Designation: F3322 – 18

Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes[1]

This standard is issued under the fixed designation F3322; 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 specification covers the design and manufacture requirements for deployable parachutes of small unmanned aircraft (sUA). This specification defines the design, fabrication, and test requirements of installable, deployable parachute recovery systems (PRS) that are designed to be integrated into a sUA to lessen the impact energy of the system should the sUA fail to sustain normal stable safe flight. Compliance with this specification is intended to support an applicant in obtaining permission from a civil aviation authority (CAA) to fly a sUA over people.

1.2 This specification is applicable to the design, construction, and test of deployable parachute recovery systems that may be incorporated into the system or structure, or both, of sUA seeking civil aviation authority (CAA) approval in the form of technical standard orders (TSO), flight certificates, flight waivers, flight permits, or other like documentation.

1.3 *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.

1.4 *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.*

1.5 *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 *Federal Standards:*[2]

14 CFR Part 107 Small Unmanned Aircraft Systems

MIL-STD-1629A Procedures for Performing a Failure Mode, Effects, and Criticality Analysis

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *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.

3.1.1.1 *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.

3.1.2 *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.

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

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

3.1.4 *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.

3.1.5 *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.

3.1.5.1 *Discussion*—Hazardous materials laws (for air transportation, for proper handling, storage, etc.) may apply

[1] This specification is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.01 on Airworthiness.

Current edition approved Sept. 1, 2018. Published September 2018. DOI: 10.1520/F3322-18.

[2] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

when using hazardous materials such as pyrotechnic devices, cold gas generators, or compressed CO_2 for a ballistic parachute.

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

3.1.7 *canopy filling/inflamation time, n*—time from canopy (line) stretch to the first full open canopy position.

3.1.8 *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 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

3.1.9 *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.

3.1.9.1 *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.

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

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

3.1.11.1 *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.

3.1.12 *energy measurement, n*—Kinetic energy is calculated as: $KE = 1/2\ mv^2$. Whereas "m" equals sUAs takeoff mass and "v" equals descent speed.

3.1.13 *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.

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

3.1.15 *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.

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

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

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

3.1.18 *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.

3.1.18.1 *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.

3.1.19 *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.

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

3.1.20.1 *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.

3.1.21 *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).

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

3.1.22.1 *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.

3.1.23 *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.

3.1.24 *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.

3.1.25 *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.

3.1.26 *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.

3.1.27 *operational environment, v*—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.

3.1.28 *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.

3.1.28.1 *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.

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

3.1.30 *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.

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

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

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

3.1.33.1 *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.

3.1.34 *Remote-Pilot-In-Command (RPIC)*—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.

3.1.35 *"shall" versus "should" versus "may", v*—use of the word "shall" implies that a procedure or statement is mandatory and shall be followed to comply with this specification, "should" implies recommended, and "may" implies optional at the discretion of the supplier, manufacturer, or operator.

3.1.35.1 *Discussion*—Since "shall" statements are requirements, 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 and could lead to development of future requirements. "May" statements are provided to clarify acceptability of a specific item or practice and offer options for satisfying requirements.

3.1.36 *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.

3.1.37 *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.

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

3.1.38.1 *Discussion*—When the supplier is not the manufacturer, the supplier can only ensure that the components comply with accepted consensus standards.

3.1.39 *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.

3.1.40 *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.

4. Applicability

4.1 In this specification, designers and manufacturers of deployable parachutes for sUA shall find design references and criteria to use in designing, manufacturing parachutes, and parachute deploying systems with the intent of lessening the impact energy of the sUA in the instance that the sUA is unable to sustain operational flight.

5. Design Standards for Deployable Parachutes

5.1 *General:*

5.1.1 This section provides design criteria for deployable parachutes of sUA with the expectation that parachutes designed using this specification are designed to lessen the impact energy of the descending system for the purpose of enabling operations over people and persons not intended as part of the flight operations of the sUA.

5.1.1.1 The designers or manufacturers, or both, of the parachute recovery system may design the parachute recovery system to orient the sUA so that the sUA under canopy-aided descent is in an orientation that exposes the least risk to persons on the ground.

5.1.2 The manufacturer may produce a parachute recovery system for a sUA that is limited to the number of deployments. If the parachute recovery system is designed for a limited number of uses per a designated flight envelope, the manufacturer shall define the number of deployments before replacement is required in the PM.

5.1.2.1 Key components of the parachute recovery system shall be serialized by the manufacturer, so they can be traced to the end user (operator). Key information that should be kept by the manufacturer may include date of manufacture, product revision, and any quality assurance (QA) inspection information. Key components include: parachute, deployment device, deployment controller (electronics, FTS, ATS, MTD, and so forth), and other key components. Records shall be kept on customer or integrator sales and the serial numbers of the components delivered.

5.1.3 The parachute shall be sized to reduce residual energy of the sUA and may be combined with other energy reduction components such as airbags (including any attachments, parachute deployment system, payload, electronics, propellers, and so forth) with an attached parachute recovery system.

5.1.4 The PRS shall be designed to deploy successfully within the full flight performance envelope of the sUA once the sUA reaches its minimum deployable altitude.

5.1.5 This specification provides the minimum testing criteria for the installed performance according to the methods and measurement techniques that shall be provided by the manufacturer of the parachute recovery system to the operator/owner of the sUA.

5.1.6 The manufacturer shall define in the PM the process for preflight/post flight inspection of the parachute recovery system.

5.2 *Installation Design*—Each integrator of a sUA deployable parachute recovery system shall provide a general PM with documentation described in 3.1.30. The PM shall be used for all instructions and procedures for installation, arming, disarming, and maintenance of the parachute recovery system. The parachute recovery system shall be pre-packed and repacked per 5.2.1.

5.2.1 Parachute recovery systems approved for flight over people will be provided to the operator with the parachute pre-packed by the integrator or an authorized and approved third party. The integrator will approve third-party parachute packers. The integrator will specify both in the PM and on the parachute recovery system the service life of the packed parachute before it needs to be recertified, repacked, or replaced.

5.2.2 All components of the parachute recovery system shall be protected against loss of strength in service as a result of normal wear, operational environment, corrosion, contamination, and abrasion.

5.3 *Parachute Component Design Safety Factors:*

5.3.1 The parachute manufacturer shall provide a specification called maximum dynamic shock load (MDSL). The MDSL is used to qualify a parachute as being suitable for use at a given calculated opening shock load for the sUA and the given maximum deployment velocity. This is determined by a combination of measured and rated material strengths and measured strength of key canopy components such as the bridle, canopy shroud line connection break strength, and other critical parachute components in line from the bridle up to the canopy. The component having the lowest aggregated break strength of the parachute is the measured break strength. This value is then divided by two to give MDSL. The resulting MDSL will be ½ the measured strength of the parachute. Appendix X1 shows an example of an MDSL calculation done with OSCALC.

5.3.2 For main canopy parachutes, the parachute manufacturer-specified MDSL shall meet or exceed the calculated expected maximum opening force calculated for a given parachute recovery system as integrated into a sUA at maximum deployment velocity.

5.3.3 For all main risers (shock cords) of the parachute package, the design factor shall be based on the nominal strength of the materials used and the calculated maximum opening forces per 5.3.1.

5.4 *Main Canopy Design*—The main canopy dimensions and rate of descent shall be calculated using the following variables and equations:

5.4.1 *Main Canopy Nominal Diameter Equation:*

$$D_O = \sqrt{((S_O)/\pi)} \text{ (ft or m)} \quad (1)$$

where:

D_O = nominal diameter of the parachute that is calculated by the total canopy surface area; S_O; and

S_O = total canopy surface area but shall not include vent holes and other openings seen in the canopy that are a part of the design (ft^2 or m^2).

5.4.2 *Main Canopy Rate of Descent Calculation (at Sea Level):*

$$vc_O = \sqrt{[(2\ W_T)/(S_O\ C\ (D_O)\rho_O)]} \text{ (ft/s or m/s)} \quad (2)$$

where:

WT = total measured weight of the sUAS and parachute assembly (that is, parachute, risers, deployment system, holding canister, and so forth) (pounds or Newtons);

$C(D_O)$ = parachute drag coefficient related to S_O; measures the efficiency of drag force produced by the main canopy area; and

ρ_O = sea level air density (slugs/ft^3 or kg/m^3). For calculation, the nominal value to be used is 0.00238 slg/ft^3 (1.225 kg/m^3) at sea level and 59°F (15°C).

5.4.3 *Main Canopy Rate of Descent Calculation (at a Specific Altitude):*

$$vc = \sqrt{[(2\ W_T)/(S_O \quad C\ (D_O)\ \rho_O)]} \cdot 1\sqrt{(\rho / \rho\ 0)} \text{(ft/s or m/s)} \quad (3)$$

where:

ρ = air density at a specific altitude; the air density measured above an altitude of 1000 ft (305 m) MSL shall be taken into account when calculating the descent velocity of a sUA in parachute-assisted return to earth (slugs/ft^3 or kg/m^3).

5.5 *Glide Slope and Vertical Velocity:*

5.5.1 The integrator may design the parachute deployment system to glide the sUA through descent.

5.5.2 For parachute operation using passive fill of the canopy (non-high energy active inflation), the parachute manufacturer should specify the filling distance of the canopy. Optional filling time can be provided and is rated at a specified velocity at canopy opening. These can be determined using the filling distance of parachute canopy equation:

$$sf = nD_P \quad (4)$$

where:

sf = filling distance of the parachute canopy;
D_P = parachute diameter at full inflation (ft or m); and
n = dimensionless fill constant defined by the type of main parachute canopy design used.

5.6 *Risers/Attachment Lines:*

5.6.1 The riser(s) attachment point shall be placed on the sUA so not to interfere with engine or propellers during in-flight operations or during deployment of the parachute.

5.6.2 The risers and other attachment lines shall not induce friction due to poor parachute packing to the rest of the canopy system during opening of the canopy.

5.7 *Designs and Precautionary Remarks for Deployment of Main Canopy:*

5.7.1 The opening of the parachute housing should be designed in such a way that, upon deployment, the parachute recovery system and connected risers shall not be caught on, damaged, or cut by blemishes, burrs, sharp edges, and any other defects that may cause interferences with proper deployment/inflation of the parachute recovery system. The parachute, risers or attachment lines, and lead lines shall be protected from abrasion during ejection/release and shall not entangle into the sUA in a manner that would render the parachute and sUA unable to descend at the defined descent rate.

NOTE 1—Although use of a FTS is required, there may be residual energy in recently killed motors that leave spinning propellers or "pinwheeling" propellers that create a hazard for parachute canopies and risers. Care shall be taken to avoid propellers or other control surfaces of the sUA.

5.7.2 The main canopy may be extracted with the aid of a pilot chute. If the main canopy is designed to be deployed with the aid of a pilot chute, then:

5.7.2.1 The pilot chute shall be held to the same design criteria seen in 5.3 – 5.7.

5.7.2.2 The pilot chute shall be designed not to interfere with the deployment process of the main canopy once the canopy has been extracted into free air unless the manufacturer has specified other intended uses for the pilot chute during descent.

5.7.3 The main canopy may be extracted with the aid of a ballistic ejection system. If the main canopy is designed to be deployed with the aid of a ballistic system, then:

5.7.3.1 The ballistic ejection system shall be controlled in such a manner as to not create a fire on the sUA.

5.7.3.2 The ballistic ejection system electronic signaling shall not interfere with the main electronic system of the sUA and shall not be affected by the expected operating environment (high-intensity irradiated field (HIRF) environment considerations).

5.7.3.3 If the parachute risers and harnesses connect to the sUA via the parachute ejection device, then the material strength of the ballistic ejection system attachment to the sUA and attachment points of the ballistic system shall be designed to be two times greater than the maximum opening shock load as calculated in 5.3.1. In any case, the connection strength of the parachute ejection device to the sUA shall be strong enough to accommodate the recoil force of the ballistic system when discharging the parachute and risers.

5.7.4 The integrator shall supply placards or labels for the exterior such that these placards or labels can be seen by first responders at accident or incident sites.

5.7.4.1 *Scope*—These placards or labels are to provide a visual warning to rescue or other personnel at the scene of an accident or incident in the event that the sUA involved is equipped with a ballistically deployed emergency parachute recovery system.

5.7.4.2 *Installation and Size of Placard or Label*—The parachute integrator shall permanently install the warning placards or labels on the parachute recovery system in a manner as specified below. For placards or labels that are required to be attached to the airframe, the sUA operator holds responsibility for visual placement of placards specified by this specification.

(1) *Danger Placard*—A triangular placard or label in which each side is at least 80 % the diameter of the largest circle encompassed by the largest projected surface shape of the PRS.

(2) The danger placard shall be placed adjacent to the parachute egress point for enclosed sUA in which the parachute recovery system may not be visible from the exterior. The integrator may include a QR code that leads to a web page that includes all the relevant information.

(3) The danger placard shall have the word "DANGER" and provide contact information for rescue personnel to seek help from the manufacturer and the type of ballistic deployment device (see proposed placard in Appendix X2).

(4) A danger placard shall be applied directly on any ballistic extraction device on aircraft that do not have the parachute recovery system inside the sUA airframe. This placard or label will warn rescue personnel in the event the ballistic device becomes separated from the sUA airframe at impact. Appendix X2 contains an example of such labeling.

5.7.4.3 *Label Size and Color*—All placards or labels shall follow the coloration methods described in the following.

(1) Danger Placard—Danger placards or labels shall be printed with a red border with white letters (or reverse type) and a descriptive graphic element (see proposed placard in Appendix X2).

(2) Identification Placard—Identification placards or labels shall be printed with a black border with orange letters surrounding an orange center with a descriptive graphic element (see proposed placard in Appendix X2).

(3) External placards or labels shall be printed using a reflective background material for enhanced visibility in low light or obscured conditions.

5.8 *Electronic System Considerations:*

5.8.1 All parachute recovery system electronics shall have a dedicated power source, such as a battery or capacitor, independent from the sUA's power supply(s). During a failure, this power source shall have enough energy to supply properly all connected electronics throughout a failure detection and descent. The independent power source may harvest charging power from the sUA.

5.8.2 All parachute recovery system electronics shall not interfere with operations of the sUA during normal flight. The parachute recovery system electronics may override the sUA's systems in the case that the sUA can no longer sustain safe flight.

5.8.3 The parachute recovery system shall be equipped with an autonomous triggering system (ATS) independent from any flight critical system of the sUA to deploy the parachute recovery system when a malfunction of the sUA is detected.

NOTE 2—The ATS can be integrated as part of the flight critical systems of the sUA instead of being an independent system if the integrator can demonstrate that the level of the sUA's system integrity is commensurate with industry standards recognized by the governing CAA for flight critical systems.

NOTE 3—If the ATS does not have a physical or electronic safety to prevent deployment while on the ground, then a warning shall be present in the PM that states when the motors are running and a critical failure occurs when the sUA is on the ground or on take-off/landing, that the ATS will allow the PRS to deploy which may present a ballistic/projectile hazard to personnel if they are in close proximity to the sUA during those phases of flight.

5.8.3.1 In the event of a deployment the PRS shall record the descent rate (descent rate shall be recorded as time vs altitude) and the method of deployment (ATS or MTD).

5.8.4 To prevent propellers from injuring people on the ground after a deployment the PRS shall also include a Flight Termination System (FTS).

5.8.4.1 The FTS shall activate at the time of or before parachute deployment is initiated.

5.8.5 The parachute recovery system shall be equipped with a manual triggering device (MTD).

5.8.5.1 The manufacturer may include a downlink system that allows the parachute recovery system to communicate to the RPIC.

5.9 *Maintenance and Continued Operational Safety Expectations:*

5.9.1 *Parachute Manual*—The manufacturer shall provide a parachute manual when providing the parachute recovery system to the operator of the sUA. The minimum contents of the parachute manual shall include the following topics here in this specification.

5.9.2 *Inspection Intervals and Criteria:*

5.9.2.1 *Intervals*—The manufacturer shall define in the PM the number or schedule or both of periodic inspection intervals that the owner/operator shall inspect the installed parachute recovery system.

5.9.2.2 *Criteria*—The manufacturer may offer inspection services to the operator for the defined inspection intervals. If the manufacturer allows for the operator/owner of the parachute recovery system to do their own inspections, the inspection criteria shall be defined in the PM with full explanations of how to recognize defects that could hinder normal operation.

5.9.3 *Maintenance Procedures:*

5.9.3.1 *Defects*—If the operator/owner of the parachute is to do their own inspections of the system, the manufacturer shall define maintenance procedures for the operator/owner to fix common defects impeding operation. If a defect found by the operator/owner is not covered in the PM or is too extensive for the operator/owner to repair on their own, the manufacturer shall provide information in the PM on how the operator/owner may return the parachute recovery system to the manufacturer for proper corrections or suggestions on following steps the operator/owner may take for a replacement parachute recovery system.

5.9.3.2 *Repacking*—For parachute recovery systems approved for flight over people the repacking method will be omitted from the PM and the manufacturer shall provide direction to the operator/owner in the PM on how to send the parachute or parachute recovery system, or both, properly to the manufacturer for repacking.

5.9.3.3 *Environmental Operating Limitations*—Any environmental factors that are outside of the functional capabilities of the PRS shall be clearly defined in the PM, including but not limited to: wind speed, temperature, humidity, altitude, and precipitation.

(1) Altitude/environment considerations shall be incorporated into the flight envelope of the PRS. Hot weather, high elevation, or heavy payload considerations, or combinations thereof, shall be taken into account when defining the operation limitations of the PRS and the manufacturer shall make these considerations known in the PM.

5.9.4 *Materials:*

5.9.4.1 *Fungus-proof Materials*—Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where such material is used and not hermetically sealed, they shall be treated with a fungicidal agent acceptable to the procuring activity; however, if they will be used in a hermetically sealed enclosure, fungicidal treatment will not be necessary.

6. Testing Standards of Deployable Parachutes

6.1 *General:*

6.1.1 *Testing Responsible Party*—The responsible party for testing the sUA with the PRS is the integrator. As defined in 3.1.20, the integrator could also be the parachute manufacturer, operator, or the sUA manufacturer. The integrator can work