UAS Standards, Reg, Law & Exam

FAA Regulations: Part 107

Lesson 5f – Operations: Maintenance and Inspection

Objectives of Operations

- To determine that the applicant is knowledgeable in radio communication procedures
- To determine that the applicant is knowledgeable in airport operations
- To determine that the applicant is knowledgeable in sUAS emergency procedures
- To determine that the applicant is knowledgeable in aeronautical decision-making
- To determine that the applicant is knowledgeable in the physiological factors affecting remote pilot performance
- To determine that the applicant is knowledgeable in sUAS maintenance and inspection procedures

Operations – Maintenance and Inspection Procedures

- Basic maintenance
- Preflight inspection
- 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
- Appropriate record keeping
- Persons who may perform maintenance on an sUAS

Basic Maintenance – 1

- A maintenance schedule may, or may not be provided by the UAS manufacturer
- For example, for DJI Matrice 300 Pro has a basic maintenance schedule as following

Type	Maintenance Items	Maintenance Advice	Period
Basic Maintenance	1. Regular maintenance items 2. Updates and calibration 3. Deep cleaning	Factory service recommended	Total flight time is 200 hours, or the product has been used for 6 months.

Basic Maintenance – 2

- If your UAS manufacturer did not provide one you will need to create it to comply with the regulations of Part 107
- A scheduled maintenance protocol requires you to do two things
  - Document any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations; this should be accomplished with either a written or on-line maintenance log for each of your sUAS
  - Record the time-in-service for that component at the time of the maintenance procedure

Basic Maintenance – 3

- Maintenance be performed in accordance with the manufacturer's instructions
- Logging maintenance is a critical piece to maintaining your aircraft; according to the FAA you should log:
  - Any repair
  - Modification
  - Overhaul, or replacement of a system component resulting from normal flight operations
  - And include a record of the time-in-service for that component at the time of the maintenance procedure
- For your own purposes you should also log:
  - Battery cycles
  - Firmware updates

Preflight Inspection

- In addition to the preflight inspection recommended by the manufacturer the FAA also recommends that the following items on the checklist on the following slide also be included in the routine preflight inspection
- A copy of the checklist is available from the class website on CNM Learn

Preflight Inspection

Sample Preflight Inspection Checklist

Even if the small unmanned aircraft system (sUAS) manufacturer has a written preflight inspection procedure, it is recommended that the Remote Pilot in Command (Remote PIC) ensure that the following inspection items are incorporated into the preflight inspection procedure required by part 107 to help the Remote PIC determine that the sUAS is in a condition for safe operation.

Conduct a preflight visual or functional check of the aircraft, including (but not limited to) the steps below.

- ☐ Visually inspect the condition of the unmanned aircraft system components
- ☐ Inspect the airframe structure, including undercarriage, all flight control surfaces and linkages
- ☐ Inspect registration markings for proper display and legibility
- ☐ Inspect moveable control surface(s), including airframe attachment point(s)
- ☐ Inspect servo motor(s), including attachment point(s)
- ☐ Inspect the propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.
- ☐ Verify all systems (e.g. aircraft, control unit) have an adequate energy supply for the intended operation and are functioning properly
- ☐ Inspect the avionics, including control link transceiver, communication/navigation equipment and antenna(s)
- ☐ Calibrate UAS compass prior to any flight
- ☐ Inspect the control link transceiver, communication/navigation data link transceiver, and antenna(s)
- ☐ Check that the display panel, if used, is functioning properly
- ☐ Check ground support equipment, including takeoff and landing systems, for proper operation
- ☐ Check that control link correct functionality is established between the aircraft and the control station
- ☐ Check for correct movement of control surfaces using the control station
- ☐ Check on board navigation and communication data links
- ☐ Check flight termination system, if installed
- ☐ Check fuel for correct type and quantity
- ☐ Check battery levels for the aircraft and control station
- ☐ Check that any equipment, such as a camera, is securely attached
- ☐ Verify communication with UAS and that the UAS has acquired GPS location from at least 4 satellites
- ☐ Start the UAS propellers to inspect for any imbalance or irregular operation
- ☐ Verify all controller operation for heading and altitude
- ☐ If required by flight path walk through, verify any noted obstructions that may interfere with the UAS
- ☐ At a controlled low altitude, fly within range of any interference and recheck all controls and stability

Adapted from: Advisory Circular 107, *Small Unmanned Aircraft Systems* (as amended)

Techniques to Mitigate Mechanical Failures

- This refers to all elements used in sUAS operations
- Make sure all batteries are properly charged, and that you understand what the discharge typically looks like during a routine flight operation; one of the ways that this can be done is by following the sUAS manufacturer's operating manual power consumption tables; note that discharge rates vary with differences in flying conditions; flying in windy conditions, for example, will result in a more rapid rate of discharge
- Alternatively, the sUAS may include a system that detects power levels and alerts the remote pilot when remaining aircraft power is diminishing to a level that is inadequate for continued flight operation; most systems include this feature and in many cases will return to home and/or land when the battery reaches a predefined level of discharge

Record Keeping

- A huge part of operating sUAS safely and responsibly is to log your flight operations and to log your system maintenance and inspection
- Logging can be done manually or through the help of an automated flight logging system
- Flight logging should include all components of your UA, including the remote controller, launch and recovery equipment, communications link equipment, payload, and any other components required to safely operate the UA

Persons Who May Perform Maintenance on An sUAS

- In some instances, the sUAS or component manufacturer may require certain maintenance tasks be performed by the manufacturer or by a person or facility (personnel) specified by the manufacturer
- It is highly recommended that the maintenance be performed in accordance with the manufacturer's instructions; however, if the operator decides not to use the manufacturer or personnel recommended by the manufacturer and is unable to perform the required maintenance, the operator should consider the expertise of maintenance personnel familiar with the specific sUAS and its components
- In addition, though not required, the use of certificated maintenance providers are encouraged, which may include repair stations, holders of mechanic and repairman certificates, and persons working under the supervision of these mechanics and repairman

Rule-of-Thumb for Maintenance

- Perform routine maintenance after every 200 flights or 50 flight hours, unless otherwise stated in your UAS operating manual

Examples – sUAS Maintenance and Inspection

- AC 107-2A Appendix C
- Small Unmanned Aircraft Maintenance, Inspections, and Condition for Safe Operation
  - A small unmanned aircraft must be maintained in a condition for safe operation
  - Prior to flight, the RPIC is responsible for conducting a check of the small unmanned aircraft to verify it is actually in a condition for safe operation (§ 107.15)
  - Guidance regarding how to determine that a small unmanned aircraft is in a condition for safe operation is found in Chapter 7, Small Unmanned Aircraft Maintenance and Inspection

Examples – sUAS Maintenance and Inspection

- AC 107-2A Appendix C
- Small UAS Maintenance And Inspection Best Practices
  - 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.
  - For Category 4 maintenance requirements for operating in accordance with 14 CFR part 107, see Chapter 8, paragraph 8.3.7.4.
  - For Category 4 record retention requirements, see Chapter 8, paragraph 8.3.7.4.1.

Examples – sUAS Maintenance and Inspection

- AC 107-2A Appendix C
- 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.

Examples – sUAS Maintenance and Inspection

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.

Examples – sUAS Maintenance and Inspection

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.