UAS 1010-D01

Operations

Lesson 5f: Maintenance and Inspection

Task	***F. Maintenance and Inspection Procedures (*)***
References	AC 107-2
Objective	To determine that the applicant is knowledgeable in sUAS maintenance and inspection procedures.
Knowledge	The applicant demonstrates understanding of:
UA.V.F.K1	Basic maintenance.
UA.V.F.K2	Preflight inspection.
UA.V.F.K3	Techniques to mitigate mechanical failures of all elements used in sUAS operations, such as the battery and/or any device(s) used to operate the sUAS.
UA.V.F.K4	Appropriate record keeping.
UA.V.F.K5	Persons that may perform maintenance on an sUAS.

CHAPTER 7.
SMALL UAS MAINTENANCE AND INSPECTION

1. **Applicability.** Section 107.15 requires the remote PIC to perform checks of the small unmanned aircraft prior to each flight to determine whether the small UAS is in a condition for safe operation. This chapter provides guidance on how to inspect and maintain a small UAS. Additionally, Appendix C, Small UAS Maintenance and Inspection Best Practices, contains expanded information and best practices for small UAS maintenance and inspection.

2. **Maintenance.** Small UAS maintenance includes scheduled and unscheduled overhaul, repair, inspection, modification, replacement, and system software upgrades of the small UAS and its components necessary for flight. Whenever possible, the operator should maintain the small UAS and its components in accordance with manufacturer's instructions. The aircraft manufacturer may provide the maintenance program, or, if one is not provided, the applicant may choose to develop one. See paragraph 7.3.5 for suggested benefits of recordkeeping. (See paragraph 8.3.7.4 for Category 4 maintenance requirements. See paragraph 8.3.7.4.1 for Category 4 record retention requirements and owner and operator responsibilities.)

1. Scheduled Maintenance. The small UAS manufacturer may provide documentation for scheduled maintenance of the entire small unmanned aircraft and associated system equipment. The manufacturer may identify components of the small UAS that should undergo scheduled periodic maintenance or replacement based on time-in-service limits (such as flight hours, cycles, and/or the calendar-days). Operators should adhere to the manufacturer's recommended schedule for such maintenance, in the interest of achieving the longest and safest service life of the small UAS.

    1. If the small UAS manufacturer or component manufacturer does not provide scheduled maintenance instructions, the operator should establish a scheduled maintenance protocol. Such protocol could entail documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure. Over time, the operator should then be able to establish a reliable maintenance schedule for the small UAS and its components.

2. Unscheduled Maintenance. During the course of a preflight inspection, the remote PIC may discover a small UAS component is in need of servicing (such as lubrication), repair, modification, overhaul, or replacement outside of the scheduled maintenance period as a result of normal flight operations or resulting from a mishap. In addition, the small UAS manufacturer or component manufacturer may require an unscheduled system software update to correct a problem. In the event such a condition is found, flight operations should not occur until the issue is corrected.

3. Performing Maintenance. In some instances, the small UAS or component manufacturer may require completion of certain maintenance tasks by the manufacturer or by a person or facility (personnel) the manufacturer specifies. Maintenance should occur in accordance with the manufacturer's instructions. However, if the operator declines to use the manufacturer or personnel the manufacturer recommends are unable to perform the required maintenance, the operator should consider the expertise of maintenance personnel familiar with the specific small UAS and its components.

7.2.3.1 If the operator or other maintenance personnel are unable to repair, modify, or overhaul a small UAS or component back to its safe operational specification, the operator should replace the small UAS or component with one that is in a condition for safe operation. All required maintenance should be completed before each flight, and preferably in accordance with the manufacturer's instructions or, in lieu of that, within known industry best practices.

7.3 Preflight Inspection.

Pursuant to the requirements of § 107.49, in addition to assessing the intended area of operation and planning the operation as described above in paragraph 5.10, the remote PIC must inspect the small UAS to ensure that it is in a condition for safe operation prior to each flight. This inspection includes examining the small UAS for equipment damage or malfunction(s). This preflight inspection should be conducted in accordance with the small UAS manufacturer's inspection procedures when available (usually found in the manufacturer's owner or maintenance manual) and/or an inspection procedure developed by the small UAS owner or operator.

1. Creating an Inspection Program. As an option, small UAS owners or operators may wish to create an inspection program for their small UAS. The person creating such an inspection program may find sufficient details to assist in the development of a suitable inspection program tailored to a specific small UAS in a variety of industry programs.

2. Scalable Preflight Inspection. The preflight check as part of the inspection program should include an appropriate small UAS preflight inspection that is scalable to the small UAS, program, and operation that the remote PIC performs prior to each flight. An appropriate preflight inspection should encompass the entire system in order to determine a continued condition for safe operation prior to flight.

3. Title 14 CFR Part 43 Appendix D Guidelines.

Another option and best practice may include opting to comply with the portions of part 43 appendix D. Although part 43 appendix D is technically a maintenance inspection checklist and not a preflight inspection checklist, it provides a logical and systematic approach to performing an inspection by dividing the aircraft into subgroups. It details inspection of the airframe, then the flight controls, then the batteries, then the engine, etc. Unlike manned aircraft that require significant disassembly, most small UAS inspection items are visible without necessitating the need for disassembly. In the absence of a manufacturer's instructions, an operator may use part 43 appendix D as a guide to develop their own inspection program, but it is not comprehensive, as it does not address unique UAS features like datalinks or support equipment. An operator would need to identify those items not covered and include them in their inspection program.

4. Preflight Inspection Items.

Even if the small UAS manufacturer has a written preflight inspection procedure, the FAA recommends the remote PIC ensure the following inspection items be incorporated into the remote PIC's preflight inspection procedure. Such a practice will ensure the remote PIC accurately determines that the small UAS is in a condition for safe operation. The preflight inspection should include a visual or functional check of the following items.

1. Visual condition inspection of the small UAS components;
2. Airframe structure (including undercarriage), all flight control surfaces, and linkages;
3. Registration markings, for proper display and legibility (part 48, § 48.205);
4. Moveable control surface(s), including airframe attachment point(s);
5. Servo motor(s), including attachment point(s);
6. Propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.;
7. Check fuel for correct type and quantity;
8. Check that any equipment, such as a camera, is securely attached;
9. Check that control link connectivity is established between the aircraft and the CS;
10. Verify communication with small unmanned aircraft and that the small UAS has acquired GPS location from the minimum number of satellites specified by the manufacturer;
11. Verify all systems (e.g., aircraft and control unit) have an adequate power supply for the intended operation and are functioning properly; twilight and night);

12. Verify correct indications from avionics, including control link transceiver, communication/navigation equipment, and antenna(s);
13. Display panel, if used, is functioning properly;
14. Check ground support equipment, including takeoff and landing systems, for proper operation;
15. Verify adequate communication between CS and small unmanned aircraft exists; check to ensure the small UAS has acquired GPS location from the minimum number of satellites specified by the manufacturer;
16. Check for correct movement of control surfaces using the CS;
17. Check flight termination system, if applicable;
18. Check that the anti-collision light is functioning (if operating during civil twilight and night);
19. Calibrate small UAS compass prior to any flight;
20. Verify controller operation for heading and altitude;
21. Start the small UAS propellers to inspect for any imbalance or irregular operation;
22. At a controlled low altitude, fly within range of any interference and recheck all controls and stability; and
23. Check battery levels for the aircraft and CS.

7.3.5 Benefits of Recordkeeping.

Small UAS owners and operators may find recordkeeping to be beneficial. This may be done by documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure. The operator would then be able to establish a reliable maintenance schedule for the small UAS and its components.

The use of hardcopy and/or electronic logbook format for recordkeeping, inclusive of all periodic inspections, maintenance, preventative maintenance, repairs, and alterations performed on the small UAS, is useful in documenting the history of the small UAS.

Recordkeeping would include all components of the small UAS, including: small unmanned aircraft, CS, launch and recovery equipment, Command and Control (C2) link equipment, payload, and any other components required to safely operate the small UAS.

7.3.5 Benefits of Recordkeeping.

Recordkeeping of documented maintenance and inspection events reinforces owner/operator responsibility through a systematic means to determine that the small UAS is in a condition for safe flight.

Maintenance and inspection recordkeeping provides retrievable evidence of vital safety assessment data defining the condition of safety-critical systems and components supporting the decision to launch.

For operators that rapidly accumulate flight operational hours/cycles, recordkeeping of a small UAS may provide an essential safety support. Methodical maintenance and inspection data collection can prove to be very helpful in the tracking of small UAS component service life, as well as systemic component, equipage, and structural failure events.

APPENDIX C.

SMALL UAS MAINTENANCE AND INSPECTION BEST PRACTICES

1. In the interest of assisting operators with varying background levels of small UAS knowledge and skill, below is a chart offering conditions that, if noticed during a preflight inspection or check, may support a determination that the small unmanned aircraft is not in a condition for safe operation. Further inspection to identify the scope of damage and extent of possible repair needed to remedy the unsafe condition may be necessary prior to flight.

2. For Category 4 maintenance requirements for operating in accordance with 14 CFR part 107, see Chapter 8, paragraph 8.3.7.4.

3. For Category 4 record retention requirements, see Chapter 8, paragraph 8.3.7.4.1.

Table C-1. Small UAS Condition Chart

Conditions that may result in the small unmanned aircraft not being in a condition for safe operation include, but are not limited to, the following:

Condition	Action
1. Structural or skin cracking	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
2. Delamination of bonded surfaces	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
3. Liquid or gel leakage	Further inspect to determine source of the leakage. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.

Condition	Action
4. Strong fuel smell	Further inspect to determine source of the smell. Leakage exiting the aircraft may be present and/or accumulating within a sealed compartment. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
5. Smell of electrical burning or arcing	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
6. Visual indications of electrical burning or arcing (black soot tracings, sparking)	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
7. Noticeable sound (decibel) change during operation by the propulsion system	Further inspect entire aircraft with emphasis on the propulsion system components (i.e., motors and propellers) for damage and/or diminished performance. Assess the need and extent of repairs that may be needed for continued safe flight operations.
8. Control inputs not synchronized or delayed	Discontinue flight and/or avoid further flight operations until further inspection and testing of the control link between the ground control unit and the aircraft. Ensure accurate control communications are established and reliable prior to further flight to circumvent possible loss of control resulting in the risk of a collision or flyaway. Assess the need and extent of repairs that may be needed for continued safe flight operations.

Condition	Action
9. Battery casing distorted (bulging)	Further inspect to determine integrity of the battery as a reliable power source. Distorted battery casings may indicate impending failure resulting in abrupt power loss and/or explosion. An electrical hazard may be present, posing a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
10. Diminishing flight time capability (electric powered propulsion systems)	Further inspect to determine integrity of the battery as a reliable power source. Diminishing battery capacity may indicate impending failure due to exhausted service life, internal, or external damage. An electrical hazard may be present, posing a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
11. Loose or missing hardware/fasteners	Further inspect to determine structural integrity of the aircraft and/or components with loose or missing hardware/fasteners. Loose or missing hardware/fasteners may pose a risk of negatively impacting flight characteristics, structural failure of the aircraft, dropped objects, loss of the aircraft, and risk to persons and property on the ground. For continued safe flight operations, secure loose hardware/fasteners. Replace loose hardware/fasteners that cannot be secured. Replace missing hardware/fasteners.