Remote Pilot Certification Course

Before the FARs

• With the growing use of Model aircraft the FAA began looking into establishing Regulations Governing the use of model aircraft in the National Air Space (NAS)
• However, public concerns regarding property damage from failed operations and privacy issues caused many states to take up the issue and pass laws before the FAA released new regulations
• Bottomline: check the state and local laws regarding UAS operations before you start

FAR Regulating Drone Operations

• Now that FAR 101 and 107 have been put in force it is necessary to understand these requirements as well as State laws

The FAR’s and Public Laws

Register Your Drone

• 48.15 Requirement to register.
• No person may operate a small unmanned aircraft that is eligible for registration under 49 U.S.C. 44101-44103 unless one of the following criteria has been satisfied:
  • (a) The owner has registered and marked the aircraft in accordance with this part;
  • (b) The aircraft weighs 0.55 pounds or less on takeoff, including everything that is on board or otherwise attached to the aircraft; or
  • (c) The aircraft is an aircraft of the Armed Forces of the United States.

FAR 101

• 101.1 Applicability.
• (a) This part prescribes rules governing the operation in the United States, of the following:
  • 5) Any model aircraft that meets the conditions specified in §101.41. For purposes of this part, a model aircraft is an unmanned aircraft that is:
    • (i) Capable of sustained flight in the atmosphere;
    • (ii) Flown within visual line of sight of the person operating the aircraft; and
    • (iii) Flown for hobby or recreational purposes.
FAR 101 Details

• Subpart E—Special Rule for Model Aircraft
  • 101.41 Applicability.
    • This subpart prescribes rules governing the operation of a model aircraft (or an aircraft being developed as a model aircraft) that meets all of the following conditions as set forth in section 336 of Public Law 112-95:
      • (a) The aircraft is flown strictly for hobby or recreational use;
      • (b) The aircraft is operated in accordance with a community-based set of safety guidelines;
      • (c) The aircraft is limited to not more than 55 pounds unless
      • (d) The aircraft is operated in a manner that does not interfere with, and gives way to, any manned aircraft; and
      • (e) When flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation.

FAR 107

• 107.1 Applicability.
  • (a) Except as provided in paragraph (b) of this section, this part applies to the registration, airman certification, and operation of civil small unmanned aircraft systems within the United States.
  • (b) This part does not apply to the following:
    • (1) Air carrier operations;
    • (2) Any aircraft subject to the provisions of part 101 of this chapter; or
    • (3) Any operation that a remote pilot in command elects to conduct pursuant to an exemption issued under section 333 of Public Law 112-95.

FAR 107

• § 107.7 Inspection, testing, and demonstration of compliance.
  • (a) A remote pilot in command, owner, or person manipulating the flight controls of a small unmanned aircraft system must, upon request, make available to the Administrator:
    • (1) The remote pilot certificate with a small UAS rating; and
    • (2) Any other document, record, or report required to be kept under the regulations of this chapter.
  • (b) The remote pilot in command, visual observer, owner, operator, or person manipulating the flight controls of a small unmanned aircraft system must, upon request, allow the Administrator to make any test or inspection of the small unmanned aircraft system, to determine compliance with the regulations.

FAR 107

• §107.9 Accident reporting.
  • No later than 10 calendar days after an operation that meets the criteria of either paragraph (a) or (b) of this section, a remote pilot in command must report to the FAA, in a manner acceptable to the Administrator, any operation of the small unmanned aircraft involving at least:
    • (a) Serious injury to any person or any loss of consciousness; or
    • (b) Damage to any property, other than the small unmanned aircraft, that exceeds $500.00.

FAR 107

• Subpart B—Operating Rules
  • §107.12 Requirement for a remote pilot certificate with a small UAS rating.
    • (a) Except as provided in paragraph (c) of this section, no person may manipulate the flight controls of a small unmanned aircraft system unless:
      • (1) That person has a remote pilot certificate with a small UAS rating issued pursuant to Subpart C of this part and satisfies the requirements of §107.65; or
      • (2) That person is under the direct supervision of a remote pilot in command and the remote pilot in command has the ability to immediately take direct control of the flight of the small unmanned aircraft.

FAR 107

Subpart B—Operating Rules continued

• §107.12 Requirement for a remote pilot certificate with a small UAS rating.
  • (b) Except as provided in paragraph (c) of this section, no person may act as a remote pilot in command unless that person has a remote pilot certificate with a small UAS rating issued pursuant to Subpart C of this part and satisfies the requirements of §107.65.
  • (c) The Administrator may, consistent with international standards, authorize an airman to operate a civil foreign-registered small unmanned aircraft without an FAA-issued remote pilot certificate with a small UAS rating.
107 Subpart B—Operating Rules continued

107.15 Condition for safe operation.
• (a) No person may operate a small unmanned aircraft system unless it is in a condition for safe operation. Prior to each flight, the remote pilot in command must check the small unmanned aircraft system to determine whether it is in a condition for safe operation.
• (b) No person may continue flight of the small unmanned aircraft when he or she knows or has reason to know that the small unmanned aircraft system is no longer in a condition for safe operation.

107.17 Medical condition.
• No person may manipulate the flight controls of a small unmanned aircraft system or act as a remote pilot in command, visual observer, or direct participant in the operation of the small unmanned aircraft if he or she knows or has reason to know that he or she has a physical or mental condition that would interfere with the safe operation of the small unmanned aircraft system.

107.19 Remote pilot in command.
• (a) A remote pilot in command must be designated before or during the flight of the small unmanned aircraft.
• (b) The remote pilot in command is directly responsible for and is the final authority as to the operation of the small unmanned aircraft system.
• (c) The remote pilot in command must ensure that the small unmanned aircraft will pose no undue hazard to other people, other aircraft, or other property in the event of a loss of control of the aircraft for any reason.
• (d) The remote pilot in command must ensure that the small UAS operation complies with all applicable regulations of this chapter.
• (e) The remote pilot in command must have the ability to direct the small unmanned aircraft to ensure compliance with the applicable provisions of this chapter.

107.21 In-flight emergency.
• (a) In an in-flight emergency requiring immediate action, the remote pilot in command may deviate from any rule of this part to the extent necessary to meet that emergency.
• (b) Each remote pilot in command who deviates from a rule under paragraph (a) of this section must, upon request of the Administrator, send a written report of that deviation to the Administrator.

107.23 Hazardous operation.
• No person may operate a small UAS in a careless or reckless manner, or drop objects that create an undue hazard

107.25 Operation from a moving vehicle or aircraft.
• No person may operate a small unmanned aircraft system from a moving aircraft.
• UAS may be operated from a moving land or water-borne vehicle flown over a sparsely populated area and is not transporting another person’s property for compensation or hire.

107.29 Daylight operation.
• (a) No person may operate a small unmanned aircraft system during night.
• (b) No person may operate a small unmanned aircraft system during periods of civil twilight unless the small unmanned aircraft has lighted anti-collision lighting visible for at least 3 statute miles.
• (c) For purposes of paragraph (b) of this section, civil twilight refers to a period of that begins
  • (1) 30 minutes before official sunrise and ends at official sunrise;
  • (2) at official sunset and ends 30 minutes after official sunset.
FAR 107 Subpart B—Operating Rules continued

• §107.31 Visual line of sight aircraft operation.
  • (a) With vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one is used), and the person manipulating the flight control of the small unmanned aircraft system must be able to see the unmanned aircraft throughout the entire flight in order to:
    • Know the unmanned aircraft’s location, attitude, altitude, and direction of flight;
    • (3) Observe the airspace for other air traffic or hazards; and Determine that the unmanned aircraft does not endanger the life or property of another.

• §107.37 Operation near aircraft; right-of-way rules.
  • Each small unmanned aircraft must yield the right of way to all aircraft, airborne vehicles, and launch and reentry vehicles. Yielding the right of way means that the small unmanned aircraft must give way to the aircraft or vehicle and may not pass over, under, or ahead of it unless well clear.
  • (b) No person may operate a small unmanned aircraft so close to another aircraft as to create a collision hazard.

FAR 107 Subpart B—Operating Rules continued

• §107.35 Operation of multiple small unmanned aircraft.
  • A person may not operate or act as a remote pilot in command or visual observer in the operation of more than one unmanned aircraft at the same time.

• §107.36 Carriage of hazardous material.
  • A small unmanned aircraft may not carry hazardous material.

FAR 107 Subpart B—Operating Rules continued

• §107.41 Operation in certain airspace.
  • No person may operate a small unmanned aircraft in Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace designated for an airport unless that person has prior authorization from Air Traffic Control (ATC).

• §107.43 Operation in the vicinity of airports.
  • No person may operate a small unmanned aircraft in a manner that interferes with operations and traffic patterns at any airport, heliport, or seaplane base.

FAR 107 Subpart B—Operating Rules continued

• §107.45 Operation in prohibited or restricted areas.
  • No person may operate a small unmanned aircraft in prohibited or restricted areas unless that person has permission from the using or controlling agency, as appropriate.

• §107.47 Flight restrictions in the proximity of certain areas designated by notice to airmen.
  • A person acting as a remote pilot in command must comply with the provisions of §§91.117 through 91.145 and 99.7 of this chapter.
107.49 Preflight familiarization, inspection, and actions for aircraft operation.

(a) Prior to flight, the remote pilot in command must:

1. Assess the operating environment, considering risks to persons and property in the immediate vicinity both on the surface and in the air. This assessment must include:
   1. Local weather conditions;
   2. Local airspace and any flight restrictions;
   3. The location of persons and property on the surface; and
   4. Other ground hazards.

(b) Ensure that all persons directly participating in the small unmanned aircraft operation are informed about the operating conditions, emergency procedures, contingency procedures, roles and responsibilities, and potential hazards;

(c) Ensure that all control links between ground control station and the small unmanned aircraft are working properly;

(d) If the small unmanned aircraft is powered, ensure that there is enough available power for the small unmanned aircraft system to operate for the intended operational time; and

(e) Ensure that any object attached or carried by the small unmanned aircraft is secure and does not adversely affect the flight characteristics or controllability of the aircraft.

107.51 Operating limitations for small unmanned aircraft.

A remote pilot in command and the person manipulating the flight controls of the small unmanned aircraft system must comply with all operating limitations:

(a) The groundspeed may not exceed 87 knots (100 miles per hour).

(b) The altitude cannot be higher than 400 feet above ground level, unless the small unmanned aircraft:

1. Is flown within a 400-foot radius of a structure; and

2. Does not fly higher than 400 feet above the structure’s immediate uppermost limit.

(c) The minimum flight visibility must be no less than 3 statute miles.

(d) The minimum distance of the small unmanned aircraft from clouds must be no less than 500 feet below the cloud; and 2,000 feet horizontally from the cloud.

107.61 Eligibility.

Subject to the provisions of 107.57 and 107.59, in order to be eligible for a remote pilot certificate with a small UAS rating under this subpart, a person must:

(a) Be at least 16 years of age;

(b) Be able to read, speak, write, and understand the English language.

(c) Not have a physical or mental condition that would interfere with the safe operation

(d) Demonstrate aeronautical knowledge by satisfying one of the following conditions:

1. Pass an initial aeronautical knowledge test

2. If a person holds a pilot certificate (other than a student pilot certificate) issued under part 61 of this chapter and meets the flight review requirements specified in §61.56, complete an initial training course covering the areas of knowledge specified in §107.74(a) in a manner acceptable to the Administrator.

107.65 Aeronautical knowledge

A person may not operate a small unmanned aircraft system unless that person has completed one of the following, within the previous 24 calendar months:

(a) Passed an initial aeronautical knowledge test covering the areas of knowledge specified in §107.73(a);

(b) Passed a recurrent aeronautical knowledge test covering the areas of knowledge specified in §107.73(b); or

(c) If a person holds a pilot certificate (other than a student pilot certificate) issued under part 61 of this chapter and meets the flight review requirements specified in §61.56, passed either an initial or recurrent training course covering the areas of knowledge specified in §107.74(a) or (b) in a manner acceptable to the Administrator.
FAR 107 Subpart C—Remote Pilot Certification

- **107.67 Knowledge tests: General procedures and passing grades.**
  - (a) Knowledge tests prescribed by or under this part are given by persons and in the manner designated by the Administrator.
  - (b) An applicant for a knowledge test must have proper identification at the time of application that contains the applicant’s:
    - (1) Photograph;
    - (2) Signature;
    - (3) Date of birth, which shows the applicant meets or will meet the age requirements of this part for the certificate and rating sought before the expiration date of the airman knowledge test report; and
    - (4) Permanent mailing address. If the applicant’s permanent mailing address is a post office box number, then the applicant must also provide a current residential address.
  - (c) The minimum passing grade for the knowledge test will be specified by the Administrator.
  - (d) A person who receives a certificate of waiver issued under this section:
    - (1) May deviate from the regulations of this part to the extent specified in the certificate of waiver; and
    - (2) Must comply with any conditions or limitations that are specified in the certificate of waiver.

FAR 107 Subpart D—Waivers

- **107.200 Waiver policy and requirements.**
  - (a) The Administrator may issue a certificate of waiver authorizing a deviation from any regulation specified in §107.205 if the Administrator finds that a proposed small UAS operation can safely be conducted under the terms of that certificate of waiver.
  - (b) A request for a certificate of waiver must contain a complete description of the proposed operation and justification that establishes that the operation can safely be conducted under the terms of a certificate of waiver.
  - (c) The Administrator may prescribe additional limitations that the Administrator considers necessary.
  - (d) A person who receives a certificate of waiver issued under this section:
    - (1) May deviate from the regulations of this part to the extent specified in the certificate of waiver; and
    - (2) Must comply with any conditions or limitations that are specified in the certificate of waiver.

FAA Moving Forward to Enable Safe Integration of Drones

- WAVERINGTON – The FAA published airworthiness criteria for the proposed certification of 10 different Unmanned Aircraft Systems (UAS) or drones as special class aircraft. This is a crucial step to enabling more complex drone operations beyond what is allowed under the small unmanned aircraft rule (Part 107), including package delivery.
  - “The development of airworthy, durable, and reliable unmanned aircraft is a crucial step forward for this innovative sector,” said Dr. Michael C. Romanowski, director of Aircraft Certification Service Policy and Innovation. “Type certification will help increase both public and regulatory confidence in drone technology as operations become more advanced.”
  - The applicants’ drones range from five to 60 pounds and include several types of vehicle designs, including both fixed wing and rotorcraft, and are all electric powered. Each notice outlines the applicant’s proposed UAS for certification and the airworthiness criteria proposed by the FAA.
  - All 10 applicants are asking for the approval to operate up to 20 aircraft with a single operation.

Practice Questions

1) When using a small UA in a commercial operation, who is responsible for briefing the participants about emergency procedures?
   - A) The FAA inspector
   - B) The lead visual observer
   - C) The remote PIC

2) To avoid a possible collision with a manned airplane, you estimate that your small UA climbed to an altitude greater than 600 feet AGL. To whom must you report the deviation?
   - A) Air Traffic Control
   - B) The National Transportation Safety Board
   - C) Only when the operator will be paid for commercial service.

3) According to 14 CFR part 107, who is responsible for determining the performance of a small unmanned aircraft?
   - A) Remote pilot in command
   - B) Manufacturer
   - C) Owner or operator

4) Which technique should a remote pilot use to scan for traffic? A remote pilot should
   - A) Systematically focus on different segments of the sky for short intervals
   - B) Concentrate on relative movement detected in the peripheral vision area
   - C) Continuously scan the sky from right to left

5) Under what conditions would a small UA not have to be registered before it is operated in the United States?
   - A) When the aircraft weighs more than 55 pounds on takeoff, including everything on-board or attached
   - B) When the aircraft has a takeoff weight that is less than 55 pounds, including fuel and attachments
   - C) All small UAS need to be registered regardless of weight of the aircraft before, during or after the flight.

6) According to 14 CFR part 48, when must a person register a small UA with the Federal Aviation Administration?
   - A) All civilian small UAS weighing greater than .55 pounds must be registered regardless of operation
   - B) When the small UA is used for any purpose other than as a model aircraft
   - C) Only when the operator will be paid for commercial service.
Practice Questions

7) According to 14 CFR part 107, what is required to operate a small UA within 30 minutes after official sunset
   • A) Use of anti-collision lights
   • B) Must operate in a rural area
   • C) Use of a transponder

8) According to 14 CFR part 48, when would a small UA owner not be permitted to register it
   • A) if the owner is less than 13 years of age
   • B) All persons must register their small UA
   • C) If the owner does not have a valid United States driver’s license

Maintenance

Maintenance of your Small UAS

• As a RPIC you are responsible for the safe operation of the UAS
• Safe operation can only be achieved when:
  • the aircraft is fully functional
  • the vehicle and control unit are communicating
  • all parts are safe for use
• Quote from AC 107-2
  • “An sUAS must be maintained in a condition for safe operation. Prior to flight, the remote PIC is responsible for conducting a check of the sUAS and verifying that it is actually in a condition for safe operation.”

What maintenance must be performed?

• The aircraft manufacturer may provide the maintenance program, or, if one is not provided, the applicant may choose to develop one.
• The best approach is to follow a comprehensive maintenance program that includes:
  • Scheduled: inspections, replacement and repair of parts or components in advance of a failure that will assure continued safe operation
  • Unscheduled: any maintenance that is required outside of the scheduled maintenance program

Performing Maintenance

• In all cases follow the manufacturers recommendations and instructions.
• If the operator is not capable of performing the maintenance recommended by the manufacturer
  • Consider the expertise of maintenance personnel familiar with the specific sUAS and components
  • Although not required, consider the use of a certificated maintenance provider
• All maintenance should be completed before the sUAS is returned to service
Performing Maintenance

• Preflight Inspection:
  • If available, use the manufacturer's checklist.
  • Details from a sample Preflight check list
    • Visually inspect the condition of the unmanned aircraft system components
      • Check the fuselage for evidence of damage or misalignment
      • Check for any evidence of cracks or stress
    • Inspect the airframe structure, including undercarriage, all flight control surfaces and linkages
      • Check the flight controls for freedom of movement
    • Check registration markings for proper display and legibility
    • Inspect servo motor(s), including attachment point(s)
      • Look for evidence of stress or damage
      • Check the operation
    • Inspect the propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.
      • Check that each powerplant propeller or fan blades is not damaged
      • Check that the powerplant is functioning and responding to controls
  • Preflight Inspection: continued
    • 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
    • Check that the display panel, if used, is functioning properly
  • Batteries
    • The battery is the fuel source for your sUAS and this some special maintenance to consider
      • Visual inspection cause for rejection
        • Any indication of excessive heat (discoloration anywhere on the battery case)
        • Any distortion of the case
        • Any burn spots in the battery box (where the battery is located in the aircraft)
      • Battery use:
        • Always follow the manufacturer’s guidance for use, charging and recharging use
        • When the aircraft manufacturer instructions or restrictions differ from the battery manufacturer always follow the stricter
  • Bottom line you need to assure that the sUAS is ready for the flight planned

Maintenance record keeping

• Develop a maintenance record system to help maintain readiness
  • Create a system that is easy to use
  • Create a data storage solution that can be easily searched
  • Create a record solution that provide for research
  • Use the records to evaluate the effectiveness of the of the maintenance and inspection program

Questions

• 1. While preparing your sUAS for flight, you notice that one of the propeller blades has a nick. What action should you take?
  • Remove and replace the propeller; consult manufacturer guidelines for repair, if any.
  • When in doubt, remove and replace any damaged part. If repair is allowed, it should be outlined by the manufacturer. The RPIC should consult the manufacturer about such repair.
• 2. During the preflight inspection who is responsible for determining the aircraft is safe for flight?
  • The Remote Pilot in Command
  • The RPIC of an sUAS is responsible for determining the aircraft is safe for flight
Questions

• 3) Under what condition should the operator of a small unmanned aircraft establish a scheduled maintenance protocol?
  • When the manufacturer does not provide maintenance schedule.
  • Follow all manufacturer maintenance recommendations to achieve the longest and safest service life of the sUAS. If the sUAS or component manufacturer does not provide scheduled maintenance instructions, it is recommended that you establish your own scheduled maintenance protocol.

• 4) Which of the following scenarios is a RPIC required to perform a preflight inspection of their sUAS?
  • Preflight inspections are required before each flight, thus there is no scenario that precludes such an inspection.
  • The RPIC must inspect the sUAS before each flight.

• 5) Which of the following sources of information should you consult first when determining what maintenance should be performed on an sUAS or its components?
  • Manufacturer guidance.
  • The preferred source of information is the manufacturer’s guidance about maintenance schedule and instructions.

• 6) How should an sUAS preflight inspection be accomplished for the first flight of the day?
  • Thorough and systematic means recommended by the manufacturer.
  • The preflight inspection should be a thorough and systematic means by which the remote PIC determine that the sUAS is ready for safe flight. Most Aircraft Manuals or Pilot’s Operating Handbooks contain a section on preflight inspection that should be used for guidance.

• 7) When should the battery for an unmanned aircraft be replaced?
  • Per the guidelines of the sUAS manufacturer or the battery manufacturer, whichever is more restrictive.
  • Follow all manufacturer maintenance recommendation to achieve the longest and safest service life of the sUAS. By adhering to the more restrictive limitation or component life cycle the Remote PIC will be assured of being in compliance of both the sUAS and battery manufacturers’ guidelines.

• 8) When performing preflights, or scheduled maintenance procedures, to avoid missing important steps, always use the
  • Appropriate checklists.
  • To avoid missing important steps, always use the appropriate checklists whenever they are available. Consistent adherence to approved checklists is a sign of a disciplined and competent pilot.

• 9) Scheduled maintenance should be performed in accordance with the?
  • Manufacturers’ suggested procedures.
  • Follow all manufacturer maintenance recommendations to achieve the longest and safest service life of the sUAS. If the sUAS or component manufacturer does not provide scheduled maintenance instructions, it is recommended that you establish your own scheduled maintenance protocol.

• 10) Which of the following lithium batteries should not be used?
  • A battery with a bulge on one side of its case.
  • Damages batteries should never be used or charged. Lithium batteries do normally get warm during discharge. Avoid the use of hot batteries. New batteries should be treated per manufacturing instructions, but do not normally need several charge cycles to use.

Charts and Airspace

Today’s Topics

• Sectional Chart Symbols
• Airspace
• Special Use Airspace
• NOTAMS
Types of VFR Charts

- **Sectional**
  - 1:500,000 scale
  - Most commonly used

- **Terminal Aeronautical Chart (TAC)**
  - 1:250,000 scale
  - Only for congested airspace

Sectional Chart

- Covers airspace up to 18,000 feet
- Issued every 56 days
- Background colors indicate elevation

Where to Get Sectional Charts

**Electronic**
- [www.skyvector.com](http://www.skyvector.com) (free)
- Flight Plan Go app (free)
- Fore Flight app

**Paper**
- Maybe available at local airport
- [www.sportys.com](http://www.sportys.com)

Blue airports = Control tower

Magenta airports = Non-towered
Towers

- Beware of Guy Wires

2,000' MSL
1,638' AGL (above ground level)
Southern Illinois University

Airspace

- Controlled Airspace
- Uncontrolled Airspace
- Special Use Airspace (SUA)
- Other Airspace

Flight Visibility and Clouds

- Minimum 3 statute miles (sm) visibility
- No less than 500 feet below and 2000 feet horizontally from a cloud

- AC 107-2

Controlled Airspace

- Class A, B, C, D, and E airspace.
- Commercial sUAS require permission to operate in B, C, D, and E airspace if it begins at the surface.
<table>
<thead>
<tr>
<th>Airspace</th>
<th>Used For</th>
<th>Is ATC Permission Required</th>
<th>Chart Marking</th>
<th>Altitude Marking</th>
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</thead>
<tbody>
<tr>
<td>Class A</td>
<td>High Altitude</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class B</td>
<td>Biggest Airports</td>
<td>Yes (check altitude notation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class C</td>
<td>Large Airports</td>
<td>Yes (check altitude notation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class D</td>
<td>Medium Airports</td>
<td>Yes (always starts at the surface)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class E to surface with airport</td>
<td>Small Airport</td>
<td>Yes (check altitude symbol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class E elsewhere</td>
<td>Almost Everywhere</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class G</td>
<td>Good to Go</td>
<td>No</td>
<td>Not Charted, no other airspace shown</td>
<td></td>
</tr>
</tbody>
</table>

**Class A Airspace**

- No small UAS operations (too high)
- Above 18,000ft MSL (above Sea Level) up to about 60,000 ft
- Not on Sectional Chart

**Class B Airspace**

- Typically up to 10,000 MSL
- Each Class B airspace is tailored to the airports needs
- "Upside down wedding cake"
- Altitudes shown by:

**Class C Airspace**

- Typically extends up to 4,000 AGL
- Tailored to specific airport
- 5 NM inner ring: surface to 4,000’ AGL
- 5-10 NM outer ring: 1,200’ to 4,000’ AGL
- 20 NM outer area (not charted)
- Altitudes shown as: Commercial sUAS need prior ATC Authorization to fly here
- Authorization not needed here.
Class D Airspace

- Usually extends up to 2,500 feet AGL
- Tailored to specific airport
- Top altitude shown as:

  ![Image](https://example.com/image1)

- The Control Tower may only be part time
- The airspace then becomes class G or E when the tower is closed.

Class E Airspace

- Class E airspace may begin at:
  - the surface (affects sUAS operations)

  But usually begins at:
  - 700' AGL (above ground level)
  - 1,200' AGL
  - above other airspace (A, B, C, or D)
  - above 60,000 MSL feet

Class E Airspace at the Surface

- Class E starts at the surface inside the dashed magenta circle

  ![Image](https://example.com/image2)

  - Commercial sUAS need prior ATC Authorization to fly here

Uncontrolled Airspace – Class G

- Not technically shown on the chart,
  - Class G always begins at the surface, unless some other airspace is shown at the surface.

- Extends from surface to base of overlying controlled airspace.

- Commercial sUAS okay to operate here
Flight Visibility and Clouds

- Minimum 3 statute miles (sm) visibility
- No less than 500 feet below and 2000 feet horizontally from a cloud
  - AC 107-2

(Refer to Figure 71, area 1.) The floor of the Class E airspace above Georgetown Airport (E36) is at

- A. the surface.
- B. 700 feet AGL.
- C. 3,823 feet MSL.

(Refer to Figure 76.) What ATC permissions are required to operate near Anderson Airport?

- A. ATC clearance required.
- B. No ATC permission is required.
- C. Waiver must be requested.

(Refer to Figure 75.) The airspace surrounding the Gila Bend AF AUX Airport (GXF) (area 6) is classified as Class

- A. B.
- B. C.
- C. D.

The typical outer radius limits of Class C airspace are

- A. 10 NM.
- B. 20 NM.
- C. 30 NM.
Special Use Airspace

Established to protect/confine activities or landmarks.

When charted, information will include altitudes, hours of operation, and controlling agency name.

<table>
<thead>
<tr>
<th>Special Use Airspace Type</th>
<th>Is Flight Allowed?</th>
<th>Chart Markings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibited</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Restricted</td>
<td>No, if active (unless with explicit permission)</td>
<td></td>
</tr>
<tr>
<td>Air Defense Identification Zone (ADIZ)</td>
<td>No, along US borders</td>
<td></td>
</tr>
<tr>
<td>Temporary Flight Restrictions (TFR)</td>
<td>Not charted; sporting events, Presidents, airshows, etc.</td>
<td></td>
</tr>
<tr>
<td>National Security Area</td>
<td>Yes, but would be a bad idea</td>
<td></td>
</tr>
<tr>
<td>Warning Area</td>
<td>Yes, likely in international waters</td>
<td></td>
</tr>
<tr>
<td>Military Operating Area (MOA) and Alert Area</td>
<td>Yes, use caution</td>
<td></td>
</tr>
<tr>
<td>Military Training Routes</td>
<td>No, with caution, get a briefing with 1800wxbrief.com or by calling 1-800-WX-BRIEF</td>
<td></td>
</tr>
</tbody>
</table>

Special Use Airspace

- **RESTRICTED AREAS**
- **PROHIBITED AREAS**

Restricted Airspace

Hazards to non-participating aircraft:
- Aerial gunnery, guided missiles, artillery firing

Can fly here if:
- Area is inactive
- Controlling agency permission

Check Sectional tab for altitudes, hours of operation, and contact info.

Prohibited Airspace

- For national security:
  - White House
  - Capitol
  - Etc.

- Check Sectional tab for altitudes, hours of operation, and contact info.
Special Use Airspace

- SUAS use Caution
- WARNING AREAS
- ALERT AREAS
- MILITARY OPERATING AREAS (MOA)
- CONTROLLED FIRING AREAS

Warning Areas

- Hazards to non-participating aircraft
  - Aerial gunnery, guided missiles, artillery firing
  - International Waters
- Check Sectional tab for altitudes, hours of operation, and contact info

Alert Areas

- High Concentration of Unusual Activity
  - Pilot training, helicopters, parachuting, drones
- Check Sectional tab for altitudes, hours of operation, and contact info

Military Operation Area (MOA)

- Military Training, aerial refueling, formation flight, maneuvers
- Check Sectional tab for altitudes, hours of operation, and contact info

Other Airspace

- TFR (Temporary Flight Restriction)
- ADIZ (Air Defense Identification Zone)
- MTR (Military Training Routes)
- PARACHUTE AREAS
- NSA (National Security Areas)
- Controlled Firing Area

TFR

- Published by NOTAM for
  - Presidential TFRs/NOTAMs
  - Emergency response TFRs and NOTAMs
  - Forest fires and other disasters
  - Standing TFRs that go into and out of effect
  - Stadiums for sporting events
  - Awareness of college football
- Found at
  - tfr.faa.gov
**ADIZ**

Along US National Borders

**Military Training Routes (MTR)**

**Parachute Area/Glider Area**

- Parachuting
  - Check Chart Supplement (A/FD) for common hours/days of operation

**National Security Area**

- These areas are likely to have TFRs issued regularly
- You can fly here, but be prepared to talk to authorities

**Controlled Firing Area**

- Artillery firing, gunnery, etc.
  - Not Charted
    - Temporary
    - You don’t really know where they are
  - They will stop firing if the see/detect non-participating aircraft

(Refer to Figure 75, area 6) Where can you find additional information about "R-2305"?

- A. On the Special Use Airspace section of the chart.
- B. In the Aeronautical Information Manual.
- C. In the Chart Supplements U.S. (Formerly A/FD).
Under what condition, if any, may remote pilots fly through a restricted area?

- A. When flying on airways with an ATC clearance.
- B. With the controlling agency’s authorization.
- C. Regulations do not allow this.

NOTAM Types

- NOTAM (D)
  - Airport closures or changes
- Flight Data Center (FDC) NOTAM
  - Temporary flight restrictions
- Pointer NOTAM
  - Point to another NOTAM
- Military NOTAM
  - Military facility information

- Published NOTAMs (published every 28 days)
  - Long term or known in advance (Super Bowl, etc.)

NOTAMs

- Where to get
  - www.1800wxbrief.com
  - www.faa.gov
  - www.skyvector.com (not official)

- Example FDC NOTAM - Airshow

**FDC 6/4539 ZTL NC AIRSPACE MONROE, NC TEMPORARY FLIGHT RESTRICTION. PURSUANT TO 14 CFR SECTION 91.145, MANAGEMENT OF AIRCRAFT OPERATIONS IN THE VICINITY OF AERIAL DEMONSTRATIONS AND MAJOR SPORTING EVENTS, AIRCRAFT OPERATIONS ARE PROHIBITED WITHIN AN AREA DEFINED AS A 5 NM RADIUS OF 350108N0803713W (CLT127019.3) SFC - 3500FT UNLESS AUTHORIZED BY ATC. EFFECTIVE 1611112000 UTC UNTIL 1611112200 UTC, 1611121630 UTC UNTIL 1611122200 UTC, AND 1611131630 UTC UNTIL 1611132200 UTC. DUE TO VARIOUS AERIAL DEMONSTRATIONS, GEORGE CLINE, TELEPHONE 336-337-8183, IS THE POINT OF CONTACT. THE CHARLOTTE/CLT/APPROACH TELEPHONE 704-359-1020, IS THE COORDINATION FACILITY. 1611112000**

Time-critical information on airports and changes that affect the national airspace system are provided by

- A. Notices to Airmen (NOTAMS).
- B. the Chart Supplements U.S. (formerly Airport/Facilities Directory or A/FD).
- C. Advisory Circulaters (ACs).

(Refer Figure 20, area 5.) How would a remote PIC “CHECK NOTAMS” as noted in the CAUTION box regarding the unmarked balloon?

- A. By utilizing the B4UFLY mobile application.
- B. By contacting the FAA district office.
- C. By obtaining a briefing via an online source such as 1800WXbrief.com.
Latitude Versus Longitude

- Latitude – lines running E and W parallel to Equator
- Longitude – lines running N and S parallel to the Prime Meridian

“Longitude goes up and down, Latitude goes Round and Round”

Latitude and Longitude

- Grid System

- Listed in Degrees° and minutes’
  - For example Carbondale airport is N37°46.69’ / W089°15.12’

- Or in Degrees° minutes’ and seconds”
  - 37°47’27.51”N 089°00’48.23”W

(Refer to Figure 21.) What airport is located approximately 47 (degrees) 40 (minutes) N latitude and 101 (degrees) 26 (minutes) W longitude?
- A. Mercer County Regional Airport.
- B. Semshenko Airport.
- C. Garrison Airport.

An FDC NOTAM will typically contain information
- A. regarding public gatherings of large groups.
- B. regarding military operations.
- C. regarding available hard surface runways.

(Refer to Figure 23, area 3.) The top of the group obstruction approximately 11 nautical miles from the Savannah VORTAC on the 009 degree radial is
- A. 400 feet AGL.
- B. 454 feet MSL.
- C. 432 feet MSL.

Other Areas to Consider Avoiding

- Power plants
- Industrial production facilities

Because of
- Thermal plumes
- Security concerns
Birds and Wildlife

• Some birds may be agitated by sUAS and even attack the sUAS

• Bird/wildlife strikes
  • Can be reported at...
  • http://Wildlife.faa.gov/strikenew.aspx

Questions

Overview

• Types of airports
• Airport Information
• Airport Markings
• Security Areas

Airports

Types of Airports

• Towered (controlled)
  • Airspace: B, C, D
    • Need Waiver and ATC permission to operate

• Non-Towered (uncontrolled)
  • Airspace E, G
    • Need Waiver for E

• Civil, Military, or Private

Airport Information

• Chart Supplement (formerly Airport/Facility Directory)
• NOTAM
• ATIS
• Aeronautical Charts
  • Variation
  • Latitude / Longitude
Airport Information

- Chart Supplement
- Chart Supplement (formerly Airport/Facility Directory)
- NOTAM
  - List of currently unusual conditions within the National Aerospace System (runway, taxiway closures, approach changes, etc.)
  - Found at DUATS, 1800wxbrief.com, Flight Service Stations, or pilotweb

- ATIS
  - Recorded information about weather and airport conditions on a published ATC frequency
  - Towered airports only

Aeronautical Charts

- Coordinates are used to locate objects or points on Earth
  - Consist of Latitude and Longitude

- True North and Magnetic North are not the same point.
  - The angular difference between True and Magnetic is Variation
**Airport Markings**

- Typically associated with airline operations
- Badge (Issued by airport) or escort required
  - Likely need a waiver to operate at these airports, so be sure to ask the Airport Authority if an escort is needed if you are working on the secure side of the airport.

---

**Security Areas**

- Typically associated with airline operations
- Badge (Issued by airport) or escort required
  - Likely need a waiver to operate at these airports, so be sure to ask the Airport Authority if an escort is needed if you are working on the secure side of the airport.

---

**Questions**

The most comprehensive information on a given airport is provided by

A. the Chart Supplements U.S. (formerly Airport/Facility Directory).
B. Notices to Airmen (NOTAMs).
C. Terminal Area Chart (TAC).

---

**Questions**

An aircraft announces that they are on short final for runway 9. Where will the aircraft be in relation to the airport?

A. North.
B. West.
C. East.
Questions

An aircraft announces that they are on short final for runway 9. Where will the aircraft be in relation to the airport?

A. North.
B. West.
C. East.

Questions

What is required to enter an airport SIDA?

A. You must pass the TSA screening.
B. You must have an FAA-issued pilot certificate.
C. You must have an airport-issued or approved ID.

Radio Communication

Basic Rules of Radio Communication

- LISTEN FIRST
- Plan your transmission
- Make your radio call
- Listen

- Know where other aircraft are – build your mental picture of the traffic in the area
- Know what type of aircraft are operating in the area – relative speed
- Know where you and your aircraft are with respect to the local airport and runway structures
- Wait for the breaks in the radio chatter so you don’t step on another transmission
Basic Rules of Radio Communication

- LISTEN FIRST
- Plan your transmission
  - Know what you will say before you press the PTT
- Efficiency and clarity are important – aircraft radios only allow one clear transmission at a time on each frequency
- If talking to air traffic control, plan what you expect them to say to you so you can plan your response
  - Being ahead of the communications helps to maintain control of your aircraft
- If talking to air traffic control, plan what you expect them to say to you so you can plan your response
  - Who they are
  - Who you are
  - Where you are
  - What you want
  - Who they are again (if uncontrolled)
  - Listen

Basic Rules of Radio Communication

- LISTEN FIRST
- Plan your transmission
- Make your radio call
- Be concise and accurate
- Who they are
- Who you are
- Where you are
- What you want
- Who they are again (if uncontrolled)

Basic Rules of Radio Communication

- LISTEN FIRST
- Plan your transmission
- Make your radio call
- Be concise and accurate
  - Who they are
  - Who you are
  - Where you are
  - What you want
  - Who they are again (if uncontrolled)
- Listen

Phraseology: Letters

Pronunciation is a little different in aviation in order to ensure understanding.

Letters
Numbers
Phrases
Distance
Altitude
Phraseology: Letters

<table>
<thead>
<tr>
<th>Letter</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Mike</td>
</tr>
<tr>
<td>N</td>
<td>November</td>
</tr>
<tr>
<td>P</td>
<td>Papa</td>
</tr>
<tr>
<td>R</td>
<td>Romeo</td>
</tr>
<tr>
<td>S</td>
<td>Sierra</td>
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<tr>
<td>T</td>
<td>Taxi</td>
</tr>
<tr>
<td>U</td>
<td>Uniform</td>
</tr>
<tr>
<td>V</td>
<td>Victor</td>
</tr>
<tr>
<td>W</td>
<td>Whiskey</td>
</tr>
<tr>
<td>X</td>
<td>Xray</td>
</tr>
<tr>
<td>Y</td>
<td>Yankee</td>
</tr>
<tr>
<td>Z</td>
<td>Zulu</td>
</tr>
</tbody>
</table>

Phraseology: Numbers

<table>
<thead>
<tr>
<th>Digit</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Zero</td>
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<tr>
<td>1</td>
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<td>2</td>
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<td>7</td>
<td>Seven</td>
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<tr>
<td>8</td>
<td>Eight</td>
</tr>
<tr>
<td>9</td>
<td>Nine</td>
</tr>
</tbody>
</table>

Phraseology

- Phrases
  - Roger: I have received and understood your transmission
  - Wilco: I have received and will comply with your instruction

- Departure
- Arrival
- Position Report

Questions

A visual observer notices a manned aircraft approaching the area in which sUAS operations are taking place, flying just north of the area from west to east. What call could the Remote PIC/visual observer make on CTAF to alert the manned pilot?

A. Zephyrhills traffic, unmanned aircraft Xray Yankee Zulu, operating five NM south of the airport at or below 400 AGL, located at the three o’clock position of the Cessna just north of our position, Zephyrhills traffic.

B. Zephyrhills traffic, unmanned aircraft at three o’clock of manned aircraft in the area, Zephyrhills traffic.

C. Zephyrhills traffic, unmanned aircraft Xray Yankee Zulu to Cessna in the area, look for us at your three o’clock position, we are about a mile south.
Certification and Waivers

Certification

- Remote Pilot certification required for commercial, for hire operations.
  - Includes for hire:
    - Survey
    - Photography
    - Research
    - Promotion / Propaganda / Marketing

Limitations

- Under 400 AGL
- Under 100 mph (87 knots)
- Not over people
- Only 1 UA per remote pilot
- Daytime only
- Under 55lbs
- Class G airspace only

Unless otherwise authorized, what is the maximum airspeed at which a person may operate an sUAS below 400 feet?

A. 200 Knots
B. 80 mph
C. 100 mph

Power company employees use an sUAS to inspect a long stretch of high voltage powerlines. Due to muddy conditions, their vehicle must stay beside the road and the crew must use binoculars to maintain visual line of sight with the aircraft. Is this sUAS operation in compliance with 14 CFR Part 107?

A. Yes, the operation is compliant with Part 107.
B. There is not enough information to make a determination.
C. No, the operation is not compliant with Part 107.
What may be used to assist compliance with sUAS see-and-avoid requirements?
A. Binoculars.
B. First-person view camera.
C. Remote pilot diligence.

Sunrise is 0645. When can you launch your sUAS operation?
A. 0645.
B. 0615.
C. 0715

Which crewmember must hold a remote pilot certificate with an sUAS rating?
A. Remote Pilot in Command.
B. Person manipulating the controls.
C. Visual Observer.

When requesting a waiver, the required documents should be presented to the FAA at least how many days prior to the planned operation?
A. 30 days.
B. 10 days.
C. 90 days.

Except when necessary for takeoff or landing, what is the minimum safe altitude required for a remote pilot to operate an sUAS over people?
A. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.
B. An altitude of 200 feet above the highest obstacle within a horizontal radius of 1,000 feet.
C. You may not operate an sUAS over people who are not part of the sUAS operation.
Aeronautical Decision Making

What is ADM?

• ADM is the systematic approach to decision making that pilots use to ensure the most appropriate decision. For a given set of circumstances

• Much of ADM entails risk management and mitigation and being aware of the situation the aircraft is in.

• 80% of all accidents are a result of human error.

PAVE

• The risk elements of a flight can be categorized as:
  • Pilot
  • Aircraft
  • Environment
  • External Pressures

Pilot

• Am I rested?
• Am I ill?
• Am I medicated?
• Am I intoxicated?
• Am I competent?
• Am I qualified?
• Am I safe?

Remote Pilot: Fitness for duty

• Illness
• Medication
• Stress (physical, emotional, etc)
• Alcohol
• Fatigue
• Eating

Aircraft

• Is my aircraft airworthy?
• Is it capable of this mission?
• Is it capable of being operated in these conditions? (Night, etc)
• Can I maintain visual contact with my aircraft? (White UA on cloudy or snowy day)
enVironment

- Can I maintain visual contact with my UA?
- Are the weather conditions VFR?
- Am I within 5 statute miles of an airport? Do I have permission to be here?
- Are there other aircraft in the area? What type? What altitude?

External pressures

- Why do I need to make this flight now?
- Why do I need to make this flight here?
- Can this wait for better conditions?
- Am I being pressured into completing this flight when it is unsafe to do so?

Situational Awareness

- An understanding of what is happening with and around your aircraft
- Maintain visual contact with UA
- Maintain control of UA
- Scan for other traffic
- Listen to the local radio frequency
- Build a “big picture” in your mind of what is happening around your UA

Visual Scanning

- Small sections of the sky
- Deliberate pausing to scan
- Eyes designed to look for motion
- Motion induced blindness

Visual Scanning

- Small sections of the sky
- Deliberate pausing to scan
- Eyes designed to look for motion
- Motion induced blindness

Hazardous Attitudes

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Antidote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macho</td>
<td>“I can do it.”</td>
</tr>
<tr>
<td>Invulnerability</td>
<td>“It won’t happen to me.”</td>
</tr>
<tr>
<td>Anti-Authority</td>
<td>“Don’t tell me what to do.”</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>“Do something quickly.”</td>
</tr>
<tr>
<td>Resignation</td>
<td>“What’s the use?”</td>
</tr>
<tr>
<td></td>
<td>Taking chances is foolish.</td>
</tr>
<tr>
<td></td>
<td>It could happen to me.</td>
</tr>
<tr>
<td></td>
<td>Follow the rules, they are right.</td>
</tr>
<tr>
<td></td>
<td>Not so fast think first.</td>
</tr>
<tr>
<td></td>
<td>I can make a difference.</td>
</tr>
</tbody>
</table>
Operational Pitfalls

Crew Resource Management

- Make use of your resources.
- Visual observer.
- ATC.

Risk management, as part of the aeronautical decision making (ADM) process, relies on which features to reduce the risks associated with each flight?

- Application of stress management and risk element procedures.
- Situational awareness, problem recognition, and good judgment.
- The mental process of analyzing all information in a particular situation and making a timely decision on what action to take.

- The effective use of all available resources - human, hardware, and information - prior to and during flight to ensure the successful outcome of the operation is called risk management.

- Crew resource management.
- Safety management system.
<table>
<thead>
<tr>
<th>The effective use of all available resources - human, hardware, and information prior to and during flight to ensure the successful outcome of the operation is called</th>
</tr>
</thead>
<tbody>
<tr>
<td>risk management.</td>
</tr>
<tr>
<td>crew resource management.</td>
</tr>
<tr>
<td>safety management system.</td>
</tr>
<tr>
<td>The accurate perception and understanding of all the risk element factors and conditions is</td>
</tr>
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<tr>
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</tr>
<tr>
<td>Identify the hazardous attitude or characteristic a Remote Pilot in Command displays while taking risks in order to impress others?</td>
</tr>
<tr>
<td>Impulsivity.</td>
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<tr>
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</tr>
<tr>
<td>Invulnerability.</td>
</tr>
<tr>
<td>Machoism.</td>
</tr>
</tbody>
</table>
You have been hired as a Remote Pilot in Command by a local TV news station to film breaking news with a small unmanned aircraft. You expressed a safety concern and the station manager has instructed you to “fly first, ask questions later.” What type of hazardous attitude does this attitude represent?

- Invulnerability.
- Impulsivity.
- Machoism.

Emergencies

RPIC Duties and Responsibilities

- Duty to keep command and control of aircraft
- Responsible for the safe operation of the aircraft
- Responsible for damage done if RPIC fails in duty and responsibility

Lost GPS

- Is your UA directly controllable if it loses its GPS link?
- Is it programmed with a failsafe if it is not directly controllable?
- Is the failsafe operationally safe? (If the failsafe is to “land immediately” and the operation is over a large crowd or over water, this may not be appropriate)

Lost link

- Is the UA programmable to land on its own or return to a defined point if you lose connection to it?
**Flyaway**

- Do you have procedures in place if the UA becomes unresponsive and flies off?

**Collision**

- Insurance requirements
  - People
  - Property
  - Aircraft
  - Antenna Towers
- FAA reporting: $500 or more
- NTSB reporting

**You are part of a news crew, operating an UAS to cover a breaking story. You experience a flyaway during landing. The unmanned aircraft strikes a vehicle, causing approximately $800 worth of damage. When must you report the accident to the FAA?**

  - Anytime.
  - Within 10 days.
  - Not to exceed 30 days.

**While operating a small unmanned aircraft system (UAS), you experience a flyaway and several people suffer injuries. Which of the following injuries requires reporting to the FAA?**

  - An injury requiring an overnight hospital stay.
  - Scrapes and cuts bandaged on site.
  - Minor bruises.
What should a remote pilot do if the UAS they are operating collides with a bird or wildlife?

- Report the collision to ATC.
- File an accident report with the NTSB.
- File a wildlife strike report with the FAA.

Most midair collision accidents occur during:

- Hazy days.
- Clear days.
- Cloudy nights.

Questions

Aerodynamics, Loading, and Performance

Dr. Charley Rodriguez
SIU Aviation Technologies
Forces Acting on an Aircraft

Aircraft Axes and Control

- Three Axes
  - Longitudinal – Axis runs fore and aft
    - Aileron (Banking the aircraft)
  - Lateral – Axis spans left to right
    - Elevator (Pitching the aircraft)
  - Yaw – Axis passes vertically through the aircraft
    - Rudder (Turning the aircraft left and right)

Flight Begins with Aerodynamics

- Heavier-than-air flying machines rely on the generation of forces that produce dynamic reactions with the air.
- These reactions typically involve the movement of air in relation to the wings, propellers, rotors, compressor blades, turbine blades, etc.
- The net results are changes in the pressure of the air interacting with the aerodynamic component.
  - Normally a differential air pressure is applied to and distributed across aerodynamic surface(s).
- A small pressure differential applied over a large surface area will produce considerable force (e.g., Lift and Thrust).

Bernoulli’s Principle

- Daniel Bernoulli a Swiss mathematician
- Researched fluid dynamics
  - Wrote Hydrodynamica 1738
- Bernoulli’s Principle in simple terms
  - As velocity of a flowing fluid increases, pressure decreases.
  - Air passing over the top of a wing or cambered surface of a propeller or rotor experiences an increase in velocity and a reduction of pressure to establish a pressure differential for the production of LIFT or THRUST

Lift and Stalls

- Lift is created through the dynamic action of the air flowing across an airfoil (aerodynamics).
- Pressure differential produced across surface.
  - Generated by the relative air flow at or above a certain velocity and
  - Airfoil within the appropriate angle to the relative wind (angle of attack) (too high of angle of attack = STALL).
  - Air flows in smooth layers (LAMINAR FLOW) around airfoil or rotor.
- Stalls occur when airfoil no longer produces sufficient lift to sustain flight.
  - Usually associated with disruption of laminar flow due to high angle of attack.
  - Stall speed increases with aircraft weight (load).

Lift

- Aerodynamic Lift – Explained by Bernoulli’s Conservation of Energy Law
  - Low Pressure High Velocity
  - Longer Distance
  - High Pressure Low Velocity
  - Shorter Distance
  - Also known as the “Longer Path” or “Equal Transit” Theory

SIU Southern Illinois University
Laminar Flow and Stall

Aircraft Stability

- We typically prefer positive dynamic stability.
  - With positive dynamic stability the aircraft recovers from a disturbance to its previous flight path.
  - Makes aircraft easier to control.
  - Commonly built into airplanes and aerostats.
  - Not prevalent in traditional helicopters with tail rotors.
  - Appears to be included in quadcopters and other multi-rotor machines.

Controllability and Maneuverability

- Controllability – Aircraft lacking positive dynamic stability are typically difficult to control.
  - In extreme cases, aircraft may be dependent on computers to control the craft in flight.
- Maneuverability – Stability is a factor in the maneuverability of an aircraft.
  - Does a high-performance aerobatic aircraft have the same stability and maneuverability as a flight-training aircraft?

Power Versus Atmosphere

- Effects on air breathing engines and aerostats
- Effects on non-air breathing propulsion systems
  - Electric motors
  - Elastic mechanisms
  - Mechanical launchers
  - Rocket engines
- Effects on lifting surfaces, flight controls, and propellers (propulsion system)
**Things to Remember**

- To ensure proper aircraft performance, always follow manufacturer’s recommendations.
- Flying any aircraft beyond its weight limit will adversely affect performance.
  - How would running a marathon race carrying a back pack containing 100 pounds of weight affect your performance?
- Besides performance, exceeding maximum weight may result in structural failures.
  - Flight loads
  - Hard landings
  - Inertia issues

**Overweight Issues**

- If the aircraft can get off the ground...
  - flight time and operational range are reduced as more power is consumed keeping the aircraft in the air
  - the ability to climb is curtailed,
  - aircraft stability is adversely affected, and
  - the reaction of the aircraft during flight to rapid and aggressive control inputs slows down due to inertia (momentum).
- If no information regarding weight limitations is provided by the manufacturer, avoid flying with other than standard payload(s).
- The remote pilot in command is responsible for ensuring that objects carried by the UAV are secured and do not affect flight characteristics or controllability of the aircraft.

**Center of Gravity (CG) or Balance**

- The location of the aircraft where balance occurs.
- CG limits exist in both longitudinal (fore and aft) and lateral (side-to-side) dimensions.
- CG may change as aircraft consumes fuel, if applicable.
- If loading results in the CG being out of limits, aircraft flight characteristics will be compromised (may be unable to control aircraft).
- On fixed-winged aircraft, as the center of pressure (CP) of the wing changes with flight attitude, an improper CG problem may be exacerbated.
- CG may change when payload is released from aircraft.

**CG Issues Affect Small and Large Craft**

**Copters CG**

- For single-rotor helicopters and counter-rotating rotors, the CG will be directly under the mast, for all practical purposes.
- For quadcopters, hexacopters, octocopters, decaicopters, etc., the CG will be in the center of the craft.
  - If the payload weight is out of CG range, the rotor(s) nearest the balance point must work harder to lift the extra weight it supports.
  - Improper CG loading may result in ineffective flight controls.
  - Some aircraft may include marks on the airframe and placards to assist with loading operations.

**Quadcopter CG**

- If the aircraft can get off the ground...
  - flight time and operational range are reduced as more power is consumed keeping the aircraft in the air
  - the ability to climb is curtailed,
  - aircraft stability is adversely affected, and
  - the reaction of the aircraft during flight to rapid and aggressive control inputs slows down due to inertia (momentum).
- If no information regarding weight limitations is provided by the manufacturer, avoid flying with other than standard payload(s).
- The remote pilot in command is responsible for ensuring that objects carried by the UAV are secured and do not affect flight characteristics or controllability of the aircraft.
Airborne Loads

• While aloft, aircraft and payload may be subjected to flight loads.
• When the air is "bumpy", the craft will bounce around like a car on a rough road. The aerial bumps place loads on the aircraft and payload.
• When flying in a straight and level path, the load on the aircraft equals the force of gravity or 1-G.
• Moving the flight controls will change the direction of the aircraft in proportion to the control input and alter the G-load experienced by the craft.

Calculating G-Loads While In a Bank

• Multiply the weight of the aircraft, including payload, times the load factor shown in the chart.
• For example, in a 45° bank the load factor is 1.414. If the aircraft weighs 20 pounds, the load factor will increase the weight to 28.28 pounds during the bank.

Sling Loads

• Effect of drag
• Pendulum effect
  – The greater the length of the sling, the more pronounced the effect
• Affect on stability (rocks aircraft)
• Additional momentum

G-Loads While Banking the Aircraft

• Subjecting the aircraft and payload to high G-loads could cause...
  – structural failure (break a wing or airframe member),
  – payload to shift or break away from its mooring resulting in change of CG and possible change in weight,
  – loss of altitude,
  – flight path to be altered,
  – problems in controllability and maneuverability, and
  – aerodynamic stalls at higher speeds.

What You Can Do?

• Before each flight ensure that the aircraft is properly loaded, within the CG limit, and payload secure.
  – Even if within the gross weight and CG limits, various conditions may alter aircraft performance (e.g., high temperatures, high humidity, high density altitudes, high/gusty winds, terrain and buildings, etc.).
• Follow the rules and make sound decisions.
• Practice flying in various conditions to build and sharpen your flying skill and knowledge of the handling characteristics of the machine.
To ensure that the unmanned aircraft center of gravity (CG) limits are not exceeded, follow the aircraft loading instructions specified in the ...
A. Aircraft Weight and Balance Handbook.
B. Pilot’s Operating Handbook or UAS Flight Manual.
C. Aeronautical Information Manual (AIM).

Question 1: Answer B

Before any flight, verify that the unmanned aircraft is correctly loaded by determining the weight and balance condition. Review any available manufacturer weight and balance data and follow all restrictions and limitations.

The angle of attack at which an airfoil stalls will ...
A. increase if the CG is moved forward.
B. remain the same regardless of gross weight.
C. change with an increase in gross weight.

Question 2: Answer B

When the angle of attack is increased to between $18^\circ$ and $20^\circ$ (critical angle of attack) on most airfoils, the airstream can no longer follow the upper curvature of the wing because of the excessive change in direction. The airfoil will stall if the critical angle of attack is exceeded. The airspeed at which stall occurs will be determined by weight and load factor, but the stall angle of attack is the same.
Question 3

Refer to the following Figure

If an aircraft weighs 10 pounds, what approximate weight would the structure be required to support during a 60° banked turn while maintaining altitude?

Question 3: Answer C

Using the previous Figure, if an aircraft weighs 10 pounds, what approximate weight would the structure be required to support during a 60° banked turn while maintaining altitude?

A. 10.15 pounds.
B. 30 pounds.
C. 20 pounds.

Question 4

Which of the following is true regarding weight and balance of small unmanned aircraft?

A. CG cannot change during flight.
B. Lateral CG is not important to small unmanned aircraft operations.
C. Operations outside weight and balance limitations may result in loss of control.

Question 4: Answer C

Loading the aircraft outside of limitations (weight, balance, or both) may lead to moments that exceed the capabilities of the flight controls and engine(s) [or motor(s)], thus possibly leading to loss of control or other performance anomalies.
Question 5

An increase in load factor will cause an unmanned aircraft to...
A. stall at a higher airspeed.
B. have a tendency to spin.
C. be more difficult to control.

Question 5: Answer A

Stall speed increases in proportion to the square root of the load factor. Thus, with a higher load factor (aircraft becomes heavier), an aircraft will stall at a speed which is higher than the normal stall speed. Answer (B) is incorrect because an airplane’s tendency to spin does not relate to an increase in load factors. Answer (C) is incorrect because an airplane’s stability determines its controllability.

Question 6

When operating an aircraft, the RPIC is responsible for using...
A. the most current weight and balance data.
B. weight and balance data from the factory.
C. recent weight and balance data.

Question 6: Answer A

It is the responsibility of the remote PIC to use the most current weight and balance data when planning a flight and operating the sUAS.

Question 7

What could be a consequence of operating a small unmanned aircraft above its maximum allowable weight?
A. Shorter endurance.
B. Increased maneuverability.
C. Faster speed.
Question 7: Answer A
Excessive weight reduces the flight performance in almost every respect, including a shorter endurance. In addition, operating above the maximum weight limitation can compromise the structural integrity of an unmanned aircraft.

Question 8
When loading cameras or other equipment on an sUAS, mount the items in a manner that ...
A. is visible to the visual observer or other crewmembers.
B. does not adversely affect the center of gravity.
C. can be easily removed without the use of tools.

Question 8: Answer B
Any mounted equipment should be balanced in a manner that does not adversely affect the center of gravity or result in unsafe performance.

Question 9
In a 75° banking turn, UAVs will ...
A. be more susceptible to spinning.
B. stall at a higher airspeed.
C. stall at a lower airspeed.

Question 9: Answer B
Stall speed increases in proportion to the square root of the load factor. Thus, with a load factor of 4, an aircraft will stall at a speed which is double the normal stall speed.

Question 10
Before each flight, the Remote PIC must ensure that ...
A. ATC has granted clearance.
B. the site supervisor has approved the flight.
C. objects carried on the sUAS are secure.
Question 10: Answer C

Prior to each flight, the RPIC must ensure that any object attached to or carried by the small unmanned aircraft is secure and does not adversely affect the flight characteristics or controllability of the aircraft.

Weather Theory

Atmosphere and Temperature

What is weather?
- Where does weather occur?
- What causes weather?

Where does weather occur?

The Atmosphere

- Gaseous envelope
  - N ~ 78%
  - O2 ~21%
  - Other ~1%
  - H2O (0.5%)
What Causes Weather?

• $\Delta T$

What is Temperature?

What Does Temperature Do?

• Ideal Gas Law

$PV = nRT$

Temperature Changes Everything

• $T$ increases
  • $V$ increases
  • $p$/($m/n$) (density) decreases $[n/V]$

How it works

Hadley Cell Cross-Section

- 30°N
- Horse Latitudes
- 0° (Equator)
- 30°S
- The Doldrums
Why did a cloud form?

- Temperature decreases with altitude
- So does Dew Point Temperature

What happens when T = DPT?

DPT

- Dew Point
  - Temperature at which condensation occurs
  - "Amount of water that is in the air"

Lapse Rate

How T and DPT change w/ altitude tells us lots.
Weather Defined

- Wx = Δ Atmosphere / Δ T
  - Changes in the atmosphere due to changes in temperature.

FAA Question

- Every weather process is the result of?
  - A) movement of air
  - B) pressure differential
  - C) heat exchange

What is wind?

- What causes wind?

Cloud Avoidance

Test hint: It doesn't matter what airspace you're in, this is it!
What Causes Wind?

- Differences in pressure.
  - Remember Ideal Gas Law?

What is Pressure?

- Think of units you know, they’ll tell you everything.
- PSI
  - Pounds Per Sq. Inch.
  - Force Per Area
  \[ P = \frac{F}{A} \]

How do we measure pressure?

- Think of units again
  - Inches of Mercury (“Hg”)
    - Std: 29.92”
    - PSI
    - Std: 14.7 PSI
    - Millibar
    - Std: 1013.25 mb

Standard Atmosphere

- T= 15°C
- Pressure = 29.92” Hg

Circulation Patterns and Pressure
Because the earth rotates, things don’t appear to move in straight lines.

This is called the Coriolis Force.

What it looks like to us:

What just happened?

• CF works on large scales.
• What sorts of movement occur on large scales?
What direction does air flow?

How strong will the wind be?

PGF

- ΔP/D
- How do I get a stronger wind?
  - A) Increase Numerator
  - B) Decrease Denominator.
  - C) Both A and B.

Other Causes of Wind

Other causes of wind...
What is wind?

• Air moving from high pressure to low pressure.
• Sometimes, the path it takes isn’t linear.
  • Coriolis and Friction.

Wind UAS Hazards

• Strong winds will drain battery and decrease performance.
• Localized winds (around obstructions) will create unpredictable, rapidly changing turbulence.

Wind Shear

• $\Delta V/\Delta Alt$

Wind Shear UAS Hazards

• Poor performance
  • Need to vary power dramatically
• Turbulence
  • Difficult to control
  • Difficult to track (line of sight)

FAA Question

• Where does wind shear occur?
  • A) High Altitudes
  • B) Low Latitudes
  • C) Anywhere, Anytime

Weather Theory
Airmasses

- Mass of air, w/ unifying characteristics (T/DPT)

Front

- Boundary between to or more airmasses.
- Temperature and Wind will always change across a front.
  - T change most obvious.
- Laymans: “Zone between Temp, Humidity, Wind”
Weather and Fronts

Cold Front Hazards

- They make **thunderstorms**.
- Thunderstorms make problems!

FAA Question

- The zone between temp, humidity, and DPT is called
  - A) A front
  - B) An airmass
  - C) Wind shear

Weather Theory

Thunderstorm Development

- What makes a thunderstorm?
- How is a thunderstorm different than a cloud?

Thunderstorm Shopping List

- Want a thunderstorm, buy these:
  1. Moisture
  2. Lifting Action
  3. Unstable Air
1) Moisture
• Need a high DPT

2) Lifting Action
• How can we create upward movement of air?

   - Fronts (Think cold front ramp)
   - Low Pressure
   - Thermals
   - Orographic Lift

Lifting Action

Thermals
• Require **solar heating**.
• Occur over **dry** areas.
  - **Empty fields**, parking lots = thermals
  - Forests, lakes, oceans = no thermals

Lifting Action + Moisture = Cloud

3) (un)Stability
• What is stability?
• Universal Concept
Stability defined
• Actual lapse rate v. standard lapse rate
• Is the air aloft colder or warmer than it should be?
  • If colder then unstable
  • If warmer then stable
• Decrease stability by warming from below

Temperature Inversion
• Temperature should decrease with altitude.
• If it increases, that is an inversion.
  • TEMPERATURE INVERSIONS ARE STABLE

Stable v. Unstable
Stable
• Poor Visibility
• Steady/Drizzle Rain
• Smooth Flight

Unstable
• Good Visibility
• Showery Precip
• Bumpy

Stable = 4 S’s
  - Stable, Smooth, Steady Rain, (Poor) Visibility

So we’ve built a rain cloud...
• What makes a thunderstorm?
• What makes thunder?

Lightning
• Lightning is always associated with thunderstorms
Life Cycle

- 1) Cumulus / Developing
  - Updrafts
- 2) Mature / Raining
  - Updrafts / Downdrafts (Precip)
  - * Most dangerous for UAS
- 3) Dissipating
  - Downdrafts

Thunderstorm Hazards

- Lightning poses greatest risk to UAS
  - Damage / destruction
- Microburst (strong dissipating stage)
  - Destructive, but <15 minutes
- Wind shear common to thunderstorms
  - Up to 20 miles away!

Convective SIGMETS

- Significant thunderstorms
  - Winds ≥ 50 kts
  - Hail ≥ ¾”
  - Squallines, tornados, embedded thunderstorms

Squalls

- Non frontal narrow band of storms.
  - Typically ahead of a cold front.
  - Occur anywhere / any altitude
  - Strong!

FAA Question

- What measurement can be used to determine the stability of the atmosphere?
  - A) Atmospheric pressure
  - B) Actual lapse rate
  - C) Wind shear
Weather Theory

Part V: Fog

Fog

- Fog = ground cloud.
- T = DPT
- Multiple types!

Radiation Fog

- Calm, clear, night
- Earth cools to DPT
- Moisture near ground condenses \( \rightarrow \) FOG

Steam Fog

- How do you make steam?
- Hot water!
- Lakes stay warm, earth cools.
- If \( T < 32 \text{F} \) can cause ice!
- Turbulent to UAS
- No wind
Advection Fog

- Warm, moist air (high DPT) pushed over colder land.
- Requires wind

Upslope Fog

- Light wind pushes air up mountain
- Air cools as it is lifted
- Requires wind

Fog Hazards

- Fog reduces visibility
- Fog can lift into a cloud
- To predict fog, watch T/DPT spread.

FAA Question

- An airmass moving inland from the coast in winter is likely to result in
  - A) Fog
  - B) Rain
  - C) Frost
Density Altitude

- Temperature and pressure make density
- Density = amount of air/volume.
- Density changes performance
  - Low density = less lift, less propeller efficiency
  - Low P, high T, high humidity = high DA

Ice

- Ice adds weight
- Ice decreases aerodynamic efficiency
- Ice requires:
  - Visible moisture
  - ≤ 32°F / 0°C

Freezing Rain (FZRA)

- Supercooled water that freezes on contact
- Most hazardous = greatest accumulation rate
- Ice pellets are an indicator of FZRA
Frost

- Surface less than freezing and <$\text{DPT}$
- Water vapor cools, crystallizes.
- Disrupts airflow = Bad lift & propeller efficiency

Aviation Weather Sources

Weather Briefing

- Prior to Flight. The remote PIC must:
  - 1. Conduct an assessment of the operating environment. The assessment must include at least the following:
    - Local weather conditions

Sources

- Encouraged to use
  - www.1800wxbrief.com
  - www.aviationweather.gov

Briefings

- Standard
  - Adverse & current conditions, synopsis, forecast, winds aloft, notams.
  - Complete weather overview
  - Recommended prior to every operation.

- Abbreviated
  - When you need supplemental, updated information.

Surface Weather

- AWOS ASOS
  - Automated Weather/Surface Observation System
  - Used to generate METAR (aviation routine weather report)
Decoding the METAR

**Ceiling**
- Lowest layer of clouds or obscuration
- Broken, overcast
- >5/8 sky coverage

**TAFs**
- Terminal Aerodrome Forecast
- 5sm radius around airport
- 24/30 hr valid period
- 0Z, 06Z, 12Z, 18Z
- READS LIKE METAR

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Decoding the TAF

**TAF Trivia**
- Only Cumulonimbus (CB) will be denoted
- Other cloud types will not be indicated in TAF
- Why?
FAA Question

• The remarks for KMDW list RAB35, what does this mean?
  • A) blowing mist
  • B) rain began at 1835z
  • C) pressure has risen .35"

FAA Question

• What is the ceiling at KMDH?
  KMDH 031552Z 32008KT 10SM SCT005 BKN010 10/10 A2982 RMK AO2 SLP099 T01000100
  • A) 500' AGL
  • B) 10SM
  • C) 1000' AGL

Bonus Question: How high can you fly your drone?

Introduction

• Hyperventilation
• Stress
• Fatigue
• Dehydration
• Heatstroke
• Drugs
• Alcohol
• Vision

Physiology

• Definition – Excessive rate of breathing

• Cause – Unexpected stressful situation.

• Symptoms: Visual impairment, Unconsciousness, Lightheaded sensation, Tingling sensations, Hot and cold sensations, and Muscle spasms.

• Treatment: Slow breathing rate by talking or breathing into a paper bag

Stress

• Physical stress
• Physiological stress
• Psychological stress

• Acute
• Chronic
Stress Management

• Exercise and Diet
• Relaxation
• Time Management

Fatigue

• Acute
  • Mild hypoxia (oxygen deficiency)
  • Stress
  • Prevention
    • Diet
    • Adequate Sleep
    • Stress Management

Fatigue

• Chronic
  • Underlying long term psychological stress
  • Underlying disease
  • Prevention
    • Reduce reoccurring acute fatigue
    • Stress Management
    • Seek help from a physician

Dehydration

• Critical loss of water from the body.

• Causes - Hot temperatures, wind, humidity, and diuretic drinks.

• Symptoms - Headache, fatigue, cramps, sleepiness, and dizziness.

Heatstroke

• Condition caused by any inability of the body to control its temperature.

• Symptoms—temperature above 105º, skin hot and dry.

• Treatment—get to a cool place, spray body with cool water (not icy), seek medical assistance immediately.

Heat Stress Prevention

• Stay Hydrated

• Minimize Exposure through
  • Protective Clothing
  • Protective Headgear
  • Limit time in the sun

• Regulate activity in hot environments
Drugs

- OTC Drugs
  - Antihistamines
  - Decongestants
  - Diphenhydramine

- Wait 48 hours after taking medication.

- “Am I taking medicine that could make me drowsy”
- “Why am I taking this medication”

Alcohol

- Decreases the efficiency of the human body.
- Complications
  - Impair judgment
  - Decrease sense of responsibility
  - Affect coordination
  - Diminish memory
  - Reduce reasoning ability
  - Lower attention span

Alcohol Rules

- Blood alcohol level be less than .04 percent
- 8 hours pass between drinking alcohol and piloting an aircraft
- A pilot with a blood alcohol level of .04 percent or greater after 8 hours cannot fly until the blood alcohol falls

- When a stressful situation is encountered in flight, an abnormal increase in the volume of air breathed in and out can cause a condition known as
  - Hyperventilation
  - Aerosinusitis
  - Aerotitis

- Which would most likely result in hyperventilation?
  - Insufficient oxygen
  - Excessive carbon monoxide
  - Insufficient carbon dioxide
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- Insufficient carbon dioxide.

As a pilot, flying for long periods in hot summer temperatures increases the susceptibility of dehydration since the dry air at altitude tends to increase the rate of water loss from the body. Moist air at altitude helps retain the body’s moisture. Temperature decreases with altitude.

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- Removing stress from personal life.
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You are a Remote Pilot in Command for a co-op energy service provider. You plan to use your unmanned aircraft to inspect powerlines in the remote area 15 hours away from your home office. After the drive, fatigue impacts your abilities to complete your assignment on time. What kind of fatigue is this?
- Chronic fatigue.
- Acute fatigue.
- Exhaustion.
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Fatigue can be recognized easily by an experienced pilot.
- as being in an impaired state.
- by an ability to overcome sleep deprivation.

Which will almost always affect your ability to fly?
- Over-the-counter analgesics and antihistamines.
- Antibiotics and anesthetic drugs.
- Prescription analgesics and antihistamines.

Fatigue is one of the most treacherous hazards to flight safety
- because it results in slow performance.
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