection program.

3.1.22.1 *Discussion*—More information can be found in Specification **F2908**.

3.1.23 *preventative maintenance and servicing*, *n*—simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations that support the condition for safe operation of the aircraft system.

3.1.23.1 *Discussion*—This may include both hardware- and software-related preventative maintenance and servicing. Aircraft systems are serviced at a minimum time, or cycle, interval that will prevent system or component failure because of insufficient servicing.

3.1.24 *propeller*, *n*—device for propelling an aircraft that has blades on a powerplant-driven shaft and, when rotated, produces by its action on the air a thrust approximately perpendicular to its plane of rotation.

3.1.24.1 *Discussion*—It includes control components normally supplied by its manufacturer but does not necessarily include main and auxiliary rotors or rotating airfoils of engines.

3.1.25 *propulsion system*, *n*—consists of one or more powerplants (for example, a combustion engine or an electric propulsion unit and, if used, a propeller or rotor) together with the associated installation of fuel system, control, and electrical power supply (for example, batteries, electronic speed controls, fuel cells, or other energy supply).

3.1.26 *qualified maintainer*, *n*—person trained in the tools, techniques, and practices necessary to assure completion of the work in accordance with accepted industry practices, OEM instructions, or the nation’s CAA.

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

3.1.28 *repairs and alterations, n*—instructions from the manufacturer that define a major and minor “repair” and a major and minor “alteration” in the UMM or the UFM, or both, as well as identify who is authorized to perform each classification of repair or authorization.

3.1.29 *rotor, n*—propeller that is positioned to provide principle lift/vertical thrust and is capable of being driven entirely by action of the air when the rotorcraft is in motion (for example, autorotative state).

3.1.30 *scheduled maintenance, n*—includes any of the maintenance actions accomplished on a regular basis that support the condition for safe operation of the aircraft system.

3.1.30.1 *Discussion*—This may include inspections and other activities that are performed to detect potential failures of system components before failure occurs.

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

3.1.32 *supplier, n*—any entity engaged in the design and production of components (other than payload if it is not required for safe operation of the UAS) used on a UAS.

3.1.33 *support equipment, n*—all associated equipment, whether ground based or airborne, used to enable safe operation of the UA.

3.1.33.1 *Discussion*—This may include all elements of the control station, C2 links, telemetry, navigation, communications equipment, as well as equipment that may be used to launch and recover the aircraft.

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

3.1.35 *unscheduled maintenance, n*—includes procedures, instructions, and standards for troubleshooting and maintenance that occurs on an unscheduled or unpredictable basis.

3.1.35.1 *Discussion*—A need for unscheduled maintenance may result from scheduled maintenance task, inspections, or unforeseen events such as, but not limited to, hard landings, tail strikes, or any other mishap in which a maintenance action is required to correct a known condition to ensure the UAS is in a condition for safe operation before further flight.

3.2 Acronyms:

3.2.1 *EO/IR*—electro-optical/infrared

3.2.2 *GAA*—governing aviation authority

3.2.3 *GPS*—global positioning system

3.2.4 *UFM*—unmanned aircraft flight manual

3.2.5 *UMM*—unmanned aircraft maintenance manual

3.2.6 *VTOL*—vertical takeoff and landing

4. General Requirements

4.1 This specification is intended for lightweight UAS permitted to operate over a defined area and in airspace controlled by a nation’s CAA.

4.2 The baseline covered by this specification should not require an authorization by a CAA for the flight but stay within defined boundaries for the operation (for example, distance from airports, from people, maximum weight, altitude, airspeed, and operational envelope). However, unless otherwise allowed by a nation’s CAA or subject to voluntarily compliance by an applicant, this specification applies to UA that conduct expanded operations that typically require authorization from the CAA (for example, operations authorization for specific category UAS or an applicable certificate of waiver/authorization) with specific limitations adapted to the operation.

4.3 These requirements apply to UAS that are:

4.3.1 *Fixed-Wing*—Heavier than air and supported in flight by the dynamic reaction of the air against its wings. The UA may be powered or unpowered; the UA may have rigid, semi-rigid, or flexible wings.

4.3.2 *VTOL*—Heavier than air and capable of vertical or near-vertical takeoffs and landings. The rotor system may be powered or unpowered; rotors may be either fixed collective pitch or collective pitch control that are not adjustable in flight.

4.3.3 *Hybrid UAS*—Combination of fixed-wing and VTOL design.

5. Maintenance and Inspection Requirements

5.1 The UAS shall be maintained for continued airworthiness, being in a condition for safe operation, and in accordance with any and all rules and regulations applicable to UAS limitations and performance capabilities required by the nation’s CAA.

NOTE 1—“Continued airworthiness” and “condition for safe operation” refer to the condition of the aircraft, control station(s), and other associated elements relative to wear, deterioration, equipment malfunctions, structural damage, or any other discrepancy that renders the aircraft in a condition that is determined not safe for flight operations.

NOTE 2—Initial airworthiness of the aircraft, required on-board and off-board systems, and miscellaneous equipment is established by conformance to the appropriate ASTM International design and construct standards or the nation’s CAA.

NOTE 3—In regard to maintenance programs versus inspection programs, maintenance personnel should not confuse an inspection program with the elements that make up a more extensive maintenance program. An inspection program will only capture a list of scheduled inspections, whereas a maintenance program will encompass many elements to include inspections, overhaul requirements, repair schemes, and the scheduled replacement of parts.

5.2 Maintenance:

5.2.1 The manufacturer should provide instructions for continued airworthiness and maintaining the system in condition for safe operation in a manufacturer-provided maintenance program. The aircraft maintenance program shall include unscheduled and scheduled maintenance instructions.

5.2.2 In the absence of a manufacturer-provided maintenance program, it is the responsibility of the owner/operator to determine the requirements to maintain the system in condition