The Commercial UAV Flight Manual

FAA Part 107 Study Guide

S. Kern

1st Edition

THE COMMERCIAL UAV FLIGHT MANUAL

Cover by: S.D. KERN

Printed in U.S.A

Dedication

To My Family

Contents

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Introduction to the FAA

Before you begin your training as a commercial sUAS pilot, it is important to have a basic understanding of the responsibilities, safety regulations, and issues applicable to such an endeavor. This includes understanding the role of the Federal Aviation Administration (FAA) as it applies to sUAS in the National Airspace (NAS).

The Role of the Federal Aviation Administration (FAA)

The FAA is empowered by regulations to promote aviation safety and establish safety standards for civil aviation. The FAA achieves these objectives under the Code of Federal Regulations (CFR), which is the codification of the general and permanent rules published by the executive departments and agencies of the United States Government. The regulations are divided into 50 different codes, called Titles, that represent broad areas subject to Federal regulation. FAA regulations are listed under Title 14, Aeronautics and Space, which encompasses all aspects of civil aviation from how to earn a pilot's certificate to maintenance of an aircraft. For the pilot, certain parts of 14 CFR are more relevant than others. During flight training, it is helpful for the pilot to become familiar with the parts and subparts that relate to flight training and pilot certification. For instance, 14 CFR part 61 pertains to the certification of pilots, flight instructors, and ground instructors. It also defines the eligibility, aeronautical knowledge, and flight proficiency, as well as training and testing requirements for each type of pilot certificate issued. 14 CFR part 91 provides guidance in the areas of general flight rules, visual flight rules (VFR), and instrument flight rules (IFR), while 14 CFR part 43 covers aircraft maintenance, preventive maintenance, rebuilding, and alterations.

Title 14 CFR Chapter 1, Federal Aviation Administration, is broken down into subchapters. For the sUAS pilot, certain parts of 14 CFR are more relevant than others.

During training, it is helpful for the pilot to become familiar with the parts and subparts that relate to flight training and pilot certification. For instance, 14 CFR part 61 pertains to the certification of pilots, flight instructors, and ground instructors. It also defines the eligibility, aeronautical knowledge, flight proficiency, as well as training and testing requirements for each type of pilot certificate issued. 14 CFR part 91 provides guidance in the areas of general flight rules, visual flight rules (VFR), and instrument flight rules (IFR), while 14 CFR part 107 pertains to all things sUAS.

Code of Federal Regulations				
Title	**Volume**	**Chapter**	**Subchapters**	
Title 14 Aeronautics and Space	1	I	A	Definitions and Abbreviations
			B	Procedural Rules
			C	Aircraft
	2		D	Airmen
			E	Airspace
			F	Air Traffic and General Rules
	3		G	Air Carriers and Operators for Compensation or Hire: Certification and Operations
			H	Schools and Other Certified Agencies
			I	Airports
			J	Navigational Facilities
			K	Administrative Regulations
			L–M	Reserved
			N	War Risk Insurance
	4	II	A	Economic Regulations
			B	Procedural Regulations
			C	Reserved
			D	Special Regulations
			E	Organization
			F	Policy Statements
		III	A	General
			B	Procedure
			C	Licensing
	5	V		
		VI	A	Office of Management and Budget
			B	Air Transportation Stabilization Board

Primary Locations of the FAA

The FAA headquarters are in Washington, DC, and there are nine regional offices strategically located across the United States. The agency's two largest field facilities are the Mike Monroney Aeronautical Center (MMAC) in Oklahoma City, Oklahoma, and the William J. Hughes Technical Center (WJHTC) in Atlantic City, New Jersey. Home to FAA training and logistics services, the MMAC provides a number of aviation safety-related and business support services. The WJHTC is the premier aviation research and development and test and evaluation facility in the country. The center's programs include testing and evaluation in ATC, communication, navigation, airports, aircraft safety, and security. Furthermore, the WJHTC is active in long-range development of innovative aviation systems and concepts, development of new

ATC equipment and software, and modification of existing systems and procedures.

Obtaining Assistance from the FAA

Information can be obtained from the FAA by phone, Internet/e-mail, or mail. To talk to the FAA toll-free 24 hours a day, call 1-866-TELL-FAA (1-866-835-5322). To visit the FAA's website, go to www.faa.gov. Individuals can also e-mail an FAA representative at a local FSDO office by accessing the staff e-mail address available via the "Contact FAA" link at the bottom of the FAA home page. Letters can be sent to:

Federal Aviation Administration
800 Independence Ave,
SW Washington, DC 20591

FAA Reference Material

The FAA provides a variety of important reference material for the student, as well as the advanced civil aviation pilot. In addition to the regulations provided online by the FAA, several other publications are available to the user. Almost all reference material is available online at www.faa.gov in downloadable format. Commercial aviation publishers also provide published and online reference material to further aid the aviation pilot.

Flight Standards District Offices (FSDO's)

Throughout the world, the FAA has approximately 100 Flight Standards District Offices and International Field Offices, commonly referred to as "FSDOs" and "IFOs." Through these offices, information and services are provided for the aviation community. In the U.S., FSDO phone numbers are listed in the blue pages of the telephone directory under United States Government Offices, Department of Transportation, Federal Aviation Administration. Another convenient method is using the FSDO Locator available on the Regulatory Support Division's web site.

Aviation Safety Inspector (ASI)

The Aviation Safety Inspectors (ASIs) administer and enforce safety regulations and standards for the production, operation, maintenance, and/or modification of aircraft used in civil aviation. They also specialize in conducting inspections of various aspects of the aviation system, such as aircraft and parts manufacturing, aircraft operation, aircraft airworthiness, and cabin safety. ASIs must complete a training program at the FAA Academy in Oklahoma City, Oklahoma, which includes airman evaluation, and pilot testing techniques and procedures. ASIs also receive extensive on-the-job training and recurrent training on a regular basis. The FAA has approximately 3,700 inspectors located in its FSDO offices. All questions concerning pilot certification (and/or requests for other aviation information or services) should be directed to the local FSDO.

sUAS And The FAA

In 2012, Congress passed the FAA Modernization and Reform Act of 2012 (PL 112-95). PL 112-95, Section 333 directed the Secretary of Transportation to determine whether UAS operations posing the least amount of public risk and no threat to national security could safely be operated in the NAS and, if so, to establish requirements for the safe operation of these systems in the NAS, prior to completion of the UAS comprehensive plan and rulemakings required by PL 112-95, Section 332. On February 23, 2015, as part of its ongoing efforts to integrate UAS operations in the NAS and in accordance with PL 112-95, Section 333, the FAA issued a Notice of Proposed Rulemaking (NPRM) proposing to amend its regulations to adopt specific rules for the operation of sUAS in the NAS. Over 4,600 public comments were submitted in response to the NPRM. In consideration of the public comments, the FAA issued a final rule adding part 107, integrating civil sUAS into the NAS. Part 107 allows sUAS operations for many different non-hobby and nonrecreational purposes without requiring airworthiness certification, exemption, or a Certificate of Waiver or Authorization (COA). In addition, part 107 also applies to sUAS used for hobby or recreation that are not flown in accordance with part 101 subpart E

Recreation and Hobby Use

The regulations outlined in part 107, do not apply to the following:

1. Model aircraft that are operated in accordance with Part 101 Subpart E, Model Aircraft), which applies to model aircraft meeting all of the following criteria:

- The aircraft is flown strictly for hobby or recreational use;

- The aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;

- The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;

- The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft;

- When flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control (ATC) tower (when an air traffic facility is located at the airport) with prior notice of the operation;

- The aircraft is capable of sustained flight in the atmosphere; and

- The aircraft is flown within Visual Line of Sight (VLOS) of the person operating the aircraft.

2. Operations conducted outside the United States

3. Amateur rockets

4. Moored balloons

5. Unmanned free balloons

6. Kites

7. Public aircraft operations

8. Air carrier operations.

What is an sUAS?

A Small Unmanned Aircraft System (sUAS) is also known as a Drone, Unmanned Aircraft Vehicle (UAV), Unpiloted Aerial Vehicle, or Remotely Piloted Aircraft (RPA). The FAA refers to them as an Small Unmanned Aircraft System (sUAS) and defines them as a small Unmanned Aircraft (UA) and its associated elements (including communication links) that are required for the safe and efficient operation in the NAS.

There are a few main components to a sUAS:

1. Air Vehicle System: this includes an airframe, power source, and flight control system.

2. Control System(s) to send and receive data, and control information. A remote, ground station, or laptop may also be used for this purpose.

3. Payload: these are the tools on board such as a camera or sensor.

4. Software is used to process data collected.

Types of UAS range in battery life, fuel capacity, size, functionality, and price. Typically, flight software on a laptop is used as a ground control station for transmitting remote commands to the aircraft. The aircraft receives the signal through a transmitter and flies itself using GPS and inertial navigation systems

There are two main types of an sUAS:

- Fixed-wing
- Vertical take-off and landing system (VTOL), also known as rotorcraft, or multi-rotors.

What can an sUAS do?

An UAS can do one or many things at once depending on the model. The small UAS are often limited to one function at a time due to their size and limited payload capacity. However, their payload can often be exchanged with another payload adding to its versatility.

Overview of sUAS operations

- Aerial Photography: Digital SLR (single-lens reflex), high resolu tion, geo-referenced, metric cameras, day or night use, near-infra red, and low-light
- Video: Electro-optical video (used to focus on a location or iden tify moving objects), infrared (IR), geo-referenced, high definition, continuous pan, and image stabilization

- GPS and geospatial data collection
- Inertial Measurement Unit (IMU) for an aircraft's yaw, pitch, and roll
- LiDAR
- Network Communications
- Gravity measurements
- Air Sample Collection

Operational Environment

sUAS have the ability to operate almost anywhere with the right authorizations and a properly trained aircrew. sUAS have the unique ability to operate in almost any environment and space.

Including:

- Water-covered areas, wetlands
- Remote or small locations
- Areas of dense vegetation
- Dangerous locations, such as those caused by storms or infrastructure failures

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Useful Definitions and Abrreviations

Ailerons: Primary flight control surfaces mounted on the trailing edge of an airplane wing, near the tip.

Altimeter: A flight instrument that indicates altitude by sensing pressure changes.

Altimeter setting: Station pressure (the barometric pressure at the location the reading is taken) which has been corrected for the height of the station above sea level.

Ambient pressure: The pressure in the area immediately surrounding the aircraft.

Ambient temperature: The temperature in the area immediately surrounding the aircraft

Control Station (CS): An interface used by the remote pilot or the person manipulating the controls to control the flight path of the small UA.

Corrective Lenses: Glasses or contact lenses.

Model Aircraft: An Unmanned Aircraft that is:

- Capable of sustained flight in the atmosphere;
- Flown within VLOS of the person operating the aircraft; and
- Flown for hobby or recreational purposes.

Person Manipulating the Controls: A person other than the remote pilot in command (PIC) who is controlling the flight of an sUAS under the supervision of the remote PIC.

Remote Pilot in Command (Remote PIC or Remote Pilot): A person who holds a remote pilot certificate with an sUAS rating and has the final authority and responsibility for the operation and safety of an sUAS operation conducted under part 107.

Small Unmanned Aircraft (UA): A UA weighing less than 55 pounds, including everything that is onboard or otherwise attached to the aircraft, and can be flown without the possibility of direct human intervention from within or on the aircraft.

Small Unmanned Aircraft System (sUAS): A small UA and its associated elements (including communication links and the components that control the small UA) that are required for the safe and efficient operation of the small UA in the NAS.

Visual Observer (VO): A person acting as a flightcrew member who assists the small UA remote PIC and the person manipulating the controls to see and avoid other air traffic or objects aloft or on the ground.

Abbreviations:

1. **AC:** Advisory Circular.

2. **ACR**: Airman Certification Representative.

3. **AGL:** Above Ground Level.

4. **ATC:** Air Traffic Control.

5. **CFI:** Certificated Flight Instructor.

6. **CFR:** Code of Federal Regulations.

7. **DPE:** Designated Pilot Examiner.

8. **FAA:** Federal Aviation Administration.

9. **FSDO:** Flight Standards District Office.

10. **GPS**: Global Positioning System.

11. **IACRA:** Integrated Airmen Certification and/or Rating Application.

12. **KTC:** Knowledge Testing Center.

13. **MSL**: Mean Sea Level.

14. **NOTAM:** Notice to Airmen.

15. **NAS:** National Airspace System.

16. **PIC:** Pilot in Command.

17. **UA**: Unmanned Aircraft.

18. **UAS:** Unmanned Aircraft System.

19. **U.S.C.:** United States Code.

20. VLOS: Visual Line Of Sight

21. **VO:** Visual Observer.

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Accident/Incident Reporting

The remote PIC of the sUAS is required to report an accident to the FAA within 10 days if it meets any of the following thresholds:

1. At least serious injury to any person or any loss of consciousness. A serious injury is an injury that qualifies as Level 3 or higher on the Abbreviated Injury Scale (AIS) of the Association for the Advancement of Automotive Medicine (AAAM). The AIS is an anatomical scoring system that provides a means of ranking the severity of an injury and is widely used by emergency medical personnel. Within the AIS system, injuries are ranked on a scale of 1 to 6, with Level 1 being a minor injury, Level 2 is moderate, Level 3 is serious, Level 4 is severe, Level 5 is critical, and Level 6 is a nonsurvivable injury. The FAA currently uses serious injury (AIS Level 3) as an injury threshold in other FAA regulations.

Note: It would be considered a "serious injury" if a person requires hospitalization, but the injury is fully reversible (including, but not limited to, head trauma, broken bone(s), or laceration(s) to the skin that requires suturing).

2. Damage to any property, other than the small UA, if the cost is greater than $500 to repair or replace the property (whichever is lower).

Note: For example, a small UA damages a property whose fair market value is $200, and it would cost $600 to repair the damage. Because the fair market value is below $500, this accident is not required to be reported. Similarly, if the aircraft causes $200 worth of damage to property whose fair market value is $600, that accident is also not required to be reported because the repair cost is below $500.

Abbreviated Injury Scale	
Level 1	Minor Injury
Level 2	Moderate Injury
Level 3	Serious Injury
Level 4	Severe Injury
Level 5	Critical Injury
Level 6	Non-survivable

Figure 3.1 Abbreviated Injury Scale

Submitting the Report

The accident report must be made within 10 calendar-days of the operation that created the injury or damage. The report may be submitted to the appropriate FAA Regional Operations Center (ROC) electronically or by telephone. Electronic reporting can be completed at www.faa.gov/uas/. To make a report by phone, see Figure 3-1, FAA Regional Operations Centers Telephone List. Reports may also be made to the nearest jurisdictional FSDO (http://www.faa.gov/about/office_org/field_offices/fsdo/). The report should include the following information:

1. sUAS remote PIC's name and contact information;

2. sUAS remote PIC's FAA airman certificate number;

3. sUAS registration number issued to the aircraft, if required (FAA registration number);

4. Location of the accident;

5. Date of the accident;

6. Time of the accident;

7. Person(s) injured and extent of injury, if any or known;

8. Property damaged and extent of damage, if any or known; and

9. Description of what happened

National Transportation Safety Board (NTSB) Reporting. In addition to the report submitted to the ROC, and in accordance with the criteria established by the NTSB, certain sUAS accidents must also be reported to the NTSB. For more information, visit www.ntsb.gov.

FAA REGIONAL OPERATIONS CENTER	
LOCATION WHERE ACCIDENT OCCURRED:	***TELEPHONE:***
DC, DE, MD, NJ, NY, PA, WV, and VA	**404-305-5150**
AL, CT, FL, GA, KY, MA, ME, MS, NC, NH, PR, RI, SC, TN, VI, and VT	**404-305-5156**
AK, AS, AZ, CA, CO, GU, HI, ID, MP, MT, NV, OR, UT, WA, and WY	**425-227-1999**
AR, IA, IL, IN, KS, LA, MI, MN, MO, ND, NE, NM, OH, OK, SD, TX, and WI	**817-222-5006**

SAMPLE NTSB ACCIDENT/INCIDENT REPORT

NATIONAL TRANSPORTATION SAFETY BOARD
PILOT/OPERATOR AIRCRAFT ACCIDENT/INCIDENT REPORT
This form to be used for reporting civil and public use aircraft accidents and incidents

BASIC INFORMATION

Accident/Incident Location

Nearest City/Place: ______________________ State: ______

ZIP: ____________ Country: ______________________

Latitude: __________ (dd:mm:ss N/S) Longitude: __________ (ddd:mm:ss E/W)

Date/Time

Date: ______________ *mm/dd/yyyy* Local Time: __________

Time Zone: __________

Phase of Operation

☐ Standing ☐ Takeoff (incl. initial climb) ☐ Cruise ☐ Hover
☐ Taxi ☐ Climb ☐ Maneuvering ☐ Other
☐ Descent ☐ Landing ☐ Approach ☐ Unknown

Collision with Other Aircraft

☐ Midair
☐ On-ground
☐ None

Altitude of In-Flight Occurrence

__________ ft MSL

AIRCRAFT INFORMATION

Manufacturer: ______________________

Model: ______________________

Serial Number: ______________

Registration Number: __________ **Amateur-built:** ☐ Yes ☐ No

Max Gross Weight: __________ lbs

Weight at Time of Accident/Incident: __________ lbs

Location of Center of Gravity at Time of Accident/Incident:

__________ inches from ☐ nose or ☐ datum

-or- __________ Percent Mean Aerodynamic Cord (% MAC)

Category of Aircraft

☐ Airplane
☐ Balloon
☐ Blimp/Dirigible
☐ Glider
☐ Gyrocraft
☐ Helicopter
☐ Powered lift
☐ Ultralight
☐ Unknown

Type of Airworthiness Certificate
(Check all that apply)

Standard
☐ Normal
☐ Utility
☐ Acrobatic
☐ Transport

Special
☐ Restricted
☐ Limited
☐ Provisional
☐ Experimental
☐ Special Flight
☐ Light Sport

Number of Seats: ________

If Large Aircraft, how many seats for:

Flight Crew: __________
Cabin Crew: __________
Passengers: __________

Landing Gear ☐ Retractable

Check any additional landing gear configuration that applies:

☐ Tricycle ☐ Tailwheel
☐ Amphibian ☐ High Skid
☐ Emergency Float ☐ Skid
☐ Float ☐ Ski
☐ Hull ☐ Ski/Wheel
☐ Unknown

Type of Maintenance Program

☐ Annual
☐ Conditional (Amateur-built only)
☐ Manufacturer's Inspection Program
☐ Other Approved Inspection Program (AAIP)
☐ Continuous Airworthiness
☐ Other, specify: ______________

Last Inspection Type

☐ 100 Hour ☐ Continuous Airworthiness
☐ AAIP ☐ Conditional Inspection
☐ Annual ☐ Unknown

Date Last Inspection: __________ *mm/dd/yyyy*

Airframe Total Time: __________hrs

hours measured at *(check one)*

☐ Last Inspection ☐ Time of Accident/Incident

IFR Equipped

☐ Yes ☐ No ☐ Unknown

Stall Warning System Installed

☐ Yes ☐ No ☐ Unknown

Type of Fire Extinguishing System

☐ None
☐ Specify ______________________

ELT Installed

☐ Yes ☐ No

ELT Activated

☐ Yes ☐ No

ELT Aided in Locating Accident/Incident

☐ Yes ☐ No

ELT Manufacturer: ______________________

Model/Series: ______________________

Serial Number: ______________________

Battery Type: ______________ **Battery Exp. Date:** ________

Engine Type

☐ Reciprocating ☐ Turbo Jet
☐ Turbo Shaft ☐ Turbo Fan
☐ Turbo Prop ☐ Unknown

Reciprocating Fuel System Type

☐ Carburetor
☐ Fuel Injected

Propeller

☐ Fixed Pitch
☐ Controllable Pitch

Manufacturer: ______________________

Model: ______________________

Engine	Engine Manufacturer	Engine Model/Series	Manufacturer's Serial Number	Date of Mfg. *mm/dd/yyyy*	Engine Rated Power Measured as *(check one)* ☐ Horsepower or ☐ lbs of Thrust	Total Time (hours)	Time Since Inspection (hours)	Time Since Overhaul (hours)
Eng. 1								
Eng. 2								
Eng. 3								
Eng. 4								

OWNER/OPERATOR INFORMATION

Registered Aircraft Owner

Name: ______________________________

Fractional Ownership Aircraft: ☐ Yes ☐ No

Owner Address

City: ______________________________
State: __________ ZIP: ___________
Country: ______________________________

Operator of Aircraft ☐ Same As Registered Owner

Name: ______________________________
Doing Business As: ______________________________
Air Carrier/Operator Designator (4 Character Code): ______________

Operator Address ☐ Same As Registered Owner

City: ______________________________
State: __________ ZIP: ___________
Country: ______________________________

Regulation Flight Conducted Under

☐ FAR 91 ☐ FAR 129 ☐ FAR 91 Special Flight ☐ Public Use (select type)
☐ FAR 103 ☐ FAR 133 ☐ Non-US, Commercial ☐ *Federal* ☐ *State* ☐ *Local*
☐ FAR 121 ☐ FAR 135 ☐ Non-US, Non-commercial ☐ Unknown
☐ FAR 125 ☐ FAR 137 ☐ Armed Forces

Revenue Sightseeing Flight

☐ Yes ☐ No

Air Medical Flight

☐ Yes ☐ No

Purpose of Flight
for FAR 91, 103, 133, 137 *(Select one)*

☐ Personal
☐ Business
☐ Executive/Corporate
☐ Other Work Use
☐ Instructional
☐ Ferry
☐ Positioning
☐ Aerial Application
☐ Aerial Observation
☐ Air Drop
☐ Air Race / Show
☐ Flight Test
☐ Public Use
☐ Unknown

Revenue Operation
for FAR 121, 125, 129, 135 *(Select one)*

☐ Scheduled or Commuter
☐ Non-Scheduled or Air Taxi

Domestic or International

☐ Domestic ☐ International

Cargo Operation

☐ Passenger/Cargo
☐ Passenger __________ How many?
☐ Cargo ____________ lbs
☐ Mail

Type of Commercial Operating Certificate Held
(Check all that apply)

☐ None
☐ Flag Carrier Operating Certificate (121)
☐ Supplemental
☐ Air Cargo
☐ Foreign Air Carriers (129)
☐ Commuter Air Carrier (135)
☐ On-Demand Air Taxi (135)
☐ Large Helicopter (127)

☐ Rotorcraft External Load (133)
- or -
☐ Agricultural Aircraft (137)

☐ Other Operator of Large Aircraft

OTHER AIRCRAFT – COLLISION (If air or ground collision occurred, complete this section for *other* aircraft)

Aircraft Registration Number
____

Manufacturer: ______________________________
Model: ______________________________

Damage to Other Aircraft

☐ Destroyed ☐ Minor
☐ Substantial ☐ None

Registered Owner of Other Aircraft

First Name: ______________________________
Middle Initial: ________
Last Name: ______________________________

City: ______________________________
State: __________ ZIP: ___________
Country: ______________________________

Pilot of Other Aircraft

First Name: ______________________________
Middle Initial: ________
Last Name: ______________________________

City: ______________________________
State: __________ ZIP: ___________
Country: ______________________________

MECHANICAL MALFUNCTION/FAILURE (If more space is needed, continue on separate sheet)

Was there Mechanical Malfunction/Failure? ☐ Yes ☐ No ☐ Unknown
(If yes, list the name of the part, manufacturer, part no., serial no., and describe the failure.)

Total Time/Cycles On Part

____________ Hours

____________ Cycles

Time Since This Part Inspected/Overhauled

____________ Hours

DAMAGE TO AIRCRAFT AND OTHER PROPERTY

Aircraft Damage

☐ None ☐ Substantial
☐ Minor ☐ Destroyed

Aircraft Fire

☐ None ☐ Both Ground and In-Flight
☐ In-Flight ☐ Unknown Origin
☐ On-Ground

Aircraft Explosion

☐ None ☐ Both Ground and In-Flight
☐ In-Flight ☐ Unknown Origin
☐ On-Ground

4

Operating Limitations and Responsibilities

This chapter provides guidance regarding sUAS operating limitations and the responsibilities of the remote pilot in command (PIC), person manipulating the controls, visual observer (VO), and anyone else that may be directly participating in the sUAS operation. A person is also a direct participant in the sUAS operation if his or her involvement is necessary for the safe operation of the sUAS

Aircraft Operation

Just like a manned-aircraft PIC, the remote PIC of an sUAS is directly responsible for, and is the final authority as to, the operation of that UAS. The remote PIC will have final authority over the flight. Additionally, a person manipulating the controls can participate in flight operations under certain conditions. It is important to note that a person may not operate or act as a remote PIC or VO in the operation of more than one UA at the same time. The following items describe the requirements for both a remote PIC and a person manipulating the controls:

Remote PIC

A person acting as a remote PIC of an sUAS in the National Airspace System (NAS) under part 107 must obtain a remote pilot certificate with an sUAS rating issued by the FAA prior to sUAS operation. The remote PIC must have this certificate easily accessible during flight operations. Again, the remote PIC will have the final authority and responsibility for the operation and safety of an sUAS operation conducted under part 107.

Additionally, part 107 permits transfer of control of an sUAS between certificated remote pilots. Two or more certificated remote pilots transferring operational control (i.e., the remote PIC designation) to each other may do so only if they are both capable of maintaining Visual Line of Sight (VLOS) of the UA and without loss of control (LOC). For example, one remote pilot may be designated the remote PIC at the beginning of the operation, and then at some point in the operation another remote pilot may take over as remote PIC by positively communicating that he or she is doing so. As the person responsible for the safe operation of the UAS, any remote pilot who will assume remote PIC duties should meet all of the requirements of part 107, including awareness of factors that could affect the flight.

Person Manipulating the Flight Controls

A person who does not hold a remote pilot certificate or a remote pilot that that has not met the recurrent testing/training requirements of part 107 may operate the sUAS under part 107, as long as he or she is directly supervised by a remote PIC and the remote PIC has the ability to immediately take direct control of the sUAS. This ability is necessary to ensure that the remote PIC can quickly address any hazardous situation before an accident occurs. The ability for the remote PIC to immediately take over the flight controls could be achieved by using a number of different methods.

For example, the operation could involve a "buddy box" type system that uses two control stations (CS): one for the person manipulating the flight controls and one for the remote PIC that allows the remote PIC to override the other CS and immediately take direct control of the small UA. Another method could involve the remote PIC standing close enough to the person manipulating the flight controls so as to be able to physically take over the CS from the other person. A third method could employ the use of an automation system whereby the remote PIC could immediately engage that system to put the small UA in a pre-programmed "safe" mode (such as in a hover, in a holding pattern, or "return home")

Autonomous Operations

An autonomous operation is generally considered an operation in which the remote pilot inputs a flight plan into the CS, which sends it to the autopilot onboard the small UA. During automated flight, flight control inputs are made by components onboard the aircraft, not from a CS. Thus, the remote PIC could lose the control link to the small UA and the aircraft would still continue to fly the programmed mission/return home to land. During automated flight, the remote PIC also must have the ability to change routing/altitude or command the aircraft to land immediately. The ability to direct the small UA may be through manual manipulation of the flight controls or through commands using automation.

The remote PIC must retain the ability to direct the small UA to ensure compliance with the requirements of part 107. There are a number of different methods that a remote PIC may utilize to direct the small UA to ensure compliance with part 107. For example, the remote pilot may transmit a command for the autonomous aircraft to climb, descend, land now, proceed to a new waypoint, enter an orbit pattern, or return to home. Any of these methods may be used to satisfactorily avoid a hazard or give right of way.

NOTE The use of automation does not allow a person to simultaneously operate more than one small UA.

Figure 4.1 Ground Control Station (GCS)

Ground Control Station

The Ground Control Station (GCS) is the collective term for the components used to control the vehicle both on the ground and while airborne. These base components include:

1. Portable Ground Station (PGS) 900 MHz
2. Windows®-based laptop
3. GPS antenna
4. 900 MHz omnidirectional antenna

For video operations you need the following additional equipment:

1. Video link

2. Video antenna

Video Link

The video link is a one-way radio that transmits live imagery to the ground station. It typically operates in the C band (4.4 to 4.9 GHz) and radiates between 1-3 watts of RF. The antenna is typically located on the top of the aircraft.

The operator can select the exact channel on which it transmits from among the available channels. However, the transmitter and receiver must be tuned to the same channel for the system to work.

While using the link on the ground, take care to not overheat the transmitter. Limit usage in overheated conditions in accordance with the manufacturers instructions.

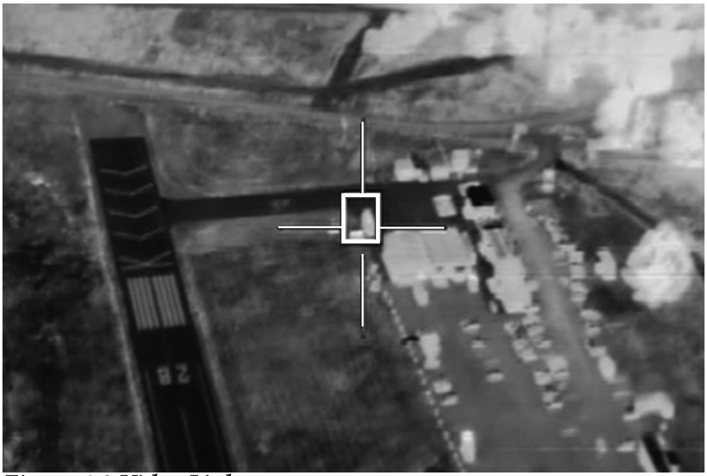


Figure 4.2 Video Link

Radio Link

The actual link between the ground and the aircraft is achieved through the Portable Ground Station (PGS). The PGS is typically a small ruggedized case that houses the 900 MHz radio link and is the connection point for all antennas, video link wiring, and the PC interface. The actual vehicle interface is through a PC laptop plugged into the PGS and running a manufacture specific software. Depending on the model and manufacturer the autopilot has an internal radio link for command and control. This link is typically an RF analog serial modem. Additional radio links may be required for sensor data, comms relay, and electronic warfare. The autopilot has an internal channel for payload pass-through that lets the payload communicate through the autopilot.

5

Aircraft Registration

A small UA must be registered, as provided for in 14 CFR part 47 or part 48 prior to operating under part 107. Part 48 is the regulation that establishes the streamlined online registration option for sUAS that will be operated only within the territorial limits of the United States. The online registration Web address is http://www.faa.gov/uas/registration/. Guidance regarding sUAS registration and marking may be found at http://www.faa.gov/licenses_certificates/aircraft_certification/ aircraft_registry/. Alternatively, sUAS can elect to register under part 47 in the same manner as manned aircraft.

Registration of Foreign-Owned and Operated sUAS

If sUAS operations involve the use of foreign civil aircraft, the operator would need to obtain a Foreign Aircraft Permit pursuant to 14 CFR part 375, § 375.41 before conducting any commercial air operations under this authority. Foreign civil aircraft means, a) an aircraft of foreign registry that is not part of the armed forces of a foreign nation, or b) a U.S.-registered aircraft owned, controlled, or operated by persons who are not citizens or permanent residents of the United States. Application instructions are specified in § 375.43. Applications should be submitted by electronic mail to the Department of Transportation (DOT) Office of International Aviation, Foreign Air Carrier Licensing Division. Additional information can be obtained at https://cms.dot.gov/policy/aviation-policy/licensing/foreign-carriers

6

Aero-Medical

Introduction

It is important for a pilot to be aware of the mental and physical standards required for the type of flying performed. This chapter provides information on medical certification and on a variety of aero-medical factors related to flight activities.

Being able to safely operate the sUAS relies on, among other things, the physical and mental capabilities of the remote PIC, person manipulating the controls, VO, and any other direct participant in the sUAS operation. Though the person manipulating the controls of an sUAS and VO are not required to obtain an airman medical certificate, they may not participate in the operation of an sUAS if they know or have reason to know that they have a physical or mental condition that could interfere with the safe operation of the sUAS.

Physical or Mental Incapacitations

Obvious examples of physical or mental incapacitations that could render a remote PIC, person manipulating the controls, or VO incapable of performing their sUAS operational duties include, but are not limited to, such things as:

1. The temporary or permanent loss of the dexterity necessary to operate the CS to safely control the small UA.

2. The inability to maintain the required "see and avoid" vigilance due to blurred vision.

3. The inability to maintain proper situational awareness of the small UA operations due to illness and/or medication(s), such as after taking medications with cautions not to drive or operate heavy machinery.

4. A debilitating physical condition, such as a migraine headache

or moderate or severe body ache(s) or pain(s) that would render the remote PIC, person manipulating the controls, or VO unable to perform sUAS operational duties.

5. A hearing or speaking impairment that would inhibit the remote PIC, person manipulating the controls, and VO from effectively communicating with each other. In a situation such as this, the remote PIC must ensure that an alternative means of effective communication is implemented. For example, a person who is hearing impaired may be able to effectively use sign language to communicate

Health and Physiological Factors Affecting Pilot Performance

Stress

Stress is the body's response to physical and psychological demands placed upon it. The body's reaction to stress includes releasing chemical hormones (such as adrenaline) into the blood and increasing metabolism to provide more energy to the muscles. Blood sugar, heart rate, respiration, blood pressure, and perspiration all increase. The term "stressor" is used to describe an element that causes an individual to experience stress. Examples of stressors include physical stress (noise or vibration), physiological stress (fatigue), and psychological stress (difficult work or personal situations).

Fatigue

Fatigue is frequently associated with pilot error. Some of the effects of fatigue include degradation of attention and concentration, impaired coordination, and decreased ability to communicate. These factors seriously influence the ability to make effective decisions. Physical fatigue results from sleep loss, exercise, or physical work. Factors such as stress and prolonged performance of cognitive work result in mental fatigue.

Dehydration and Heatstroke

Dehydration is the term given to a critical loss of water from the body. Causes of dehydration are hot flight decks and flight lines, wind, humidity, and diuretic drinks—coffee, tea, alcohol, and caffeinated soft drinks. Some common signs of dehydration are headache, fatigue, cramps, sleepiness, and dizziness.

The first noticeable effect of dehydration is fatigue, which in turn makes top physical and mental performance difficult, if not impossible. Flying for long periods in hot summer temperatures or at high altitudes increases the susceptibility to dehydration because these conditions tend to increase the rate of water loss from the body.

To help prevent dehydration, drink two to four quarts of water every 24 hours. Since each person is physiologically different, this is only a guide. Most people are aware of the eight-glasses-a-day guide: If each glass of water is eight ounces, this equates to 64 ounces, which is two quarts. If this fluid is not replaced, fatigue progresses to dizziness, weakness, nausea, tingling of hands and feet, abdominal cramps, and extreme thirst.

Alcohol

Alcohol impairs the efficiency of the human body. Studies have shown that consuming alcohol is closely linked to performance deterioration. Pilots must make hundreds of decisions, some of them time-critical, during the course of a flight. The safe outcome of any flight depends on the ability to make the correct decisions and take the appropriate actions during routine occurrences, as well as abnormal situations. The influence of alcohol drastically reduces the chances of completing a flight without incident. Even in small amounts, alcohol can impair judgment, decrease sense of responsibility, affect coordination, constrict visual field, diminish memory, reduce reasoning ability, and lower attention span. As little as one ounce of alcohol can decrease the speed and strength of muscular reflexes, lessen the efficiency of eye movements while reading, and increase the frequency at which errors are committed.

Type Beverage	Typical Serving (oz)	Pure Alcohol Content (oz)
Table wine	4.0	.48
Light beer	12.0	.48
Aperitif liquor	1.5	.38
Champagne	4.0	.48
Vodka	1.0	.50
Whiskey	1.25	.50

0.01–0.05% (10–50 mg)	average individual appears normal
0.03–0.12%* (30–120 mg)	mild euphoria, talkativeness, decreased inhibitions, decreased attention, impaired judgment, increased reaction time
0.09–0.25% (90–250 mg)	emotional instability, loss of critical judgment, impairment of memory and comprehension, decreased sensory response, mild muscular incoordination
0.18–0.30% (180–300 mg)	confusion, dizziness, exaggerated emotions (anger, fear, grief), impaired visual perception, decreased pain sensation, impaired balance, staggering gait, slurred speech, moderate muscular incoordination
0.27–0.40% (270–400 mg)	apathy, impaired consciousness, stupor, significantly decreased response to stimulation, severe muscular incoordination, inability to stand or walk, vomiting, incontinence of urine and feces
0.35–0.50% (350–500 mg)	unconsciousness, depressed or abolished reflexes, abnormal body temperature, coma, possible death from respiratory paralysis (450 mg or above)

* Legal limit for motor vehicle operation in most states is 0.08 or 0.10% (80–100 mg of alcohol per dL of blood).

Impairments in vision and hearing can occur from consuming as little as one drink.

The alcohol consumed in beer and mixed drinks is ethyl alcohol, a central nervous system depressant. From a medical point of view, it acts on the body much like a general anesthetic. The "dose" is generally much lower
and more slowly consumed in the case of alcohol, but the basic effects on the human body are similar. Alcohol is easily and quickly absorbed by the digestive tract. The bloodstream absorbs about 80 to 90 percent of the alcohol in a drink within 30 minutes when ingested on an empty stomach. The body requires about 3 hours to rid itself of all the alcohol contained in one mixed drink or one beer.

While experiencing a hangover, a pilot is still under the influence of alcohol. Although a pilot may think he or she is functioning normally, motor and mental response impairment is still present. Considerable amounts of alcohol can remain in the body for over 16 hours, so pilots should be cautious about flying too soon after drinking.

7

Aeronautical Decision-Making (ADM) and Crew Resource Management (CRM)

ADM is a systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances. A remote PIC uses many different resources to safely operate an sUAS and needs to be able to manage these resources effectively. CRM is a component of ADM, where the pilot of sUAS makes effective use of all available resources: human resources, hardware, and information. Many remote pilots operating under part 107 may use a VO, oversee other persons manipulating the controls of the small UA, or any other person who the remote PIC may interact with to ensure safe operations. Therefore, a remote PIC must be able to function in a team environment and maximize team performance. This skill set includes situational awareness, proper allocation of tasks to individuals, avoidance of work overloads in self and in others, and effectively communicating with other members of the crew, such as VOs and persons manipulating the controls of an sUAS. Appendix A, Risk

Assessment Tools, contains expanded information on ADM and CRM, as well as sample risk assessment tools to aid in identifying hazards and mitigating risks.

The importance of learning and understanding effective ADM skills cannot be overemphasized. While progress is continually being made in the advancement of pilot training methods, aircraft equipment and systems, and services for pilots, accidents still occur. Despite all the changes in technology to improve flight safety, one factor remains the same: the human factor which leads to errors. It is estimated that approximately 80 percent of all aviation accidents are related to human factors and the vast majority of these accidents occur during landing (24.1 percent) and takeoff (23.4 percent).

Hazard and Risk

Two defining elements of ADM are hazard and risk. Hazard is a real or perceived condition, event, or circumstance that a pilot encounters. When faced with a hazard, the pilot makes an assessment of that hazard based upon various factors. The pilot assigns a value to the potential impact of the hazard, which qualifies the pilot's assessment of the hazard—risk.
Therefore, risk is an assessment of the single or cumulative hazard facing a pilot; however, different pilots see hazards differently. For example, the pilot arrives to preflight and discovers a small, blunt type nick in the leading edge at the middle of the aircraft's prop. Since the aircraft is parked on the tarmac, the nick was probably caused by another aircraft's prop wash blowing some type of debris into the propeller. The nick is the hazard (a present condition). The risk is prop fracture if the engine is operated with damage to a prop blade.

The seasoned pilot may see the nick as a low risk. He realizes this type of nick diffuses stress over a large area, is located in the strongest portion of the propeller, and based on experience, he doesn't expect it to propagate a crack which can lead to high risk problems. He does not cancel his flight. The inexperienced pilot may see the nick as a high risk factor because he is unsure of the affect the nick will have on the prop's operation and he has been told that damage to a prop could cause a catastrophic failure. This assessment leads him to cancel his flight.
Therefore, elements or factors affecting individuals are different and

profoundly impact decision-making. These are called human factors and can transcend education, experience, health, physiological aspects, etc.

Another example of risk assessment was the flight of a Beechcraft King Air equipped with deicing and anti-icing. The pilot deliberately flew into moderate to severe icing conditions while ducking under cloud cover. A prudent pilot would assess the risk as high and beyond the capabilities of the aircraft, yet this pilot did the opposite. Why did the pilot take this action?
Past experience prompted the action. The pilot had successfully flown into these conditions repeatedly although the icing conditions were previously forecast 2,000 feet above the surface. This time, the conditions were forecast from the surface. Since the pilot was in a hurry and failed to factor in the difference between the forecast altitudes, he assigned a low risk to the hazard and took a chance. He and the passengers died from a poor risk assessment of the situation.

History of ADM

For over 25 years, the importance of good pilot judgment, or aeronautical decision-making (ADM), has been recognized as critical to the safe operation of aircraft, as well as accident avoidance. The airline industry, motivated by the need to reduce accidents caused by human factors, developed the first training programs based on improving ADM. Crew resource management (CRM) training for flight crews is focused on the effective use of all available resources: human resources, hardware, and information supporting ADM to facilitate crew cooperation and improve decision-making. The goal of all flight crews is good ADM and the use of CRM is one way to make good decisions.

Research in this area prompted the Federal Aviation Administration (FAA) to produce training directed at improving the decision-making of pilots and led to current FAA regulations that require that decision-making be taught as part of the pilot training curriculum. ADM research, development, and testing culminated in 1987 with the publication of six manuals oriented to the decision-making needs of variously rated pilots. These manuals provided multifaceted materials designed to reduce the number of decision-related accidents. The effectiveness of these materials was validated in independent studies where student pilots received such training in conjunction with the standard flying curriculum. When tested, the pilots who had received ADM-training made fewer in-flight errors than those who had not received ADM training. The differences were statistically significant and ranged from about 10 to 50 percent fewer judgment errors. In the operational environment, an operator flying about 400,000 hours annually demonstrated a 54 percent reduction in accident rate after using these materials for recurrency training.

Contrary to popular opinion, good judgment can be taught. Tradition held that good judgment was a natural by-product of experience, but as pilots continued to log accident-free flight hours, a corresponding increase of good judgment was assumed. Building upon the foundation of conventional decision-making, ADM enhances the process to decrease the probability of human error and increase the probability of a safe flight. ADM provides a structured, systematic approach to analyzing changes that occur during a flight and how these changes might affect the safe outcome of a flight. The ADM process addresses all aspects of decision-making in the flight deck and identifies the steps involved in good decision-making.

Steps for good decision-making are:

1. Identifying personal attitudes hazardous to safe flight
2. Learning behavior modification techniques
3. Learning how to recognize and cope with stress
4. Developing risk assessment skills
5. Using all resources
6. Evaluating the effectiveness of one's ADM skills

Risk Management

The goal of risk management is to proactively identify safety-related hazards and mitigate the associated risks. Risk management is an important component of ADM. When a pilot follows good decision-making practices, the inherent risk in a flight is reduced or even eliminated. The ability to make good decisions is based upon direct or indirect experience and education.

RISK ASSESSMENT

Pilot's Name		Flight From		To	

SLEEP

1. Did not sleep well or less than 8 hours	2	
2. Slept well	0	

HOW DO YOU FEEL?

1. Have a cold or ill	4	
2. Feel great	0	
3. Feel a bit off	2	

WEATHER AT TERMINATION

1. Greater than 5 miles visibility and 3,000 feet ceilings	1	
2. At least 3 miles visibility and 1,000 feet ceilings, but less than 3,000 feet ceilings and 5 miles visibility	3	
3. IMC conditions	4	

Column total

HOW IS THE DAY GOING?

1. Seems like one thing after another (late, making errors, out of step)	3	
2. Great day	0	

IS THE FLIGHT

1. Day?	1	
2. Night?	3	

PLANNING

1. Rush to get off ground		3	
2. No hurry		1	
3. Used charts and computer to assist		0	
4. Used computer program for all planning	Yes	3	
	No	0	
5. Did you verify weight and balance?	Yes	0	
	No	3	
6. Did you evaluate performance?	Yes	0	
	No	3	
7. Do you brief your passangers on the ground and in flight?	Yes	0	
	No	2	

Column total

TOTAL SCORE

Hazardous Attitudes and Antidotes

Being fit to fly depends on more than just a pilot's physical condition and recent experience. For example, attitude will affect the quality of decisions. Attitude is a motivational predisposition to respond to people, situations, or events in a given manner. Studies have identified five hazardous attitudes that can interfere with the ability to make sound decisions and exercise authority properly: anti-authority, impulsivity, invulnerability, macho, and resignation.

Hazardous attitudes contribute to poor pilot judgment but can be effectively counteracted by redirecting the hazardous attitude so that correct action can be taken. Recognition of hazardous thoughts is the first step toward neutralizing them. After recognizing a thought as hazardous, the pilot should label it as hazardous, then state the corresponding antidote. Antidotes should be memorized for each of the hazardous attitudes so they automatically come to mind when needed.

The Five Hazardous Attitudes

Anti-Authority: "Don't tell me."
This attitude is found in people who do not like anyone telling them what to do. In a sense, they are saying, "No one can tell me what to do." They may be resentful of having someone tell them what to do, or may regard rules, regulations, and procedures as silly or unnecessary. However, it is always your prerogative to question authority if you feel it is in error.

Impulsivity: "Do it quickly."
This is the attitude of people who frequently feel the need to do something, anything, immediately. They do not stop to think about what they are about to do; they do not select the best alternative, and they do the first thing that comes to mind.

Invulnerability: "It won't happen to me."
Many people falsely believe that accidents happen to others, but never to them. They know accidents can happen, and they know that anyone can be affected. However, they never really feel or believe that they will be personally involved. Pilots who think this way are more likely to take chances and increase risk.

Macho: "I can do it."
Pilots who are always trying to prove that they are better than anyone else think, "I can do it—I'll show them." Pilots with this type of attitude will try to prove themselves by taking risks in order to impress others. While this pattern is thought to be a male characteristic, women are equally susceptible.

Resignation: "What's the use?"
Pilots who think, "What's the use?" do not see themselves as being able to make a great deal of difference in what happens to them. When things go well, the pilot is apt to think that it is good luck. When things go badly, the pilot may feel that someone is out to get me, or attribute it to bad luck. The pilot will leave the action to others, for better or worse. Sometimes, such pilots will even go along with unreasonable requests just to be a "nice guy."

Pilot

A pilot must continually make decisions about competency, condition of health, mental and emotional state, level of fatigue, and many other variables. For example, a pilot may be called early in the morning to make a long flight. If a pilot has had only a few hours of sleep and is concerned that the congestion being experienced could be the onset of a cold, it would be prudent to consider if the flight could be accomplished safely.

A pilot had only 4 hours of sleep the night before being asked by the boss to fly to a meeting in a city 750 miles away. The reported weather was marginal and not expected to improve. After assessing fitness as a pilot, it was decided that it would not be wise to make the flight. The boss was initially unhappy, but later convinced by the pilot that the risks involved were unacceptable.

Environment

This encompasses many elements not pilot or airplane related. It can include such factors as weather, air traffic control, navigational aids (NAVAIDS), terrain, takeoff and landing areas, and surrounding obstacles. Weather is one element that can change drastically over time and distance.

A pilot was landing a small airplane just after a heavy jet had departed a parallel runway. The pilot assumed that wake turbulence would not be a problem since landings had been performed under similar circumstances. Due to a combination of prevailing winds and wake turbulence from the heavy jet drifting across the landing runway, the airplane made a hard landing. The pilot made an error when assessing the flight environment.

Aircraft

A pilot will frequently base decisions on the evaluations of the airplane, such as performance, equipment, or airworthiness.

During a preflight, a pilot noticed a small amount of oil dripping from the bottom of the cowling. Although the quantity of oil seemed insignificant at the time, the pilot decided to delay the takeoff and have a mechanic check the source of the oil. The pilot's good judgment was confirmed when the mechanic found that one of the oil cooler hose fittings was loose.

External Pressures

The interaction between the pilot, airplane, and the environment is greatly influenced by the purpose of each flight operation. The pilot must evaluate the three previous areas to decide on the desirability of undertaking or continuing the flight as planned. It is worth asking why the flight is being made, how critical is it to maintain the schedule, and is the trip worth the risks?

On a ferry flight to deliver an airplane from the factory, in marginal weather conditions, the pilot calculated the groundspeed and determined that the airplane would arrive at the destination with only 10 minutes of fuel remaining. The pilot was determined to keep on schedule by trying to "stretch" the fuel supply instead of landing to refuel. After landing with low fuel state, the pilot realized that this could have easily resulted in an emergency landing in deteriorating weather conditions. This was a chance that was not worth taking to keep the planned schedule.

The PAVE Checklist

Another way to mitigate risk is to perceive hazards. By incorporating the PAVE checklist into preflight planning, the pilot divides the risks of flight into four categories: ***Pilot-in-command (PIC), Aircraft, enVironment, and External pressures (PAVE)*** which form part of a pilot's decision-making process. With the PAVE checklist, pilots have a simple way to remember each category to examine for risk prior to each flight. Once a pilot identifies the risks of a flight, he or she needs to decide whether the risk or combination of risks can be managed safely and successfully. If not, make the decision to cancel the flight. If the pilot decides to continue with the flight, he or she should develop strategies to mitigate the risks. One way a pilot can control the risks is to set personal minimums for items in each risk category. These are limits unique to that individual pilot's current level of experience and proficiency.

P = Pilot in Command (PIC)

The pilot is one of the risk factors in a flight. The pilot must ask, "Am I ready for this trip?" in terms of experience, recency, currency, physical and emotional condition. The IMSAFE checklist provides the answers.

A = Aircraft

What limitations will the aircraft impose upon the trip? Ask the following questions:

- Is this the right aircraft for the flight?

- Am I familiar with and current in this aircraft? Aircraft performance figures and the AFM are based on a brand new aircraft flown by a professional test pilot. Keep that in mind while assessing personal and aircraft performance.

- Is this aircraft equipped for the flight? Instruments? Lights? Navigation and communication equipment adequate?

- Can this aircraft carry the planned load?

- Can this aircraft operate at the altitudes needed for the trip

V = EnVironment

Weather is an major environmental consideration. Earlier it was suggested pilots set their own personal minimums, especially when it comes to weather. As pilots evaluate the weather for a particular flight, they should consider the following:

- What are the current ceiling and visibility? In mountainous terrain, consider having higher minimums for ceiling and visibility, particularly if the terrain is unfamiliar.

- Consider the possibility that the weather may be different than forecast.

- Consider the winds at the airports being used and the strength of the crosswind component.

- If flying in mountainous terrain, consider whether there are strong winds aloft. Strong winds in mountainous terrain can cause severe turbulence and downdrafts and be very hazardous for aircraft even when there is no other significant weather.

- Are there any thunderstorms present or forecast?

E = External Pressures

External pressures are influences external to the flight that create a sense of pressure to complete a flight—often at the expense of safety. Factors that can be external pressures include the following:

- The desire to finish

8

VLOS Aircraft Operation

The remote PIC and person manipulating the controls must be able to see the small UA at all times during flight. Therefore, the small UA must be operated closely enough to the CS to ensure visibility requirements are met during small UA operations. This requirement also applies to the VO, if used during the aircraft operation. However, the person maintaining VLOS may have brief moments in which he or she is not looking directly at or cannot see the small UA, but still retains the capability to see the UA or quickly maneuver it back to VLOS. These moments can be for the safety of the operation (e.g., looking at the controller to see battery life remaining) or for operational necessity.

For operational necessity, the remote PIC or person manipulating the controls may intentionally maneuver the UA so that he or she loses sight of it for brief periods of time. Should the remote PIC or person manipulating the controls lose VLOS of the small UA, he or she must regain VLOS as soon as practicable.

For example: A remote PIC stationed on the ground utilizing a small UA to inspect a rooftop may lose sight of the aircraft for brief periods while inspecting the farthest point of the roof. As another example, a remote PIC conducting a search operation around a fire scene with a small UA may briefly lose sight of the aircraft while it is temporarily behind a dense column of smoke.

However, it must be emphasized that even though the remote PIC may briefly lose sight of the small UA, he or she always has the see-and-avoid responsibilities. The circumstances of what would prevent a remote PIC from fulfilling those responsibilities will vary, depending on factors such as the type of UAS, the operational environment, and distance between the remote PIC and the UA. For this reason, there is no specific time interval that interruption of VLOS is permissible, as it would have the effect of potentially allowing a hazardous interruption or prohibiting a reasonable one. If VLOS cannot be regained, the remote PIC or person manipulating the controls should follow predetermined procedures for a loss of VLOS.

These procedures are determined by the capabilities of the sUAS and may include:

- **Immediately landing the UA**
- **Entering hover mode**
- **Return to home sequence**

Thus, the VLOS requirement would not prohibit actions such as scanning the airspace or briefly looking down at the small UAV.

Unaided Vision

VLOS must be accomplished and maintained by unaided vision, except vision that is corrected by the use of eyeglasses (spectacles) or contact lenses. Vision aids, such as binoculars, may be used only momentarily to enhance situational awareness. For example, the remote PIC, person manipulating the controls, or VO may use vision aids to avoid flying over persons or conflicting with other aircraft. Similarly, first person view devices may be used during operations, but do not satisfy the VLOS requirement. While the rule does not set specific vision standards, the FAA recommends that remote PICs, persons manipulating the controls, and VOs maintain 20/20 distant vision acuity (corrected) and normal field of vision.

Visual Observer (VO)

The use of a VO is optional. The remote PIC may choose to use a VO to supplement situational awareness and VLOS. Although the remote PIC and person manipulating the controls must maintain the capability to see the UA, using one or more VOs allows the remote PIC and person manipulating the controls to conduct other mission-critical duties (such as checking displays) while still ensuring situational awareness of the UA. The VO must be able to effectively communicate:

- The small UA location, attitude, altitude, and direction of flight;

- The position of other aircraft or hazards in the airspace; and

- The determination that the UA does not endanger the life or property of another.

To ensure that the VO can carry out his or her duties, the remote PIC must ensure that the VO is positioned in a location where he or she is able to see the small UA sufficiently to maintain VLOS. The remote PIC can do this by specifying the location of the VO. The FAA also requires that the remote PIC and VO coordinate to 1) scan the airspace where the small UA is operating for any potential collision hazard, and 2) maintain awareness of the position of the small UA through direct visual observation. This would be accomplished by the VO maintaining visual contact with the small UA and the surrounding airspace, and then communicating to the remote PIC and person manipulating the controls the flight status of the small UA and any hazards which may enter the area of operation, so that the remote PIC or person manipulating the controls can take appropriate action.

To make this communication possible, the remote PIC, person manipulating the controls, and VO must work out a method of effective communication, which does not create a distraction and allows them to understand each other. The communication method must be determined prior to operation. This effective communication requirement would permit the use of communication-assisting devices, such as a hand-held radio, to facilitate communication from a distance. As shown in figures 8.1-8.2.

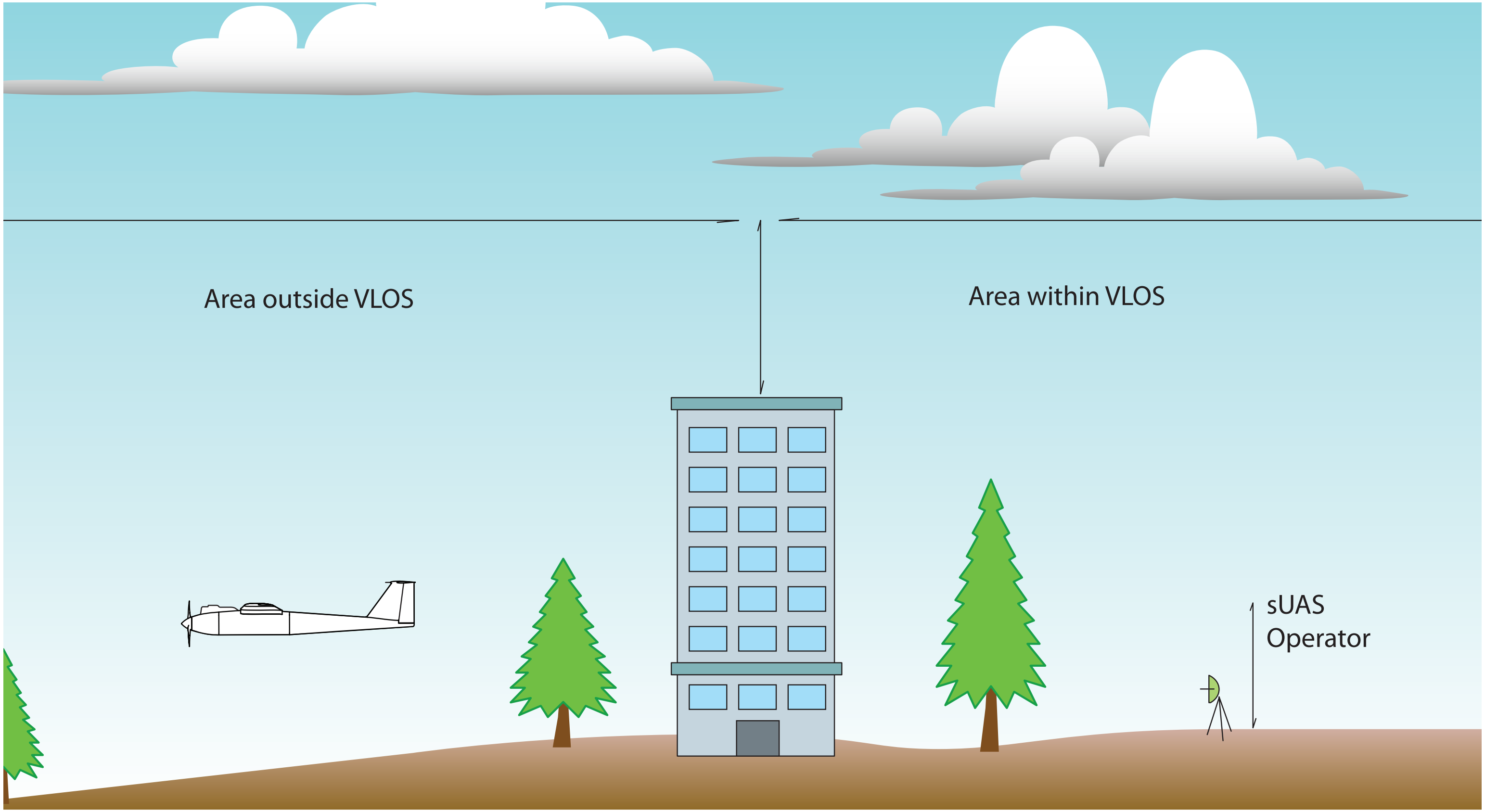


Figure 8.1 VLOS Operations

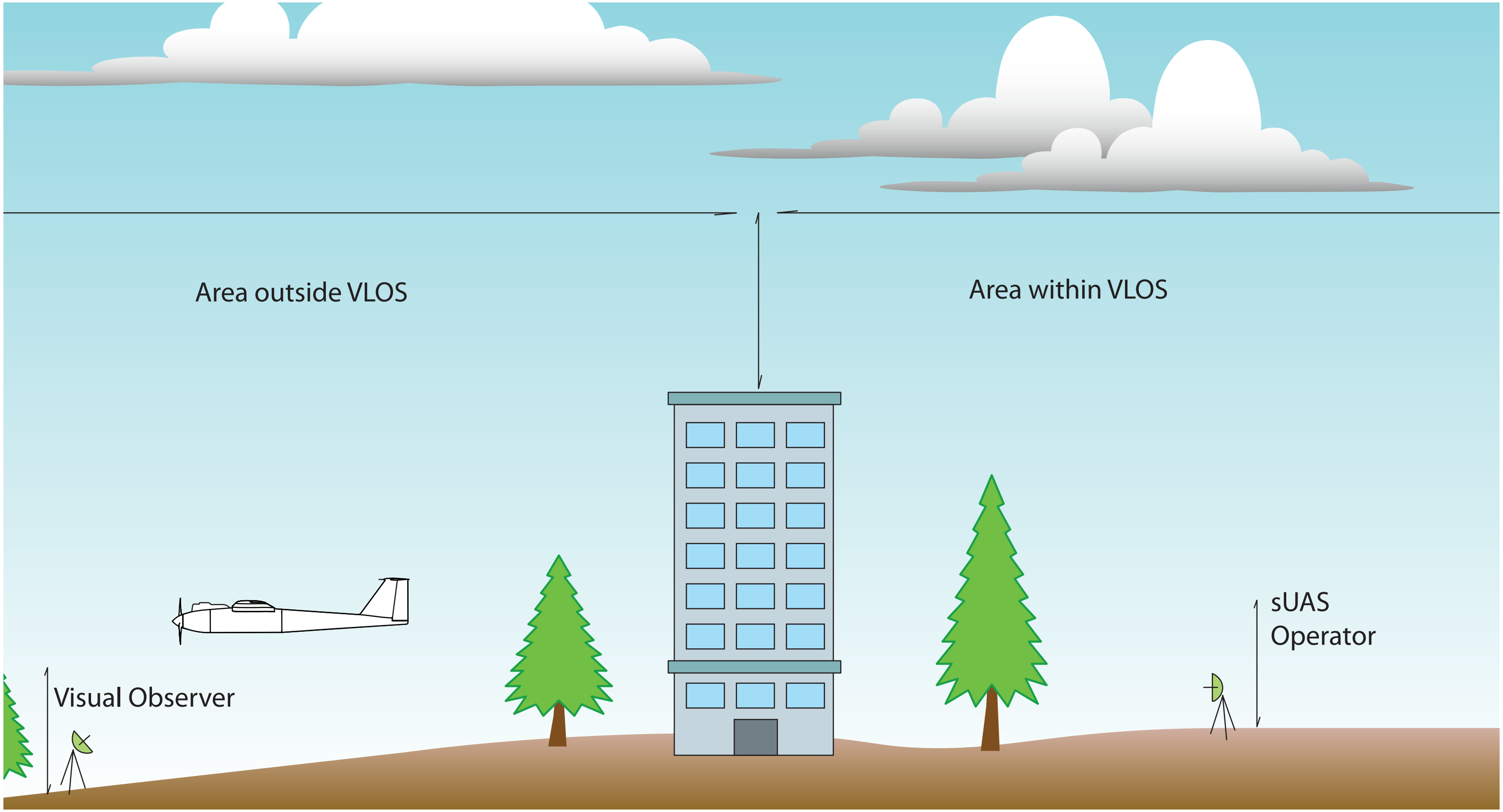
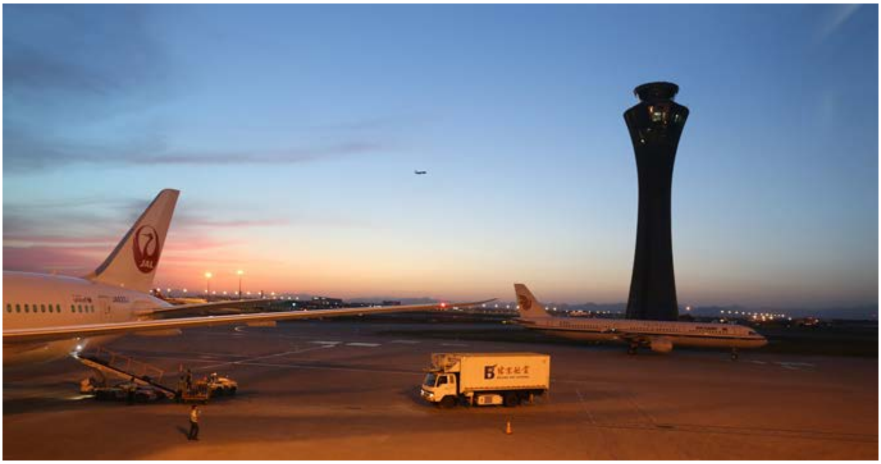


Figure 8.2 Use Of Visual Observer

9



A Basic Understanding Of Airspace

Operation Near Airports; in Certain Airspace; in Prohibited or Restricted Areas; or in the Proximity of Certain Areas Designated by a Notice to Airmen (NOTAM)

Though many sUAS operations will occur in uncontrolled airspace, there are some that may need to operate in controlled airspace. Operations 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, are not allowed unless that person has prior authorization from air traffic control (ATC). The link to the current authorization process can be found at www.faa.gov/uas/. The sUAS remote PIC must understand airspace classifications and requirements. Failure to do so would be in violation of the part 107 regulations and may potentially have an adverse safety effect. Although sUAS will not be subject to part 91, the equipage and communications requirements outlined in part 91 were designed to provide safety and efficiency in controlled airspace. Accordingly, while sUAS operating under part 107 are not subject to part 91, as a practical matter, ATC authorization or clearance may depend on operational parameters similar to those found in part 91. The FAA has the authority to approve or deny aircraft operations based on traffic density, controller workload, communication issues, or any other type of operations that could potentially impact the safe and expeditious flow of air traffic in that airspace. Those planning sUAS operations in controlled airspace are encouraged to contact the FAA as early as possible.

Small UA Operations Near an Airport—Notification and Permissions.

Unless the flight is conducted within controlled airspace, no notification or authorization is necessary to operate at or near an airport. When operating in the vicinity of an airport, the remote PIC must be aware of all traffic patterns and approach corridors to runways and landing areas. The remote PIC must avoid operating anywhere that the presence of the sUAS may interfere with operations at the airport, such as approach corridors, taxiways, runways, or helipads. Furthermore, the remote PIC must yield right-of-way to all other aircraft, including aircraft operating on the surface of the airport.

Remote PICs are prohibited from operating their small UA in a manner that interferes with operations and traffic patterns at airports, heliports, and seaplane bases. While a small UA must always yield right-of-way to a manned aircraft, a manned aircraft may alter its flightpath, delay its landing, or take off in order to avoid an sUAS that may present a potential conflict or otherwise affect the safe outcome of the flight.

For example: A UA hovering 200 feet above a runway may cause a manned aircraft holding short of the runway to delay takeoff, or a manned aircraft on the downwind leg of the pattern to delay landing.

While the UA in this scenario would not pose an immediate traffic conflict to the aircraft on the downwind leg of the traffic pattern or to the aircraft intending to take off, nor would it violate the right-of-way provision of § 107.37(a), the small UA would have interfered with the operations of the traffic pattern at an airport.

> In order to avoid interfering with operations in a traffic pattern, remote PICs should avoid operating in the traffic pattern or published approach corridors used by manned aircraft. When operational necessity requires the remote PIC to operate at an airport in uncontrolled airspace, the remote PIC should operate the small UA in such a way that the manned aircraft pilot does not need to alter his or her flightpath in the traffic pattern or on a published instrument approach in order to avoid a potential collision. Because remote PICs have an obligation to yield right-of-way to all other aircraft and avoid interfering in traffic pattern operations, the FAA expects that most remote PICs will avoid operating in the vicinity of airports because their aircraft generally do not require airport infrastructure, and the concentration of other aircraft increases in the vicinity of airports.

Air Traffic Organization (ATO).

The ATO does not have the authority to deny sUAS operations on the basis of equipage that exceeds the part 107 requirements. Because additional equipage and technologies, such as geo-fencing, have not been certificated by the FAA, they need to be examined on a case-by-case basis in order for the FAA to determine their reliability and functionality. Additionally, requiring ATC to review equipage would place a burden on ATC and detract from other duties. Instead, a remote pilot who wishes to operate in controlled airspace because he or she can demonstrate mitigations through equipage may do so by applying for a waiver

Recurring or Long-Term Operations.

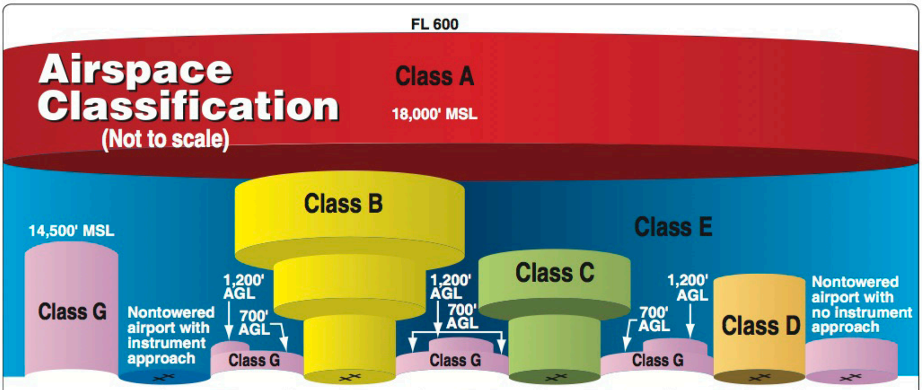
For recurring or long-term operations in a given volume of controlled airspace, prior authorization could perhaps include a letter of agreement (LOA) to identify shortfalls and establish operating procedures for sUAS. This LOA will outline the ability to integrate into the existing air traffic operation and may improve the likelihood of access to the airspace where operations are proposed. This agreement will ensure all parties involved are aware of limitations and conditions and will enable the safe flow of aircraft operations in that airspace. For short-term or short-notice operations proposed in controlled airport airspace, a LOA may not be feasible. Prior authorization is required in all cases

Temporary Flight Restrictions

Certain temporary flight restrictions may be imposed by way of a Notice To Airman or (NOTAM). Therefore, it is necessary for the sUAS remote PIC to check for NOTAMs before each flight to determine if there are any applicable airspace restrictions.

Type of Airspace

It is important that sUAS remote PICs also be aware of the type of airspace in which they will be operating their small UA. Referring to the B4UFly app or a current aeronautical chart (http://faacharts.faa.gov/) of the intended operating area will aid the sUAS remote PIC's decisionmaking regarding operations in the NAS



	Class A	Class B	Class C	Class D	Class E	Class G
Entry Requirements	ATC clearance	ATC clearance	Prior two-way communications	Prior two-way communications	Prior two-way communications*	None
Minimum Pilot Qualifications	Instrument Rating	Private or Student certification—local restrictions apply.	Student certificate	Student certificate	Student certificate	Student certificate
Two-Way Radio Communications	Yes	Yes	Yes	Yes	Yes, under IFR flight plan*	None
Special VFR Allowed	No	Yes	Yes	Yes	Yes	N/A
VFR Visibility Minimum	N/A	3 statute miles	3 statute miles	3 statute miles	3 statute miles**	1 statute mile†
VFR Minimum Distance from Clouds	N/A	Clear of clouds	500' below, 1,000' above, 2,000' horizontal	500' below, 1,000' above, 2,000' horizontal	500' below,** 1,000' above, 2,000' horizontal	Clear of clouds†
VFR Aircraft Separation	N/A	All	IFR aircraft	Runway operations	None	None
Traffic Advisories	Yes	Yes	Yes	Workload permitting	Workload permitting	Workload permitting
Airport Application	N/A	• Radar • Instrument approaches • Weather • Control tower • High density	• Radar • Instrument approaches • Weather • Control tower	• Instrument approaches • Weather • Control tower	• Instrument approaches • Weather	• Control tower

*Exception: temporary tower or control tower present
**True only below 10,000 feet
† True only during day at or below 1,200 feet AGL (see 14 CFR part 91)

AGL—above ground level
FL—flight level
MSL—mean sea level

Airspace Classification

Introduction:

The two categories of airspace are: regulatory and nonregulatory. Within these two categories, there are four types: controlled, uncontrolled, special use, and other airspace. The categories and types of airspace are dictated by the complexity or density of aircraft movements, nature of the operations conducted within the airspace, the level of safety required, and national and public interest.

Controlled Airspace

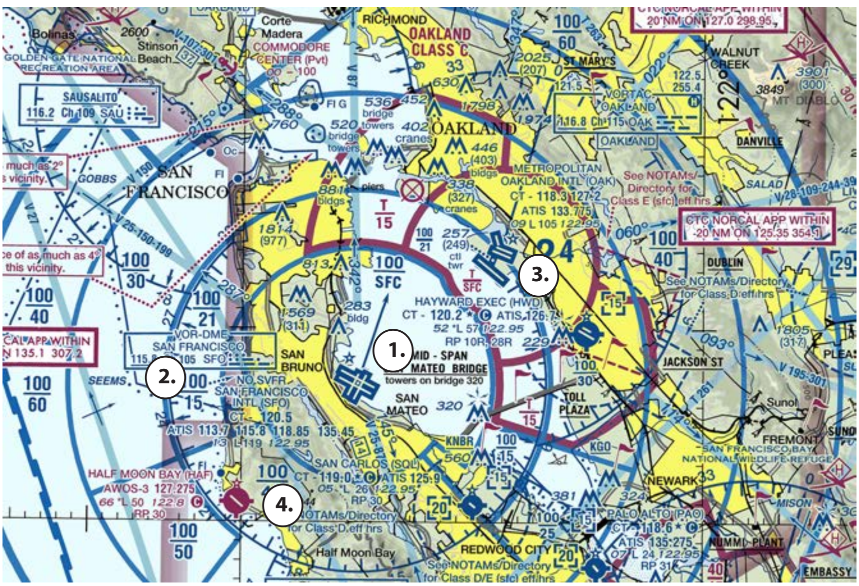
Controlled airspace is a generic term that covers the different classifications of airspace and defined dimensionswithin which air traffic control (ATC) service is provided in accordance with the airspace classification. Controlled airspace consists of:

1. ***Class A.*** Generally, airspace from 18,000 feet mean sea level (MSL) up to and including flight level (FL) 600, including the airspace overlying the waters within 12 nautical miles (NM) of the coast of the 48 contiguous states and Alaska. Unless otherwise authorized, all pilots must operate their aircraft under instrument flight rules (IFR).

2. ***Class B***. Generally, airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of airport operations or passenger enplanements. The configuration of each Class B airspace area is individually tailored, consists of a surface area and two or more layers (some Class B airspace areas resemble upside-down wedding cakes), and is designed to contain all published instrument procedures once an aircraft enters the airspace. An air traffic control (ATC) clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation

services within the airspace.

3. ***Class C.*** Generally, airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower are serviced by a radar approach control and have a certain number of IFR operations or passenger enplanements. Although the configuration of each Class C area is individually tailored, the airspace usually consists of a surface area with a 5 NM radius, an outer circle with a 10 NM radius that extends from 1,200 feet to 4,000 feet above the airport elevation and an outer area. Each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while within the airspace.



1. Class Bravo Airport
2. Class Bravo Airspace (Solid Blue Line)
3. Class Charlie Airport
4. Class Echo Airport (Underneath Class Bravo Airspace)

4. ***Class D***. Generally, airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that

have an operational control tower. The configuration of each Class D airspace area is individually tailored and, when instrument procedures are published, the airspace normally designed to contain the procedures. Arrival extensions for instrument approach procedures (IAPs) may be Class D or Class E airspace. Unless otherwise authorized, each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while in the airspace.

5. ***Class E***. Generally, if the airspace is not Class A, B, C, or D, and is controlled airspace, then it is Class E airspace. Class E airspace extends upward from either the surface or a designated altitude to the overlying or adjacent controlled airspace. When designated as a surface area, the airspace is configured to contain all instrument procedures. Also in this class are federal airways, airspace beginning at either 700 or 1,200 feet above ground level (AGL) used to transition to and from the terminal or en route environment, and en route domestic and offshore airspace areas designated below 18,000 feet MSL. Unless designated at a lower altitude, Class E airspace begins at 14,500 MSL over the United States, including that airspace overlying the waters within 12 NM of the coast of the 48 contiguous states and Alaska, up to but not including 18,000 feet MSL, and the airspace above FL 600.

Uncontrolled Airspace

Uncontrolled airspace or Class G airspace is the portion of the airspace that has not been designated as Class A, B, C, D, or E. It is therefore designated uncontrolled airspace. Class G airspace extends from the surface to the base of the overlying Class E airspace

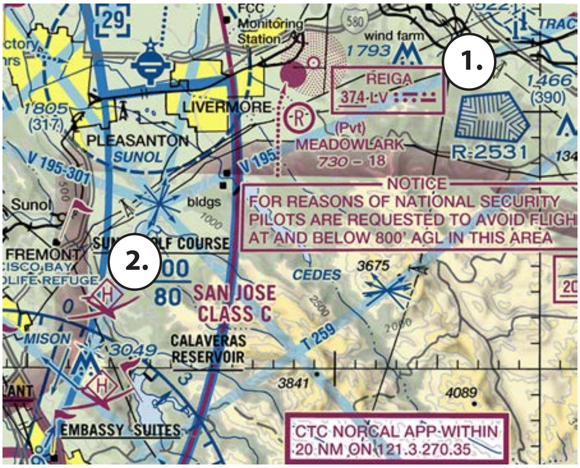
1.***Class G***. Airspace not designated as Class A, B, C, D, or E. Class G airspace is essentially uncontrolled by ATC except when associated with a temporary control tower.

Special Use Airspace

Special use airspace is the designation for airspace in which certain activities must be confined or where limitations may be imposed on aircraft operations that are not part of those activities. Certain special use airspace areas can create limitations on the mixed use of airspace. The special use airspace depicted on instrument charts includes the area name or number, effective altitude, time and weather conditions of operation, the controlling agency, and the chart panel location. On National Aeronautical Navigation Products (AeroNav Products) en route charts, this information is available on one of the end panels.

Prohibited areas contain airspace of defined dimensions within which the flight of aircraft is prohibited. Such areas are established for security or other reasons associated with the national welfare. These areas are published in the Federal Register and are depicted on aeronautical charts. The area is charted as a “P” followed by a number (e.g., “P-123”).

Restricted areas are areas where operations are hazardous to nonparticipating aircraft and contain airspace within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Activities within these areas must be confined because of their nature, or limitations may be imposed upon aircraft operations that are not a part of those activities, or both. Restricted areas denote the existence of unusual, often invisible,
hazards to aircraft (e.g., artillery firing, aerial gunnery, or guided missiles). IFR flights may be authorized to transit the
airspace and are routed accordingly. Penetration of restricted areas



1. **Restricted Area** (Do Overfly)
2. Glider Area

without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. ATC facilities apply the following procedures when aircraft are operating on an IFR clearance (including those cleared by ATC to maintain visual flight rules (VFR)-On-Top) via a route that lies within joint-use restricted airspace:

1.If the restricted area is not active and has been released to the Federal

Aviation Administration (FAA), the ATC facility will allow the aircraft to operate in the restricted airspace without issuing specific clearance for it to do so.

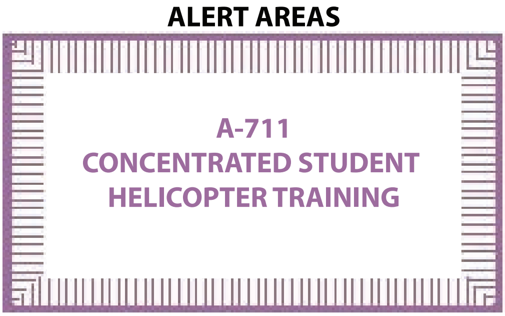
2. If the restricted area is active and has not been released to the FAA, the ATC facility will issue a clearance that will ensure the aircraft avoids the restricted airspace.

Restricted areas are charted with an "R" followed by a number (e.g., "R-5701") and are depicted on the en route chart appropriate for use at the altitude or FL being flown.

Warning areas are similar in nature to restricted areas; however, the U.S. Government does not have sole jurisdiction over the airspace. A warning area is airspace of defined dimensions, extending from 12 NM outward from the coast of the United States, containing activity that may be hazardous to nonparticipating aircraft. The purpose of such areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both. The airspace is designated with a "W" followed by a number (e.g., "W-123").

Military operations areas (MOAs) consist of airspace with defined vertical and lateral limits established for the purpose of separating certain military training activities from IFR traffic. Whenever an MOA is being used, nonparticipating IFR traffic may be cleared through an MOA if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic. MOAs are depicted on sectional, VFR terminal area, and en route low altitude charts and are not numbered (e.g., "Boardman MOA").

Alert areas are depicted on aeronautical charts with an "A" followed by a number (e.g., "A-123") to inform nonparticipating pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity. Pilots should exercise caution in alert areas. All activity within an alert area shall be conducted in accordance with regulations, without waiver, and pilots of participating aircraft, as well as pilots transiting the area, shall be equally responsible for collision avoidance.



Military Training Routes (MTRs) are routes used by military aircraft to maintain proficiency in tactical flying. These routes are usually established below 10,000 feet MSL for operations at speeds in excess of 250 knots. Some route segments may be defined at higher altitudes for purposes of route continuity. Routes are identified as IFR (IR) and VFR

(VR) followed by a number. MTRs with no segment above 1,500 feet AGL are identified by four number characters (e.g., IR1206, VR1207). MTRs that include one or more segments above 1,500 feet AGL are identified by three number characters (e.g., IR206, VR207). IFR low altitude en route charts depict all IR routes and all VR routes that accommodate operations above 1,500 feet AGL. IR routes are conducted in accordance with IFR regardless of weather conditions.

Temporary flight restrictions (TFRs) are put into effect when traffic in the airspace would endanger or hamper air or ground activities in the designated area. For example, a forest fire, chemical accident, flood, or disaster-relief effort could warrant a TFR, which would be issued as a Notice to Airmen (NOTAM).

National Security Areas (NSAs) consist of airspace with defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Flight in NSAs may be temporarily prohibited by regulation under the provisions of Title 14 of the Code of Federal Regulations (14 CFR) part 99 and prohibitions will be disseminated via NOTAM.

Aeronautical Charts

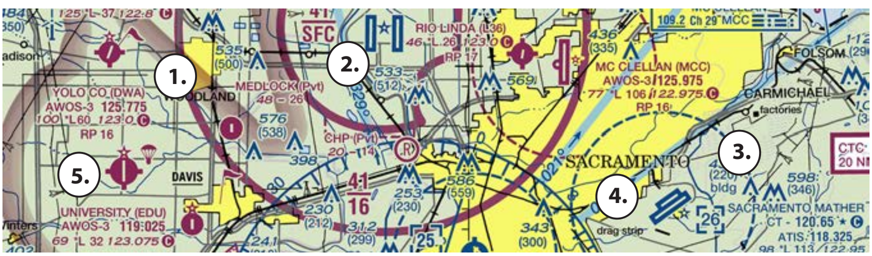
An aeronautical chart is the road map for a pilot flying under VFR. The chart provides information that allows pilots to track their position and provides available information that enhances safety. The three aeronautical charts used by VFR pilots are:

- **Sectional**
- **VFR Terminal Area**
- **World Aeronautical**

A free catalog listing aeronautical charts and related publications including prices and instructions for ordering is available at the Aeronautical Navigation Products website: www.aeronav.faa.gov.

Sectional Charts

Sectional charts are the most common charts used by pilots today. The charts have a scale of 1:500,000 (1 inch = 6.86 nautical miles (NM) or approximately 8 statute miles (SM)), which allows for more detailed information to be included on the chart. The charts provide an abundance of information, including airport data, navigational aids, airspace, and topography. By referring to the chart legend, a pilot can interpret most of the information on the chart. A pilot should also check the chart for other legend information, which includes air traffic control (ATC) frequencies and information on airspace. These charts are revised semiannually except for some areas outside the conterminous United States where they are revised annually.



1. Class Charlie Airspace (Thick Magenta line)

2. Class Charlie Airport

3. Class Delta Airspace (Blue Dotted line

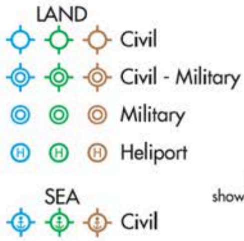
4. Class Delta Airport

5. Class Echo Airport

L E G E N D

AIRPORTS

Airports/Seaplane bases shown in BLUE and GREEN have an approved Low Altitude Instrument Approach Procedure published. Those in BLUE have an approved DOD Low Altitude Instrument Approach Procedure and/or DOD RADAR MINIMA published in DOD FLIPS or Alaska Terminal. Airports/Seaplane bases shown in BROWN do not have a published Instrument Approach Procedure.



1. A solid-line box enclosing the airport name indicates 14 CFR part 93 Special Requirements—see Directory/Supplement
2. "NO SVFR" above the airport name indicates 14 CFR part 91 fixed-wing special VFR flight is prohibited
3. C or D following the airport name indicates Class C or Class D Airspace
4. Pvt—Private use
5. Associated city names for public airports are shown above or preceding the airport name. If airport name and city name are the same, only the airport name is shown. The airport identifier in parentheses follows the airport name. City names for military airports are not shown.

Lighting Capability:

- L Lighting available
- Pilot Controlled Lighting
- ★ Part-time or on request
- \- No lighting available at private facilities—indicates no lighting information is available.

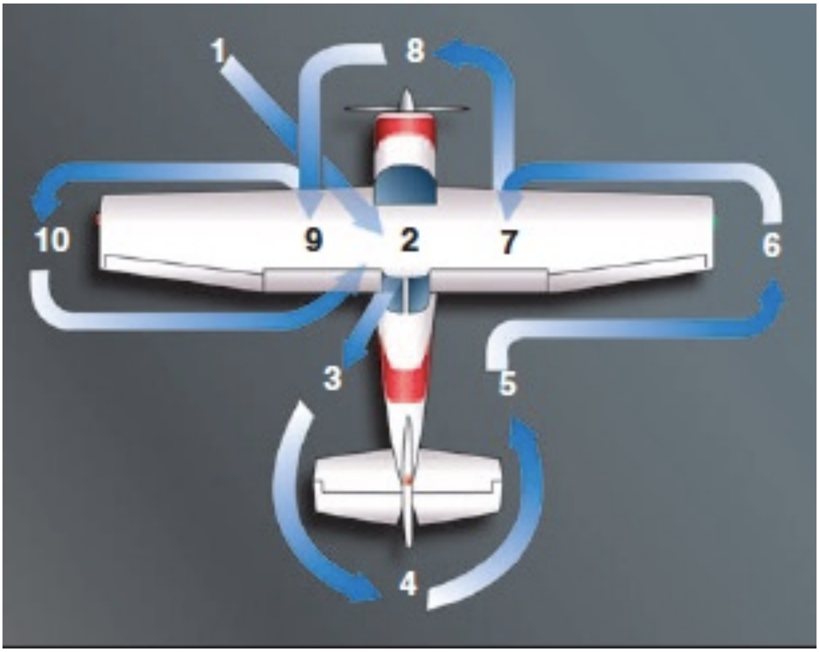
10

Preflight Familiarization, Inspection, and Actions for Aircraft Operation

The remote PIC must complete a preflight familiarization, inspection, and other actions, such as crewmember briefings, prior to beginning flight operations. The FAA has produced many publications providing in-depth information on topics such as aviation weather, aircraft loading and performance, emergency procedures, ADM, and airspace, which should all be considered prior to operations. Additionally, all remote pilots are encouraged to review FAA publications.

Prior to Flight

Figure 10.1 Preflight inspection



The remote PIC must:

1. Conduct an assessment of the operating environment. The assessment must include at least the following:

- Local weather conditions,
- Local airspace and any flight restrictions,
- The location of persons and property on the surface, and
- Other ground hazards.

2. Ensure that all persons directly participating in the small UA operation are informed about the following:

- Operating conditions,
- Emergency procedures,

• Contingency procedures,

• Roles and responsibilities of each person involved in the operation,and

• Potential hazards.

3. Ensure that all control links between the CS and the small UA are working properly. For example, before each flight, the remote PIC must determine that the small UA flight control surfaces necessary for the safety of flight are moving correctly through the manipulation of the small UA CS. If the remote PIC observes that one or more of the control surfaces are not responding correctly to CS inputs, then the remote PIC may not conduct flight operations until correct movement of all flight control surface(s) is established.

4. Ensure there is sufficient power to continue controlled flight operations to a normal landing. One of the ways that this could be done is by following the sUAS manufacturer's operating manual power consumption tables. Another method would be to include a system on the sUAS 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.

5. Ensure that any object attached or carried by the small UA is secure and does not adversely affect the flight characteristics or controllability of the aircraft.

6. Ensure that all necessary documentation is available for inspection, including the remote PIC's remote pilot certificate, aircraft registration (if required), and Certificate of Waiver (CoW) (if applicable.

Safety Risk Assessment

These preflight familiarizations, inspections, and actions can be accomplished as part of an overall safety risk assessment. The FAA encourages the remote PIC to conduct the overall safety risk assessment as a method of compliance with the prohibition on operations over certain persons and the requirement to remain clear of other aircraft.

11

Operating Limitations for Small UAS

The small UA must be operated in accordance with the following limitations:

- Cannot be flown faster than a groundspeed of 87 knots (100 miles per hour);

- Cannot be flown higher than 400 feet above ground level (AGL), unless flown within a 400-foot radius of a structure and does not fly higher than 400 feet above the structure's immediate uppermost limit; As shown in figure 11.1

- Minimum visibility, as observed from the location of the CS, may not be less than 3 statute miles (sm); and

- Minimum distance from clouds being no less than 500 feet below a cloud and no less than 2000 feet horizontally from the cloud.

Note: These operating limitations are intended, among other things, to support the remote pilot's ability to identify hazardous conditions relating to encroaching aircraft or persons on the ground, and to take the appropriate actions to maintain safety

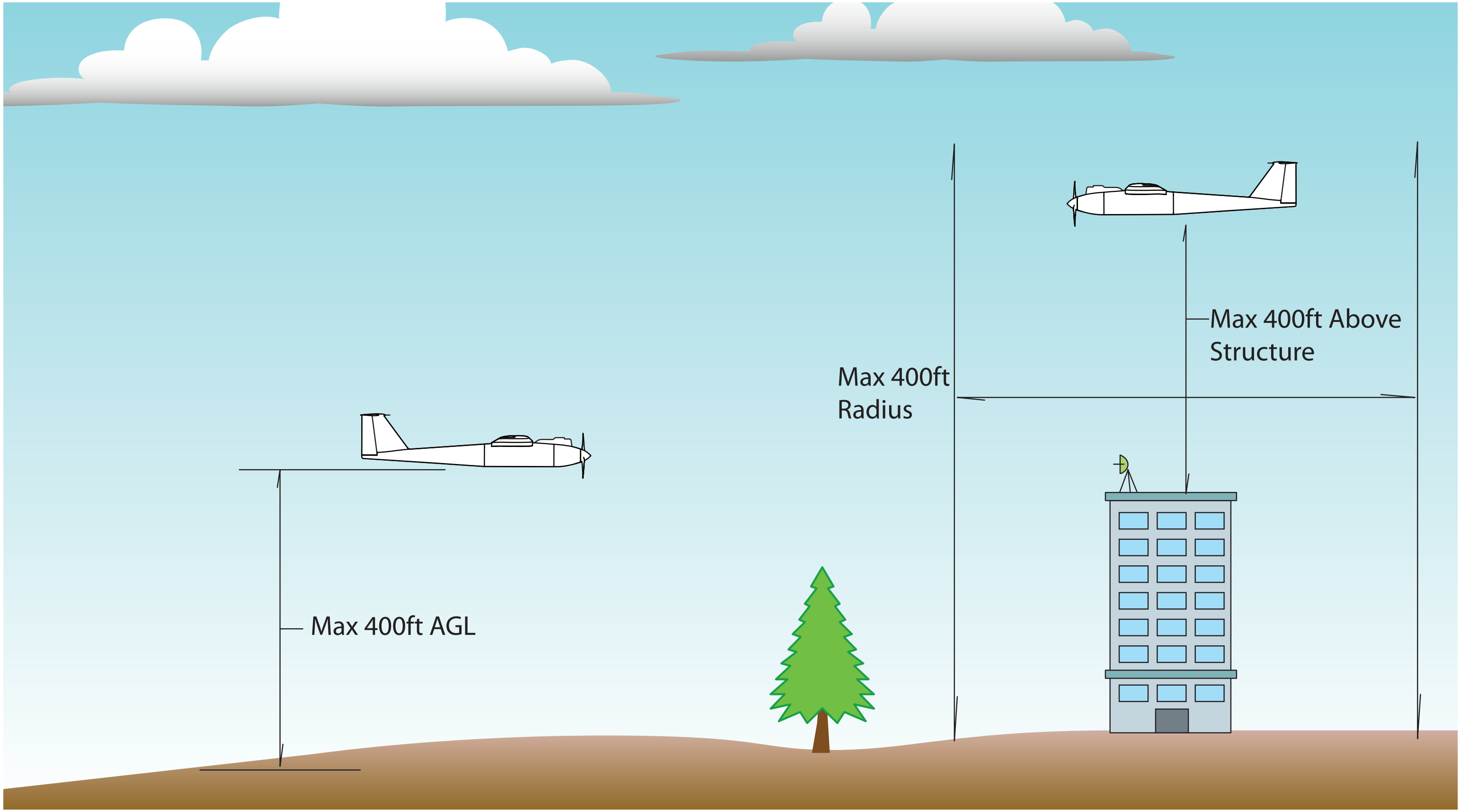


Figure 11.1 Altitude limitations

Determining Groundspeed

There are many different types of sUAS and different ways to determine groundspeed. Therefore, this guidance will only touch on some of the possible ways for the remote PIC to ensure that the small UA does not exceed a groundspeed of 87 knots during flight operations. Some of the possible ways to ensure that 87 knots is not exceeded are as follows:

- Installing a Global Positioning System (GPS) device on the small UA that reports groundspeed information to the remote pilot, wherein the remote pilot takes into account the wind direction and speed and calculates the small UA airspeed for a given direction of flight, or

- Timing the groundspeed of the small UA when it is flown between two or more fixed points, taking into account wind speed and direction between each point, then noting the power settings of the small UA to operate at or less than 87 knots groundspeed, or

- Using the small UA's manufacturer design limitations (e.g., installed groundspeed limiters).

Determining Altitude

In order to comply with the maximum altitude requirements of part 107, as with determining groundspeed, there are multiple ways to determine a small UA's altitude above the ground or structure. Some possible ways for a remote pilot to determine altitude are as follows:

- Installing a calibrated altitude reporting device on the small UA that reports the small UA altitude above mean sea level (MSL) to the remote pilot, wherein the remote pilot subtracts the MSL elevation of the CS from the small UA reported MSL altitude to determine the small UA AGL altitude above the terrain or structure;

- Installing a GPS device on the small UA that also has the capability of reporting MSL altitude to the remote pilot;

- With the small UA on the ground, have the remote pilot and VO pace off 400 feet from the small UA to get a visual perspective of the small UA at that distance, wherein the remote pilot and VO maintain that visual perspective or closer while the small UA is in flight; or

- Using the known height of local rising terrain and/or structures as a reference.

Visibility and Distance from Clouds

Once the remote PIC and VO have been able to reliably establish the small UA AGL altitude, it is incumbent on the remote PIC to determine that visibility from the CS is at least 3 sm and that the small UA is kept at least 500 feet below a cloud and at least 2,000 feet horizontally from a cloud. One of the ways to ensure adherence to the minimum visibility and cloud clearance requirements is to obtain local aviation weather reports that include current and forecast weather conditions. If there is more than one local aviation reporting station near the operating area, the remote PIC should choose the closest one that is also the most representative of the terrain surrounding the operating area. If local aviation weather reports are not available, then the remote PIC may not operate the small UA if he or she is not able to determine the required visibility and cloud clearances by other reliable means. It is imperative that the UA not be operated above any cloud, and that there are no obstructions to visibility, such as smoke or a cloud, between the UA and the remote PIC. As shown in figure 11.2.

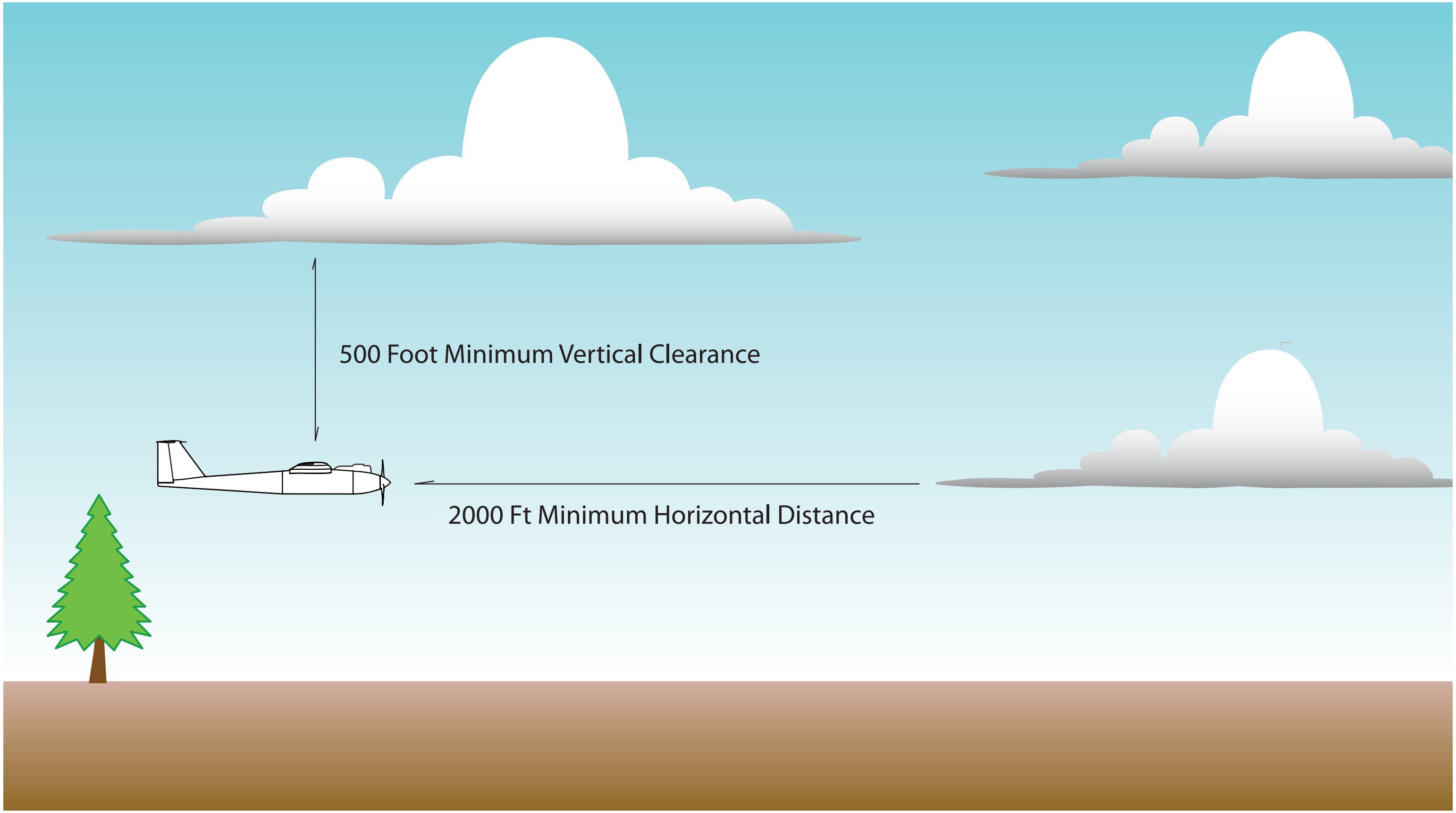


Figure 11.2 Cloud Clearences

Prohibited Operation Over Persons

Part 107 prohibits a person from flying a small UA directly over a person who is not under a safe cover, such as a protective structure or a stationary vehicle. However, a small UA may be flown over a person who is directly participating in the operation of the sUAS, such as the remote PIC, other person manipulating the controls, a VO, or crewmembers necessary for the safety of the sUAS operation, as assigned and briefed by the remote PIC. There are several ways that the sUAS remote PIC can comply with these requirements, such as:

- Selecting an operational area (site) that is clearly unpopulated/uninhabited. If selecting a site that is populated/inhabited, have a plan of action which ensures persons remain clear of the operating area, remain indoors, or remain under safe cover until such time that the small UA flight has ended. Safe cover is a structure or stationary vehicle that would protect a person from harm if the small UA were to crash into that structure or vehicle;

- Establishing an operational area in which the remote PIC has taken reasonable precautions to keep free of persons not directly participating in the operation of the sUAS;

• Choosing an operating area that is sparsely populated, or, ideally, clear of persons if operating a small UA from a moving vehicle;

• Having a plan of action that ensures the small UA remains clear of persons who may enter the operating area.

• Adopt an appropriate operating distance from persons not directly participating in the operation of the sUAS.

Remaining Clear of Other Aircraft:

A remote PIC has a responsibility to operate the small UA so it remains clear of and yields to all other aircraft. This is traditionally referred to as "see and avoid." To satisfy this responsibility, the remote PIC must know the location and flight path of his or her small UA at all times. The remote PIC must be aware of other aircraft, persons, and property in the vicinity of the operating area, and maneuver the small UA to avoid a collision, as well as prevent other aircraft from having to take action to avoid the small UA.

Operations from Moving Vehicles

Part 107 permits operation of an sUAS from a moving land or water-borne vehicle over a sparsely-populated area. However, operation from a moving aircraft is prohibited. Additionally, small UA transporting another person's property for compensation or hire may not be operated from any moving vehicle.

Waiving the Sparsely-Populated Area Provision

Although the regulation states that operations from a moving vehicle may only be conducted over a sparsely-populated area, this provision may be waived (see paragraph 5.19). The operation is subject to the same restrictions that apply to all other part 107 operations. For instance, the remote PIC operating from a moving vehicle is still required to maintain VLOS and operations are still prohibited over persons not directly involved in the operation of the sUAS unless under safe cover. The remote PIC is also responsible for ensuring that no person is subject to undue risk as a result of LOC of the small UA for any reason. If a VO is not located in the same vehicle as the remote PIC, the VO and remote PIC must still maintain effective communication.

Careless or Reckless Operation of sUAS.

Part 107 also prohibits careless or reckless operation of an sUAS. Flying an sUAS while driving a moving vehicle is considered to be careless or reckless because the person's attention would be hazardously divided. Therefore, the remote PIC or person manipulating the flight controls cannot operate an sUAS and drive a moving vehicle in a safe manner and remain in compliance with part 107.

Applicable Laws

Other laws, such as state and local traffic laws, may also apply to the conduct of a person driving a vehicle. Many states currently prohibit distracted driving and state or local laws may also be amended in the future to impose restrictions on how cars and public roads may be used with regard to an sUAS operation. The FAA emphasizes that people involved in an sUAS operation are responsible for complying with all applicable laws and not just the FAA's regulations

Transportation of Property

Part 107 permits transportation of property by sUAS for compensation or hire. These operations must be conducted within a confined area and in compliance with the operating restrictions of part 107. When conducting the transportation of property, the transport must occur wholly within the bounds of a state. It may not involve transport between, 1) Hawaii and another place in Hawaii through airspace outside Hawaii, 2) the District of Columbia (DC) and another place in DC, or 3) a territory or possession of the United States and another place in the same territory or possession, as this is defined by statute as interstate air transportation.

Limitations

As with other operations in part 107, sUAS operations involving the transport of property must be conducted within VLOS of the remote pilot. While the VLOS limitation can be waived for some operations under the rule, it cannot for transportation of property. Additionally, part 107 does not allow the operation of an sUAS from a moving vehicle or aircraft if the small UA is being used to transport property for compensation or hire. This limitation cannot be waived. The maximum total weight of the small UA (including any property being transported) is limited to under 55 pounds. Additionally, other provisions of part 107 require the remote pilot to know the UA's location; to determine the UA's attitude, altitude, and direction; to yield the right-of-way to other aircraft; and to maintain the ability to see and avoid other aircraft.

Hazardous Materials

Part 107 does not allow the carriage of hazardous materials because the carriage of hazardous materials poses a higher level of risk.

Operations while Impaired

Part 107 does not allow operation of an sUAS if the remote PIC, person manipulating the controls, or VO is unable to safely carry out his or her responsibilities. It is the remote PIC's responsibility to ensure all crewmembers are not participating in the operation while impaired. While drug and alcohol use are known to impair judgment, certain over-the-counter medications and medical conditions could also affect the ability to safely operate a small UA. For example, certain antihistamines and decongestants may cause drowsiness. We also emphasize that part 107 prohibits a person from serving as a remote PIC, person manipulating the controls, VO, or other crewmember if he or she:

- Consumed any alcoholic beverage within the preceding 8 hours;
- Is under the influence of alcohol;

- Has a blood alcohol concentration of .04 percent or greater; and/or

- Is using a drug that affects the person's mental or physical capabilities.

Medical Conditions

Certain medical conditions, such as epilepsy, may also create a risk to operations. It is the remote PIC's responsibility to determine that their medical condition is under control and they can safely conduct a UAS operation

Daylight Operations

Part 107 prohibits operation of an sUAS at night, which is defined in part 1 as the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in The Air Almanac, converted to local time. In the continental United States (CONUS), evening civil twilight is the period of sunset until 30 minutes after sunset and morning civil twilight is the period of 30 minutes prior to sunrise until sunrise. In Alaska, the definition of civil twilight differs and is described in The Air Almanac. The Air Almanac provides tables which are used to determine sunrise and sunset at various latitudes. These tables can also be downloaded from the Naval Observatory and customized for your location.

Civil Twilight Operations

When sUAS operations are conducted during civil twilight, the small UA must be equipped with anticollision lights that are capable of being visible for at least 3 sm. However, the remote PIC may reduce the visible distance of the lighting less than 3 sm during a given flight if he or she has determined that it would be in the interest of safety to do so, for example if it impacts his or her night vision. sUAS not operated during civil twilight are not required to be equipped with anti-collision lighting

In-Flight Emergency

An in-flight emergency is an unexpected and unforeseen serious occurrence or situation that requires urgent, prompt action. In case of an in-flight emergency, the remote PIC is permitted to deviate from any rule of part 107 to the extent necessary to respond to that emergency. A remote PIC who exercises this emergency power to deviate from the rules of part 107 is required, upon FAA request, to send a written report to the FAA explaining the deviation. Emergency action should be taken in such a way as to minimize injury or damage to property.

Careless or Reckless Operation

As with manned aircraft, remote PICs are prohibited from engaging in a careless or reckless operation. We also note that because sUAS have additional operating considerations that are not present in manned aircraft operations, there may be additional activity that would be careless or reckless if conducted using an sUAS. For example, failure to consider weather conditions near structures, trees, or rolling terrain when operating in a densely populated area could be determined as careless or reckless operation.

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Certificate of Waiver

Part 107 includes the option to apply for a Certificate of Waiver (CoW). This CoW will allow an sUAS operation to deviate from certain provisions of part 107 if the Administrator finds that the proposed operation can be safely conducted under the terms of that CoW. A list of the waivable sections of part 107 can be found in § 107.205 and are listed below:

- Section 107.25, Operation from a moving vehicle or aircraft. However, no waiver of this provision will be issued to allow the carriage of property of another by aircraft for compensation or hire.

- Section 107.29, Daylight operation.

- Section 107.31, Visual line of sight aircraft operation. However, no waiver of this provision will be issued to allow the carriage of property of another by aircraft for compensation or hire.

- Section 107.33, Visual observer.

- Section 107.35, Operation of multiple small unmanned aircraft systems.

- Section 107.37(a), Yielding the right of way.

- Section 107.39, Operation over people.

- Section 107.41, Operation in certain airspace.

- Section 107.51, Operating limitations for small unmanned aircraft.

Applying for a CoW. To apply for a CoW under § 107.200, an applicant must go to www.faa.gov/uas/ and follow the instructions.

Application Process

The application must contain a complete description of the proposed operation and a justification, including supporting data and documentation (as necessary), that establishes that the proposed operation can safely be conducted under the terms of a CoW. Although not required by part 107, the FAA encourages applicants to submit their application at least 90 days prior to the start of the proposed operation. The FAA will strive to complete review and adjudication of waivers within 90 days; however, the time required for the FAA to make a determination regarding waiver requests will vary based on the complexity of the request. The amount of data and analysis required as part of the application will be proportional to the specific relief that is requested. For example, a request to waive several sections of part 107 for an operation that takes place in a congested metropolitan area with heavy air traffic will likely require significantly more data and analysis than a request to waive a single section for an operation that takes place in a sparsely-populated area with minimal air traffic. If a CoW is granted, that certificate may include specific special provisions designed to ensure that the sUAS operation may be conducted as safely as one conducted under the provisions of part 107. A listing of standard special provisions for part 107 waivers will be available on the FAA's Web site at http://www.faa.gov/uas/

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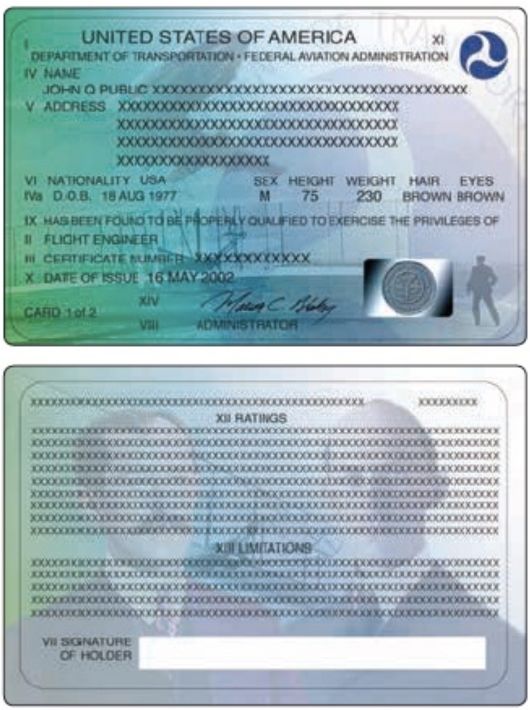
Pilot Certification

This chapter provides the airman certification requirements and procedures for persons acting as remote pilot in command (PIC) of a small UA operated in the National Airspace System (NAS).

Note: In the aviation context, the FAA typically refers to "licensing" as "certification."

Remote Pilot Certification: A person exercising the authority of PIC in compliance with part 107 is considered a "remote pilot in command" (remote PIC). As such, prior to acting as remote PIC, he or she must obtain a remote pilot certificate with an sUAS rating.

Eligibility



A person applying for a remote pilot certificate with an sUAS rating must meet and maintain the following eligibility requirements, as applicable:

- Be at least 16 years of age.

- Be able to read, speak, write, and understand the English language. However, the FAA may make an exception if the person is unable to meet one of these requirements due to medical reasons, such as a hearing impairment.

• Be in a physical and mental condition that would not interfere with the safe operation of an sUAS.

• Pass the initial aeronautical knowledge test at an FAA-approved knowledge testing center (KTC). However, a person who already holds a pilot certificate issued under 14 CFR part 61, except a student pilot certificate, and has successfully completed a flight review in accordance with part 61 within the previous 24 calendar-months is only required to successfully complete a part 107 online training course, found at www.faasafety.gov. For more information concerning aeronautical knowledge tests and training

Application Process

Applicants Without Part 61 Certificates

A person who does not have a part 61 pilot certificate or a part 61 certificate holder who has not completed a part 61 flight review in the previous 24 calendar-months must use the following process. A part 61 pilot who has completed a flight review within the previous 24 calendar-months may elect to use this process.

1. Pass an initial aeronautical knowledge test administered at a KTC (see paragraph 6.6).

2. Complete the Remote Pilot Certificate and/or Rating Application for a remote pilot certificate (FAA Form 8710-13).

• **Option 1 (Online Form)**

This is the fastest and simplest method. The FAA Form 8710-13 application should be completed online using the electronic FAA Integrated Airmen Certificate and/or Rating Application (IACRA) system **(https://iacra.faa.gov/iacra/)**.

Note: When the applicant uses this online option, the application will be transmitted electronically from the applicant to the Airman Registry. The only electronic signature that will be reflected on the IACRA application will be the applicant's. The applicant will then receive a confirmation email once his or her application has completed the Transportation Security Administration (TSA) vetting process. The email will provide information that will allow the applicant to log into the IACRA system and print a copy of the temporary certificate.

- **Option 2 (Paper Application)**

An applicant could also submit a paper application. If the applicant chooses the paper method, the original initial aeronautical knowledge test report must be mailed with the application to the following address:

DOT/FAA
Airmen Certification Branch (AFS-760)
P.O. Box 25082
Oklahoma City, OK 73125

Note: A temporary airman certificate will not be provided to the remote pilot applicant if they do not hold a part 61 certificate. For this reason, it would be of the applicant's best interest to utilize Option 1 (IACRA system) instead of the paper method, in order to receive a temporary airman certificate once the application has completed the TSA vetting process.

3. Receive permanent remote pilot certificate once all other FAA internal processing is complete.

Applicants with Part 61 Certificates

Instead of the process described above, a person who holds a part 61 pilot certificate, except a student pilot certificate, and has completed a flight review within the previous 24 calendar-months may elect to apply using the following process:

1. Complete the online course (Part 107 small Unmanned Aircraft Systems (sUAS), ALC-451) located within the FAA Safety Team (FAASTeam) Web site (www.faasafety.gov) and receive a completion certificate.

2. Complete the Remote Pilot Certificate and/or Rating Application

for a remote pilot certificate (FAA Form 8710-13).

- **Option 1 (Online Application)**

In almost all cases, the application should be completed online using the electronic FAA IACRA system (https://iacra.faa.gov/iacra/). The applicant must include verification that he or she completed the online course or passed an initial aeronautical knowledge test. The applicable official document(s) must be uploaded into IACRA either by the applicant or the certifying officer

- Option 2 (Paper)

The application may be completed on paper. Using this method, the certificate of completion for the online course or original initial aeronautical knowledge test report must be included with the application. Please note that the processing time will be increased if a paper application is used.

3. Contact a FSDO, an FAA DPE, an ACR, or an FAA CFI to make an appointment to validate the applicant's identification. The applicant must present the completed FAA Form 8710-13 along with the online course completion certificate or knowledge test report (as applicable) and proof of a current flight review. The FAA Form 8710-13 application will be signed by the applicant after the FSDO, DPE, ACR, or CFI examines the applicant's photo identification and verifies the applicant's identity. The FAA representative will then sign the application. The identification presented must include a photograph of the applicant, the applicant's signature, and the applicant's actual residential address (if different from the mailing address). This information may be presented in more than one form of identification. Acceptable methods of identification include, but are not limited to U.S. drivers' licenses, government identification cards, passports, and military identification cards (refer to AC 61-65). If using paper or IACRA method, an appropriate FSDO representative, a DPE, or an ACR will issue the applicant a temporary airman certificate.

Note: A CFI is not authorized to issue a temporary certificate. They can process applications for applicants who do not need a temporary certificate. If using IACRA and the applicant is utilizing a CFI as the FAA representative, the applicant can print their own temporary airman certificate after receiving an email from the FAA notifying them that it is available. If using the paper method and the applicant is utilizing a CFI as the FAA representative, the applicant will not be issued a temporary airman certificate. Once the FSDO has signed and approved the application, it will be mailed to the Registry for the issuance of the permanent certificate.

4. Receive permanent remote pilot certificate once all other FAA internal processing is complete.

Security Disqualification

After the FAA receives the application, the TSA will automatically conduct a background security screening of the applicant prior to issuance of a remote pilot certificate. If the security screening is successful, the FAA will issue a permanent remote pilot certificate. If the security screening is not successful, the applicant will be disqualified and a temporary pilot certificate will not be issued. Individuals who believe that they improperly failed a security threat assessment may appeal the decision to the TSA.

Aeronautical Knowledge Tests (Initial and Recurrent)

It is important to have and retain the knowledge necessary to operate a small UA in the NAS. This aeronautical knowledge can be obtained through self-study, taking an online training course, taking an in-person training course, or any combination thereof. The FAA has published the Small Unmanned Aircraft Systems Airman Certification Standard (https://www.faa.gov/training_testing/testing/acs/) that provides the necessary reference material.

Note: The below information regarding initial and recurrent knowledge tests apply to persons who do not hold a current part 61 airman certificate.

Initial Test

A person applying for remote pilot certificate with an sUAS rating must pass an initial aeronautical knowledge test given by an FAA-approved KTC. The initial knowledge test will cover the aeronautical knowledge areas listed below:

1. Applicable regulations relating to sUAS rating privileges, limitations, and flight operation;

2. Airspace classification and operating requirements, and flight restrictions affecting small UA operation;

3. Aviation weather sources and effects of weather on small UA performance;

4. Small UA loading and performance;

5. Emergency procedures;

6. Crew Resource Management (CRM);

7. Radio communication procedures;

8. Determining the performance of small UA;

9. Physiological effects of drugs and alcohol;

10. Aeronautical decision-making (ADM) and judgment;

11. Airport operations; and

12. Maintenance and preflight inspection procedures.

NOTE: A part 61 certificate holder who has completed a flight review within the previous 24 calendar-months may complete an initial online training course instead of taking the knowledge test.

Recurrent Test

After a person receives a remote pilot certificate with an sUAS rating, that person must retain and periodically update the required aeronautical knowledge to continue to operate a small UA in the NAS. To continue exercising the privileges of a remote pilot certificate, the certificate holder must pass a recurrent aeronautical knowledge test within 24 calendar-months of passing either an initial or recurrent aeronautical knowledge test. A part 61 pilot certificate holder who has completed a flight review within the previous 24 calendar-months may complete a recurrent online training course instead of taking the knowledge test.

Recurrent Test Cycle Examples

Person passes an initial aeronautical knowledge test on September 13, 2016.	**THEN**	Recurrent knowledge test must be passed no later than September 30, 2018, which does not exceed 24 calendar-months
Person does not pass recurrent knowledge test until October 5, 2018.	**THEN**	Person may not exercise the privileges of the remote pilot certificate between October 1, 2018, and October 5, 2018, when the test is passed. The next recurrent knowledge test must be passed no later than October 31, 2020, which does not exceed 24 calendar-months.
Person elects to take recurrent knowledge test prior to October 2020. The recurrent knowledge test is taken and passed on July 15, 2020.	**THEN**	The next recurrent knowledge test must be passed no later than July 31, 2022, which does not exceed 24 calendar-months.

The recurrent aeronautical knowledge test areas are as follows:

1. Applicable regulations relating to sUAS rating privileges, limitations, and flight operation;

2. Airspace classification and operating requirements and flight restrictions affecting small UA operation;

3. Emergency procedures;

4. CRM;

5. ADM and judgment;

6. Airport operations; and

7. Maintenance and preflight inspection procedures.

Test Providers

KTCs will administer initial and recurrent examinations provided by the FAA. In order to take an aeronautical knowledge test, an applicant will be required to schedule an appointment with the KTC providing proper government-issued photo identification to the KTC on the day of scheduled testing. The location of the closest KTC can be found at http://www.faa.gov/training_testing/testing/media/test_centers.pdf.

Aeronautical Knowledge Training Course (Initial and Recurrent)

This section is applicable only to persons who hold a part 61 airman certificate, other than a student pilot certificate, and have a current flight review.

Initial Training Course

A pilot applying for a remote pilot certificate may complete an initial training course instead of the knowledge test. The training course can be taken online at www.faasafety.gov. The initial training course will cover the aeronautical knowledge areas listed below:

1. Applicable regulations relating to sUAS rating privileges, limitations, and flight operation;

2. Effects of weather on small UA performance;

3. Small UA loading and performance;

4. Emergency procedures;

5. CRM;

6. Determining the performance of small UA; and

7. Maintenance and preflight inspection procedures.

Knowledge Tests

The knowledge test is the computer portion of the tests taken to obtain pilot certification. The test contains questions of the objective, multiple-choice type. This testing method conserves the applicant's time, eliminates any element of individual judgment in determining grades, and saves time in scoring.

FAA Airman Knowledge Test Guides for every type of pilot certificate address most questions you may have regarding the knowledge test process.

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sUAS Maintenence

Section 107.15 requires the remote PIC to perform checks of the UA prior to each flight to determine if the sUAS is in a condition for safe operation. This chapter provides guidance on how to inspect and maintain an sUAS.

Maintenence

sUAS maintenance includes scheduled and unscheduled overhaul, repair, inspection, modification, replacement, and system software upgrades of the sUAS and its components necessary for flight. Whenever possible, the operator should maintain the sUAS and its components in accordance with manufacturer's instructions. The aircraft manufacturer may provide the maintenance program, or, if one is not provided, the applicant may choose to develop one.

Scheduled Maintenance

The sUAS manufacturer may provide documentation for scheduled maintenance of the entire UA and associated system equipment. There may be components of the sUAS that are identified by the manufacturer to undergo scheduled periodic maintenance or replacement based on time-in-service limits (such as flight hours, cycles, and/or the calendar-days). All manufacturer scheduled maintenance instructions should be followed in the interest of achieving the longest and safest service life of the sUAS

If there are no scheduled maintenance instructions provided by the sUAS manufacturer or component manufacturer, the operator should establish a scheduled maintenance protocol. This could be done by documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure.

Over time, the operator should then be able to establish a reliable maintenance schedule for the sUAS and its components.

Unscheduled Maintenance

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

Performing Maintenance

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

If the operator or other maintenance personnel are unable to repair, modify, or overhaul an sUAS or component back to its safe operational specification, then it is advisable to replace the sUAS or component with one that is in a condition for safe operation. It is important that all required maintenance be completed before each flight, and preferably in accordance with the manufacturer's instructions or, in lieu of that, within known industry best practices

Preflight inspections

Preflight Inspection

Before each flight, the remote PIC must inspect the sUAS to ensure that it is in a condition for safe operation, such as inspecting for equipment damage or malfunction(s). The preflight inspection should be conducted in accordance with the sUAS manufacturer's inspection procedures when available (usually found in the manufacturer's owner or maintenance manual) and/or an inspection procedure developed by the sUAS owner or operator.

Creating an Inspection Program

As an option, the sUAS owner or operator may wish to create an inspection program for their UAS. The person creating an inspection program for a specific sUAS may find sufficient details to assist in the development of a suitable inspection program tailored to a specific sUAS in a variety of industry programs.

Scalable Preflight Inspection.

The preflight check as part of the inspection program should include an appropriate UAS preflight inspection that is scalable to the UAS, program, and operation to be performed prior to each flight. An appropriate preflight inspection should encompass the entire system in order to determine a continued condition for safe operation prior to flight.

Preflight Inspection Items

Even if the sUAS manufacturer has a written preflight inspection procedure, it is recommended that the 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. The preflight inspection should include a visual or functional check of the following items:

1. Visual condition inspection of the UAS components;

2. Airframe structure (including undercarriage), all flight control surfaces, and linkages;

3. Registration markings, for proper display and legibility;

4. Moveable control surface(s), including airframe attachment point(s);

5. Servo motor(s), including attachment point(s);

6. Propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.;

7. Verify all systems (e.g., aircraft and control unit) have an adequate energy supply for the intended operation and are functioning properly;

8. Avionics, including control link transceiver, communication/navigation equipment, and antenna(s);

9. Calibrate UAS compass prior to any flight;

10. Control link transceiver, communication/navigation data link transceiver, and antenna(s);

11. Display panel, if used, is functioning properly;

12. Check ground support equipment, including takeoff and land-

ing systems, for proper operation;

13. Check that control link correct functionality is established between the aircraft and the CS;

14. Check for correct movement of control surfaces using the CS;

15. Check onboard navigation and communication data links;

16. Check flight termination system, if installed;

17. Check fuel for correct type and quantity;

18. Check battery levels for the aircraft and CS;

19. Check that any equipment, such as a camera, is securely attached;

20. Verify communication with UAS and that the UAS has acquired GPS location from at least four satellites;

21. Start the UAS propellers to inspect for any imbalance or irregular operation;

22. Verify all controller operation for heading and altitude;

23. If required by flight path walk through, verify any noted obstructions that may interfere with the UAS; and

24. At a controlled low altitude, fly within range of any interference and recheck all controls and stability.

Benefits of Recordkeeping

sUAS owners and operators may find recordkeeping to be beneficial This could be done by documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure. Over time, the operator should then be able to establish a reliable maintenance schedule for the sUAS and its components. Recordkeeping that includes a record of all periodic inspections, maintenance, preventative maintenance, repairs, and alterations performed on the sUAS could be retrievable from either hardcopy and/or electronic logbook format for future reference. This includes all components of the sUAS, including: small UA, CS, launch and recovery equipment, C2 link equipment, payload, and any other components required to safely operate the sUAS. Recordkeeping of documented maintenance and inspection events reinforces owner/operator responsibilities for airworthiness through systematic condition for safe flight determinations. Maintenance and inspection recordkeeping provides retrievable empirical evidence of vital safety assessment data defining the condition of safety-critical systems and components supporting the decision to launch. Recordkeeping of an sUAS may provide essential safety support for commercial operators that may experience rapidly accumulated flight operational hours/cycles. Methodical maintenance and inspection data collection can prove to be very helpful in the tracking of sUAS component service life, as well as systemic component, equipage, and structural failure events.

15

Basic Aerodynamic Principals

The Wing

To understand aerodynamic forces, a pilot needs to understand basic terminology associated with airfoils. The chord line is the straight line intersecting the leading and trailing edges of the airfoil, and the term chord refers to the chord line longitudinal length. (As viewed from the side). The mean camber is a line located halfway between the upper and lower surfaces. Viewing the wing edgewise, the mean camber connects with the chord line at each end. The mean camber is important because it assists in determining aerodynamic qualities of an airfoil. The measurement of the maximum camber; inclusive of both the displacement of the mean camber line and its linear measurement from the end of the chord line, provide properties useful in evaluating airfoils.

Review of Basic Aerodynamics

The UAS Operator must understand the relationship and differences between several factors that affect theperformance of an aircraft in flight. Also, it is crucial to understand how the aircraft reacts to various control and power changes, because the environment in which UAS pilots fly has inherent hazards not found in visual flying. The basis for this understanding is found in the four forces acting on an aircraft and Newton's Three Laws of Motion.

Relative Wind: is the direction of the airflow with respect to an airfoil.

Angle of Attack (AOA): is the acute angle measured between the relative wind, or flight path and the chord of the airfoil.

Flight path: is the course or track along which the aircraft is flying or is intended to be flown.

The Four Forces

The four basic forces acting upon an aircraft in flight are ***lift, weight, thrust,*** and ***drag.***

Lift

Lift is a component of the total aerodynamic force on an airfoil and acts perpendicular to the relative wind.
Relative wind is the direction of the airflow with respect to an airfoil. This force acts straight up from the average center of pressure (CP), which is called the center of lift. It should be noted that it is a point along the chord line of an airfoil through which all aerodynamic forces are considered to act. The magnitude of lift varies proportionately with speed, air density, shape and size of the airfoil, and AOA. During straight-and-level flight, lift and weight are equal.

Weight

Weight is the force exerted by an aircraft from the pull of gravity. It acts on an aircraft through its center of gravity (CG) and is straight down. This should not be confused with the center of lift, which can be significantly different from the CG. As an aircraft is descending, weight is greater than lift.

Thrust

Thrust is the forward force produced by the powerplant/propeller or rotor. It opposes or overcomes the force of drag. As a general rule, it acts parallel to the longitudinal axis.

Drag

Drag is the net aerodynamic force parallel to the relative wind and is generally a sum of two components: induced drag and parasite drag.

Induced Drag

Induced drag is caused from the creation of lift and increases with AOA. Therefore, if the wing is not producing lift, induced drag is zero. Conversely, induced drag decreases with airspeed.

Parasite Drag

Parasite drag is all drag not caused from the production of lift. Parasite drag is created by displacement of air by the aircraft, turbulence generated by the airfoil, and the hindrance of airflow as it passes over the surface of the aircraft or components. All of these forces create drag not from the production of lift but the movement of an object through an air mass. Parasite drag increases with speed and includes skin friction drag, interference drag, and form drag.

Skin Friction Drag

Covering the entire "wetted" surface of the aircraft is a thin layer of air called a boundary layer. The air molecules on the surface have zero velocity in relation to the surface; however, the layer just above moves over the stagnant molecules below because it is pulled along by a third layer close to the free stream of air. The velocities of the layers increase as the distance from the surface increases until free stream velocity is reached, but all are affected by the free stream. The distance (total) between the skin surface and where free stream velocity is reached is called the boundary layer. At subsonic levels the cumulative layers are about the thickness of a playing card, yet their motion sliding over one another creates a drag force. This force retards motion due to the viscosity of the air and is called skin friction drag. Because skin friction drag is related to a large surface area its affect on smaller aircraft is small versus large transport aircraft where skin friction drag may be considerable.

Interference Drag

Interference drag is generated by the collision of airstreams creating eddy currents, turbulence, or restrictions to smooth flow. For instance, the airflow around a fuselage and around the wing meet at some point, usually near the wing's root. These airflows interfere with each other causing a greater drag than the individual values. This is often the case when external items are placed on an aircraft. That is, the drag of each item individually, added to that of the aircraft, are less than that of the two items when allowed to interfere with one another

Form Drag

Form drag is the drag created because of the shape of a component or the aircraft. If one were to place a circulardisk in an air stream, the pressure on both the top and bottom would be equal. However, the airflow starts
to break down as the air flows around the back of the disk. This creates turbulence and hence a lower pressure results. Because the total pressure is affected by this reduced pressure, it creates a drag. Newer aircraft are generally made with consideration to this by fairing parts along the fuselage (teardrop) so that turbulence and form drag is reduced. Total lift must overcome the total weight of the aircraft, which is comprised of the actual weight and the tail-down force used to control the aircraft's pitch attitude. Thrust must overcome total drag in order to provide forward speed with which to produce lift. Understanding how the aircraft's relationship between these elements and the environment provide proper interpretation of the aircraft's instruments

Newton's First Law, the Law of Inertia

Newton's First Law of Motion is the Law of Inertia. It states that a body at rest will remain at rest, and a body in motion will remain in motion, at the same speed and in the same direction until affected by an outside force. The force with which a body offers resistance to change is called the force of inertia. Two outside forces are always present on an aircraft in flight: gravity and drag. The pilot uses pitch and thrust controls to counter or change these forces to maintain the desired flightpath. If a pilot reduces power while in straight-and-level flight, the aircraft will slow due to drag. However, as the aircraft slows there is a reduction of lift, which causes the aircraft to begin a descent due to gravity.

Newton's Second Law, the Law of Momentum

Newton's Second Law of Motion is the Law of Momentum, which states that a body will accelerate in the same direction as the force acting upon that body, and the acceleration will be directly proportional to the net force and inversely proportional to the mass of the body. Acceleration refers either to an increase or decrease in velocity, although deceleration is commonly used to indicate a decrease. This law governs the aircraft's ability to change flight path and speed, which are controlled by attitude (both pitch and bank) and thrust inputs. Speeding up, slowing down, entering climbs or descents, and turning are examples of accelerations that the pilot controls in everyday flight.

Newton's Third Law, the Law of Reaction

Newton's Third Law of Motion is the Law of Reaction, which states that for every action there is an equal and opposite reaction. This law is also responsible for a portion of the lift that is produced by a wing, from the downward deflection of the airflow around it. This downward force of the relative wind results in an equal but opposite (upward) lifting force created by the airflow over the wing

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Performance

Your ability to predict the performance of a sUAS is extremely important. It allows you to determine how much weight the sUAS can carry before takeoff, if your sUAS can safely hover at a specific altitude and temperature, how far it will take to climb above obstacles, and what your maximum climb rate will be.

Factors Affecting Performance

A sUAS performance is dependent on the power output of the engine and the lift production of the rotors, whether it is the main rotor(s) or tail rotor. Any factor that affects engine and rotor efficiency affects performance. The three major factors that affect performance are density altitude, weight, and wind.

Density Altitude

The density of the air directly affects the performance of the sUAS. As the density of the air increases, engine power output, rotor efficiency, and aerodynamic lift all increase. Density altitude is the altitude above mean sea level at which a given atmospheric density occurs in the standard atmosphere. It can also be interpreted as pressure altitude corrected for nonstandard temperature differences.

To calculate pressure altitude without the use of an altimeter, remember that the pressure decreases approximately 1 inch of mercury for every 1,000-foot increase in altitude. For example, if the current local altimeter setting at a 4,000-foot elevation is 30.42, the pressure altitude would be 3,500 feet. (30.42 – 29.92 =.50 in. Hg. 3 1,000 feet = 500 feet. Subtracting 500 feet from 4,000 equals 3,500 feet)

The four factors that most affect density altitude are: atmospheric pressure, altitude, temperature, and the moisture content of the air.

Atmospheric Pressure

Due to changing weather conditions, atmospheric pressure at a given location changes from day to day. If the pressure is lower, the air is less dense. This means a higher density altitude and less helicopter performance.

Altitude

As altitude increases, the air becomes thinner or less dense. This is because the atmospheric pressure acting on a given volume of air is less, allowing the air molecules to move further apart. Dense air contains more air molecules spaced closely together, while thin air contains less air molecules because they are spaced further apart. As altitude increases, density altitude increases.

Temperature

Temperature changes have a large affect on density altitude. As warm air expands, the air molecules move further apart, creating less dense air. Since cool air contracts, the air molecules move closer together, creating
denser air. High temperatures cause even low elevations to have high density altitudes.

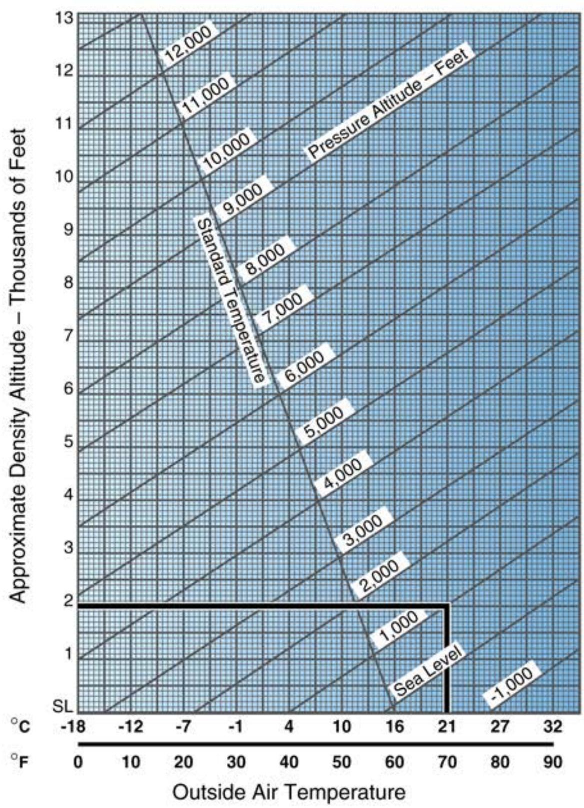
Moisture (Humidity)

The water content of the air also changes air density because water vapor weighs less than dry air. Therefore, as the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance.

Humidity, also called "relative humidity," refers to the amount of water vapor contained in the atmosphere, and is expressed as a percentage of the maximum amount of water vapor the air can hold. This amount varies with temperature; warm air can hold more water vapor, while colder air can hold less. Perfectly dry air that contains no water vapor has a relative humidity of 0 percent, while saturated air that cannot hold any more water vapor, has a relative humidity of 100 percent. Humidity alone is usually not considered an important factor in calculating density altitude and sUAS performance; however, it does contribute. There are no rules-of-thumb or charts used to compute the effects of humidity on density altitude, so you need to take this into consideration by expecting a decrease in hovering and takeoff performance in high humidity conditions.

Winds

Wind direction and velocity also affect hovering, takeoff, and climb performance. Translational lift occurs anytime there is relative airflow over the rotor disc. This occurs whether the relative airflow is caused by sUAS movement or by the wind. As wind speed increases, translational lift increases, resulting in less power required to hover.



Altimeter Setting	Pressure Altitude Conversion Factor
28.0	1,824
28.1	1,727
28.2	1,630
28.3	1,533
28.4	1,436
28.5	1,340
28.6	1,244
28.7	1,148
28.8	1,053
28.9	957
29.0	863
29.1	768
29.2	673
29.3	579
29.4	485
29.5	392
29.6	298
29.7	205
29.8	112
29.9	20
29.92	0
30.0	-73
30.1	-165
30.2	-257
30.3	-348
30.4	-440
30.5	-531
30.6	-622
30.7	-712
30.8	-803
30.9	-893
31.0	-983