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Standard Terminology for Unmanned Aircraft Systems[1]

This standard is issued under the fixed designation F3341/F3341M; 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 terminology standard covers definitions of terms and concepts related to unmanned aircraft systems (UAS). It is intended to encourage the consistent use of terminology throughout all ASTM unmanned aircraft system standards and is intended to complement F3060 Standard Terminology for Aircraft. Terms already included in Terminology F3060 are not duplicated here.

1.2 A definition adapted from a particular standard within the ASTM F38 collection of standards is not limited to use within only those standards.

1.3 Additional terms specific to a given standard may be defined solely within that standard and not included here.

1.4 *Units*—The definitions of units will be as defined in NIST SP 330, and will not be duplicated in this document. NIST SP 330 is available on the internet.[2] The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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

1.6 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

F2395 Terminology for Unmanned Aircraft Systems (Withdrawn 2014)[4]

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

F2909 Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems

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

F3060 Terminology for Aircraft

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

F3196 Practice for Seeking Approval for Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations

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

F3266 Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement

F3269 Practice for Methods to Safely Bound Behavior of Aircraft Systems Containing Complex Functions Using Run-Time Assurance

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

F3322 Specification for Small Unmanned Aircraft System (sUAS) Parachutes

F3330 Specification for Training and the Development of Training Manuals for the UAS Operator

F3364 Practice for Independent Audit Program for Unmanned Aircraft Operators

F3365 Practice for Compliance Audits to ASTM Standards on Unmanned Aircraft Systems

[1] This terminology is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.03 on Personnel Training, Qualification and Certification.

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[2] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

F3366 Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)
F3379 Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement
F3389/F3389M Test Method for Assessing the Safety of Small Unmanned Aircraft Impacts
F3411 Specification for Remote ID and Tracking
F3423 Specification for Vertiport Design
F3442/F3442M Specification for Detect and Avoid System Performance Requirements
F3548 Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability
F3563 Specification for Design and Construction of Large Fixed Wing Unmanned Aircraft Systems

2.2 *Other Documents:*

14 CFR 107 Small Unmanned Aircraft Systems[5]
ICAO UTM Framework Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization[6]
NIST SP 330 The International System of Units[2]

NOTE 1—A source reference will be given for all terms herein. That original source may no longer contain the definition or that definition may have been edited for inclusion herein.

[5] Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.
[6] Available from International Civil Aviation Organization (ICAO), 999 Robert-Bourassa Boulevard, Montréal, Québec H3C 5H7, Canada, https://www.icao.int.

3. Terminology

3.1 *Definitions:*

constrained-space operation, *n*—an unmanned aircraft systems operation in which UA's flight environment is limited by walls, ceiling, net, or other physical limitation of the volume; also referred to as an "indoor operation." This definition is not to be used to denote virtual constraints, such as geofences or geocages.

strategic deconfliction, *n*—the arrangement, negotiation, coordination, and prioritization of intended operational volumes, routes, or trajectories to minimize the likelihood of airborne conflicts between operations. **(adapted from ICAO UTM Framework)**

unmanned aircraft, UA, *n*—an aircraft operated without the possibility of direct human intervention from within or on the aircraft. **14 CFR 107.3**

visual range, *n*—distance that unaided (except for normal prescription eyewear) human vision can effectively monitor and provide deconfliction during a UAS operation. **F2395**

3.2 *Abbreviations and Acronyms:*

UA—unmanned aircraft

4. Keywords

4.1 aircraft; remotely piloted aircraft; terminology; sUAS; UAS; unmanned aircraft system

APPENDIXES

(Nonmandatory Information)

X1. AIRWORTHINESS TERMINOLOGY

INTRODUCTION

This terminology appendix contains a listing of terms, abbreviations, acronyms, and symbols related to UAS airworthiness covered by published ASTM Subcommittee F38.01 standards. The intent is to provide baseline definitions that will result in consistent definitions across all of the ASTM UAS standards.

As terms, abbreviations, acronyms, and symbols are incorporated into new standards, and actually used, they may require some slight modification prior to being incorporated into the mandatory section of F3341/F3341M.

abstain

abstain, *v*—prior to starting a particular test method, the UA manufacturer or designated operator shall choose to enter the test or abstain. Any abstention shall be granted before the test begins. The test form shall be clearly marked as such, indicating that the manufacturer acknowledges the omission of the performance data while the test method was available at the test time. **F3298**

abstain, *v*—before starting a particular test method, the unmanned aircraft (UA) manufacturer or designated operator shall choose to enter the test or decline to perform the test and any abstention shall be granted before the test begins. **F3322**

DISCUSSION—The test form shall be clearly marked as such, indicating that the manufacturer acknowledges the omission of the performance data while the test method was available at the test time. **F3322**

acceptable entanglement, *n*—interaction of the parachute canopy, risers, or lines with the sUA that does not reduce the effectiveness of the parachute recovery system. **F3322**

airframe, *n*—airframe means the 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. **F3298**

airworthiness, *n*—condition in which the unmanned aircraft systems (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. **F3298**

alert, *n*—a generic term used to describe a control station indication meant to attract the attention of and identify to the flightcrew a non-normal operational or airplane system condition. Alerts are classified at levels or categories corresponding to Warnings, Cautions, and Advisories. Alert indications also include non-normal range markings (for example, exceedances on instruments and gauges). **F3298**

alert function, A1F, *n*—the function within the DAA system tasked with notifying the avoid function (whether human or automated system, or both) of the presence of an intruder. **F3442/F3442M**

analysis, *n*—technique based on analytical evidence obtained without any intervention on the submitted element using mathematical or probabilistic calculation, logical reasoning (including the theory of predicates), modeling or simulation, or combinations thereof, under defined conditions to show theoretical compliance. **F3298**

applicant

applicant, *n*—the person or organization responsible for seeking the approval to operate, and operating, an unmanned aircraft (UA). The applicant may be one of the following entities: manufacturer, operator, or original equipment manufacturer. **F3389/F3389M**

applicant/proponent, *n*—the person or organization responsible for seeking the approval to operate and operating a UA. The applicant/proponent may be one of the following entities: manufacturer, operator, or original equipment manufacturer. **F3298**

applicant/proponent, *n*—person or organization responsible for seeking the approval to operate and operating a small unmanned aircraft (sUA). **F3322**

DISCUSSION—The applicant/proponent may be one of the following entities: manufacturer, operator, or original equipment manufacturer (OEM). **F3322**

application programming interface, API—definition of the inputs and outputs for operations intended for use by other software modules. **F3201**

architecture, *n*—architecture is made up of the definition of the sUAS Software components, the data that flows between the components (data flow), and the order of execution of the components (control flow). **F3201**

as flown or as to be flown, *n*—these terms represent the configuration under test and describe the mass and structural properties of the sUA and its payloads. During test, the as flown or as to be flown configuration structure and impact characteristics shall be representative of the flight configuration being considered for use. **F3389/F3389M**

automatic flight control system, *n*—a system which includes all equipment to control automatically the flight of an aircraft to a path or altitude described by references, internal or external, to the aircraft. **F3298**

autonomous triggering system, ATS, *n*—device or components independent from any flight critical system of the sUA that will detect and initiate parachute deployment upon detection of a critical failure of the sUA in flight. **F3322**

avoid function, A2F, *n*—the function within the DAA system tasked with providing the flight guidance necessary to maneuver away from the potential *hazard* posed by detected intruder(s). Avoidance may be executed automatically by a flight controller or manually by a *pilot*. **F3442/F3442M**

ballistic ejection, *n*—ejection of the parachute recovery system into free air with the use of springs, pyrotechnic gas generators, or the use of inert gases or compressed air. **F3322**

DISCUSSION—Hazardous materials laws (for air transportation, for proper handling, storage, etc.) may apply when using hazardous materials such as pyrotechnic devices, cold gas generators, or compressed CO_2 for a ballistic parachute. **F3322**

beyond visual line of sight, BVLOS, *n*—operation when the UA cannot be seen by the individuals responsible for see-and-avoid with unaided (other than corrective lenses or sunglasses, or both) vision, but where the location of the sUA is known through technological means without exceeding the performance capabilities of the C2 link. **F3442/F3442M**

bill of materials, BOM—specific list of all components defined by this specification that make up the parachute recovery system. **F3322**

bit error rate detection, BER—rate at which errors occur in a transmission system; applicable to any system that transmits data over a network of some form in which noise, interference, and phase jitter may cause degradation of the digital signal. **F3002**

C2 range, *n*—distance between GCS and UA at which positive control of the UA can be maintained. **F3002**

canopy filling/inflammation time—time from canopy (line) stretch to the first full open canopy position. **F3322**

category 2 operations, *n*—under the Micro UAS Advisory Rulemaking Committee (ARC), a Category 2 operation is an sUA permitted to operate over people if it weighed more than 0.55 lb, but still presented a 1 % or less chance of "serious injury" (Abbreviated Injury Scale (AIS) level 3 or greater) upon impact with a person. **F3389/F3389M**

category 3 operations, *n*—under the Micro UAS ARC, a Category 3 operation is an sUA permitted to operate over

people if it presented a 30 % or less chance of causing an AIS level 3 or greater injury upon impact with a person. The manufacturer of the small UAS would be required to certify to the FAA that the small UAS did not, in the most probable failure modes, exceed the typical or likely impact energy threshold. **F3389/F3389M**

code churn, *n*—the quantity and frequency of additions, deletions, and modifications to the source code for software. **F3201**

code coverage, *n*—a measure used to describe the degree to which the source code of a program is tested by a particular test suite. **F3201**

command and control (C2) link(s), *n*—safety-critical radio-frequency (RF) link(s) between the ground control station (GCS) and the unmanned aircraft (UA). **F3002**

complex function, *n*—software function or algorithm that may cause the UAS to operate in a manner that is difficult to predict due to compounded implications from factors such as sensor measurement precision, algorithm complexity, environmental variables (for example, gusts, traffic, electromagnetic effects, etc.), multi-core processing, probabilistic algorithms, fuzzy logic, machine learning, genetic algorithms, resource availability, and aircraft system state. These software functions or algorithms are sometimes referred to as "autonomous," "non-deterministic," "artificial intelligence," "adaptive," or "intelligent" algorithms. **F3269**

conflict point, *n*—the time of a predicted collision or point of closest approach that is within the collision volume. **F3298**

continued safe flight

continued safe flight, *n*—a condition whereby a UA is capable of continued safe flight, possibly using emergency procedures, without requiring exceptional pilot skill. Upon landing some UA damage may occur as a result of a failure condition. **F2910**

continued safe flight, *n*—a condition whereby a UA is capable of continued controlled flight, and landing at a suitable location, possibly using emergency or abnormal procedures, but without requiring exceptional pilot skill. Some UA damage may be associated with a failure condition during flight or upon landing. **F3298**

continuous built-in test, *n*—component level tests that are critical for monitoring the integrity of data and health of the aircraft systems which are crucial for validating the data used for determining acceptable aircraft safety and stability and control. **F3269**

control and non-payload communications, CNPC, *n*—radio frequency (RF) link(s) between the control station (CS) and the unmanned aircraft (UA), also known as the Command and Control Link(s). **F3298**

controlled airspace, *n*—an airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification. **F3442/F3442M**

DISCUSSION—For example, in the United States, Classes A, B, C, D, and E airspace. **F3442/F3442M**

DISCUSSION—Controlled airspace does not automatically imply separation services, or that the location of all traffic is known. **F3442/F3442M**

controlled flight, *n*—a condition whereby the remote pilot or onboard systems or both, have the ability to perform functions to the extent necessary to continue safe flight and landing, but not necessarily full functional performance. **F3298**

control station, *n*—apparatus for hosting the remote pilot and her/his device to teleoperate the UAS. **F3298**

critical number motor failure, CNMF, *n*—number of motors required to remove a sUA from stable flight. The subject motors shall be adjacent to one another in cases in which more than one motor is being tested. In the case of an odd number of motors, the number of "failure" motors shall be rounded up to the next even number. If the integrator can demonstrate that the sUA being tested with the PRS needs to have thrust cut from more motors than defined in the example below in order to remove the aircraft from stable flight it is up to the integrator to define the number of motors to reach CNMF. Refer to Section 6, F3322, for testing.

Examples of CNMF	4 Rotor	6 Rotor	8 Rotor
	Immediate Loss of Thrust on a minimum of one or more motors	Immediate Loss of Thrust on a minimum two adjacent motors	Immediate Loss of Thrust on a minimum of three adjacent motors

F3322

critical number motor failure plus one, CNMF + 1, *n*—number of motors required to remove an sUA from stable flight plus one additional adjacent motor. **F3322**

critical speed, *n*—the speed at which the sUA is capable of its maximum kinetic energy (KE) considering both powered flight as well as failure conditions. The critical speed for fixed-wing sUA is the maximum cruise speed. The critical speed for rotor-wing sUA is the speed of the rotorcraft at terminal velocity. **F3389/F3389M**

customer, *n*—includes stakeholders outside of the sUAS manufacturer who interface with the sUAS. **F3201**

DAA cycle, *n*—the maximum time from the presence of the intruder to the execution of an avoidance maneuver. **F3442/F3442M**

decision delay, *n*—cumulative delays from the safety monitor and the RTA Switch. **F3269**

declaration of compliance, *n*—mechanism for thorough self-assessment and validation of compliance with this specification in which specific reporting or testing protocols are not listed. **F3322**

DISCUSSION—The integrator will keep documentation to support any declarations of compliance. The following information shall be retained on file at the manufacturer's facility for as long as systems remain in service: *(1)* technical data that defines the parachute recovery system's

installation in the aircraft; *(2)* technical data that define the components, assemblies, and fabrication of the system; and *(3)* engineering analyses and test data prepared for qualification with this specification. **F3322**

demonstration

demonstration, *n*—technique used to demonstrate correct operation of the submitted element against operational and observable characteristics without using physical measurements (no or minimal instrumentation or test equipment). It generally consists of a set of tests selected by the supplier to show that the element response to stimuli is suitable or to show that operators can perform their assigned tasks when using the element. Observations are made and compared with predetermined/expected responses. **F3298**

demonstration, *n*—a practical exhibition of how the PRS or components, or both, work. **F3322**

dependability, *n*—attribute of the software code that produces the consequences for which it was written, without adverse effects, in its intended environment. **F3201**

descent rate, *n*—final steady state rate of decreasing vertical altitude of the sUA at sea level conditions. **F3322**

DISCUSSION—It shall be noted that horizontal speed and the calculation of horizontal impact should be considered based on the worst-case scenario but for the purpose of this specification it is not used as a determining factor. The horizontal impact can be influenced by the construction or deconstruction of the combination of wind or the pendulum effect, or both, both of which are greatly affected by the direction of travel and orientation of the sUA in relation to the PRS during deployment. **F3322**

design maximum aircraft weight, W_{MAX}, *n*—aircraft design maximum weight for unmanned aircraft shall be the highest weight at which compliance with each applicable structural loading condition and all requirements for flight regimes is shown. **F3298**

detect and avoid, DAA, *n*—a subsystem within the UAS providing the situational awareness, alerting, and avoidance necessary to maintain safe BVLOS operation of the ownship in the presence of intruders. **F3442/F3442M**

detect function, DF, *n*—the function within the DAA system tasked with maintaining temporal and spatial awareness of intruders. **F3442/F3442M**

downlink, *n*—any RF link from UA to GCS. **F3002**

dynamic program analysis, *n*—the practice of analyzing software while it is executing, for example monitoring memory access, allocation, and deallocation during program execution. For example, Valgrind is a popular open-source tool that performs this type of analysis. **F3201**

EDS quality plan, *n*—a plan to address the software quality in the event that EDS source code is not available. See Appendix X2, F3201 for more details. **F3201**

electric propulsion unit, EPU, *n*—any electric motor and all associated devices used to provide thrust for an electric aircraft. **F3298**

encounter, *n*—the event associated with the presence of an intruder. **F3442/F3442M**

encounter rate, *n*—the number of encounters per unit time. **F3442/F3442M**

energy measurement, *n*—Kinetic energy is calculated as: KE = ½ mv^2. Whereas "m" equals sUAs takeoff mass and "v" equals descent speed. **F3322**

energy storage device, ESD, *n*—used to store energy as part of an Electric Propulsion Unit (EPU). Typical energy storage devices include but are not limited to batteries, fuel cells, or capacitors. **F3298**

entanglement, *n*—unintended physical interaction of the parachute risers, lines, or canopy with the sUA during a PRS deployment that compromises the functionality and effectiveness of the PRS. **F3322**

envelope protection, *n*—the human-machine interface extension of an automatic flight control system that prevents the remote pilot from making control commands that would force the aircraft to exceed its structural and aerodynamic operating limits. UAS with envelope protection are intended for non-acrobatic operation. Non-acrobatic operation includes: any maneuver incident to normal flying; stalls (except whip stalls); and lazy eights, chandelles, and steep turns, in which the angle of bank is not more than 60°. **F3298**

expanded operations, *n*—UAS operations that typically require authorization from the CAA (for example, Operations Authorization for Specific Category UAS or Part 107 Certificate of Waiver/Authorization) with specific limitations adapted to the operation. **F3298**

externally developed software, EDS, *n*—software developed outside of the sUAS manufacturer for which adequate records of the development process may not be available. **F3201**

extremely improbable, *n*—a probability no greater than one occurrence every 1 000 000 (10^{-6}) flight hours **F3298**

extremely remote probability, *n*—a probability no greater than one occurrence every 100 000 (10^{-5}) flight hours. **F3298**

fail box/orange wire, *n*—an independent system from the sUA that is not a normal component of the sUA during operation and is used for introducing the various failure modes independently of the sUA, the parachute recovery system (PRS), and its flight termination system (FTS) and autonomous triggering system (ATS) and manual triggering device (MTD) of the PRS. **F3322**

false deployment, *n*—an unintentional deployment of the PRS by the ATS during stable flight. **F3322**

flight control system, FCS, *n*—composed of system components intended to take GCS commands via a C2 link and control flight control surfaces and propulsion systems. **F3002**

DISCUSSION—The FCS may include autopilot functions, lost-link functions, fly-away protection functions, payload functions, and navigation functions. The FCS may be contained in one discrete component or multiple discrete components. **F3002**

flight critical system

flight-critical system, *n*—a system that, should it fail, will cause loss of control of the UA, or the UA will no longer stay capable of continued safe flight. **F3298**

flight-critical system, *n*—system that, should it fail, will cause the sUA to no longer maintain stable flight. **F3322**

flight envelope, *n*—range of combinations of speed, direction of travel, altitude, roll, angle of attack, and so forth within which the sUA is able to be safely operated without exceeding its structural design load factor. **F3322**

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. **F3298**

DISCUSSION—For airplanes, this is identified as an airplane flight manual (AFM). For UAS, this is identified as an unmanned aircraft flight manual (UFM). **F3298**

flight manual supplement, FMS, *n*—document that provides supplemental information, usually for equipment that is not part of the basic aircraft and included in the main flight manual. **F3298**

flight termination system

flight termination system, *n*—a system that terminates the flight of a UAS in the event that all other contingencies have been exhausted and further flight of the aircraft cannot be safely achieved, or other potential hazards exist that immediate discontinuation of flight. **F3298**

flight termination system, FTS, *n*—device or components that will disable the propulsion system of the sUA. **F3322**

flight training supplement, FTS, *n*—document providing guidance for training for unmanned aircraft. **F3298**

fly away

fly away, *n*—unintended flight outside of operational boundaries (altitude/airspeed/lateral) as the result of a failure of the control element or onboard systems, or both. **F3002**

fly-away, *n*—flight outside of operational boundaries (altitude/airspeed/lateral limits) as the result of a failure, interruption, or degradation of the control station or onboard systems, or both. **F3298**

fly away protection system

fly-away protection system, *n*—a system that will return the UA safely to the surface, or keep the UA within the intended operational area, when the C2 link between the pilot and the UA is lost. **F3002**

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 3.1.26, F3298. **F3298**

forebody, *n*—object connected to the parachute canopy and accompanying drogue chutes, if applicable.

DISCUSSION—The forebody shall be considered the sUA with any additional attachments (that is, parachute deployment system, payload, electronics, propellers, and so forth). **F3322**

full power failure/full power cut, *n*—sudden and immediate loss of power function to the critical flight systems of the sUA such as motors, electronic speed controllers (ESC), and avionics.

DISCUSSION—Throttling down the motors is not the same as a full power cut in a test as the former gives the operator control and advance knowledge that loss of stable flight is going to occur. **F3322**

fuzz testing, *n*—a testing technique wherein the input to a unit under test is unexpected in some way. Examples include testing with input that is invalid, unexpected, or random. **F3201**

geo-fence—a virtual geographic boundary, defined by location-based services, that enables software to trigger a response when a mobile device enters or leaves a particular area. **F3298**

ground control station, GCS—a land- or sea-based control center that provides the facilities for human control of UA. **F3002**

ground roll distance, *n*—the horizontal distance between start of takeoff or at a low height above ground (as used in rail-assisted launch), or both, and should be of sufficient distance to allow the UA to gain the manufacturer's published climb-out speed (that is, the point when V_T is reached). This may begin at the release of brakes (that is, with traditional aircraft) or at the point of launch (for example, via hand-launch or catapult system). Alternatively referred to as "departure roll." **F3298**

improbable, *n*—a probability no greater than one occurrence every 100 flight hours (10^{-2}). **F3298**

input delay—cumulative delay from the sensed inputs and the RTA Input Manager. **F3269**

inspection, *n*—technique based on visual or dimensional examination of an element; inspection is generally nondestructive, and typically includes the use of sight, hearing, smell, touch, and taste, simple physical manipulation, mechanical and electrical gauging, and measurement (F3298, F3322). No stimuli (tests) are necessary. The technique is used to check properties or characteristics best determined by observation (for example, paint color, weight, documentation, listing of code, etc.). **F3298**

integrator, *n*—entity responsible for the integration of all the various parachute components, the sUA, and the testing of the entire system. **F3322**

DISCUSSION—The integrator could also be the parachute recovery system manufacturer or the sUA manufacturer. The integrator may also

work with other named third parties to delegate various tasks. Tasks the integrator has are: *(1)* selection and integration of the parachute components, parachute deployment device, and any other electronics needed; *(2)* installation of the parachute recovery system on the sUA and working with the sUA manufacturer to integrate the system properly; *(3)* pulling together all the various component specifications to be sure they meet the requirements called out in this specification; and *(4)* performing and coordinating with a test facility all the various flight tests called out in this specification. **F3322**

internal user, *n*—includes stakeholders within the sUAS manufacturer's organization who interface with the sUAS. **F3201**

internally developed software, IDS, *n*—software developed within the sUAS manufacturer's organization. **F3201**

intruder, *n*—a manned aircraft external to ownship within or projected to be in the ownship's vicinity in the near future. **F3442/F3442M**

DISCUSSION—This definition is deliberately equivocal since the DAA system architecture and technologies employed, as well as ownship maneuvering capabilities, will shape the specific definitions of "vicinity" and "near future." **F3442/F3442M**

launch and recovery load, *n*—those loads experienced during normal launch and recovery of the UA. **F2910**

licensed band, *n*—any frequency or range of frequencies in which transmission requires permission from a governing body (for example, the Federal Communications Commission [FCC]). **F3002**

lightweight UAS, *n*—unmanned small aircraft that are approved for operation under the authority of a CAA (for example, UAS approved to operate by the FAA under 14 CFR Part 107, UAS approved to operate by EASA as Open and Specific Category UA, and UAS approved to operate by CASA as Small, Medium, or Large RPA, or combinations thereof). **F3298**

limit load, *n*—those loads experienced in the normal operation and maintenance of the UA. **F2910**

link error, *n*—degradation of the digital signal between the GCS and the UA that can be monitored by techniques including BER detection. **F3002**

link integrity, *n*—acceptable rate of transactions completed with undetected error. **F3002**

link timeout, *n*—time between the actual lost-link event being validated and the system initiating the lost-link procedure. **F3002**

loads—

flight load, n—those loads experienced within the operational flight envelope. **F3298**

ground handling load, n—those loads experienced during regular operation while the aircraft is not in flight (for example, assembly, flight preparation, taxi, and maintenance). **F3298**

launch and recovery load, n—those loads experienced during normal launch and recovery. **F3298**

landing loads, n—the load exerted upon an aircraft at touchdown or upon a runway by an airplane during touchdown and in the landing roll. **F3298**

limit load, n—the maximum load experienced in the normal operation and maintenance of the UA. **F3298**

load factor, n—the ratio of a specified load to the total weight of the aircraft. The specified load is expressed in terms of any of the following: aerodynamic forces, inertia forces, or ground or water reactions. **F3298**

opening shock load, n—this is the maximum load force under any conditions that occurs on the main parachute during the process of the parachute opening. **F3322**

ultimate load, n—limit load multiplied by the factor of safety (as determined by the CAA, but heuristically 1.5). **F3298**

loss of tailrotor effectiveness, *n*—an unanticipated yaw is defined as an uncommanded, rapid yaw towards the advancing blade that does not subside of its own accord. **F3298**

loss of well-clear risk ratio (LR) measurement, *n*—the LR is the quotient of the probability of a loss of well-clear (LoWC) given an encounter with a DAA system, and the probability of loss of well-clear given an encounter without a DAA system. The lower the LR, the better the DAA system is at preventing a loss of well-clear. The LR is a measurement to ensure that a portion of the mitigation happens before loss of well-clear as opposed to after loss of WC. **F3442/F3442M**

lost link, *n*—occurrence in which the pilot in command (PIC) has lost the ability to control positively the sUAS because of degradation, loss or interruption of the necessary control or monitoring link(s), or both. **F3002**

maneuver time, T, *n*—the maneuver time, *T*, should be the time required for the specific UA to execute a maneuver that ensures the point of closest approach of a conflicting aircraft remains outside the collision volume. The manufacturer of the UAS should determine and document this value or the means of how it is determined in real time. **F3298**

manual triggering device, MTD, *n*—device or component that can initiate deployment of the parachute recovery system at the discretion of the remote pilot in command (RPIC). **F3322**

manufacturer

manufacturer, *n*—entity responsible for assembly and integration of components and subsystems to create a safe operating sUAS. **F2910, F3002**

manufacturer, *n*—entity responsible for assembly and integration of components and subsystems to create a safe operating sUAS. The builder of kit-built systems provided by a manufacturer must conform to the manufacturer's assembly and test instructions without deviation in order for that kit-built system to meet this standard. **F2911**

manufacturer, *n*—the person or organization who causes production of a product or article. A manufacturer may also be an operator. **F3298, F3389/F3389M**

manufacturer, *n*—entity responsible for the creation of the various components of the parachute recovery system. **F3322**

DISCUSSION—These can consist of the parachute, parachute ejection device, flight termination system, parachute deployment controller, or other components. There can be any number of manufacturers. **F3322**

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

sUAS manufacturer, *n*—the organization and personnel with design responsibility for the sUAS, including the dependability of the system software. **F3201**

mean time between critical failure, MTBCF, *n*—there are two criteria for reliability that are relevant for parachute recovery systems: *(1)* MTBCF for positive activation—the probability that the parachute recovery system including its ATS and FTS will open the parachute in case of emergency and *(2)* MTBCF for false positive event—the probability that the parachute recovery system will deploy unintentionally. **F3322**

Means of Compliance (MoC), *n*—a method or process that is used to show that a rule has been complied with through either design, analysis, test, or a combination of design, analysis, and test. **F3563**

minimum deployable altitude, MDA, *n*—difference in altitude from the point of failure to the point of stabilized sUA descent under parachute; is airframe/speed dependent and certified through testing in Section 6, F3322. **F3322**

minimum flight altitude, MFA, *n*—minimum altitude above ground level of the sUA in cases in which a parachute recovery system is used for flight over people. The MFA shall be defined per the results of testing in Section 6, F3322. **F3322**

most probable, worst case (MPWC), *n*—the sUA orientation used in impact testing. The orientation is found by first using operational data, failure modes, and engineering judgment to determine the most probable impact orientations. Testing is conducted to determine the worst case (most damaging) orientation among the most probable impact orientations. **F3389/F3389M**

non-pedigreed components, *n*—hardware and software items for which the UAS manufacturer does not or cannot produce sufficient evidence that these items on their own will operate within an acceptable level of risk based on the operational risk assessment. **F3269**

opening shock load, *n*—this is the maximum load force under any conditions that occurs on the main parachute during the process of the parachute opening. **F3322**

operator

operator, *n*—the person or organization that applies for CAA approval to operate a UAS or who seeks operational approval for types of flight operations prohibited by a CAA for that UAS. **F3298**

operator, *n*—the person or organization who 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. **F3389/F3389M**

operational envelope, *n*—the subset which bounds the full set of operational cases by all associated variables (for example, speed, altitude, attitude, etc.). **F3298**

operational environment, *n*—all allowed environmental conditions (temperature operating range, humidity range, dust and other debris tolerances, and so forth) that the manufacturer will define in the environmental envelope for operation/use for the product life of the parachute recovery system. **F3322**

operational speed, *n*—the maximum speed at which the sUA can normally operate (considering the usage expectations and limitations within the flight manual). **F3389/F3389M**

out of ground effect, *n*—condition where the downwash of air from the main rotor (or propellers of a vertical flight aircraft) is unable to react with a hard surface (the ground), and commonly begins at altitude above ground level of approximately 0.5 to 1.0 times the diameter of the main rotor (or propellers of a vertical flight aircraft). **F3298**

packing/parachute packing, *v*—process of folding and condensing the main canopy, connected cables, and other attached mechanisms to fit in a design compartment of the aircraft to hold the parachute. **F3322**

DISCUSSION—The packing process shall be done in such a fashion to allow for full deployment and acceptable opening behavior in the event of parachute deployment. Parachute packing procedures shall be defined by the parachute manufacturer in the PM. **F3322**

parachute, *n*—any aerodynamic deceleration device designed to slow the descent of sUA when not under stable safe flight. **F3322**

parachute manual, PM, *n*—the minimum material provided from the manufacturer to the operator/owner of the sUA that discusses topics such as instructions and procedures for inspection, maintenance, re-pack along with any PRS limitations in regard to operational or environmental limitations and approved payloads. **F3322**

parachute maximum dynamic shock load, MDSL, *n*—maximum opening shock load force the parachute is rated for under any condition. **F3322**

parachute recovery system, PRS, *n*—summation of the components of a parachute recovery system that work to reduce descent velocity. **F3322**

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. **F3298**

pedigreed components, *n*—hardware and software items for which the UAS manufacturer produces sufficient evidence

that these items on their own will operate within an acceptable level of risk based on the operational risk assessment. F3269

penetration testing, *n*—a testing method intended to identify and correct vulnerabilities and security defects by attempting to break, bypass, or tamper with software security controls. F3201

permanent deformation

permanent deformation, *n*—a condition whereby a UA structure is altered such that it does not return to the shape required for normal flight. F2910

permanent deformation, *n*—a condition whereby a UA structure is altered such that it does not return to the shape required for normal flight upon removal of external loads. F3298

pilot chute, *n*—smaller parachute than the main canopy that is connected to the main canopy. F3322

DISCUSSION—The main purpose of the pilot chute is to be deployed before the main canopy to pull the main canopy out of a container into free air to produce full canopy. The need for a pilot chute is determined by either the parachute manufacturer or the parachute recovery system integrator. F3322

pilot in command, PIC, *n*—the pilot responsible for the operation and safety of the UA during flight time. F3002

positive control, *n*—a condition in which commanded changes in the UA flight path result in the expected maneuver(s) within an expected period of time. F3002

pre-defined limits, *n*—defined not-to-exceed restrictions that, if exceeded, would create a safety hazard. These "hard limits" are determined from the operational risk assessment (for example, taking into account vehicle characteristics, CONOPS, etc.). F3269

propeller, *n*—a device for propelling an aircraft that has blades on an engine-driven shaft and that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation. It includes control components normally supplied by its manufacturer, but does not include main and auxiliary rotors or rotating airfoils of engines. F3298

propulsion system, *n*—consists of one or more power plants (for example, a combustion engine or an electric motor 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). F2910, F2911, F3298

publish, *n*—formalized release of a document to appropriate parties. A history should be maintained for published documents. The history may be part of revision control system, printed papers in a binder, or any other auditable system. F3201

quality assurance, *n*—the practice of internally monitoring or auditing the development process. F3201

recovery control function, RCF, *n*—a pedigreed function or software algorithm to return the UAS to a safe state. For example, a sequence of commands that causes the UAS to land safely, to maneuver in space, return to level flight, or deploy a flight recovery system. F3269

RCF complete, *n*—the system state where the RCF has been effective in ensuring the UAS will not violate its pre-defined limits. F3269

RCF delay, *n*—the cumulative delay from each RCF. F3269

RCF response delay, *n*—the delay between the initiation of the RCF and RCF complete. F3269

RCF trigger thresholds, *n*—the thresholds in the safety monitor which the UAS manufacturer sets to ensure that action is taken before the UAS violates a pre-defined limit. These "soft limits" trigger the safety monitor to command the RTA switch to an appropriate RCF and account for all delays between command of the RTA switch and the execution of the recovery action. F3269

red team evaluation, *n*—a process designed to detect network and system vulnerabilities and test security by taking an attacker-like approach to system, network, or data access, or combinations thereof. F3201

remote pilot-in-command

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. F3298

remote pilot-in-command, RPIC, *n*—the person who: *(1)* has final authority and responsibility for the operation and safety of the flight; *(2)* has been designated as pilot-in-command before or during the flight. F3322

remote probability, *n*—a probability no greater than one occurrence every 10 000 flight hours (10^{-4}). F3298

rotor, *n*—a 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). F3298

Rules, *n*—universal reference to the relevant applicable regulations or standards governing airworthiness requirements for Normal Category Aeroplanes issued by the CAAs. F3563

run-time assurance architecture, RTA, *n*—a system of pedigreed components that implements real-time monitoring, prediction, and fail-safe recovery mechanisms that bounds the flight behavior of a non-pedigreed complex function to ensure the safety of a UAS. Includes the components in Fig. 1, F3269. F3269

small unmanned aircraft system, sUAS

small unmanned aircraft system, sUAS, *n*—composed of the small unmanned aircraft (sUA) and all required on-board

subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, and C2 links between the sUA and the control station. F3002

small unmanned aircraft system, sUAS, *n*—composed of the small unmanned aircraft (sUA) and all required on-board subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, and command and control (C2) links between the sUA and the control station. For purposes of this standard sUAS is synonymous with a small Remotely Piloted Aircraft System (sRPAS) and sUA is synonymous with a small Remotely Piloted Aircraft (sRPA). F2910

small unmanned aircraft system, sUAS, *n*—composed of the small unmanned aircraft (sUA) and all required on-board subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, and command and control (C2) links between the UA and the control station. For purposes of this standard sUAS is synonymous with a small Remotely Piloted Aircraft System (sRPAS) and sUA is synonymous with a small Remotely Piloted Aircraft (sRPA). F2911

small unmanned aircraft system, sUAS, *n*—composed of small unmanned aircraft (sUA-see 4.2) and all required on-board subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, all required crew members, and command and control (C2) links between sUA and the control station. F3201

snatch force, *n*—when using a pilot chute for parachute deployment, snatch force is the highest peak force needed to extract the parachute and risers from the holding canister/bay to deploy full canopy. F3322

software baseline, *n*—a known state of product software that has been formally reviewed and agreed on, that thereafter serves as the basis for further development, and can be changed only through formal change control procedures. F3201

software vulnerability, *n*—a mistake in software (also known as a weakness) that can be directly exploited to get a cyber-enabled capability to function in an unintended manner. Typically this is the violation of a reasonable security policy for the cyber-enabled capability resulting in a negative technical impact. Although all vulnerabilities involve a weakness, not all weaknesses are vulnerabilities. For example, Common Vulnerabilities and Exposures is a dictionary of common names for publicly known software-related vulnerabilities. F3201

stabilized descent, *n*—the integrator shall determine the fall speed of the sUA when the PRS has deployed based on the sUA maximum takeoff weight. The descent is considered stabilized when the vertical descent rate is within 10 % of the integrator's specified fall speed at sea level conditions. F3322

statement coverage, *n*—a testing technique that involves the execution of all the statements at least once in the source code. As a metric, it is used to calculate and measure the number of statements in the source code which have been executed. F3201

structural failure, *n*—a condition whereby the structure is not able to carry normal operating loads. F2910

sUAS Software, *n*—includes both IDS and EDS. F3201

supplier

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

DISCUSSION—Where the supplier is not the manufacturer, the supplier can only ensure that the components comply with accepted consensus standards. F2910, F2911

supplier, *n*—any entity engaged in the design and production of components (other than a payload which is not required for safe operation of the UAS) used on a UAS. F3298

supplier, *n*—any entity engaged in the design and production of components used on a sUA. F3322

DISCUSSION—When the supplier is not the manufacturer, the supplier can only ensure that the components comply with accepted consensus standards. F3322

test, *n*—designed collection of methods that are used collectively to evaluate the performance of or to identify the capability of a UAS' particular subsystem or functionality. F3298

test form, *n*—form corresponding to a test method that contains fields for recording the testing results and the associated information. F3298

testing task or task

testing task or task, *n*—activities well defined and specified according to an identified metric or an identified set of metrics for the testing UAS and operators to perform in order for the UAS' capabilities to be evaluated. F3298

testing task or task, *n*—activities well defined and specified according to an identified metric or an identified set of metrics for testing sUA parachute recovery systems and operators to perform for the sUA's parachute recovery system capabilities to be evaluated. F3322

tethered aircraft, *n*—a configuration where the unmanned aircraft remains securely attached (tethered) via a physical link to a person, the ground or an object at all times while it is flying. F3298

threat modeling, *n*—a structured approach that enables the sUAS manufacturer to identify, quantify, and address the security risks associated with an application. The process involves systematically identifying security threats and rating them according to severity and level of occurrence probability. The overall goal for threat modeling (also known as attack modeling) is the creation of customized knowledge about potential attacks relevant to the application

or organization. This customized knowledge guides decisions about changes to the code and security controls to implement. F3201

tier 1 requirements, *n*—required tasks and activities in this practice for a software malfunction or penetration that would result in a slight reduction in sUAS functional capabilities or safety margins (for reference see Minor failure conditions per AC 23.1309—1E). F3201

tier 2 requirements, *n*—required tasks and activities in this practice for any software malfunction or penetration that would result in a significant reduction in sUAS functional capabilities or safety margins with potential for injury (for reference see Major failure conditions per AC 23.1309—1E). F3201

tier 3 requirements, *n*—required tasks and activities in this standard for any software malfunction or penetration that would result in a large reduction in sUAS functional capabilities or safety margins and could be expected to result in serious injury or fatality (for reference see Hazardous or more severe failure conditions per AC 23.1309—1E). F3201

trial, *n*—numbered used to identify a series of repetitions that a UAS is required to succeed in a standard verification method for the results to meet the required statistical significance. F3298

trial, *n*—number used to identify a test within a series of repetitions that a sUA is required to succeed in a standard verification method for the results to meet the required statistical significance. F3322

vertical flight aircraft, *n*—also referred to as "VTOL" or "vertical takeoff and landing aircraft," aircraft capable of vertical or near-vertical takeoffs and landings. Vertical-lift aircraft include: F3298

fan-in-wing aircraft, n—fixed-wing aircraft with rotor fans in the wing to permit vertical or hover operations. F3298

powered-lift aircraft, n—heavier-than-air aircraft capable of vertical takeoff, vertical landing, and low-speed flight that depends principally on engine-driven lift devices or engine thrust for lift during these flight regimes and on nonrotating airfoil for lift during horizontal flight. F3298

rotorcraft, n—rotary-winged aircraft that lift vertically (to hover) and principally sustained in forward flight by power-driven rotor blades turning on a vertical axis. F3298

tiltrotor aircraft, n—rotorcraft with the axes of the power-driven proprotor blades capable of pivoting from vertical for vertical takeoff, landing, and hover operations to horizontal to derive lift from the wing in cruise. F3298

tilt-wing aircraft, n—rotorcraft with both the wing chord and the axes of the power-driven proprotor blades capable of pivoting from vertical for vertical takeoff, landing, and hover operations to horizontal to derive lift from the wing in cruise. F3298

vertical lift aircraft, n—heavier-than-air aircraft capable of vertical takeoff, vertical landing, and flight that depends principally on engine-driven lift devices or engine thrust for lift during these flight regimes. F3298

vortex ring state, n—also referred to as "settling with power," an aerodynamic condition when a vortex ring system engulfs the rotor (or propellers of a vertical flight aircraft) causing severe loss of lift. Vertical lift aircraft with higher disk loading and increased blade twist are more susceptible to vortex ring state. F3298

warning, *n*—a condition that requires immediate flight crew awareness and immediate flight crew response. F3298

X2. FLIGHT OPERATIONS TERMINOLOGY

INTRODUCTION

This terminology appendix contains a listing of terms, abbreviations, acronyms, and symbols related to UAS flight operations covered by published ASTM Subcommittee F38.02 standards. The intent is to provide baseline definitions that will result in consistent definitions across all of the ASTM UAS standards.

As terms, abbreviations, acronyms, and symbols are incorporated into new standards, and actually used, they may require some slight modification prior to being incorporated into the mandatory section of F3341/F3341M.

3D volume, *n*—a volume of airspace defined in terms of latitude, longitude, and altitude. F3548

4D volume, *n*—a 3D volume plus a start and end time for the volume. F3548

accepted, *n*—one of the operational intent states. F3548

activated, *n*—one of the operational intent states. F3548

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. F2909

aggregate operational intent conformance monitoring, *n*—a USS service that monitors an operator's aggregate conformance with operational intents over time to ensure the target