

InterNACHI Certified Drone Pilot Course

Welcome to the free, online InterNACHI Certified Drone Pilot Course



Goal:

This course is designed to help members pass the Airman Knowledge Test (AKT) required to attain a Remote Pilot Certificate from the U.S. Federal Aviation Administration (FAA). You will need the Certificate to be considered a certified commercial drone pilot in order to legally operate a drone for property inspections. The course covers the main knowledge areas to prepare for the AKT, which must be taken in person at an FAA-approved testing center. This course does not

certify you; it is intended to help you prepare you for the FAA's AKT. [Visit the FAA site for more information](#)

Objectives:

Upon successful completion of this course, the student will be able to:

- the requirements to become a drone pilot;
- the effects of weather on small unmanned aircraft performance;
- radio communication procedures; and
- the physiological factors that affect pilot performance.

Course includes:

- 43,549 words;
- online videos and graphics;
- research and writing assignments;
- 68 quiz questions in 9 quizzes;
- a 60-question final exam (drawn from a larger pool);
- instant grading; and
- a downloadable, printable Certificate of Completion.

Drone Pilot Logo

The Certified Drone Pilot Training Logo is available for use by all InterNACHI certified members who successfully complete this course, including its final exam. This logo can be found on <https://www.nachi.org/certified-drone-pilot-training.htm>



To Become a Drone Pilot

In the United States Only

This training course is provided by InterNACHI to help individuals complete the exam requirement to become a drone pilot in the United States, certified by the United States Federal Aviation Administration (FAA) according to the rules and regulations set by the FAA. Please [visit FAA's website related to become a drone pilot](#).

This course does not certify you.

This course is intended to help you prepare to take the FAA Remote Pilot Certification (RPC) exam.

If you are interested in becoming a drone pilot in another country, please contact the appropriate regulating authority in that country.

For more information on the legal aspects of drones for home inspectors, visit www.nachi.org/drone-law-home-inspectors.htm.

Becoming a Pilot in the U.S.

As of January 2018, to become a drone pilot in the United States, the FAA has provided the following guidance:

To become a drone pilot, you must:

- Be at least 16 years old
- Be able to read, speak, write, and understand English (exceptions may be made if the person is unable to meet one of these requirements for a medical reason, such as hearing impairment)
- Be in a physical and mental condition to safely operate a small UAS
- Pass the initial aeronautical knowledge exam at an FAA-approved knowledge testing center

Pilot certificate Requirements

- Must be easily accessible by the remote pilot during all UAS operations
- Valid for 2 years – certificate holders must pass a recurrent knowledge test every two years

Application Process

1. Schedule an appointment with a Knowledge Testing Center (KTC), which administer initial and recurrent FAA knowledge exams
 - a. View the list of [Knowledge Testing Centers \(PDF\)](#) to find one near you.
 - b. Applicants must bring government-issued photo ID to their test
2. Pass the initial aeronautical knowledge test – initial knowledge test areas include:
 - a. Applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation
 - b. Airspace classification and operating requirements, and flight restrictions affecting small unmanned aircraft operation
 - c. Aviation weather sources and effects of weather on small unmanned aircraft performance
 - d. Small unmanned aircraft loading and performance
 - e. Emergency procedures
 - f. Crew resource management
 - g. Radio communication procedures
 - h. Determining the performance of small unmanned aircraft
 - i. Physiological effects of drugs and alcohol
 - j. Aeronautical decision-making and judgment
 - k. Airport operations

- * Applicants who do not wish to complete FAA Form 8710-13 online may choose the paper process. Please note that the processing time will be longer if a paper application is used since it requires in-person approval and signature by a designated pilot examiner (DPE), an airman certification representative (ACR), or an FAA-certificated flight instructor (CFI), and must then be mailed to a Flight Standards District Office (FSDO) for final review and signature. Additionally, a temporary remote pilot certificate will not be provided to the applicant.

[illegible]

Knowledge Areas

In fulfilling its responsibilities for the airman certification process, the Federal Aviation Administration (FAA) Flight Standards Service (AFS) plans, develops, and maintains materials related to airman certification testing. These materials include several components. The FAA knowledge test measures mastery of the aeronautical knowledge areas listed in Title 14 of the Code of Federal Regulations (14 CFR) part 107. Other materials, such as airman knowledge testing supplements in the [Airman Knowledge Testing Supplement FAA-CT-8080 Series](#) and the [Pilot's Handbook of Aeronautical Knowledge](#), provide guidance to applicants on aeronautical knowledge and risk management.

The Federal Aviation Administration (FAA) has published the Remote Pilot - Small Unmanned Aircraft Systems (sUAS) Study Guide to communicate the knowledge areas you need to study to prepare to take the Remote Pilot Certificate with an sUAS rating airman knowledge test. This Remote Pilot - Small Unmanned Aircraft Systems Study Guide is available for download from faa.gov. This training course is based primarily upon the FAA guide and Title 14 of the Code of Federal Regulations (14 CFR) part 107. Please visit www.faa.gov/uas for more information and knowledge testing resources.

The training in this course was arranged according to the knowledge areas that are covered on the airman knowledge test for a Remote Pilot Certificate with a Small Unmanned Aircraft Systems Rating as required by Title 14 of the Code of Federal Regulations (14 CFR) part 107, section 107.73(a).

The knowledge areas are as follows:

1. Applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation;
2. Airspace classification, operating requirements, and flight restrictions affecting small unmanned aircraft operation;
3. Aviation weather sources and effects of weather on small unmanned aircraft performance;
4. Small unmanned aircraft loading;
5. Emergency procedures;
6. Crew resource management;
7. Radio communication procedures;
8. Determining the performance of small unmanned aircraft;
9. Physiological effects of drugs and alcohol;
10. Aeronautical decision-making and judgment;
11. Airport operations; and
12. Maintenance and preflight inspection procedures.

The knowledge testing supplements contain the graphics, legends, and maps that are needed to successfully respond to certain knowledge test items. ODA test center

at:http://www.faa.gov/training_testing/testing/supplements/media/sport_rec_private_akts.pdf.

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Chapter 1: Applicable Regulations

Regulations

Be familiar with [14 CFR part 107](#) and all parts referenced in part 107, as well as [AC 107-2](#).

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Chapter 2: Airspace Classification, Operating Requirements, and Flight Restrictions

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. Figure 2-1 presents a profile view of the dimensions of various classes of airspace.



Figure 2-1. Airspace profile.

Controlled Airspace

Controlled airspace is a generic term that covers the different classifications of airspace and defined dimensions within which air traffic control (ATC) service is provided in accordance with the airspace classification. Controlled airspace that is of concern to the remote pilot is:

- Class B
- Class C
- Class D
- Class E

Class B Airspace

Class B airspace is generally airspace from the surface to 10,000 feet mean sea level (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. A remote pilot must receive authorization from ATC before operating in the Class B airspace.

Class C Airspace

Class C airspace is 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 instrument flight rules (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 five nautical mile (NM) radius, an outer circle with a ten NM radius that extends from 1,200 feet to 4,000 feet above the airport elevation. A remote pilot must receive authorization before operating in Class C airspace.

Class D Airspace

Class D airspace is 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 is normally designed to contain the procedures. Arrival extensions for instrument approach procedures (IAPs) may be Class D or Class E airspace. A remote pilot must receive ATC authorization before operating in Class D airspace.

Class E Airspace

Class E airspace is the controlled airspace not classified as Class A, B, C, or D airspace. A large amount of the airspace over the United States is designated as Class E airspace. This provides sufficient airspace for the safe control and separation of aircraft during IFR operations. Chapter 3 of the [Aeronautical Information Manual \(AIM\)](#) explains the various types of Class E airspace.

Sectional and other charts depict all locations of Class E airspace with bases below 14,500 feet MSL. In areas where charts do not depict a class E base, class E begins at 14,500 feet MSL. In most areas, the Class E airspace base is 1,200 feet above ground level (AGL). In many other areas, the Class E airspace base is either the surface or 700 feet AGL. Some Class E airspace begins at an MSL altitude depicted on the charts, instead of an AGL altitude. Class E airspace typically extends up to, but not including, 18,000 feet MSL (the lower limit of Class A airspace). All airspace above FL 600 is Class E airspace.

Federal Airways, which are shown as blue lines on a sectional chart, are usually found within Class E airspace. Federal Airways start at 1,200' AGL and go up to, but, not including 18,000' MSL.

In most cases, a remote pilot will not need ATC authorization to operate in Class E airspace.

Uncontrolled Airspace

Class G 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. A remote pilot will not need ATC authorization to operate in Class G airspace.

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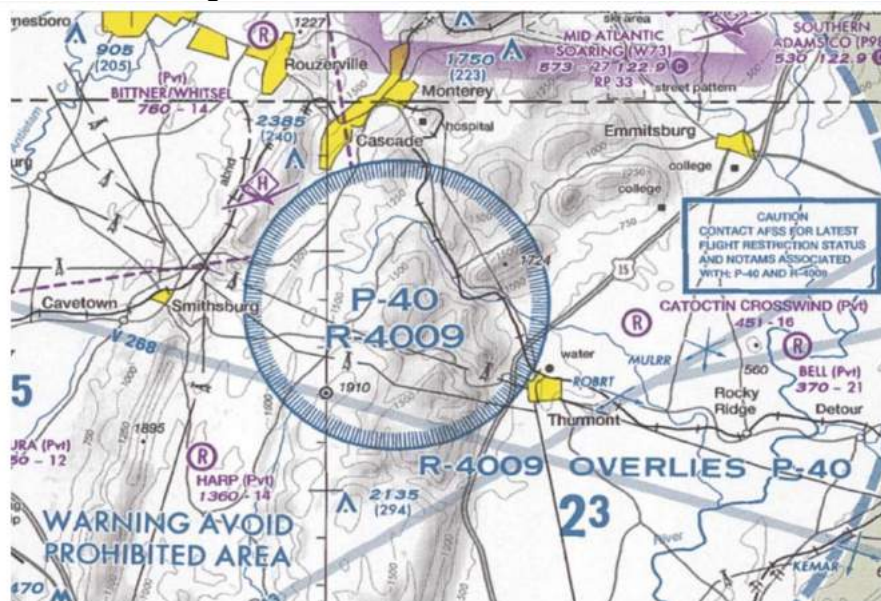
Special Use Airspace

Special use airspace or special area of operation (SAO) 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 Charting Group (NACG) en route charts, this information is available on one of the end panels. Special use airspace usually consists of:

- Prohibited areas
- Restricted areas
- Warning areas
- Military operation areas (MOAs)
- Alert areas
- Controlled firing areas (CFAs)

Prohibited Areas

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-40). Examples of prohibited areas include Camp David and the National Mall in Washington, D.C., where the White House and the Congressional buildings are



Restricted Areas

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). Penetration of restricted areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft.

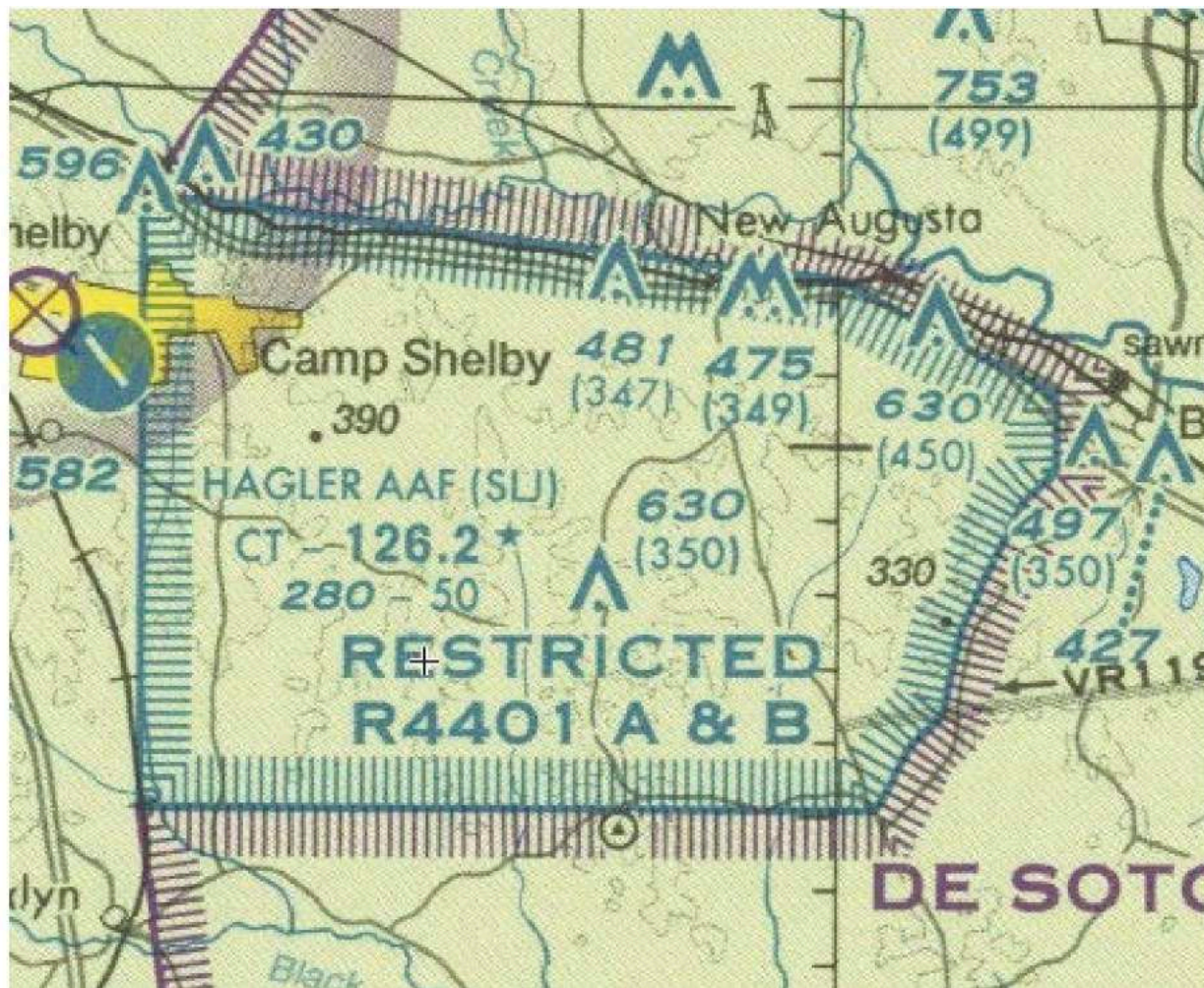


Figure 2-3. *Restricted areas on a sectional chart.*

1. If the restricted area is not active and has been released to the FAA, the ATC facility allows 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 issues a clearance that ensures the aircraft avoids the restricted airspace.

Restricted areas are charted with an “R” followed by a number (e.g., R-4401) and are depicted on the en route chart appropriate for use at the altitude or flight level (FL) being flown. [Figure 10-1] Restricted area information can be obtained on the back of the chart.

Warning Areas

Warning areas are similar in nature to restricted areas; however, the United States government does not have sole jurisdiction over the airspace. A warning area is airspace of defined dimensions, extending from 3 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-237). [Figure 2-4]

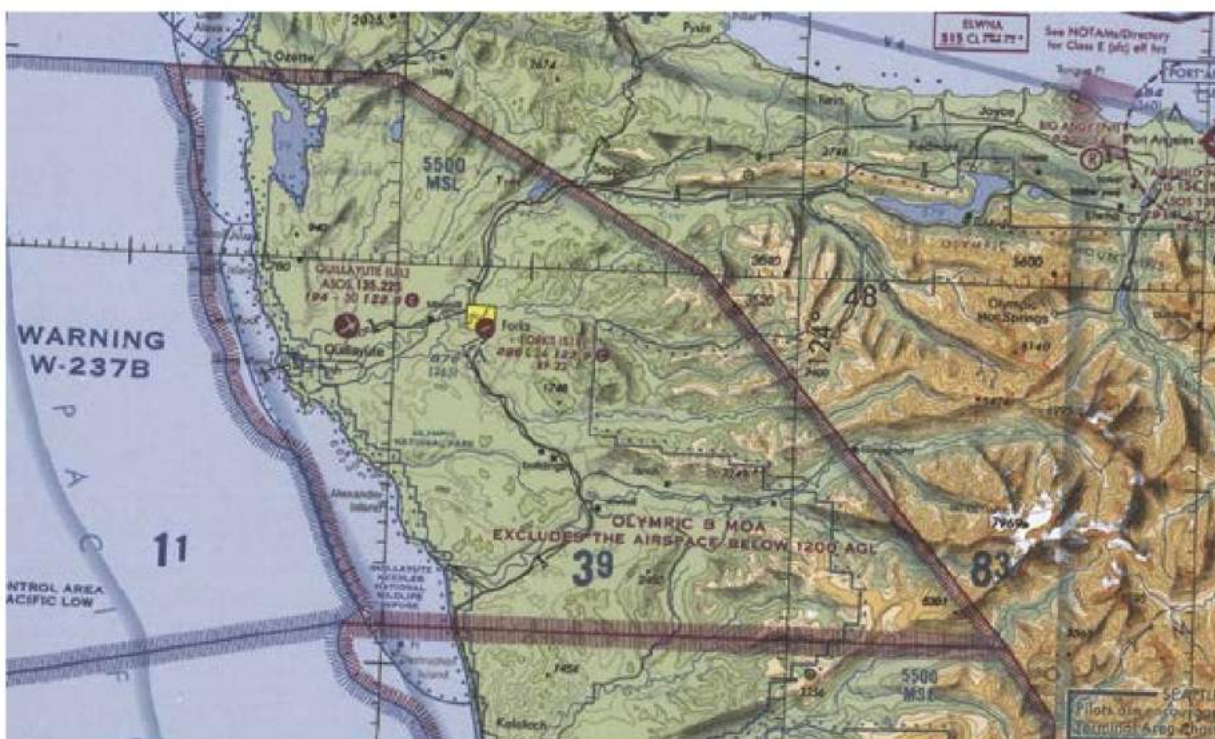


Figure 2-4. Requirements for airspace operations.

Military Operation 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 reroutes or restricts nonparticipating IFR traffic. MOAs are depicted on sectional, VFR terminal area, and en route low altitude charts and are not numbered (e.g., “Camden Ridge MOA”). [Figure 2-5] However, the MOA is also further defined on the back of the sectional charts with times of operation, altitudes affected, and the controlling agency.

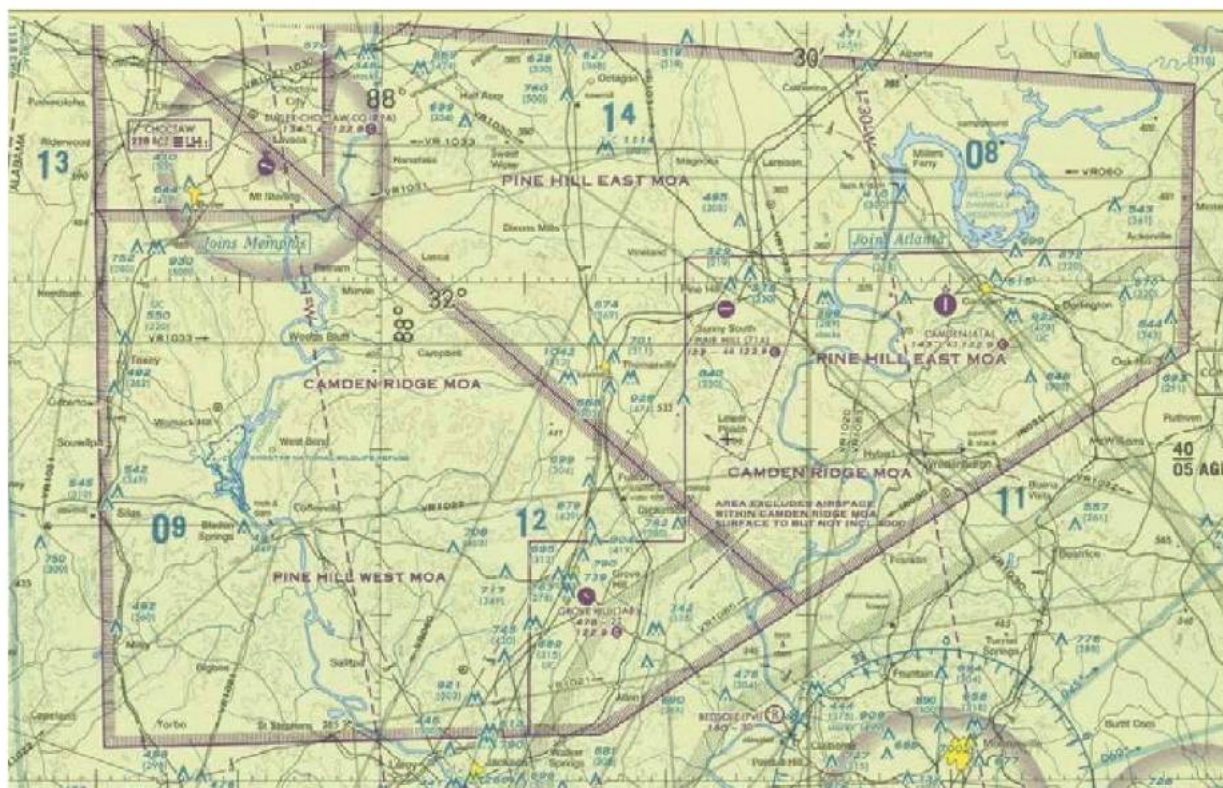


Figure 2-5. Camden Ridge MOA is an example of a military operations area.

Alert Areas

Alert areas are depicted on aeronautical charts with an “A” followed by a number (e.g., A-211) 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. [Figure 2-6]



Figure 2-6. Alert area (A-211).

Controlled Fire

CFAs contain activities that, if not conducted in a controlled environment, could be hazardous to nonparticipating aircraft. The difference between CFAs and other special use airspace is that activities must be suspended when a spotter aircraft, radar, or ground lookout position indicates an aircraft might be approaching the area. There is no need to chart CFAs since they do not cause a nonparticipating aircraft to change its flight path.

Other Airspace Areas

“Other airspace areas” is a general term referring to the majority of the remaining airspace. It includes:

- Local airport advisory (LAA)
- Military training route (MTR)

- Temporary flight restriction (TFR)
- Parachute jump aircraft operations
- Published VFR routes
- Terminal radar service area (TRSA)
- National security area (NSA)
- Air Defense Identification Zones (ADIZ) land and water based and need for Defense VFR (DVFR) flight plan to operate VFR in this airspace
- Flight Restricted Zones (FRZ) in vicinity of Capitol and White House
- Wildlife Areas/Wilderness Areas/National Parks and request to operate above 2,000 AGL
- National Oceanic and Atmospheric Administration (NOAA) Marine Areas off the coast with requirement to operate above 2,000 AGL
- Tethered Balloons for observation and weather recordings that extend on cables up to 60,000

Local Airport Advisory (LAA)

An advisory service provided by Flight Service facilities, which are located on the landing airport, using a discrete ground-to-air frequency or the tower frequency when the tower is closed. LAA services include local airport advisories, automated weather reporting with voice broadcasting, and a continuous Automated Surface Observing System (ASOS)/Automated Weather Observing Station (AWOS) data display, other continuous direct reading instruments, or manual observations available to the specialist.

Military Training Routes (MTRs)

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. [Figure 2-7] 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. VFR sectional charts depict military training activities, such as IR, VR, MOA, restricted area, warning area, and alert area information.



Figure 2-7. Military training route (MTR) chart symbols.

Temporary Flight Restrictions (TFR)

A flight data center (FDC) Notice to Airmen (NOTAM) is issued to designate a TFR. The NOTAM begins with the phrase “FLIGHT RESTRICTIONS” followed by the location of the temporary restriction, effective time period, area defined in statute miles, and altitudes affected. The NOTAM also contains the FAA coordination facility and telephone number, the reason for the restriction, and any other information deemed appropriate. The pilot should check the NOTAMs as part of flight planning.

Some of the purposes for establishing a TFR are:

- Protect persons and property in the air or on the surface from an existing or imminent hazard.
- Provide a safe environment for the operation of disaster relief aircraft.
- Prevent an unsafe congestion of sightseeing aircraft above an incident or event, that may generate a high degree of public interest.
- Protect declared national disasters for humanitarian reasons in the State of Hawaii.
- Protect the President, Vice President, or other public figures.
- Provide a safe environment for space agency operations.

Since the events of September 11, 2001, the use of TFRs has become much more common. There have been a number of incidents of aircraft incursions into TFRs that have resulted in pilots undergoing security investigations and certificate suspensions. It is a pilot's responsibility to be aware of TFRs in their proposed area of flight. One way to check is to visit the FAA website, www.tfr.faa.gov, and verify that there is not a TFR in the area.

Parachute Jump Aircraft Operations

Parachute jump aircraft operations are published in the Chart Supplement U.S. (formerly Airport/Facility Directory). Sites that are used frequently are depicted on sectional charts.

Published VFR Routes

Published VFR routes are for transitioning around, under, or through some complex airspace. Terms such as VFR flyway, VFR corridor, Class B airspace VFR transition route, and terminal area VFR route have been applied to such routes. These routes are generally found on VFR terminal area planning charts.

Terminal Radar Service Areas (TRSAs)

TRSAs are areas where participating pilots can receive additional radar services. The purpose of the service is to provide separation between all IFR operations and participating VFR aircraft. The primary airport(s) within the TRSA become(s) Class D airspace. The remaining portion of the TRSA overlies other controlled airspace, which is normally Class E airspace beginning at 700 or 1,200 feet and established to transition to/ from the en route/terminal environment. TRSAs are depicted on VFR sectional charts and terminal area charts with a solid black line and altitudes for each segment. The Class D portion is charted with a blue segmented line. Participation in TRSA services is voluntary; however, pilots operating under VFR are encouraged to contact the radar approach control and take advantage of TRSA service.

National Security Areas (NSAs)

NSAs consist of airspace of 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 are disseminated via NOTAM. Pilots are requested to voluntarily avoid flying through these depicted areas.

Air Traffic Control and the National Airspace

The primary purpose of the ATC system is to prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic. In addition to its primary function, the ATC system has the capability to provide (with certain limitations) additional services. The ability to provide additional services is limited by many factors, such as the volume of traffic, frequency congestion, quality of radar, controller workload, higher priority duties, and the pure physical inability to scan and detect those situations that fall in this category. It is recognized that these services cannot be provided in cases in which the provision of services is precluded by the above factors.

Consistent with the aforementioned conditions, controllers shall provide additional service procedures to the extent permitted by higher priority duties and other circumstances. The provision of additional services is not optional on the part of the controller, but rather is required when the work situation permits. Provide ATC service in accordance with the procedures and minima in this order except when other procedures/minima are prescribed in a letter of agreement, FAA directive, or a military document.

Operating Rules and Pilot/Equipment Requirements

The safety of flight is a top priority of all pilots and the responsibilities associated with operating an aircraft should always be taken seriously. The air traffic system maintains a high degree of safety and efficiency with strict regulatory oversight of the FAA. Pilots fly in accordance with regulations that have served the United States well, as evidenced by the fact that the country has the safest aviation system in the world.

All aircraft operating in today's National Airspace System (NAS) has complied with the CFR governing its certification and maintenance; all pilots operating today have completed rigorous pilot certification training and testing. Of equal importance is the proper execution of preflight planning, aeronautical decision-making (ADM) and risk management. ADM involves a systematic approach to risk assessment and stress management in aviation, illustrates how personal attitudes can influence decision-making, and how those attitudes can be modified to enhance safety. More detailed information regarding ADM and risk mitigation can be found in Chapter 10, "Aeronautical Decision Making and Judgment," of this course.

Pilots also comply with very strict FAA general operating and flight rules as outlined in the CFR, including the FAA's important "see and avoid" mandate. These regulations provide the historical foundation of the FAA regulations governing the aviation system and the individual classes of airspace.

Visual Flight Rules (VFR) Terms & Symbols

Remote pilots need to be familiar with the following information from the [FAA Aeronautical Chart User's Guide](#) website:

All information on the VFR Terms tab

- The following sections under "VFR Aeronautical Chart Symbols" on the VFR Symbols tab: Airports, Airspace Information, Navigational and Procedural Information, Chart Limits, Culture, Hydrography, Relief.

Notices to Airmen (NOTAMs)

Notices to Airmen, or NOTAMs, are time-critical aeronautical information either temporary in nature or not sufficiently known in advance to permit publication on aeronautical charts or in other operational publications. The information receives immediate dissemination via the National Notice to Airmen (NOTAM) System. NOTAMs contain current notices to airmen that are considered essential to the safety of flight, as well as supplemental data affecting other operational publications. There are many different reasons that NOTAMs are issued. Following are some of those reasons:

- Hazards, such as air shows, parachute jumps, kite flying, and rocket launches
- Flights by important people such as heads of state
- Inoperable lights on tall obstructions
- Temporary erection of obstacles near airfields
- Passage of flocks of birds through airspace (a NOTAM in this category is known as a BIRDTAM)

Quiz 1

_____ airspace is a term that covers the different classifications of airspace and defined dimensions.

- Controlled
- Uncontrolled
- Special Use
- Other

Which of the following is a class of controlled airspace?

- Class C
- Class G
- Class M
- Class A

_____ airspace is generally airspace from the surface to 10,000 feet mean sea level.

- Class B
- Class C
- Class D
- Class E

Class _____ airspace is generally airspace from the surface to 4,000 feet above the airport elevation.

- C
- B
- D
- E

The airspace usually consists of a surface area with a 5 nautical mile radius in Class _____.

- C
- D
- E
- B

Class _____ consists of a surface area and two or more layers.

- B
- C
- E
- D

Class _____ airspace is generally airspace from the surface to 2,500 feet above the airport elevation.

- D
- B
- E
- C

Class _____ airspace is the controlled airspace not classified as Class A, B, C, or D airspace

- E
- A
- F
- H

A large amount of the airspace over the United States is designated as Class _____ airspace.

- E
- B
- D
- C

In most areas, the Class E airspace base is _____ feet above ground level.

- 1,200
- 3,000
- 2,500
- 1,700

Which class is designated as uncontrolled airspace?

- Class G
- Class B
- Class C
- Class D

What area does special use airspace usually consist of?

- All answers are correct.
- Prohibited Area.
- Alert Area.
- Warning Area.
- Restricted Area.

MTR's are usually established below 10,000 feet MSL for operations at speeds in excess of _____ knots.

- 250
- 400
- 100
- 150

Sectional and other charts depict all locations of Class E airspace with bases below _____ feet MSL.

- 14,500
- 20,000
- 5,000
- 10,000

Class C airspace is generally airspace from the surface to _____ feet above the airport elevation.

- 4,000
- 2,000
- 8,000
- 10,000

Class _____ airspace extends from the surface to the base of the overlying Class E airspace.

- G
- A
- C
- B

Chapter 3a: Aviation Weather Sources

Introduction

In aviation, weather service is a combined effort of the National Weather Service (NWS), Federal Aviation Administration (FAA), Department of Defense (DOD), other aviation groups, and individuals. Because of the increasing need for worldwide weather services, foreign weather organizations also provide vital input. While weather forecasts are not 100 percent accurate, meteorologists, through careful scientific study and computer modeling, have the ability to predict weather patterns, trends, and characteristics with increasing accuracy. Through a complex system of weather services, government agencies, and independent weather observers, pilots and other aviation professionals receive the benefit of this vast knowledge base in the form of up-to-date weather reports and forecasts. These reports and forecasts enable pilots to make informed decisions regarding weather and flight safety before and during a flight.

Surface Aviation Weather Observations

Surface aviation weather observations are a compilation of elements of the current weather at individual ground stations across the United States. The network is made up of government and privately contracted facilities that provide continuous up-to-date weather information. Automated weather sources, such as the Automated Weather Observing Systems (AWOS), Automated Surface Observing Systems (ASOS), as well as other automated facilities, also play a major role in the gathering of surface observations.

Surface observations provide local weather conditions and other relevant information for a specific airport. This information includes the type of report, station identifier, date and time, modifier (as required), wind, visibility, runway visual range (RVR), weather phenomena, sky condition, temperature/dew point, altimeter reading, and applicable remarks. The information gathered for the surface observation may be from a person, an automated station, or an automated station that is updated or enhanced by a weather observer. In any form, the surface observation provides valuable information about individual airports around the country. These reports cover a small area and will be beneficial to the remote pilot.

Aviation Weather Reports

Aviation weather reports are designed to give accurate depictions of current weather conditions. Each report provides current information that is updated at different times. Some typical reports are METARs and PIREPs. To view a weather report, go to <http://www.aviationweather.gov/>.

Aviation Routine Weather Report (METAR)

A METAR is an observation of current surface weather reported in a standard international format. METARs are issued on a regularly scheduled basis unless significant weather changes have occurred. A special METAR (SPECI) can be issued at any time between routine METAR reports.

Example: METAR KGGG 161753Z AUTO 14021G26KT 3/4SM +TSRA BR BKN008 OVC012CB 18/17 A2970 RMK PRESFR

A typical METAR report contains the following information in sequential order:

1. Type of report—there are two types of METAR reports. The first is the routine METAR report that is transmitted on a regular time interval. The second is the aviation selected SPECI. This is a special report that can be given at any time to update the METAR for rapidly changing weather conditions, aircraft mishaps, or other critical information.
2. Station identifier—a four-letter code as established by the International Civil Aviation Organization (ICAO). In the 48 contiguous states, a unique three-letter identifier is preceded by the letter “K.” For example, Gregg County Airport in Longview, Texas, is identified by the letters “KGGG,” K being the country designation and GGG being the airport identifier. In other regions of the world, including Alaska and Hawaii, the first two letters of the four-letter ICAO identifier indicate the region, country, or state. Alaska identifiers always begin with the letters “PA” and Hawaii identifiers always begin with the letters “PH.” Station identifiers can be found by searching various websites such as DUATS and NOAA’s Aviation Weather Aviation Digital Data Services (ADDS).
3. Date and time of report—depicted in a six-digit group (161753Z). The first two digits are the date. The last four digits are the time of the METAR/SPECI, which is always given in coordinated universal time (UTC). A “Z” is appended to the end of the time to denote the time is given in Zulu time (UTC) as opposed to local time.
4. Modifier—denotes that the METAR/SPECI came from an automated source or that the report was corrected. If the notation “AUTO” is listed in the METAR/SPECI, the report came from an automated source. It also lists “AO1” (for no precipitation discriminator) or “AO2” (with precipitation discriminator) in the “Remarks” section to indicate the type of precipitation sensors employed at the automated station. When the modifier “COR” is used, it identifies a corrected report sent out to replace an earlier report that contained an error (for example: METAR KGGG 161753Z COR).
5. Wind—reported with five digits (14021KT) unless the speed is greater than 99 knots, in which case the wind is reported with six digits. The first three digits indicate the direction the true wind is blowing from in tens of degrees. If the wind is variable, it is reported as “VRB.” The last two digits indicate the speed of the wind in knots unless the wind is greater than 99 knots, in which case it is indicated by three digits. If the winds are gusting, the letter “G” follows the wind

speed (G26KT). After the letter “G,” the peak gust recorded is provided. If the wind direction varies more than 60° and the wind speed is greater than six knots, a separate group of numbers, separated by a “V,” will indicate the extremes of the wind directions.

6. Visibility—the prevailing visibility ($\frac{3}{4}$ SM) is reported in statute miles as denoted by the letters “SM.” It is reported in both miles and fractions of miles. At times, runway visual range (RVR) is reported following the prevailing visibility. RVR is the distance a pilot can see down the runway in a moving aircraft. When RVR is reported, it is shown with an R, then the runway number followed by a slant, then the visual range in feet. For example, when the RVR is reported as R17L/1400FT, it translates to a visual range of 1,400 feet on runway 17 left.
7. Weather—can be broken down into two different categories: qualifiers and weather phenomenon (+TSRA BR). First, the qualifiers of intensity, proximity, and the descriptor of the weather are given. The intensity may be light (–), moderate (), or heavy (+). Proximity only depicts weather phenomena that are in the airport vicinity. The notation “VC” indicates a specific weather phenomenon is in the vicinity of five to ten miles from the airport. Descriptors are used to describe certain types of precipitation and obscurations. Weather phenomena may be reported as being precipitation, obscurations, and other phenomena, such as squalls or funnel clouds. Descriptions of weather phenomena as they begin or end and hailstone size are also listed in the “Remarks” sections of the report. [Figure 3-1]

Qualifier		Weather Phenomena		
Intensity or Proximity 1	Descriptor 2	Precipitation 3	Obscuration 4	Other 5
– Light	MI Shallow	DZ Drizzle	BR Mist	PO Dust/sand whirls
Moderate (no qualifier)	BC Patches	RA Rain	FG Fog	SQ Squalls
+ Heavy	DR Low drifting	SN Snow	FU Smoke	FC Funnel cloud
VC in the vicinity	BL Blowing	SG Snow grains	DU Dust	+FC Tornado or waterspout
	SH Showers	IC Ice crystals (diamond dust)	SA Sand	SS Sandstorm
	TS Thunderstorms	PL Ice pellets	HZ Haze	DS Dust storm
	FZ Freezing	GR Hail	PY Spray	
	PR Partial	GS Small hail or snow pellets	VA Volcanic ash	
		UP *Unknown precipitation		
The weather groups are constructed by considering columns 1–5 in this table in sequence: intensity, followed by descriptor, followed by weather phenomena (e.g., heavy rain showers(s) is coded as +SHRA). * Automated stations only				

Figure 3-1. Descriptors and weather phenomena used in a typical METAR.

8. Sky condition—always reported in the sequence of amount, height, and type or indefinite ceiling/height (vertical visibility) (BKN008 OVC012CB, VV003). The

heights of the cloud bases are reported with a three-digit number in hundreds of feet AGL. Clouds above 12,000 feet are not detected or reported by an automated station. The types of clouds, specifically towering cumulus (TCU) or cumulonimbus (CB) clouds, are reported with their height. Contractions are used to describe the amount of cloud coverage and obscuring phenomena. The amount of sky coverage is reported in eighths of the sky from horizon to horizon. [Figure 3-2]

Sky Cover	Contraction
Less than $\frac{1}{8}$ (Clear)	SKC, CLR, FEW
$\frac{1}{8}$ – $\frac{2}{8}$ (Few)	FEW
$\frac{3}{8}$ – $\frac{4}{8}$ (Scattered)	SCT
$\frac{5}{8}$ – $\frac{7}{8}$ (Broken)	BKN
$\frac{8}{8}$ or (Overcast)	OVC

Figure 3-2. Reportable contractions for sky condition.

9. Temperature and dew point—the air temperature and dew point are always given in degrees Celsius (C) or (18/17). Temperatures below 0 °C are preceded by the letter “M” to indicate minus.
10. Altimeter setting—reported as inches of mercury ("Hg) in a four-digit number group (A2970). It is always preceded by the letter “A.” Rising or falling pressure may also be denoted in the “Remarks” sections as “PRESRR” or “PRESFR,” respectively.
11. Zulu time—a term used in aviation for UTC, which places the entire world on one time standard.
12. Remarks—the remarks section always begins with the letters “RMK.” Comments may or may not appear in this section of the METAR. The information contained in this section may include wind data, variable visibility, beginning and ending times of particular phenomenon, pressure information, and various other information deemed necessary. An example of a remark regarding weather phenomenon that does not fit in any other category would be: OCNL LTGICCG. This translates as occasional lightning in the clouds and from cloud to ground. Automated stations also use the remarks section to indicate the equipment needs maintenance.

Example: METAR KGGG 161753Z AUTO 14021G26KT 3/4SM +TSRA BR BKN008 OVC012CB 18/17 A2970 RMK PRESFR

Explanation: Routine METAR for Gregg County Airport for the 16th day of the month at 1753Z automated source. Winds are 140 at 21 knots gusting to 26. Visibility is $\frac{3}{4}$ statute

mile. Thunderstorms with heavy rain and mist. Ceiling is broken at 800 feet, overcast at 1,200 feet with cumulonimbus clouds. Temperature 18 °C and dew point 17 °C. Barometric pressure is 29.70 "Hg and falling rapidly.

Aviation Forecasts

Observed weather condition reports are often used in the creation of forecasts for the same area. A variety of different forecast products are produced and designed to be used in the preflight planning stage. The printed forecasts that pilots need to be familiar with are the terminal aerodrome forecast (TAF), aviation area forecast (FA), inflight weather advisories (Significant Meteorological Information (SIGMET), Airman's Meteorological Information (AIRMET)), and the winds and temperatures aloft forecast (FB).

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Terminal Aerodrome Forecasts (TAF)

A TAF is a report established for the five statute mile radius around an airport. TAF reports are usually given for larger airports. Each TAF is valid for a 24 or 30-hour time period and is updated four times a day at 0000Z, 0600Z, 1200Z, and 1800Z. The TAF utilizes the same descriptors and abbreviations as used in the METAR report. These

weather reports can be beneficial to the remote pilot for flight planning purposes. The TAF includes the following information in sequential order:

1. Type of report—a TAF can be either a routine forecast (TAF) or an amended forecast (TAF AMD).
2. ICAO station identifier—the station identifier is the same as that used in a METAR.
3. Date and time of origin—time and date (081125Z) of TAF origination is given in the six number code with the first two being the date, the last four being the time. Time is always given in UTC as denoted by the Z following the time block.
4. Valid period dates and times—The TAF valid period (0812/0912) follows the date/time of forecast origin group. Scheduled 24 and 30 hour TAFs are issued four times per day, at 0000, 0600, 1200, and 1800Z. The first two digits (08) are the day of the month for the start of the TAF. The next two digits (12) are the starting hour (UTC). 09 is the day of the month for the end of the TAF, and the last two digits (12) are the ending hour (UTC) of the valid period. A forecast period that begins at midnight UTC is annotated as 00. If the end time of a valid period is at midnight UTC, it is annotated as 24. For example, a 00Z TAF issued on the 9th of the month and valid for 24 hours would have a valid period of 0900/0924.
5. Forecast wind—the wind direction and speed forecast are coded in a five-digit number group. An example would be 15011KT. The first three digits indicate the direction of the wind in reference to true north. The last two digits state the wind speed in knots appended with “KT.” Like the METAR, winds greater than 99 knots are given in three digits.
6. Forecast visibility—given in statute miles and may be in whole numbers or fractions. If the forecast is greater than six miles, it is coded as “P6SM.”
7. Forecast significant weather—weather phenomena are coded in the TAF reports in the same format as the METAR.
8. Forecast sky condition—given in the same format as the METAR. Only CB clouds are forecast in this portion of the TAF report as opposed to CBs and towering cumulus in the METAR.
9. Forecast change group—for any significant weather change forecast to occur during the TAF time period, the expected conditions and time period are included in this group. This information may be shown as from (FM), and temporary (TEMPO). “FM” is used when a rapid and significant change, usually within an hour, is expected. “TEMPO” is used for temporary fluctuations of weather, expected to last less than 1 hour.
10. PROB30—a given percentage that describes the probability of thunderstorms and precipitation occurring in the coming hours. This forecast is not used for the first 6 hours of the 24-hour forecast.

Example: TAF KPIR 111130Z 1112/1212 TEMPO 1112/1114 5SM BR FM1500
16015G25KT P6SM SCT040 BKN250 FM120000 14012KT P6SM BKN080 OVC150
PROB30 1200/1204 3SM TSRA BKN030CB FM120400 1408KT P6SM SCT040
OVC080 TEMPO 1204/1208 3SM TSRA OVC030CB

Significant Meteorological Information

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Quiz 2

Clouds above _____ feet are not detected or reported by an automated station.

- 12,000
- 15,000
- 20,000
- 17,000

Station identifier is a _____-letter code as established by the International Civil Aviation Organization

- four
- eight
- two
- five

Temperatures below 0 °C are preceded by the letter “_____” to indicate minus.

- M
- Q
- T
- A

TAF is a report established for the _____ statute mile radius around an airport.

- 5
- 10
- 15
- 2

Each TAF is valid for a 24 or 30-hour time period and updated _____ times a day.

- 4
- 10
- 2
- 3

Convective SIGMETs are issued for severe thunderstorms with surface winds greater than _____ knots.

- 50
- 10
- 25

- 35

Convective SIGMETs are issued for hail at the surface greater than or equal to _____ inch in diameter.

- 3/4
- 2/3
- 1/5
- 2/5

Convective SIGMETs are issued for greater precipitation that affect at least _____ percent of a 3,000 square mile.

- 40
- 10
- 20
- 25

Cloud base heights are reported with _____-digit number in hundreds of feet AGL.

- 3
- 6
- 7
- 8

Chapter 3b: Effects of Weather on Small Unmanned Aircraft Performance

Introduction

This chapter discusses the factors that affect aircraft performance, which include the aircraft weight, atmospheric conditions, runway environment, and the fundamental physical laws governing the forces acting on an aircraft.

Since the characteristics of the atmosphere have a major effect on performance, it is necessary to review two dominant factors—pressure and temperature.

Density Altitude

The more appropriate term for correlating aerodynamic performance in the nonstandard atmosphere is density altitude—the altitude in the standard atmosphere corresponding to a particular value of air density.

As the density of the air increases (lower density altitude), aircraft performance increases. Conversely, as air density decreases (higher density altitude), aircraft performance decreases. A decrease in air density means a high density altitude; an increase in air density means a lower density altitude. Density altitude has a direct effect on aircraft performance.

Air density is affected by changes in altitude, temperature, and humidity. High density altitude refers to thin air while low density altitude refers to dense air. The conditions that result in a high density altitude are high elevations, low atmospheric pressures, high temperatures, high humidity, or some combination of these factors. Lower elevations, high atmospheric pressure, low temperatures, and low humidity are more indicative of low density altitude.

Effects of Pressure on Density

Since air is a gas, it can be compressed or expanded. When air is compressed, a greater amount of air can occupy a given volume. Conversely, when pressure on a given volume of air is decreased, the air expands and occupies a greater space. That is, the original column of air at a lower pressure contains a smaller mass of air. In other words, the density is decreased. In fact, density is directly proportional to pressure. If the pressure is doubled, the density is doubled, and if the pressure is lowered, so is the density. This statement is true only at a constant temperature.

Effects of Temperature on Density

Increasing the temperature of a substance decreases its density. Conversely, decreasing the temperature increases the density. Thus, the density of air varies inversely with temperature. This statement is true only at a constant pressure.

In the atmosphere, both temperature and pressure decrease with altitude and have conflicting effects upon density. However, the fairly rapid drop in pressure as altitude is increased usually has the dominant effect. Hence, pilots can expect the density to decrease with altitude.

Effects of Humidity (Moisture) on Density

The preceding paragraphs are based on the presupposition of perfectly dry air. In reality, it is never completely dry. The small amount of water vapor suspended in the atmosphere may be negligible under certain conditions, but in other conditions humidity may become an important factor in the performance of an aircraft. Water vapor is lighter than air; consequently, moist air is lighter than dry air. Therefore, as the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance. It is lightest or least dense when, in a given set of conditions, it contains the maximum amount of water vapor.

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 the 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 zero 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 essential factor in calculating density altitude and aircraft performance; however, it does contribute.

Performance

Performance is a term used to describe the ability of an aircraft to accomplish certain things that make it useful for certain purposes.

The primary factors most affected by performance are the takeoff and landing distance, rate of climb, ceiling, payload, range, speed, maneuverability, stability, and fuel economy.

Climb Performance Factors

Since weight, altitude and configuration changes affect excess thrust and power, they also affect climb performance. Climb performance is directly dependent upon the ability to produce either excess thrust or excess power.

Weight has a very pronounced effect on aircraft performance. If weight is added to an aircraft, it must fly at a higher angle of attack (AOA) to maintain a given altitude and speed. This increases the induced drag of the wings, as well as the parasite drag of the aircraft. Increased drag means that additional thrust is needed to overcome it, which in turn means that less reserve thrust is available for climbing. Aircraft designers go to great lengths to minimize the weight, since it has such a marked effect on the factors pertaining to performance.

A change in an aircraft's weight produces a twofold effect on climb performance. An increase in altitude also increases the power required and decreases the power available. Therefore, the climb performance of an aircraft diminishes with altitude.

Measurement of Atmosphere Pressure

To provide a common reference, the International Standard Atmosphere (ISA) has been established. These standard conditions are the basis for most aircraft performance data. Standard sea level pressure is defined as 29.92 "Hg and a standard temperature of 59 °F (15 °C). Atmospheric pressure is also reported in millibars (mb), with 1 "Hg equal to approximately 34 mb. Standard sea level pressure is 1,013.2 mb. Typical mb pressure readings range from 950.0 to 1,040.0 mb. Surface charts, high and low pressure centers, and hurricane data are reported using mb.

Since weather stations are located around the globe, all local barometric pressure readings are converted to a sea level pressure to provide a standard for records and reports. To achieve this, each station converts its barometric pressure by adding approximately 1 "Hg for every 1,000 feet of elevation. For example, a station at 5,000 feet above sea level, with a reading of 24.92 "Hg, reports a sea level pressure reading of 29.92 "Hg.

By tracking barometric pressure trends across a large area, weather forecasters can more accurately predict movement of pressure systems and the associated weather. For example, tracking a pattern of rising pressure at a single weather station generally indicates the approach of fair weather. Conversely, decreasing or rapidly falling pressure usually indicates approaching bad weather and, possibly, severe storms.

Effect of Obstructions on Wind

Another atmospheric hazard exists that can create problems for pilots. Obstructions on the ground affect the flow of wind and can be an unseen danger. Ground topography and large buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed. These obstructions range from man-made structures, like hangars, to large natural obstructions, such as mountains, bluffs, or canyons.

The intensity of the turbulence associated with ground obstructions depends on the size of the obstacle and the primary velocity of the wind. This can affect the performance of any aircraft and can present a very serious hazard.

This same condition is even more noticeable when flying in mountainous regions.

[Figure 3-3] While the wind flows smoothly up the windward side of the mountain and the upward currents help to carry an aircraft over the peak of the mountain, the wind on the leeward side does not act in a similar manner. As the air flows down the leeward side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of a mountain. The stronger the wind, the greater the downward pressure and turbulence become.



Figure 3-3. *Turbulence in mountainous regions.*

Low-Level Wind Shear

Wind shear is a sudden, drastic change in wind speed and/or direction over a very small area. Wind shear can subject an aircraft to violent updrafts and downdrafts, as well as abrupt changes to the horizontal movement of the aircraft. While wind shear can occur at any altitude, low-level wind shear is especially hazardous due to the proximity of an aircraft to the ground. Low-level wind shear is commonly associated with passing frontal systems, thunderstorms, temperature inversions, and strong upper level winds (greater than 25 knots).

Wind shear is dangerous to an aircraft. It can rapidly change the performance of the aircraft and disrupt the normal flight attitude. For example, a tailwind quickly changing to a headwind causes an increase in airspeed and performance. Conversely, a headwind changing to a tailwind causes a decrease in airspeed and performance. In either case, a pilot must be prepared to react immediately to these changes to maintain control of the aircraft.

The most severe type of low-level wind shear, a microburst, is associated with convective precipitation into dry air at cloud base. Microburst activity may be indicated by an intense rain shaft at the surface but virga at cloud base and a ring of blowing dust is often the only visible clue. A typical microburst has a horizontal diameter of 1–2 miles and a nominal depth of 1,000 feet. The lifespan of a microburst is about 5–15 minutes during which time it can produce downdrafts of up to 6,000 feet per minute (fpm) and headwind losses of 30–90 knots, seriously degrading performance. It can also produce strong turbulence and hazardous wind direction changes. During an inadvertent microburst encounter, the small UA may first experience a performance-increasing headwind, followed by performance-decreasing downdrafts, followed by a rapidly increasing tailwind. This can result in terrain impact or flight dangerously close to the ground. An encounter during approach involves the same sequence of wind changes and could force the small UA to the ground short of the intended landing area.

It is important to remember that wind shear can affect any flight at any altitude. While wind shear may be reported, it often remains undetected and is a silent danger to aviation. Always be alert to the possibility of wind shear, especially when flying in and around thunderstorms and frontal systems.

Atmospheric Stability

The stability of the atmosphere depends on its ability to resist vertical motion. A stable atmosphere makes vertical movement difficult, and small vertical disturbances dampen

out and disappear. In an unstable atmosphere, small vertical air movements tend to become larger, resulting in turbulent airflow and convective activity. Instability can lead to significant turbulence, extensive vertical clouds, and severe weather.

The combination of moisture and temperature determine the stability of the air and the resulting weather. Cool, dry air is very stable and resists vertical movement, which leads to good and generally clear weather. The greatest instability occurs when the air is moist and warm, as it is in the tropical regions in the summer. Typically, thunderstorms appear on a daily basis in these regions due to the instability of the surrounding air.

Inversion

As air rises and expands in the atmosphere, the temperature decreases. There is an atmospheric anomaly that can occur; however, that changes this typical pattern of atmospheric behavior. When the temperature of the air rises with altitude, a temperature inversion exists. Inversion layers are commonly shallow layers of smooth, stable air close to the ground. The temperature of the air increases with altitude to a certain point, which is the top of the inversion. The air at the top of the layer acts as a lid, keeping weather and pollutants trapped below. If the relative humidity of the air is high, it can contribute to the formation of clouds, fog, haze, or smoke resulting in diminished visibility in the inversion layer.

Surface-based temperature inversions occur on clear, cool nights when the air close to the ground is cooled by the lowering temperature of the ground. The air within a few hundred feet of the surface becomes cooler than the air above it. Frontal inversions occur when warm air spreads over a layer of cooler air, or cooler air is forced under a layer of warmer air.

Temperature/Dew Point Relationship

The relationship between dew point and temperature defines the concept of relative humidity. The dew point, given in degrees, is the temperature at which the air can hold no more moisture. When the temperature of the air is reduced to the dew point, the air is completely saturated and moisture begins to condense out of the air in the form of fog, dew, frost, clouds, rain, or snow.

Methods by Which Air Reaches the Saturation Point

If air reaches the saturation point while temperature and dew point are close together, it is highly likely that fog, low clouds, and precipitation will form. There are four methods by which air can reach the saturation point. First, when warm air moves over a cold surface, the air temperature drops and reaches the saturation point. Second, the saturation point may be reached when cold air and warm air mix. Third, when air cools at night through contact with the cooler ground, air reaches its saturation point. The fourth method occurs when air is lifted or is forced upward in the atmosphere.

Dew and Frost

On cool, clear, calm nights, the temperature of the ground and objects on the surface can cause temperatures of the surrounding air to drop below the dew point. When this occurs, the moisture in the air condenses and deposits itself on the ground, buildings, and other objects like cars and aircraft. This moisture is known as dew and sometimes can be seen on grass and other objects in the morning. If the temperature is below freezing, the moisture is deposited in the form of frost. While dew poses no threat to a small UA, frost poses a definite flight safety hazard. Frost disrupts the flow of air over the wing and can drastically reduce the production of lift. It also increases drag, which when combined with lowered lift production, can adversely affect the ability to take off. A small UA must be thoroughly cleaned and free of frost prior to beginning a flight.

Clouds

To pilots, the cumulonimbus cloud is perhaps the most dangerous cloud type. It appears individually or in groups and is known as either an air mass or orographic thunderstorm. Heating of the air near the Earth's surface creates an air mass thunderstorm; the upslope motion of air in the mountainous regions causes orographic thunderstorms. Cumulonimbus clouds that form in a continuous line are nonfrontal bands of thunderstorms or squall lines.

Since rising air currents cause cumulonimbus clouds, they are extremely turbulent and pose a significant hazard to flight safety. For example, if a small UA enters a thunderstorm, the small UA could experience updrafts and downdrafts that exceed 3,000 fpm. In addition, thunderstorms can produce large hailstones, damaging lightning, tornadoes, and large quantities of water, all of which are potentially hazardous to an aircraft.

Standing Lenticular Altocumulus Clouds

Standing lenticular altocumulus clouds are formed on the crests of waves created by barriers in the wind flow. The clouds show little movement, hence the name standing. Wind, however, can be quite strong blowing through such clouds. They are characterized by their smooth, polished edges. The presence of these clouds is a good indication of very strong turbulence and should be avoided.

Stability

Stability of an air mass determines its typical weather characteristics. When one type of air mass overlies another, conditions change with height. Characteristics typical of an unstable and a stable air mass are as follows:

Unstable Air	Stable Air
Cumuliform clouds	Stratiform clouds and fog
Showery precipitation	Continuous precipitation
Rough air (turbulence)	Smooth air
Good visibility (except in blowing obstructions)	Fair to poor visibility in haze and smoke

Fronts

As air masses move out of their source regions, they come in contact with other air masses of different properties. The zone between two different air masses is a frontal zone or front. Across this zone, temperature, humidity and wind often change rapidly over short distances.

Mountain Flying

When planning a flight over mountainous terrain, gather as much preflight information as possible on cloud reports, wind direction, wind speed, and stability of air. Satellites often help locate mountain waves. Adequate information may not always be available, so remain alert for signposts in the sky.

Wind at mountain top level in excess of 25 knots suggests some turbulence. Wind in excess of 40 knots across a mountain barrier dictates caution. Stratified clouds mean stable air. Standing lenticular and/or rotor clouds suggest a mountain wave; expect turbulence many miles to the lee of mountains and relative smooth flight on the windward side. Convective clouds on the windward side of mountains mean unstable air; expect turbulence in close proximity to and on either side of the mountain.

Structural Icing

Two conditions are necessary for structural icing in flight:

1. The aircraft must be flying through visible water such as rain or cloud droplets.
2. The temperature at the point where the moisture strikes the aircraft must be 0°C or colder.

Aerodynamic cooling can lower temperature of an airfoil to 0°C even though the ambient temperature is a few degrees warmer.

Thunderstorm Life Cycle

A thunderstorm cell during its life cycle progresses through three stages-(1) the cumulus, (2) the mature, and (3) the dissipating. It is virtually impossible to visually detect the transition from one stage to another; the transition is subtle and by no means abrupt. Furthermore, a thunderstorm may be a cluster of cells in different stages of the lifecycle.

The Cumulus Stage

Although most cumulus clouds do not grow into thunderstorms, every thunderstorm begins as a cumulus. The key feature of the cumulus stage is an updraft as illustrated in figure 3-4. The updraft varies in strength and extends from very near the surface to the cloud top. Growth rate of the cloud may exceed 3,000 feet per minute, so it is inadvisable to operate a small UA in an area of rapidly building cumulus clouds. Early during the cumulus stage, water droplets are quite small but grow to raindrop size as the cloud grows. The upwelling air carries the liquid water above the freezing level creating an icing hazard. As the raindrops grow still heavier, they fall. The cold rain drags air with it creating a cold downdraft coexisting with the updraft; the cell has reached the mature stage.

The Mature Stage

Precipitation beginning to fall from the cloud base is your signal that a downdraft has developed and a cell has entered the mature stage. Cold rain in the downdraft retards compressional heating, and the downdraft remains cooler than surrounding air.

Therefore, its downward speed is accelerated and may exceed 2,500 feet per minute. The down rushing air spreads outward at the surface as shown in figure 3-4 producing strong, gusty surface winds, a sharp temperature drop, and a rapid rise in pressure. The surface wind surge is a "plow wind" and its leading edge is the "first gust." Meanwhile, updrafts reach a maximum with speeds possibly exceeding 6,000 feet per minute. Updrafts and downdrafts in close proximity create strong vertical shear and a very turbulent environment. All thunderstorm hazards reach their greatest intensity during the mature stage.

The Dissipating Stage

Downdrafts characterize the dissipating stage of the thunderstorm cell as shown in figure 3-4 and the storm dies rapidly. When rain has ended and downdrafts have abated, the dissipating stage is complete. When all cells of the thunderstorm have completed this stage, only harmless cloud remnants remain.

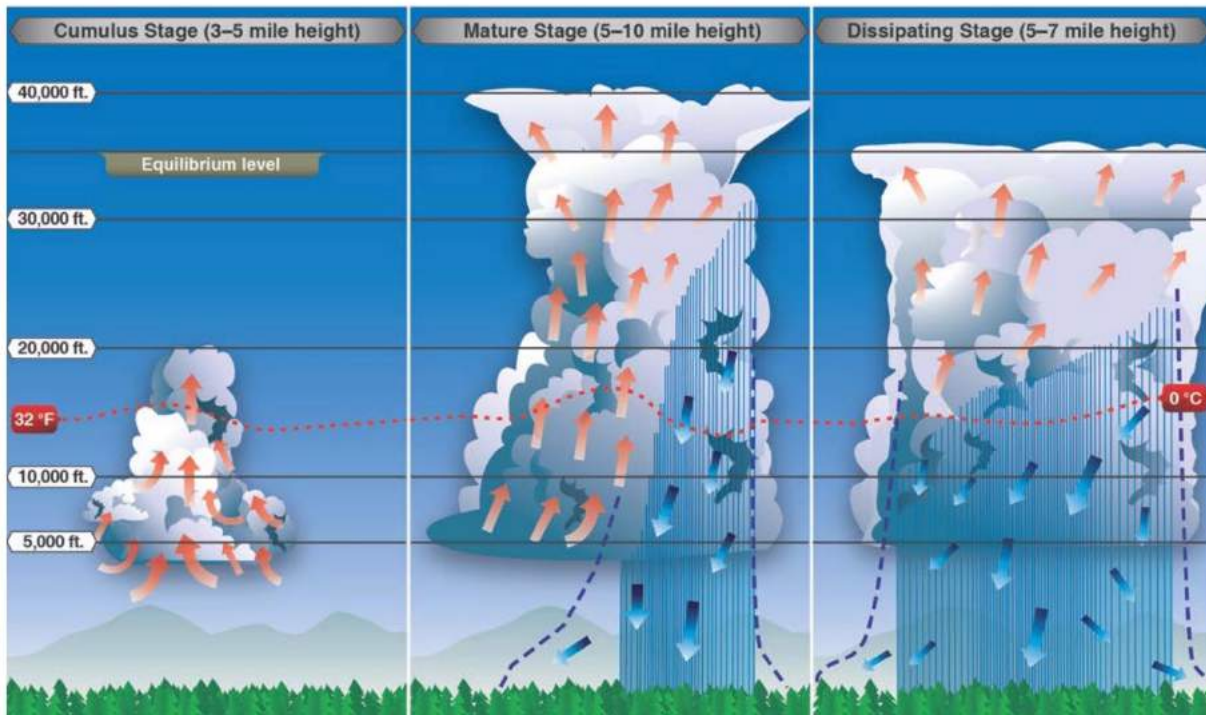


Figure 3-4. Life cycle of a thunderstorm.

Ceiling

For aviation purposes, a ceiling is the lowest layer of clouds reported as being broken or overcast, or the vertical visibility into an obscuration like fog or haze. Clouds are reported as broken when five-eighths to seven-eighths of the sky is covered with clouds. Overcast means the entire sky is covered with clouds. Current ceiling information is reported by the aviation routine weather report (METAR) and automated weather stations of various types.

Visibility

Closely related to cloud cover and reported ceilings is visibility information. Visibility refers to the greatest horizontal distance at which prominent objects can be viewed with the naked eye. Current visibility is also reported in METAR and other aviation weather reports, as well as by automated weather systems. Visibility information, as predicted by meteorologists, is available for a pilot during a preflight weather briefing.

Quiz 3

Perfectly dry air that contains no water vapor has a relative humidity of _____ percent.

- 0
- 30
- 20
- 15

Standard sea level pressure is defined as _____ "Hg.

- 29.92
- 20.02
- 15.06
- 18.92

Standard sea level pressure has a standard temperature of _____ °F.

- 59
- 30
- 35
- 40

Typical mb pressure readings range from _____ to 1,040.0 mb.

- 950.0
- 750.0
- 800.0
- 630.0

A typical microburst has a horizontal diameter of 1 – _____ miles.

- 2
- 8
- 5
- 10

A typical microburst has a nominal depth of _____ feet.

- 1,000
- 5,000
- 2,500
- 1,600

The lifespan of a microburst is about _____ minutes.

- 5-15
- 8-20
- 10-25
- 3-10

_____ is considered to be a characteristic of stable air.

- Smooth Air
- Showery precipitation
- Rough Air
- Good Visibility

_____ is considered to be a characteristic of unstable air.

- Showery Precipitation
- Continuous Precipitation
- Smooth Air
- Stratiform Fog

Wind at mountain top level in excess of _____ knots suggests some turbulence.

- 25
- 40
- 35
- 30

Wind in excess of _____ knots across a mountain barrier dictates caution.

- 40
- 15
- 25
- 60

Growth rate of the cloud may exceed _____ feet per minute.

- 3,000
- 6,000

- 1,500
- 2,000

A microburst can produce downdrafts of up to _____ feet per minute (fpm) during its lifespan .

- 6,000
- 3,000
- 2,500
- 4,000

Standard sea level pressure is _____ mb.

- 1,013.2
- 1,513.3
- 1,123.4
- 800.2

A microburst can produce headwind losses of _____ knots during its lifespan.

- 30–90
- 20-50
- 30-70
- 20-80

Chapter 4: Small Unmanned Aircraft Loading

Introduction

Before any flight, the remote pilot-in-command (PIC) should verify the aircraft is correctly loaded by determining the weight and balance condition of the aircraft. An aircraft's weight and balance restrictions established by the manufacturer or the builder should be closely followed. Compliance with the manufacturer's weight and balance limits is critical to flight safety. The remote PIC must consider the consequences of an overweight aircraft if an emergency condition arises.

- Although a maximum gross takeoff weight may be specified, the aircraft may not always safely take off with this load under all conditions. Conditions that affect takeoff and climb performance, such as high elevations, high air temperatures, and high humidity (high density altitudes) may require a reduction in weight before flight is attempted. Other factors to consider prior to takeoff are runway/launch area length, surface, slope, surface wind, and the presence of obstacles. These factors may require a reduction in weight prior to flight.
- Weight changes during flight also have a direct effect on aircraft performance. Fuel burn is the most common weight change that takes place during flight. As fuel is used, the aircraft becomes lighter and performance is improved, but this could have a negative effect on balance. In small UA operations, weight change during flight may occur when expendable items are used on board (e.g., a jettisonable load).

Adverse balance conditions (i.e., weight distribution) may affect flight characteristics in much the same manner as those mentioned for an excess weight condition. Limits for the location of the center of gravity (CG) may be established by the manufacturer. The CG is not a fixed point marked on the aircraft; its location depends on the distribution of aircraft weight. As variable load items are shifted or expended, there may be a resultant shift in CG location. The remote PIC should determine how the CG will shift and the resultant effects on the aircraft. If the CG is not within the allowable limits after loading or do not remain within the allowable limits for safe flight, it will be necessary to relocate or shed some weight before flight is attempted.

Weight

Gravity is the pulling force that tends to draw all bodies to the center of the earth. The CG may be considered as a point at which all the weight of the aircraft is concentrated.

If the aircraft were supported at its exact CG, it would balance in any attitude. It will be noted that CG is of major importance in a small UA, for its position has a great bearing upon stability. The allowable location of the CG is determined by the general design of each particular aircraft. The designers determine how far the center of pressure (CP) will travel. It is important to understand that an aircraft's weight is concentrated at the CG and the aerodynamic forces of lift occur at the CP. When the CG is forward of the CP, there is a natural tendency for the aircraft to want to pitch nose down. If the CP is forward of the CG, a nose up pitching moment is created. Therefore, designers fix the aft limit of the CG forward of the CP for the corresponding flight speed in order to retain flight equilibrium.

Weight has a definite relationship to lift. This relationship is simple, but important in understanding the aerodynamics of flying. Lift is the upward force on the wing acting perpendicular to the relative wind and perpendicular to the aircraft's lateral axis. Lift is required to counteract the aircraft's weight. In stabilized level flight, when the lift force is equal to the weight force, the aircraft is in a state of equilibrium and neither accelerates upward or downward. If lift becomes less than weight, the vertical speed will decrease. When lift is greater than weight, the vertical speed will increase.

Stability

Stability is the inherent quality of an aircraft to correct for conditions that may disturb its equilibrium and to return to or to continue on the original flight path. It is primarily an aircraft design characteristic.

Stability in an aircraft affects two areas significantly:

- Maneuverability—the quality of an aircraft that permits it to be maneuvered easily and to withstand the stresses imposed by maneuvers. It is governed by the aircraft's weight, inertia, size and location of flight controls, structural strength, and powerplant. It too is an aircraft design characteristic.
- Controllability—the capability of an aircraft to respond to the pilot's control, especially with regard to flight path and attitude. It is the quality of the aircraft's response to the pilot's control application when maneuvering the aircraft, regardless of its stability characteristics.

Load Factors

In aerodynamics, the maximum load factor (at given bank angle) is a proportion between lift and weight and has a trigonometric relationship. The load factor is measured in Gs (acceleration of gravity), a unit of force equal to the force exerted by gravity on a body at rest and indicates the force to which a body is subjected when it is accelerated. Any force applied to an aircraft to deflect its flight from a straight line produces a stress on its structure. The amount of this force is the load factor. While a course in aerodynamics is not a prerequisite for obtaining a remote pilot certificate, the competent pilot should have a solid understanding of the forces that act on the aircraft, the advantageous use of these forces, and the operating limitations of the aircraft being flown.

For example, a load factor of 3 means the total load on an aircraft's structure is three times its weight. Since load factors are expressed in terms of Gs, a load factor of 3 may be spoken of as 3 Gs, or a load factor of 4 as 4 Gs.

With the structural design of aircraft planned to withstand only a certain amount of overload, a knowledge of load factors has become essential for all pilots. Load factors are important for two reasons:

1. It is possible for a pilot to impose a dangerous overload on the aircraft structures.
2. An increased load factor increases the stalling speed and makes stalls possible at seemingly safe flight speeds.

Load Factors in Steep Turns

At a constant altitude, during a coordinated turn in any aircraft, the load factor is the result of two forces: centrifugal force and weight. [Figure 4-1] For any given bank angle, the rate-of-turn varies with the airspeed—the higher the speed, the slower the rate-of-turn (ROT). This compensates for added centrifugal force, allowing the load factor to remain the same.

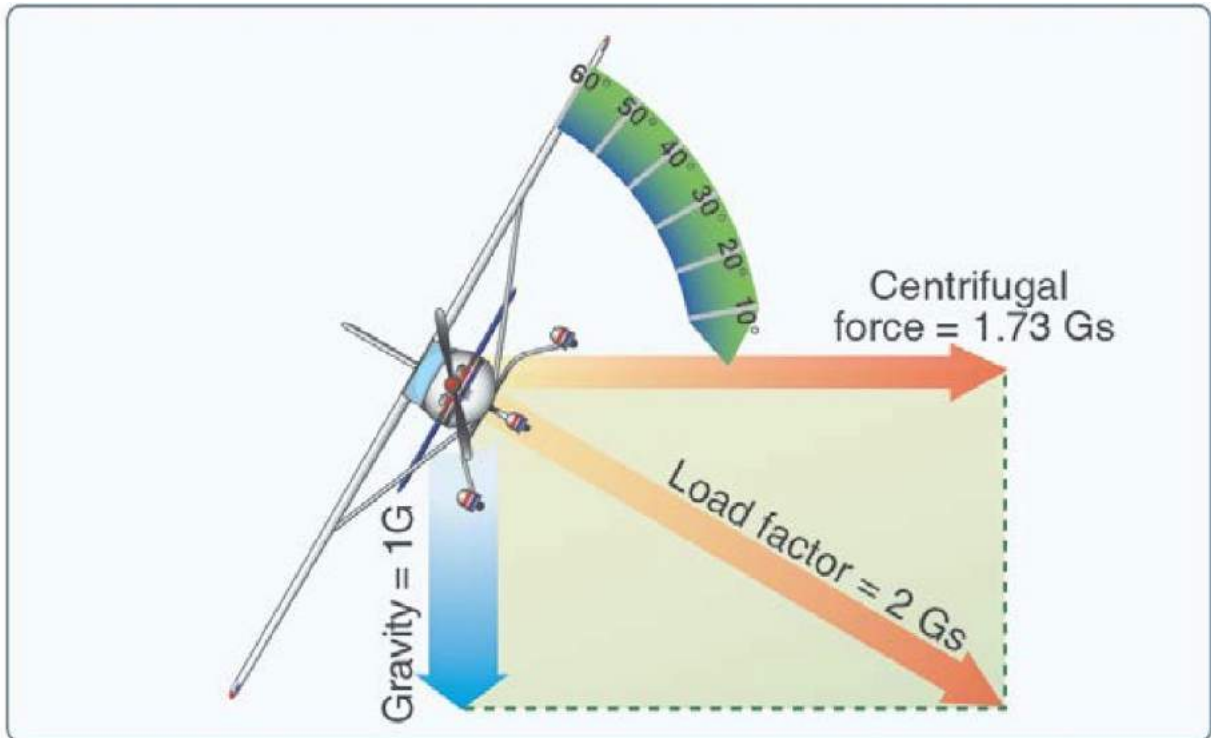


Figure 4-1. *Two forces cause load factor during turns.*

Figure 4-2 reveals an important fact about turns—the load factor increases at a terrific rate after a bank has reached 45° or 50°. The load factor for any aircraft in a coordinated level turn at 60° bank is 2 Gs. The load factor in an 80° bank is 5.76 Gs. The wing must produce lift equal to these load factors if altitude is to be maintained. It should be noted how rapidly the line denoting load factor rises as it approaches the 90° bank line, which it never quite reaches because a 90° banked, constant altitude turn is not mathematically possible. An aircraft may be banked to 90° in a coordinated turn if not trying to hold altitude. An aircraft that can be held in a 90° banked slipping turn is capable of straight knife-edged flight. At slightly more than 80°, the load factor exceeds the limit of 6 Gs, the limit load factor of an acrobatic aircraft.

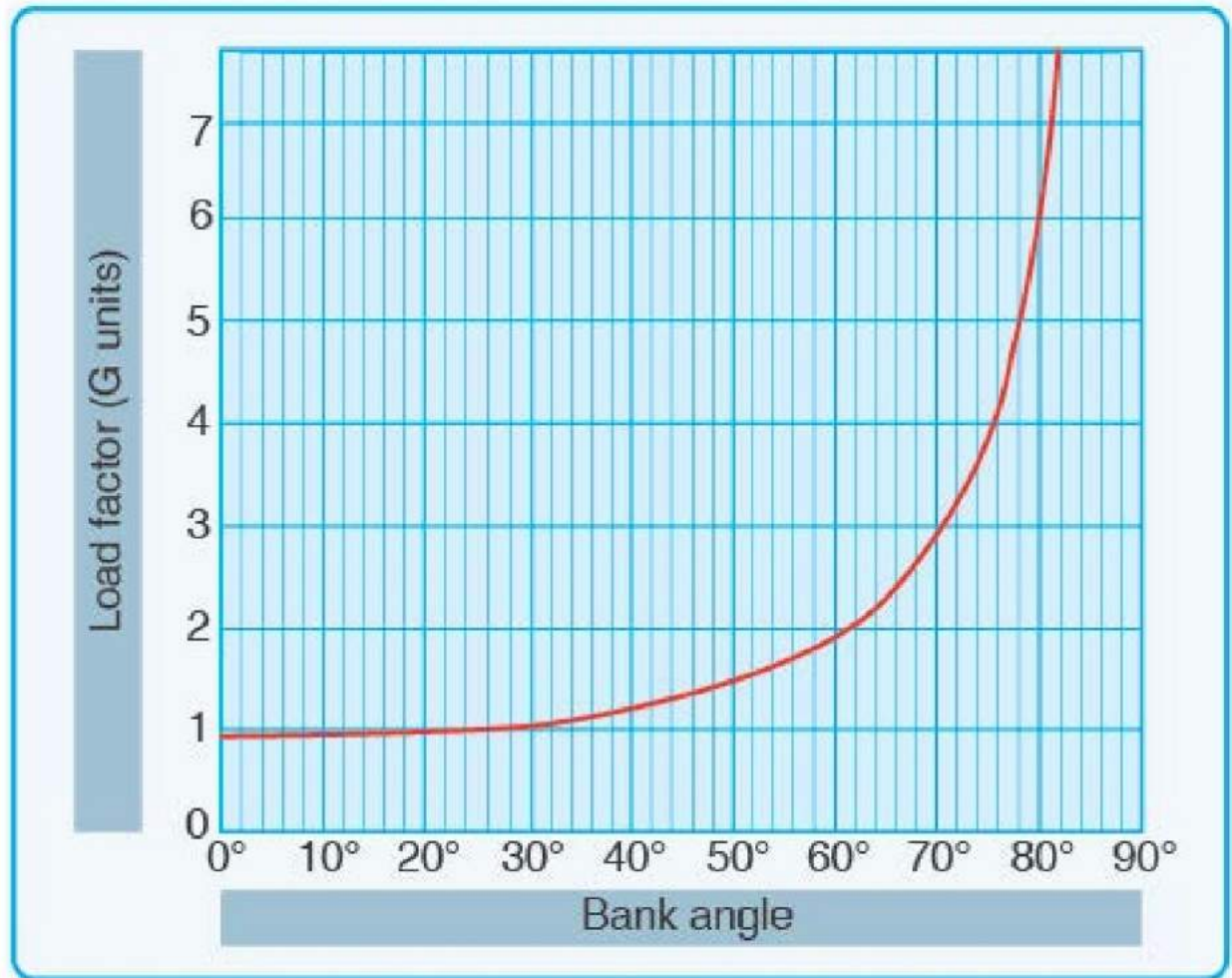


Figure 4-2. *Angle of bank changes load factor in level flight.*

Load Factors and Stalling Speeds

Any aircraft, within the limits of its structure, may be stalled at any airspeed. When a sufficiently high AOA is imposed, the smooth flow of air over an airfoil breaks up and separates, producing an abrupt change of flight characteristics and a sudden loss of lift, which results in a stall.

A study of this effect has revealed that an aircraft's stalling speed increases in proportion to the square root of the load factor. This means that an aircraft with a normal unaccelerated stalling speed of 50 knots can be stalled at 100 knots by inducing a load factor of 4 Gs. If it were possible for this aircraft to withstand a load factor of nine, it could be stalled at a speed of 150 knots. A pilot should be aware of the danger of inadvertently stalling the aircraft by increasing the load factor, as in a steep turn or spiral.

Since the load factor is squared as the stalling speed doubles, tremendous loads may be imposed on structures by stalling an aircraft at relatively high airspeeds.

[illegible]

Weight and Balance

Compliance with the weight and balance limits of any aircraft is critical to flight safety. Operating above the maximum weight limitation compromises the structural integrity of an aircraft and adversely affects its performance. Operation with the center of gravity (CG) outside the approved limits results in control difficulty. The aircraft's weight and balance data is important information for a pilot that must be frequently reevaluated.

Weight Control

Weight is the force with which gravity attracts a body toward the center of the Earth. It is a product of the mass of a body and the acceleration acting on the body. Weight is a major factor in aircraft construction and operation and demands respect from all pilots. The force of gravity continuously attempts to pull an aircraft down toward Earth. The force of lift is the only force that counteracts weight and sustains an aircraft in flight. The amount of lift produced by an airfoil is limited by the airfoil design, AOA, airspeed, and air density. To assure that the lift generated is sufficient to counteract weight, loading an aircraft beyond the manufacturer's recommended weight must be avoided. If the weight is greater than the lift generated, the aircraft may be incapable of flight.

Effects of Weight

Any item aboard an aircraft that increases the total weight is undesirable for performance. Manufacturers attempt to make an aircraft as light as possible without sacrificing strength or safety. The pilot should always be aware of the consequences of overloading. An overloaded aircraft may not be able to leave the ground, or if it does become airborne, it may exhibit unexpected and unusually poor flight characteristics. If not properly loaded, the initial indication of poor performance usually takes place during takeoff.

Excessive weight reduces the flight performance in almost every respect. For example, the most important performance deficiencies of an overloaded aircraft are:

- Higher takeoff speed
- Longer takeoff run
- Reduced rate and angle of climb
- Lower maximum altitude
- Shorter range
- Reduced cruising speed
- Reduced maneuverability
- Higher stalling speed
- Higher approach and landing speed
- Longer landing roll

The pilot must be knowledgeable about the effect of weight on the performance of the particular aircraft being flown. Excessive weight in itself reduces the safety margins

available to the pilot and becomes even more hazardous when other performance-reducing factors are combined with excess weight. The pilot must also consider the consequences of an overweight aircraft if an emergency condition arises.

Quiz 4

The load factor for any aircraft in a coordinated level turn at _____° bank is 2 Gs.

- 60
- 40
- 35
- 50

The load factor in an _____° bank is 5.76 Gs.

- 80
- 50
- 45
- 25

Which of the following is a performance deficiency of an overloaded aircraft?

- Longer takeoff run
- Faster takeoff run
- Shorter takeoff speed
- Increased cruising speed

Chapter 5: Emergency Procedures

Introduction

An inflight emergency is usually an unexpected and unforeseen event that can have serious consequences for an unprepared remote pilot. During an emergency, a remote pilot is permitted to deviate from any part of [14 CFR part 107](#) to respond to the emergency. When a remote pilot does deviate from a rule due to an emergency, the remote will report the emergency if asked to do so by the FAA (also referred to as “the Administrator”).

Inflight Emergency

A remote pilot is responsible for the safe operation of the small UA at all times. A remote pilot must ensure that the aircraft is in a safe operating condition before flight, that there is not any hazard to persons or property, and that all required crew members are properly briefed on the operation and emergency procedures.

Before every flight, a remote pilot will conduct a preflight inspection of the aircraft. If any irregularities are found in the inspection, they must be corrected before the small UA is operated. Some small UA manufacturers will provide the remote pilot with preflight inspection items. For those small UAs that do not have a manufacturer checklist, the remote should develop a checklist that will provide enough information that the aircraft will be operated in a safe condition.

When a remote pilot does experience an inflight emergency, the pilot may take any action to ensure that there is not a hazard to other people or property. For example, if during a flight the small UA experiences a battery fire, the remote pilot may need to climb the small UA above 400' AGL to maneuver to a safe landing area. In this instance, a report will need to be made only if asked to do so by the FAA.

When other crew members are used during a flight, all of those crew members must be briefed on the flight and the planned emergency procedures for the flight. The briefing will be given to any visual observers (VO) that might be used and any non-certificated person who is allowed to manipulate the flight controls of the small UA.

For more information about emergencies, refer to [14 CFR part 107](#) and [AC 107-2](#).

Chapter 6: Crew Resource Management

Overview

Crew resource management (CRM) training for flight crews is focused on the effective use of all available resources. For information on Crew Resource Management (CRM), refer to Chapter 10, “Aeronautical Decision Making and Judgment,” of this course.

Chapter 7: Radio Communication Procedures

Introduction

Radio communications are an important aspect for the safe operation of aircraft in the NAS. It is through radio communications that pilots give and receive information before, during and at the conclusion of a flight. This information aids in the flow of aircraft in highly complex airspace areas as well as in less populated areas. Pilots can also send and receive important safety of flight issues such as unexpected weather conditions, and inflight emergencies. Although small UA pilots are not expected to communicate over radio frequencies, it is important for the UA pilot to understand “aviation language” and the different conversations they will encounter if the UA pilot is using a radio to aid them in situational awareness when operating in the NAS. Although much of the information provided here is geared toward manned aircraft pilots, the UA pilot needs to understand the unique way information is exchanged in the NAS.

Understanding Proper Radio Procedures

Understanding proper radio phraseology and procedures contribute to a pilot's ability to operate safely and efficiently in the airspace system. A review of the Pilot/Controller Glossary contained in the [AIM](#) assists a pilot in understanding standard radio terminology. The AIM also contains many examples of radio communications. ICAO has adopted a phonetic alphabet that should be used in radio communications. When communicating with ATC, pilots should use this alphabet to identify their aircraft. [Figure 7-1]

[illegible]

Character	Morse Code	Telephony	Phonic Pronunciation
A	• —	Alfa	(AL-FAH)
B	— • • •	Bravo	(BRAH-VOH)
C	— • — •	Charlie	(CHAR-LEE) or (SHAR-LEE)
D	— • •	Delta	(DELL-TAH)
E	•	Echo	(ECK-OH)
F	• • — •	Foxtrot	(FOKS-TROT)
G	— — •	Golf	(GOLF)
H	• • • •	Hotel	(HOH-TEL)
I	• •	India	(IN-DEE-AH)
J	• — — —	Juliett	(JEW-LEE-ETT)
K	— • —	Kilo	(KEY-LOH)
L	• — • •	Lima	(LEE-MAH)
M	— —	Mike	(MIKE)
N	— •	November	(NO-VEM-BER)
O	— — —	Oscar	(OSS-CAH)
P	• — — •	Papa	(PAH-PAH)
Q	— — • —	Quebec	(KEH-BECK)
R	• — •	Romeo	(ROW-ME-OH)
S	• • •	Sierra	(SEE-AIR-RAH)
T	—	Tango	(TANG-GO)
U	• • —	Uniform	(YOU-NEE-FORM) or (OO-NEE-FORM)
V	• • • —	Victor	(VIK-TAH)
W	• — —	Whiskey	(WISS-KEY)
X	— • • —	Xray	(ECKS-RAY)
Y	— • — —	Yankee	(YANG-KEY)
Z	— — • •	Zulu	(ZOO-LOO)
1	• — — — —	One	(WUN)
2	• • — — —	Two	(TOO)
3	• • • — —	Three	(TREE)
4	• • • • —	Four	(FOW-ER)
5	• • • • •	Five	(FIFE)
6	— • • • •	Six	(SIX)
7	— — • • •	Seven	(SEV-EN)
8	— — — • •	Eight	(AIT)
9	— — — — •	Nine	(NIN-ER)
0	— — — — —	Zero	(ZEE-RO)

Figure 7-1. Phonetic Alphabet.

Traffic Advisory Practices at Airports

Airport Operations without Operating Control Tower

There is no substitute for alertness while in the vicinity of an airport. It is essential that pilots be alert and look for other traffic when operating at an airport without an operating control tower. This is of particular importance since other aircraft may not have communication capability or, in some cases, pilots may not communicate their presence or intentions when operating into or out of such airports. To achieve the greatest degree of safety, it is essential that all radioequipped aircraft transmit/receive on a common frequency and small UA pilots monitor other aircraft identified for the purpose of airport advisories.

An airport may have a full or part-time tower or flight service station (FSS) located on the airport, a full or part-time universal communications (UNICOM) station or no aeronautical station at all. There are three ways for pilots to communicate their intention and obtain airport/traffic information when operating at an airport that does not have an operating tower—by communicating with an FSS, a UNICOM operator, or by making a self-announce broadcast.

Many airports are now providing completely automated weather, radio check capability and airport advisory information on an automated UNICOM system. These systems offer a variety of features, typically selectable by microphone clicks, on the UNICOM frequency. Availability of the automated UNICOM will be published in the Airport/Facility Directory and approach charts.

Understanding Communication on a Common Frequency

The key to communications at an airport without an operating control tower is selection of the correct common frequency. The acronym CTAF, which stands for Common Traffic Advisory Frequency, is synonymous with this program. A CTAF is a frequency designated for the purpose of carrying out airport advisory practices while operating to or from an airport without an operating control tower. The CTAF may be a UNICOM, MULTICOM, FSS, or tower frequency and is identified in appropriate aeronautical publications.

Communication/Broadcast Procedures

A MULTICOM frequency of 122.9 will be used at an airport that is non-towered and does not have a FSS or UNICOM.

Recommended Traffic Advisory Practices

Although a remote pilot-in-command is not required to communicate with manned aircraft when in the vicinity of a non-towered airport, safety in the National Airspace System requires that remote pilots are familiar with traffic patterns, radio procedures, and radio phraseology.

When a remote pilot plans to operate close to a non-towered airport, the first step in radio procedures is to identify the appropriate frequencies. Most non-towered airports will have a UNICOM frequency, which is usually 122.8; however, you should always check the Chart Supplements U.S. or sectional chart for the correct frequency. This frequency can vary when there are a large number of non-towered airports in the area. For non-towered airports that do not have a UNICOM or any other frequency listed, the MULTICOM frequency of 122.9 will be used. These frequencies can be found on a sectional chart by the airport or in the Chart Supplements publication from the FAA.

When a manned aircraft is inbound to a non-towered airport, the standard operating practice is for the pilot to “broadcast in the blind” when 10 miles from the airport. This initial radio call will also include the position the aircraft is in relation to north, south, east or west from the airport. For example:

Town and Country traffic, Cessna 123 Bravo Foxtrot is 10 miles south inbound for landing, Town and Country traffic.

When a manned aircraft is broadcasting at a non-towed airport, the aircraft should use the name of the airport of intended landing at the beginning of the broadcast, and again at the end of the broadcast. The reason for stating the name twice is to allow others who are on the frequency to confirm where the aircraft is going. The next broadcast that the manned aircraft should make is:

Town and Country traffic, Cessna 123 Bravo Foxtrot, is entering the pattern, mid-field left down-wind for runway 18, Town and Country traffic.

The aircraft is now entering the traffic pattern. In this example, the aircraft is making a standard 45 degree entry to the downwind leg of the pattern for runway 18. Or, the aircraft could land straight-in without entering the typical rectangular traffic pattern. Usually aircraft that are executing an instrument approach will use this method. Examples of a radio broadcast from aircraft that are using this technique are:

For an aircraft that is executing an instrument approach: *Town and Country traffic, Cessna 123 Bravo Foxtrot, is one mile north of the airport, GPS runway 18, full stop landing, Town and Country traffic.*

As the aircraft flies the traffic pattern for a landing, the following radio broadcasts should be made:

Town and Country traffic, Cessna 123 Bravo Foxtrot, left base, runway 18, Town and Country traffic.

Town and Country traffic, Cessna 123 Bravo Foxtrot, final, runway 18, Town and Country traffic.

After the aircraft has landed and is clear of the runway, the following broadcast should be made:

Town and Country traffic, Cessna 123 Bravo Foxtrot, is clear of runway 18, taxing to park, Town and Country traffic.

When an aircraft is departing a non-towered airport, the same procedures apply. For example, when the aircraft is ready for takeoff, the aircraft should make the following broadcast:

Town and Country traffic, Cessna 123 Bravo Foxtrot, departing runway 18, Town and Country traffic.

For safety reasons, a remote pilot must always scan the area where they are operating a small UA. This is especially important around an airport. While it is good operating procedures for manned aircraft to make radio broadcasts in the vicinity of a non-towered airport, by regulation, it is not mandatory. For this reason, a remote pilot must always look for other aircraft in the area, and use a radio for an extra layer of situational awareness.

[illegible]

Aircraft Call Signs

When operating in the vicinity of any airport, either towered or non-towered, it is important for a remote pilot to understand radio communications of manned aircraft in the area. Although 14 CFR part 107 only requires the remote pilot to receive authorization to operate in certain airport areas, it can be a good operating practice to have a radio that will allow the remote pilot to monitor the appropriate frequencies in the area. The remote pilot should refrain from transmitting over any active aviation frequency unless there is an emergency situation. Aviation has unique communication procedures that will be foreign to a remote pilot who has not been exposed to “aviation language” previously. One of those is aircraft call signs. All aircraft that are registered in the United States will have a unique registration number, or “N” number. For example, N123AB, which would be pronounced in aviation terms by use of the phonetic alphabet as, “November One-Two-Three-Alpha-Bravo.” In most cases, “November” will be replaced with either the aircraft manufacturer’s name (make) and in some cases, the type of aircraft (model). Usually, when the aircraft is a light general aviation (GA) aircraft, the manufacturer’s name will be used. In this case, if N123AB is a Cessna 172, the call sign would be “Cessna, One-Two-Three-Alpha-Bravo.” If the aircraft is a heavier GA aircraft, such as a turbo-prop, or turbo-jet, the aircraft’s model will be used in the call sign. If N123AB is a Cessna Citation, the call sign would be stated as, “Citation, OneTwo-Three-Alpha-Bravo.” Typically, airliners will use the name of their companies and their flight number in their call signs. For example, Southwest Airlines flight 711, would be said as, “SouthwestSeven-One-One.” There are a few airlines such as British Airways who will not use the company name in their call sign. For example, British Airways uses “Speedbird.” To close, a remote pilot is not expected to communicate with other aircraft in the vicinity of an airport, and should not do so unless there is an emergency situation. However, in the interest of safety in the NAS, it is important that a remote pilot understands the aviation language and the types of aircraft that can be operating in the same area as a small UA.

Quiz 5

A _____ is a frequency designated for the purpose of carrying out airport advisory practices.

- CTAF
- CTAP
- CFAT
- CPAF

Which MULTICOM frequency is used at an airport that is non-towered?

- 122.9
- 100.9
- 155.2
- 80.3

What is the typical UNICOM frequency for non-towered airports?

- 122.8
- 140.8
- 160.2
- 101.5

Chapter 8: Determining the Performance of Small Unmanned Aircraft

Introduction

The manufacturer may provide operational and performance information that contains the operational performance data for the aircraft such as data pertaining to takeoff, climb, range, endurance, descent, and landing. To be able to make practical use of the aircraft's capabilities and limitations, it is essential to understand the significance of the operational data. The use of this data in flying operations is essential for safe and efficient operation. It should be emphasized that the manufacturers' information regarding performance data is not standardized. If manufacturer-published performance data is unavailable, it is advisable to seek out performance data that may have already been determined and published by other users of the same small UA manufacturer model and use that data as a starting point.

Effect of Temperature on Density

Increasing the temperature of a substance decreases its density. Conversely, decreasing the temperature increases the density. Thus, the density of air varies inversely with temperature. This statement is true only at a constant pressure.

In the atmosphere, both temperature and pressure decrease with altitude and have conflicting effects upon density. However, a fairly rapid drop in pressure as altitude increases usually has a dominating effect. Hence, pilots can expect the density to decrease with altitude.

Effect of Humidity (Moisture) on Density

The preceding paragraphs refer to air that is perfectly dry. In reality, it is never completely dry. The small amount of water vapor suspended in the atmosphere may be almost negligible under certain conditions, but in other conditions humidity may become an important factor in the performance of an aircraft. Water vapor is lighter than air; consequently, moist air is lighter than dry air. Therefore, as the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance. It is lightest or least dense when, in a given set of conditions, it contains the maximum amount of water vapor.

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 holds more water vapor, while cold air holds less. Perfectly dry air that contains no water vapor has a relative humidity of zero percent, while saturated air, which 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 aircraft performance, but it is a contributing factor.

Chapter 9: Physiological Factors Affecting Pilot Performance

Introduction

14 CFR part 107 does not allow operation of small UA if the remote PIC, the person manipulating the controls, or Visual Observer (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 (OTC) 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:

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

There are 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 small UA operation.

Physiological/Medical Factors

Important medical factors that a pilot should be aware of include the following:

- hyperventilation
- stress
- fatigue
- dehydration
- heatstroke
- the effects of alcohol and drugs

Hyperventilation

Hyperventilation is the excessive rate and depth of respiration leading to abnormal loss of carbon dioxide from the blood. This condition occurs more often among pilots than is generally recognized. It seldom incapacitates completely, but it causes disturbing symptoms that can alarm the uninformed pilot. In such cases, increased breathing rate and anxiety further aggravate the problem. Hyperventilation can lead to unconsciousness due to the respiratory system's overriding mechanism to regain control of breathing. Pilots encountering an unexpected stressful situation may subconsciously increase their breathing rate.

Common symptoms of hyperventilation include:

- Visual impairment
- Unconsciousness
- Lightheaded or dizzy sensation
- Tingling sensations
- Hot and cold sensations
- Muscle spasms

The treatment for hyperventilation involves restoring the proper carbon dioxide level in the body. Breathing normally is both the best prevention and the best cure for hyperventilation. In addition to slowing the breathing rate, breathing into a paper bag or talking aloud helps to overcome hyperventilation. Recovery is usually rapid once the breathing rate is returned to normal.

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).

Stress falls into two broad categories: acute (short term) and chronic (long term). Acute stress involves an immediate threat that is perceived as danger. This is the type of stress that triggers a "fight or flight" response in an individual, whether the threat is real or imagined. Normally, a healthy person can cope with acute stress and prevent stress overload. However, ongoing acute stress can develop into chronic stress.

Chronic stress can be defined as a level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall

sharply. Unrelenting psychological pressures, such as loneliness, financial worries, and relationship or work problems can produce a cumulative level of stress that exceeds a person's ability to cope with the situation. When stress reaches these levels, performance falls off rapidly. Pilots experiencing this level of stress are not safe and should not exercise their airman privileges. Pilots who suspect they are suffering from chronic stress should consult a physician.

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.

Like stress, fatigue falls into two broad categories: acute and chronic. Acute fatigue is short term and is a normal occurrence in everyday living. It is the kind of tiredness people feel after a period of strenuous effort, excitement, or lack of sleep. Rest after exertion and 8 hours of sound sleep ordinarily cures this condition.

A special type of acute fatigue is skill fatigue. This type of fatigue has two main effects on performance:

- Timing disruption—appearing to perform a task as usual, but the timing of each component is slightly off. This makes the pattern of the operation less smooth because the pilot performs each component as though it were separate, instead of part of an integrated activity.
- Disruption of the perceptual field—concentrating attention upon movements or objects in the center of vision and neglecting those in the periphery. This is accompanied by loss of accuracy and smoothness in control movements.

Acute fatigue has many causes, but the following are among the most important for the pilot:

- Mild hypoxia (oxygen deficiency)
- Physical stress
- Psychological stress
- Depletion of physical energy resulting from psychological stress
- Sustained psychological stress

Acute fatigue can be prevented by proper diet and adequate rest and sleep. A well-balanced diet prevents the body from needing to consume its own tissues as an energy source. Adequate rest maintains the body's store of vital energy.

Chronic fatigue, extending over a long period of time, usually has psychological roots, although an underlying disease is sometimes responsible. Continuous high-stress levels produce chronic fatigue. Chronic fatigue is not relieved by proper diet and adequate rest and sleep and usually requires treatment by a physician. An individual may experience this condition in the form of weakness, tiredness, palpitations of the heart, breathlessness, headaches, or irritability. Sometimes chronic fatigue even creates stomach or intestinal problems and generalized aches and pains throughout the body. When the condition becomes serious enough, it leads to emotional illness.

If suffering from acute fatigue, a remote pilot should not operate a small UA. If fatigue occurs during the operation of a small UA, no amount of training or experience can overcome the detrimental effects. Getting adequate rest is the only way to prevent fatigue from occurring. Avoid flying a small UA without a full night's rest, after working excessive hours, or after an especially exhausting or stressful day. Remote pilots who suspect they are suffering from chronic fatigue should consult a physician.

Dehydration

Dehydration is the term given to a critical loss of water from the body. Causes of dehydration are hot temperatures, 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 a small UA 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.

The key for pilots is to be continually aware of their condition. Most people become thirsty with a 1.5 quart deficit or a loss of 2 percent of total body weight. This level of dehydration triggers the “thirst mechanism.” The problem is that the thirst mechanism arrives too late and is turned off too easily. A small amount of fluid in the mouth turns this mechanism off and the replacement of needed body fluid is delayed.

Other steps to prevent dehydration include:

- Carrying a container in order to measure daily water intake.
- Staying ahead—not relying on the thirst sensation as an alarm. If plain water is not preferred, add some sport drink flavoring to make it more acceptable.
- Limiting daily intake of caffeine and alcohol (both are diuretics and stimulate increased production of urine).

Heatstroke

Heatstroke is a condition caused by any inability of the body to control its temperature. Onset of this condition may be recognized by the symptoms of dehydration, but also has been known to be recognized only upon complete collapse.

To prevent these symptoms, it is recommended that an ample supply of water be carried and used at frequent intervals, whether thirsty or not. The body normally absorbs water at a rate of 1.2 to 1.5 quarts per hour. Individuals should drink one quart per hour for severe heat stress conditions or one pint per hour for moderate stress conditions. For more information on water consumption, refer to the “Dehydration” section of this chapter.

Drugs

The Federal Aviation Regulations include no specific references to medication usage. Title 14 of the CFR prohibits acting as PIC or in any other capacity as a required pilot flight crewmember, while that person:

1. Knows or has reason to know of any medical condition that would make the person unable to meet the requirement for the medical certificate necessary for the pilot operation, or
2. Is taking medication or receiving other treatment for a medical condition that results in the person being unable to meet the requirements for the medical certificate necessary for the pilot operation.

Further, 14 CFR part [107](#) and 14 CFR part 91, sections [91.17](#) and [91.19](#) prohibit the use of any drug that affects the person's faculties in any way contrary to safety.

There are several thousand medications currently approved by the U.S. Food and Drug Administration (FDA), not including OTC drugs. Virtually all medications have the potential for adverse side effects in some people. Additionally, herbal and dietary supplements, sport and energy boosters, and some other "natural" products are derived from substances often found in medications that could also have adverse side effects. While some individuals experience no side effects with a particular drug or product, others may be noticeably affected. The FAA regularly reviews FDA and other data to assure that medications found acceptable for aviation duties do not pose an adverse safety risk.

Some of the most commonly used OTC drugs, antihistamines and decongestants, have the potential to cause noticeable adverse side effects, including drowsiness and cognitive deficits. The symptoms associated with common upper respiratory infections, including the common cold, often suppress a pilot's desire to fly, and treating symptoms with a drug that causes adverse side effects only compounds the problem. Particularly, medications containing diphenhydramine (e.g., Benadryl) are known to cause drowsiness and have a prolonged half-life, meaning the drugs stay in one's system for an extended time, which lengthens the time that side effects are present.

Prior to each and every flight, all pilots must do a proper physical self-assessment to ensure safety. A great mnemonic is IMSAFE, which stands for Illness, Medication, Stress, Alcohol, Fatigue, and Emotion.

For the medication component of IMSAFE, pilots need to ask themselves, "Am I taking any medicines that might affect my judgment or make me drowsy? For any new medication, OTC or prescribed, you should wait at least 48 hours after the first dose before flying to determine you do not have any adverse side effects that would make it unsafe to operate an aircraft. In addition to medication questions, pilots should also consider the following:

- Do not take any unnecessary or elective medications.
- Make sure you eat regular balanced meals.
- Bring a snack.
- Maintain good hydration - bring plenty of water.
- Ensure adequate sleep the night prior to the flight.
- Stay physically fit.

Alcohol

Alcohol impairs the efficiency of the human body. [Figure 9-1] 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. Impairments in vision and hearing can occur from consuming as little as one drink.

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.

[illegible]

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).		

Figure 9-1. *Impairment scale with alcohol use.*

Intoxication is determined by the amount of alcohol in the bloodstream. This is usually measured as a percentage by weight in the blood. [14 CFR part 91](#) requires that blood alcohol level be less than .04 percent and that 8 hours pass between drinking alcohol and piloting an aircraft. A pilot with a blood alcohol level of .04 percent or greater after 8 hours cannot fly until the blood alcohol falls below that amount. Even though blood alcohol may be well below .04 percent, a pilot cannot fly sooner than 8 hours after drinking alcohol. Although the regulations are quite specific, it is a good idea to be more conservative than the regulations.

Vision and Flight

The more a pilot understands about the eyes and how they function, the easier it is to use vision effectively and compensate for potential problems.

Scanning Techniques

To scan effectively, pilots must look from right to left or left to right. They should begin scanning at the greatest distance an object can be perceived (top) and move inward toward the position of the aircraft (bottom). For each stop, an area approximately 30° wide should be scanned. The duration of each stop is based on the degree of detail that is required, but no stop should last longer than 2 to 3 seconds. When moving from one viewing point to the next, pilots should overlap the previous field of view by 10° . [Figure 9-2]

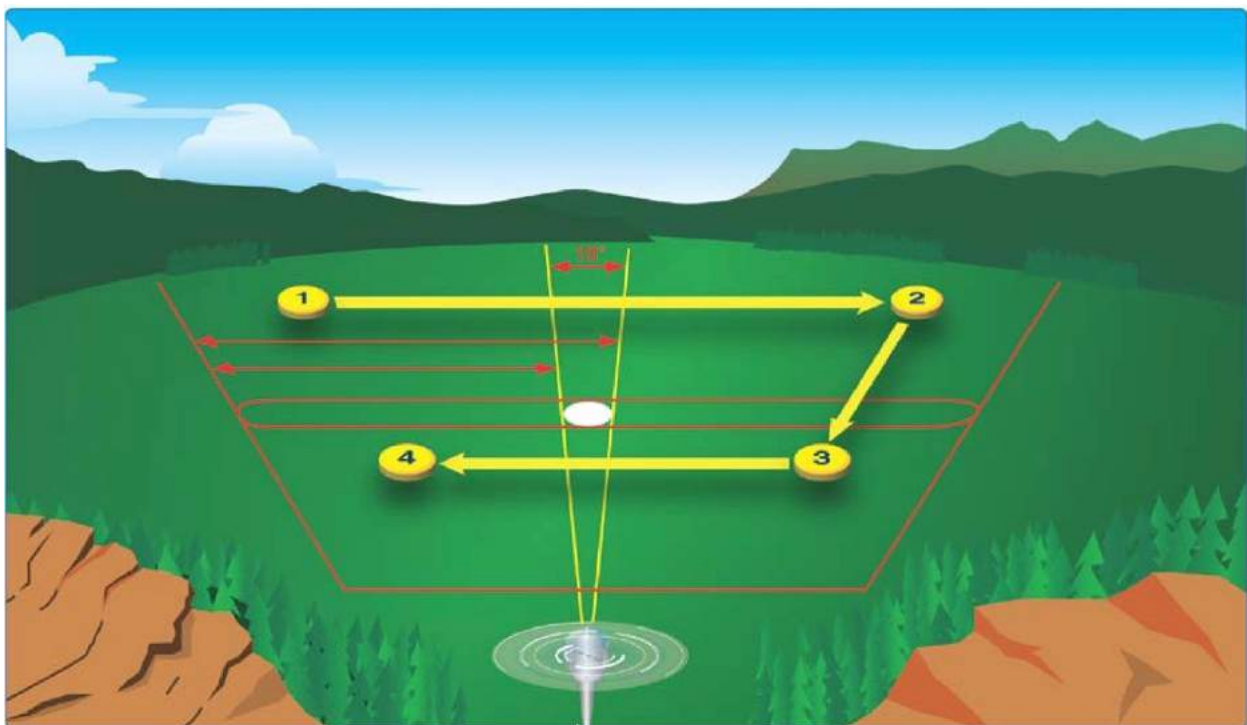


Figure 9-2. Scanning techniques.

Quiz 6

_____ is the excessive rate and depth of respiration leading to abnormal loss of carbon dioxide.

- Hyperventilation
- Stress
- Fatigue
- Dehydration

_____ is the body's response to physical and psychological demands placed upon it.

- Stress
- Fatigue
- Dehydration
- Hyperventilation

Which of the following is condition caused by any inability of the body to control its temperature?

- Heat Stroke
- Dehydration
- Drugs
- Hyperventilation

For any new medication, you should wait at least _____ hours after the first dose before flying.

- 48
- 60
- 100
- 24

Considerable amounts of alcohol can remain in the body for over _____ hours.

- 16
- 5
- 2
- 10

14 CFR part 91 requires that blood alcohol level be less than _____ percent.

- .04
- .10
- .20
- .08

For each stop, an area approximately _____ ° wide should be scanned.

- 30
- 15
- 55
- 45

A pilot cannot fly sooner than _____ hours after drinking alcohol.

- 8
- 24
- 2
- 5

Which condition is caused by hot temperatures, wind, and humidity?

- Dehydration
- Stress
- Heatstroke
- Hyperventilation

Chapter 10: Aeronautical Decision-Making and Judgment

Introduction

Aeronautical decision-making (ADM) is decision-making in a unique environment—aviation. It 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. It is what a pilot intends to do based on the latest information he or she has.

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).

ADM is a systematic approach to risk assessment and stress management. To understand ADM is to also understand how personal attitudes can influence decision-making and how those attitudes can be modified to enhance safety in the operation of a small UA. It is important to understand the factors that cause humans to make decisions and how the decision-making process not only works, but can be improved.

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. Aeronautical Decision Making and Risk Management are topics that the FAA is required to test an applicant about for the issuance of an sUAS certificate. 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 inflight

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.

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 and identifies the steps involved in good decisionmaking.

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.

[illegible]

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. The formal risk management decision-making process involves six steps as shown in Figure 10-1.

Consider automotive seat belt use. In just two decades, seat belt use has become the norm, placing those who do not wear seat belts outside the norm, but this group may learn to wear a seat belt by either direct or indirect experience. For example, a driver learns through direct experience about the value of wearing a seat belt when he or she is involved in a car accident that leads to a personal injury. An indirect learning experience occurs when a loved one is injured during a car accident because he or she failed to wear a seat belt.



Figure 10-1. Risk management decision-making process.

As you work through the ADM cycle, it is important to remember the four fundamental principles of risk management.

1. Accept no unnecessary risk. Flying is not possible without risk, but unnecessary risk comes without a corresponding return.
2. Make risk decisions at the appropriate level. Risk decisions should be made by the person who can develop and implement risk controls.
3. Accept risk when benefits outweigh dangers (costs).
4. Integrate risk management into planning at all levels. Because risk is an unavoidable part of every flight, safety requires the use of appropriate and effective risk management not just in the preflight planning stage, but in all stages of the flight.

While poor decision-making in everyday life does not always lead to tragedy, the margin for error in aviation is thin. Since ADM enhances management of an aeronautical environment, all pilots should become familiar with and employ ADM.

Resource Management (CRM) (SRM)

While CRM focuses on pilots operating in crew environments, many of the concepts apply to single-pilot operations. Many CRM principles have been successfully applied to single-pilot aircraft and led to the development of Single-Pilot Resource Management (SRM). SRM is defined as the art and science of managing all the resources available to a single pilot (prior to and during flight) to ensure the successful outcome of the flight. SRM includes the concepts of ADM, risk management (RM), task management (TM), automation management (AM), controlled flight into terrain (CFIT) awareness, and situational awareness (SA). SRM training helps the pilot maintain situational awareness by managing the automation and associated aircraft control and navigation tasks. This enables the pilot to accurately assess and manage risk and make accurate and timely decisions.

SRM is all about helping pilots learn how to gather information, analyze it, and make decisions.

[illegible]

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.

Hazardous Attitudes and Antidotes

Being fit to fly depends on more than just a pilot's physical condition and recent experience. For example, attitude affects 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. [Figure 10-2]

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.

[illegible]

The Five Hazardous Attitudes	Antidote
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.	Follow the rules. They are usually right.
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.	Not so fast. Think first.
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.	It could happen to me.
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.	Taking chances is foolish.
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 them 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."	I'm not helpless. I can make a difference.

Figure 10-2. The five hazardous attitudes identified through past and contemporary study.

Risk

During each flight, the single pilot makes many decisions under hazardous conditions. To fly safely, the pilot needs to assess the degree of risk and determine the best course of action to mitigate the risk.

Assessing Risk

For the single pilot, assessing risk is not as simple as it sounds. For example, the pilot acts as his or her own quality control in making decisions. If a fatigued pilot who has flown 16 hours is asked if he or she is too tired to continue flying, the answer may be "no." Most pilots are goal oriented and when asked to accept a flight, there is a tendency to deny personal limitations while adding weight to issues not germane to the mission. For example, pilots of helicopter emergency services (EMS) have been known (more than other groups) to make flight decisions that add significant weight to the patient's welfare. These pilots add weight to intangible factors (the patient in this case) and fail to appropriately quantify actual hazards, such as fatigue or weather, when making flight decisions. The single pilot who has no other crew member for consultation

must wrestle with the intangible factors that draw one into a hazardous position. Therefore, he or she has a greater vulnerability than a full crew.

Mitigating Risk

Risk assessment is only part of the equation.

One of the best ways single pilots can mitigate risk is to use the IMSAFE checklist to determine physical and mental readiness for flying:

1. Illness—Am I sick? Illness is an obvious pilot risk.
2. Medication—Am I taking any medicines that might affect my judgment or make me drowsy?
3. Stress—Am I under psychological pressure from the job? Do I have money, health, or family problems? Stress causes concentration and performance problems. While the regulations list medical conditions that require grounding, stress is not among them. The pilot should consider the effects of stress on performance.
4. Alcohol—Have I been drinking within 8 hours? Within 24 hours? As little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair flying skills. Alcohol also renders a pilot more susceptible to disorientation and hypoxia.
5. Fatigue—Am I tired and not adequately rested? Fatigue continues to be one of the most insidious hazards to flight safety, as it may not be apparent to a pilot until serious errors are made.
6. Emotion—Am I emotionally upset?

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: **P**ilot-in-command (PIC), **A**ircraft, **e**nvironment, and **E**xternal 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 flight?” 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? • Can this aircraft carry the planned load?

V = EnVironment

Weather

Weather is a 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 is the current ceiling and visibility?
- Consider the possibility that the weather may be different than forecast.
- Are there any thunderstorms present or forecast?
- If there are clouds, is there any icing, current or forecast? What is the temperature/dew point spread and the current temperature at altitude?

Terrain

Evaluation of terrain is another important component of analyzing the flight environment.

Airspace

Check the airspace and any temporary flight restriction (TFRs).

[illegible]

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 demonstrate pilot qualifications
- The desire to impress someone (Probably the two most dangerous words in aviation are “Watch this!”)
- The pilot’s general goal-completion orientation
- Emotional pressure associated with acknowledging that skill and experience levels may be lower than a pilot would like them to be. Pride can be a powerful external factor!

Managing External Pressures

Management of external pressure is the single most important key to risk management because it is the one risk factor category that can cause a pilot to ignore all the other risk factors.

The use of personal standard operating procedures (SOPs) is one way to manage external pressures. The goal is to supply a release for the external pressures of a flight.

Human Factors

Why are human conditions, such as fatigue, complacency and stress, so important in aviation? These conditions, along with many others, are called human factors. Human factors directly cause or contribute to many aviation accidents and have been documented as a primary contributor to more than 70 percent of aircraft accidents.

Typically, human factor incidents/accidents are associated with flight operations but recently have also become a major concern in aviation maintenance and air traffic management as well. Over the past several years, the FAA has made the study and research of human factors a top priority by working closely with engineers, pilots, mechanics, and ATC to apply the latest knowledge about human factors in an effort to help operators and maintainers improve safety and efficiency in their daily operations.

Human factors science, or human factors technologies, is a multidisciplinary field incorporating contributions from psychology, engineering, industrial design, statistics, operations research, and anthropometry. It is a term that covers the science of understanding the properties of human capability, the application of this understanding to the design, development and deployment of systems and services, and the art of ensuring successful application of human factor principles into all aspects of aviation to include pilots, ATC, and aviation maintenance. Human factors is often considered synonymous with CRM or maintenance resource management (MRM) but is really

much broader in both its knowledge base and scope. Human factors involves gathering research specific to certain situations (i.e., flight, maintenance, stress levels, knowledge) about human abilities, limitations, and other characteristics and applying it to tool design, machines, systems, tasks, jobs, and environments to produce safe, comfortable, and effective human use. The entire aviation community benefits greatly from human factors research and development as it helps better understand how humans can most safely and efficiently perform their jobs and improve the tools and systems in which they interact.

The Decision-Making Process

An understanding of the decision-making process provides the pilot with a foundation for developing ADM and SRM skills. While some situations, such as engine failure, require an immediate pilot response using established procedures, there is usually time during a flight to analyze any changes that occur, gather information, and assess risks before reaching a decision.

Risk management and risk intervention is much more than the simple definitions of the terms might suggest. Risk management and risk intervention are decision-making processes designed to systematically identify hazards, assess the degree of risk, and determine the best course of action. These processes involve the identification of hazards, followed by assessments of the risks, analysis of the controls, making control decisions, using the controls, and monitoring the results.

The steps leading to this decision constitute a decision-making process. Three models of a structured framework for problem-solving and decision-making are the 5P, the 3P using PAVE, CARE and TEAM, and the DECIDE models. They provide assistance in organizing the decision process. All these models have been identified as helpful to the single pilot in organizing critical decisions.

Single-Pilot Resource Management (SRM)

Single-Pilot Resource Management (SRM) is about how to gather information, analyze it, and make decisions. Learning how to identify problems, analyze the information, and make informed and timely decisions is not as straightforward as the training involved in learning specific maneuvers. Learning how to judge a situation and “how to think” in the endless variety of situations encountered while flying out in the “real world” is more difficult.

There is no one right answer in ADM, rather each pilot is expected to analyze each situation in light of experience level, personal minimums, and current physical and mental readiness level, and make his or her own decision.

Perceive, Process, Perform (3P) Model

The Perceive, Process, Perform (3P) model for ADM offers a simple, practical, and systematic approach that can be used during all phases of flight. To use it, the pilot will:

- Perceive the given set of circumstances for a flight
- Process by evaluating their impact on flight safety
- Perform by implementing the best course of action

Use the Perceive, Process, Perform, and Evaluate method as a continuous model for every aeronautical decision that you make. Although human beings will inevitably make mistakes, anything that you can do to recognize and minimize potential threats to your safety will make you a better pilot.

Depending upon the nature of the activity and the time available, risk management processing can take place in any of three timeframes. [Figure 10-3] Most flight training activities take place in the “time-critical” timeframe for risk management. The six steps of risk management can be combined into an easy-to-remember 3P model for practical risk management: Perceive, Process, Perform with the PAVE, CARE and TEAM checklists. Pilots can help perceive hazards by using the PAVE checklist of: Pilot, Aircraft, enVironment, and External pressures. They can process hazards by using the CARE checklist of: Consequences, Alternatives, Reality, External factors. Finally, pilots can perform risk management by using the TEAM choice list of: Transfer, Eliminate, Accept, or Mitigate.

	Strategic	Deliberate	Time-Critical
Purpose	Used in a complex operation (e.g., introduction of new equipment); involves research, use of analysis tools, formal testing, or long term tracking of risks.	Uses experience and brainstorming to identify hazards, assess risks, and develop controls for planning operations, review of standard operating or training procedures, etc.	“On the fly” mental or verbal review using the basic risk management process during the execution phase of an activity.

Figure 10-3. Risk management processing can take place in any of three timeframes.

PAVE Checklist: Identify Hazards and Personal Minimums In the first step, the goal is to develop situational awareness by perceiving hazards, which are present events, objects, or circumstances that could contribute to an undesired future event. In this step, the pilot will systematically identify and list hazards associated with all aspects of the flight: **P**ilot, **A**ircraft, **e**n**V**ironment, and **E**xternal pressures, which makes up the PAVE checklist. [Figure 10-4] All four elements combine and interact to create a unique situation for any flight. Pay special attention to the pilot-aircraft combination, and consider whether the combined “pilot-aircraft team” is capable of the mission you want to fly. For example, you may be a very experienced and proficient pilot, but your weather flying ability is still limited if you are flying an unfamiliar aircraft. On the other hand, you may have a new technically advanced aircraft that you have flown for a considerable amount of time.

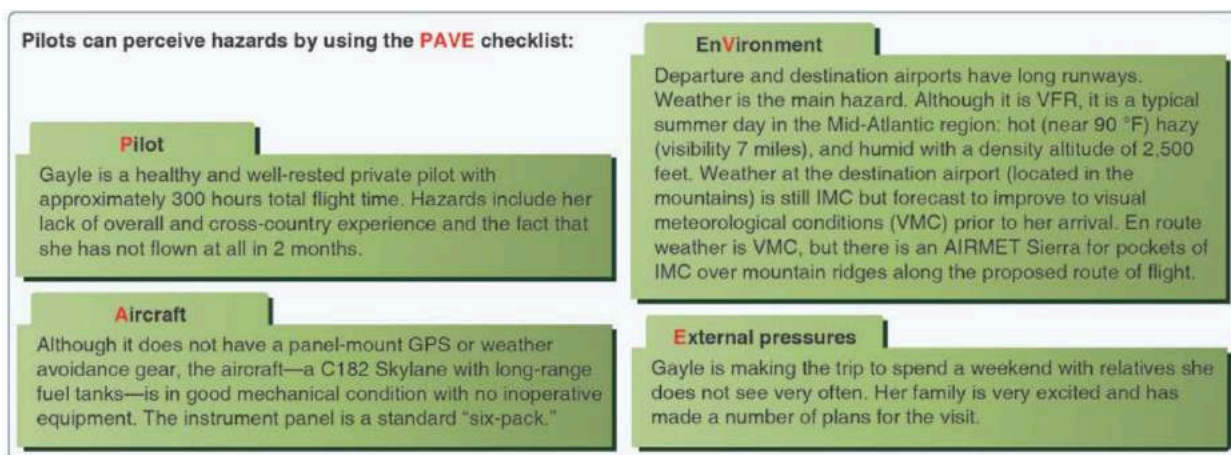


Figure 10-4. A real-world example of how the 3P model guides decisions on a cross-country trip using the PAVE checklist.

Decision-Making in a Dynamic Environment

A solid approach to decision-making is through the use of analytical models, such as the 5 Ps, 3P, and DECIDE. Good decisions result when pilots gather all available information, review it, analyze the options, rate the options, select a course of action, and evaluate that course of action for correctness.

In some situations, there is not always time to make decisions based on analytical decision-making skills. A good example is a quarterback whose actions are based upon a highly fluid and changing situation. He intends to execute a plan, but new circumstances dictate decision-making on the fly. This type of decision-making is called automatic decision-making or naturalized decision-making. [Figure 10-5B]

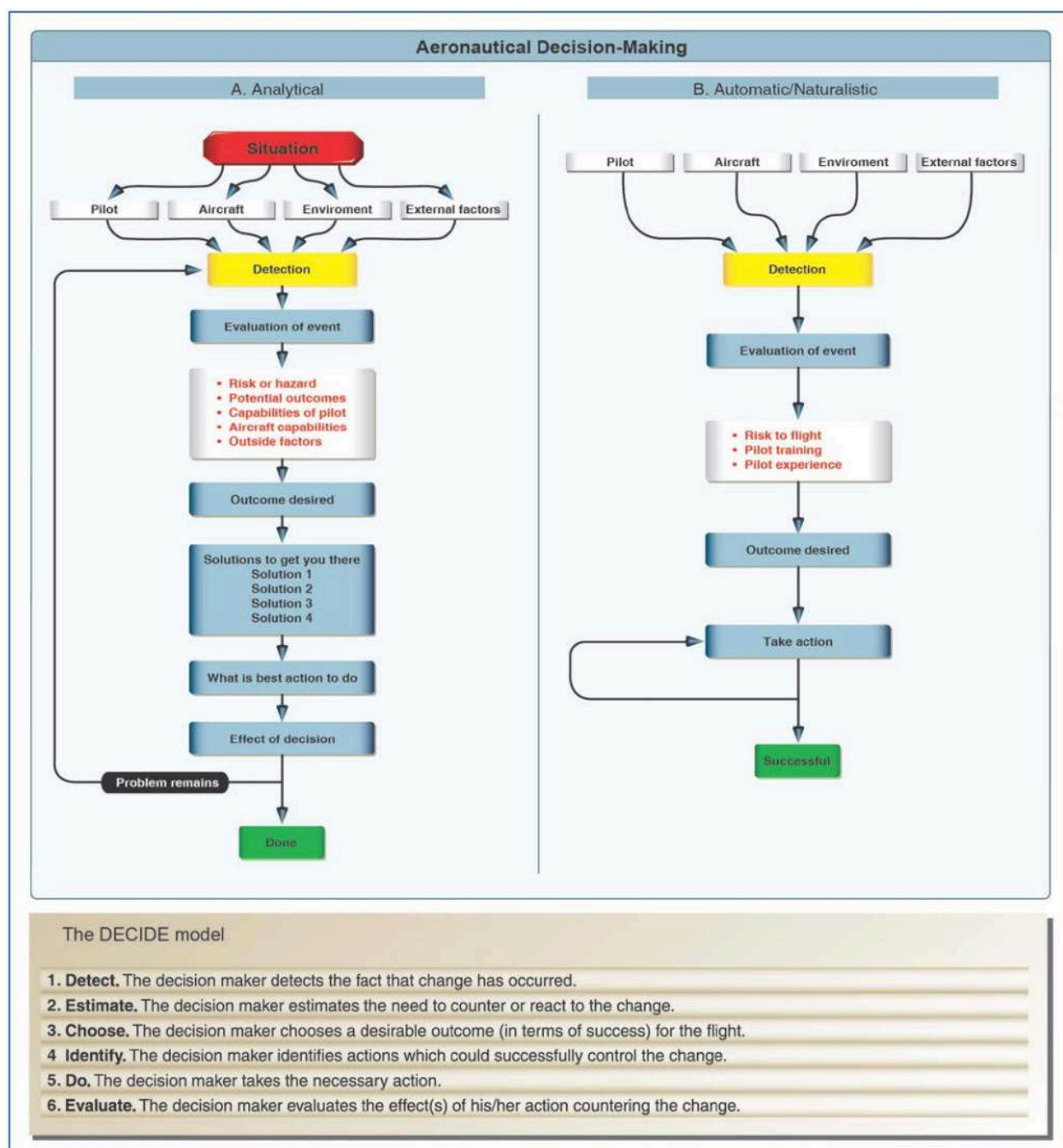


Figure 10-5. The DECIDE model has been recognized worldwide. Its application is illustrated in column A while automatic/naturalistic decision-making is shown in column B.

Automatic Decision-Making

For the past several decades, research into how people actually make decisions has revealed that when pressed for time, experts faced with a task loaded with uncertainty first assess whether the situation strikes them as familiar. Rather than comparing the pros and cons of different approaches, they quickly imagine how one or a few possible courses of action in such situations will play out.

Experts take the first workable option they can find. While it may not be the best of all possible choices, it often yields remarkably good results.

The terms “naturalistic” and “automatic decision-making” have been coined to describe this type of decision-making. The ability to make automatic decisions holds true for a range of experts from firefighters to chess players. It appears the expert’s ability hinges on the recognition of patterns and consistencies that clarify options in complex situations. Experts appear to make provisional sense of a situation, without actually reaching a decision, by launching experience-based actions that in turn trigger creative revisions.

This is a reflexive type of decision-making anchored in training and experience and is most often used in times of emergencies when there is no time to practice analytical decision-making. Naturalistic or automatic decision-making improves with training and experience, and a pilot will find himself or herself using a combination of decision-making tools that correlate with individual experience and training.

Operational Pitfalls

Although more experienced pilots are likely to make more automatic decisions, there are tendencies or operational pitfalls that come with the development of pilot experience. These are classic behavioral traps into which pilots have been known to fall. More experienced pilots, as a rule, try to complete a flight as planned. The desire to meet these goals can have an adverse effect on safety and contribute to an unrealistic assessment of piloting skills. These dangerous tendencies or behavior patterns, which must be identified and eliminated, include the operational pitfalls shown in Figure 10-6.

Operational Pitfalls	
Peer pressure	Poor decision-making may be based upon an emotional response to peers, rather than evaluating a situation objectively.
Mindset	A pilot displays mind set through an inability to recognize and cope with changes in a given situation.
Get-there-itis	This disposition impairs pilot judgment through a fixation on the original goal or destination, combined with a disregard for any alternative course of action.
Duck-under syndrome	A pilot may be tempted to make it into an airport by descending below minimums during an approach. There may be a belief that there is a built-in margin of error in every approach procedure, or a pilot may want to admit that the landing cannot be completed and a missed approach must be initiated.
Scud running	This occurs when a pilot tries to maintain visual contact with the terrain at low altitudes while instrument conditions exist.
Continuing visual flight rules (VFR) into instrument conditions	Spatial disorientation or collision with ground/obstacles may occur when a pilot continues VFR into instrument conditions. This can be even more dangerous if the pilot is not instrument rated or current.
Getting behind the aircraft	This pitfall can be caused by allowing events or the situation to control pilot actions. A constant state of surprise at what happens next may be exhibited when the pilot is getting behind the aircraft.
Loss of positional or situational awareness	In extreme cases, when a pilot gets behind the aircraft, a loss of positional or situational awareness may result. The pilot may not know the aircraft's geographical location or may be unable to recognize deteriorating circumstances.
Operating without adequate fuel reserves	Ignoring minimum fuel reserve requirements is generally the result of overconfidence, lack of flight planning, or disregarding applicable regulations.
Descent below the minimum en route altitude	The duck-under syndrome, as mentioned above, can also occur during the en route portion of an IFR flight.
Flying outside the envelope	The assumed high performance capability of a particular aircraft may cause a mistaken belief that it can meet the demands imposed by a pilot's overestimated flying skills.
Neglect of flight planning, preflight inspections, and checklists	A pilot may rely on short- and long-term memory, regular flying skills, and familiar routes instead of established procedures and published checklists. This can be particularly true of experienced pilots.

Figure 10-6. *Typical operational pitfalls requiring pilot awareness.*

Stress Management

Everyone is stressed to some degree almost all of the time. A certain amount of stress is good since it keeps a person alert and prevents complacency. Effects of stress are cumulative and, if the pilot does not cope with them in an appropriate way, they can eventually add up to an intolerable burden. Performance generally increases with the onset of stress, peaks, and then begins to fall off rapidly as stress levels exceed a person's ability to cope. The ability to make effective decisions during flight can be impaired by stress. There are two categories of stress—acute and chronic. These are

both explained in [Chapter 9](#), “Physiological Factors (Including Drugs and Alcohol) Affecting Pilot Performance,” of this course.

There are several techniques to help manage the accumulation of life stresses and prevent stress overload. For example, to help reduce stress levels, set aside time for relaxation each day or maintain a program of physical fitness. To prevent stress overload, learn to manage time more effectively to avoid pressures imposed by getting behind schedule and not meeting deadlines.

Use of Resources

To make informed decisions during flight operations, a pilot must also become aware of the available resources. Since useful tools and sources of information may not always be readily apparent, learning to recognize these resources is an essential part of ADM training. Resources must not only be identified, but a pilot must also develop the skills to evaluate whether there is time to use a particular resource and the impact its use will have upon the safety of flight.

Stressors	
Environmental	Conditions associated with the environment, such as temperature and humidity extremes, noise, vibration, and lack of oxygen.
Physiological stress	Physical conditions, such as fatigue, lack of physical fitness, sleep loss, missed meals (leading to low blood sugar levels), and illness.
Psychological stress	Social or emotional factors, such as a death in the family, a divorce, a sick child, or a demotion at work. This type of stress may also be related to mental workload, such as analyzing a problem, navigating an aircraft, or making decisions.

Figure 10-7. System stressors. Environmental, physiological, and psychological stress are factors that affect decision-making skills. These stressors have a profound impact especially during periods of high workload.

Situational Awareness

Situational awareness is the accurate perception and understanding of all the factors and conditions within the five fundamental risk elements (flight, pilot, aircraft, environment, and type of operation that comprise any given aviation situation) that affect safety before, during, and after the flight.

Maintaining situational awareness requires an understanding of the relative significance of all flight related factors and their future impact on the flight. When a pilot understands what is going on and has an overview of the total operation, he or she is not fixated on one perceived significant factor. Not only is it important for a pilot to know the aircraft's geographical location, it is also important he or she understand what is happening.

Obstacles to Maintaining Situational Awareness

Fatigue, stress, and work overload can cause a pilot to fixate on a single perceived important item and reduce an overall situational awareness of the flight. A contributing factor in many accidents is a distraction that diverts the pilot's attention from monitoring the aircraft.

Workload Management

Effective workload management ensures essential operations are accomplished by planning, prioritizing, and sequencing tasks to avoid work overload. As experience is gained, a pilot learns to recognize future workload requirements and can prepare for high workload periods during times of low workload.

In addition, a pilot should listen to ATIS, Automated Surface Observing System (ASOS), or Automated Weather Observing System (AWOS), if available, and then monitor the tower frequency or Common Traffic Advisory Frequency (CTAF) to get a good idea of what traffic conditions to expect.

Recognizing a work overload situation is also an important component of managing workload. The first effect of high workload is that the pilot may be working harder but accomplishing less. As workload increases, attention cannot be devoted to several tasks at one time, and the pilot may begin to focus on one item. When a pilot becomes task saturated, there is no awareness of input from various sources, so decisions may be made on incomplete information and the possibility of error increases.

When a work overload situation exists, a pilot needs to stop, think, slow down, and prioritize. It is important to understand how to decrease workload.

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Quiz 7

What is the estimated percentage of aviation events related to human factors?

- 80%
- 30%
- 50%
- 60%

What percentage of human factor-caused aviation accidents occur during landing?

- 24.1
- 35.3
- 10
- 8.6

What percentage of human factor-caused aviation accidents occur during takeoff?

- 23.4
- 24.1
- 15.6
- 18.2

ADM research, development, and testing culminated in _____.

- 1987
- 1923
- 1946
- 2000

Which of the following is a fundamental principle of risk management?

- All answers are correct.
- Accept no unnecessary risk.
- Accept risk when benefits outweigh dangers.
- Integrate risk management into planning.
- Accept risk when benefits outweigh dangers.

Which of the following answers is a step for good decision-making?

- All answers are correct.
- Learning behavior modification techniques.
- Using all resources.
- Learning to cope with stress.

Which of the following answers is a hazardous attitude?

- All answers are correct.
- Anti-Authority
- Impulsivity
- Invulnerability
- Resignation
- All answers are incorrect.

The IMSAFE checklist is used to determine readiness for flying. Which of the following answers is included in the checklist?

- All answers are correct.
- Illness
- Medication
- Stress
- Alcohol

What is the purpose of Single-Pilot Resource Management (SRM)?

- All answers are correct.
- Gathering information.
- Analyzing information.
- Making decisions.

Chapter 11: Airport Operations

Introduction

The definition for airports refers to any area of land or water used or intended for landing or takeoff of aircraft. This includes, within the five categories of airports listed below, special types of facilities including seaplane bases, heliports, and facilities to accommodate tilt rotor aircraft. An airport includes an area used or intended for airport buildings, facilities, as well as rights of way together with the buildings and facilities.

Types of Airports

There are two types of airports—towered and non-towered. These types can be further subdivided to:

- Civil Airports—airports that are open to the general public.
- Military/Federal Government airports—airports operated by the military, National Aeronautics and Space Administration (NASA), or other agencies of the Federal Government.
- Private Airports—airports designated for private or restricted use only, not open to the general public.

Towered Airport

A towered airport has an operating control tower. Air traffic control (ATC) is responsible for providing the safe, orderly, and expeditious flow of air traffic at airports where the type of operations and/or volume of traffic requires such a service.

Non-towered Airport

A non-towered airport does not have an operating control tower. Two-way radio communications are not required, although it is a good operating practice for pilots to monitor other aircraft on the specified frequency for the benefit of other traffic in the area. The key to monitoring traffic at an airport without an operating control tower is selection of the correct common frequency. The acronym CTAF, which stands for Common Traffic Advisory Frequency, is synonymous with this program. A CTAF is a frequency designated for the purpose of carrying out airport advisory practices while operating to or from an airport without an operating control tower. The CTAF may be a Universal Integrated Community (UNICOM), MULTICOM, FSS, or tower frequency and is identified in appropriate aeronautical publications. UNICOM is a nongovernment air/ground radio communication station that may provide airport information at public use airports where there is no tower or FSS.

Non-towered airport traffic patterns are always entered at pattern altitude. How you enter the pattern depends upon the direction of arrival. The preferred method for

entering from the downwind side of the pattern is to approach the pattern on a course 45 degrees to the downwind leg and join the pattern at midfield.

Sources for Airport Data

When a remote pilot operates in the vicinity of an airport, it is important to review the current data for that airport. This data provides the pilot with information, such as communication frequencies, services available, closed runways, or airport construction. Three common sources of information are:

- Aeronautical Charts
- Chart Supplement U.S. (formerly Airport/Facility Directory)
- Notices to Airmen (NOTAMs)
- Automated Terminal Information Service (ATIS)

Chart Supplement U.S. (formerly Airport/Facility Directory) The Chart Supplement U.S. (formerly Airport/Facility Directory) provides the most comprehensive information on a given airport. It contains information on airports, heliports, and seaplane bases that are open to the public. The Chart Supplement U.S. is published in seven books, which are organized by regions and are revised every 56 days. The Chart Supplement U.S. is also available digitally at www.faa.gov/air_traffic/flight_info/aeronav. Figure 11-1 contains an excerpt from a directory. For a complete listing of information provided in a Chart Supplement U.S. and how the information may be decoded, refer to the “Legend Sample” located in the front of each Chart Supplement U.S.

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BIRMINGHAM INTL (BHM) 4 NE UTC-6(-5DT) N33°33.83' W86°45.14'

650 B S4 FUEL 100LL, JET A OX 1, 2 LRA ARFF Index C

RWY 06-24: H1200X150 (ASPH-GRVD) S-175, D-205, DT-350 HIRL CL

RWY 06: ALSF2. TDZL. PAPI(P4L)—GA 2.8° TCH 39'.

RWY 24: MALSR. PAPI(P4L)—GA 3.0° TCH 50'. Thld displcd 1200'.

Tree. 0.5% down.

RWY 18-36: H7100X150 (ASPH-GRVD) S-75, D-170,

DT-240 MIRL

RWY 18: PAPI(P4L)—GA 3.2° TCH 52'. Ground.

RWY 36: REIL. Trees.

AIRPORT REMARKS: Attended continuously. Bird activity invof all rwys.

Normal dep point for Rwy 24 at numbers located at Twy A6. Twy F between twys G and B restricted to acft weighing 100,000 pounds or less. Twy N restricted to acft weighing 204,000 lbs or less. Twy M restricted to acft 75,000 lbs or less. Twy G restricted to acft 65,000 lbs or less. MALSR Rwy 24 controlled by twr but ops unmonitored. South ramp clsd to transient tfc permanently. Flight Notification Service (ADCUS) avbl. NOTE: See Land and Hold Short Operations Section.

WEATHER DATA SOURCES: ASOS (205) 591-6172. WSP.

COMMUNICATIONS: ATIS 119.4 UNICOM 122.95

ANNISTON FSS (ANB) TF 1-800-WX-BRIEF. NOTAM FILE BHM.

RCD 122.2 123.65 (ANNISTON FSS)

① APP/DEP CON 127.675 (231°-049°) 123.8 (050°-230°)

TOWER 119.9 118.25 GND CON 121.7 CLNC DEL 125.675 PRE-TAXI CLNC 125.675

AIRSPACE: CLASS C svc continuous etc APP CON

RADIO AIDS TO NAVIGATION: NOTAM FILE ANB.

VULCAN (H) VORTAC 114.4 VUZ Chan 91 N33°40.21' W86°53.99' 129° 9.8 NM to fld. 750/02E. HIWAS.

MC DEN NDB (HW/LOM) 224 BH N33°30.68' W86°50.74' 057° 5.6 NM to fld. NOTAM FILE BHM.

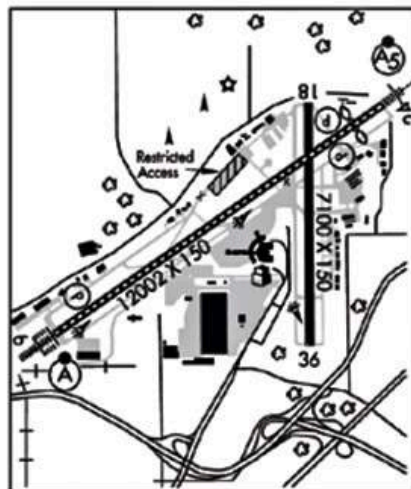
ROEBY NDB (LOM) 394 RO N33°36.46' W86°40.73' 235° 4.6 NM to fld. NOTAM FILE BHM.

ILS 110.3 I-BHM Rwy 06. CLASS IIE. LOM MC DEN NDB.

ILS/DME 109.5 I-ROE Chan 32 Rwy 24. CLASS IE. LOM ROEBY NDB.

ILS/DME 111.3 I-BXO Chan 50 Rwy 18. (LOC only).

ASR



BLACKWELL FLD (See OZARK)

BLOOD N31°49.82' W86°06.33' NOTAM FILE TOI.

NDB (MHW/LOM) 365 TO 070° 5.1 NM to Troy Muni.

NEW ORLEANS

L-18F

BOGGA N33°32.06' W85°55.88' NOTAM FILE ANB.

NDB (LOM) 211 AN 050° 4.9 to Anniston Metropolitan.

ATLANTA

BOLL WEEVIL N31°20.21' W85°59.00' NOTAM FILE ANB.

NDB (MHW) 352 BVG 121° 4.8 NM to Enterprise Muni. Unmonitored Sun and Mon 0500-1200Z†.

Unusable byd 20 NM.

NEW ORLEANS

L-18F, 19A

BRANTLEY N31°33.71' W86°17.58' NOTAM FILE ANB.

NDB (MHW) 410 XBR 120° 34.4 NM to Cairns AAF. NDB unmonitored Sun and Mon 0500-1200Z†.

NEW ORLEANS

L-18F, 19A

Figure 11-1. Chart Supplement U.S. (formerly Airport/Facility Directory excerpt.

Notices to Airmen (NOTAM)

Time-critical aeronautical information, which is of a temporary nature or not sufficiently known in advance to permit publication, on aeronautical charts or in other operational publications, that receives immediate dissemination by the NOTAM system. The NOTAM information could affect your decision to make the flight. Although NOTAMs contain information such as taxiway and runway closures, construction, communications, changes in status of navigational aids, and other information essential to planned en route, terminal, or landing operations, a remote pilot can use this information to help them make an informed decision about where and when to operate their small UA. Exercise good judgment and common sense by carefully regarding the information readily available in NOTAMs.

Prior to any flight, pilots should check for any NOTAMs that could affect their intended flight. For more information on NOTAMs, refer back to [Chapter 2](#), “Airspace Classification, Operating Requirements, and Flight Restrictions,” of this course.

Automated Terminal Information Service (ATIS)

The Automated Terminal Information Service (ATIS) is a recording of the local weather conditions and other pertinent non-control information broadcast on a local frequency in a looped format. It is normally updated once per hour but is updated more often when changing local conditions warrant. Important information is broadcast on ATIS including weather, runways in use, specific ATC procedures, and any airport construction activity that could affect taxi planning.

When the ATIS is recorded, it is given a code. This code is changed with every ATIS update. For example, ATIS Alpha is replaced by ATIS Bravo. The next hour, ATIS Charlie is recorded, followed by ATIS Delta and progresses down the alphabet.

Aeronautical Charts

An aeronautical chart is the road map for a pilot. The chart provides information that allows remote pilots to obtain information about the areas where they intend to operate. The two aeronautical charts used by VFR pilots are:

- Sectional
- VFR Terminal Area

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. Figure 11-2 is an excerpt from the legend of a sectional chart. 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.

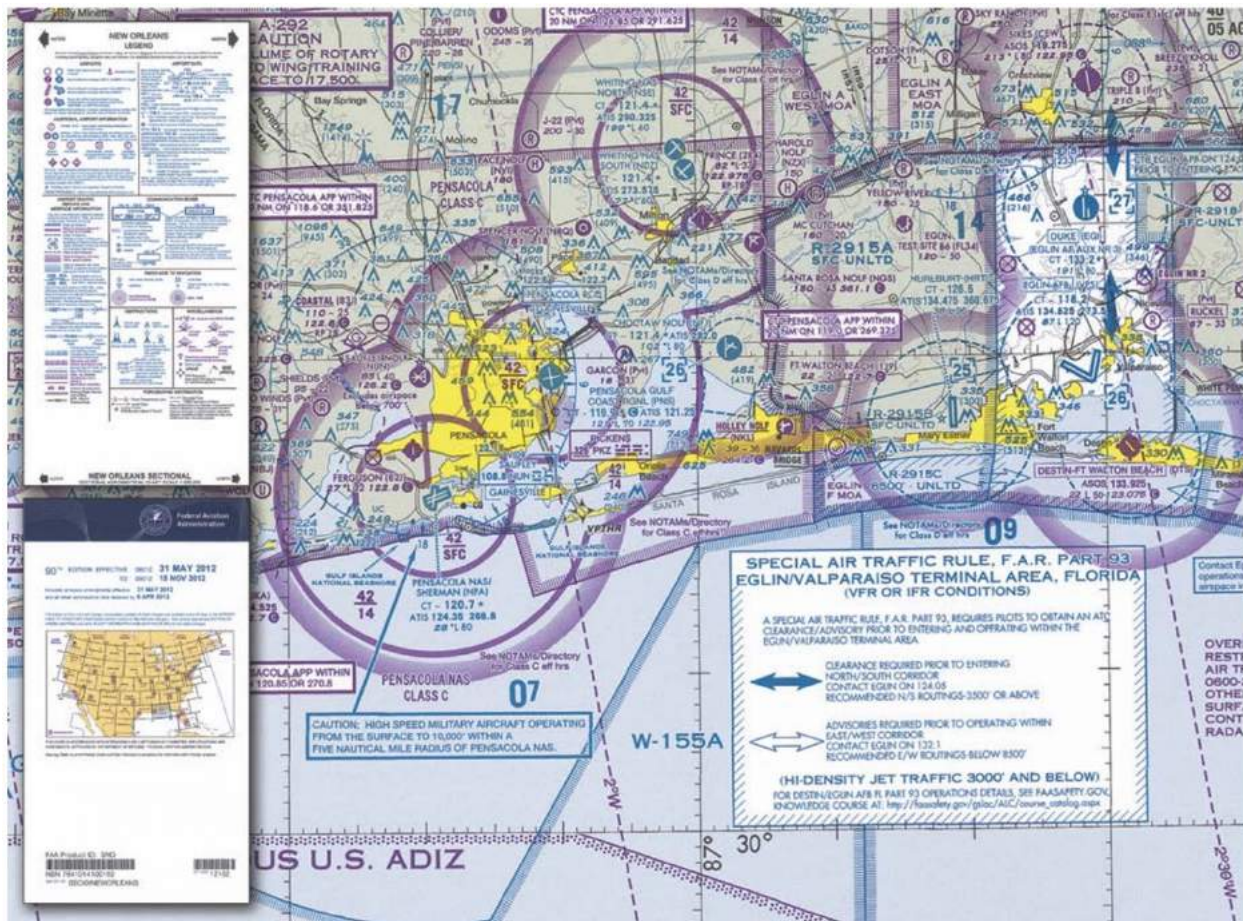


Figure 11-2. Sectional chart and legend.

Latitude and Longitude

The equator is an imaginary circle equidistant from the poles of the Earth. Circles parallel to the equator (lines running east and west) are parallels of latitude. They are

Any specific geographical point can be located by reference to its longitude and latitude. Washington, D.C., for example, is approximately 39° N latitude, 77° W longitude. Chicago is approximately 42° N latitude, 88° W longitude.

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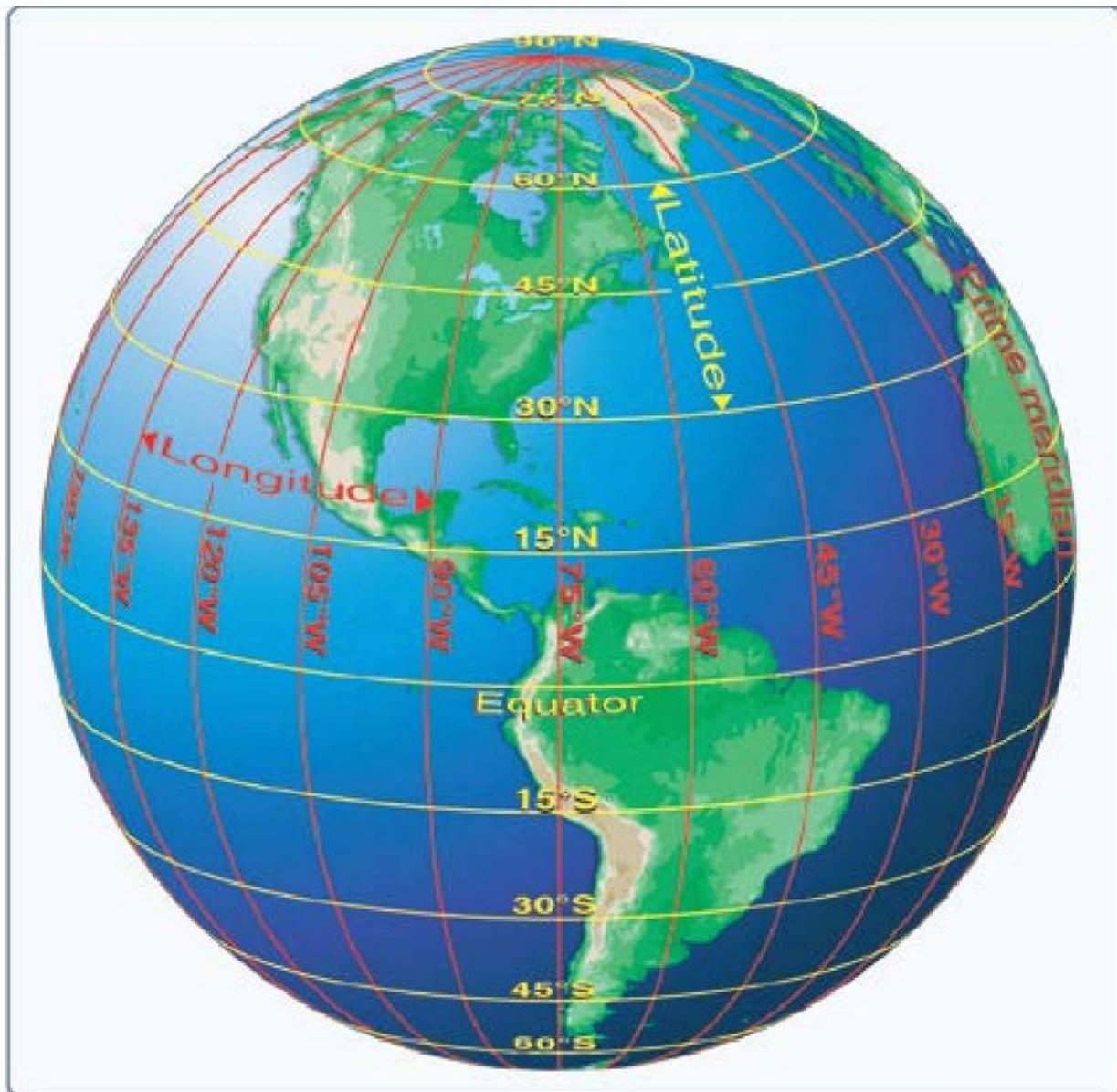


Figure 11-3. *Meridians and parallels—the basis of measuring time, distance, and direction.*

Variation

Variation is the angle between true north (TN) and magnetic north (MN). It is expressed as east variation or west variation depending upon whether MN is to the east or west of TN.

The north magnetic pole is located close to 71° N latitude, 96° W longitude and is about 1,300 miles from the geographic or true north pole, as indicated in Figure 11-4. If the Earth were uniformly magnetized, the compass needle would point toward the magnetic pole, in which case the variation between TN (as shown by the geographical meridians) and MN (as shown by the magnetic meridians) could be measured at any intersection of the meridians.

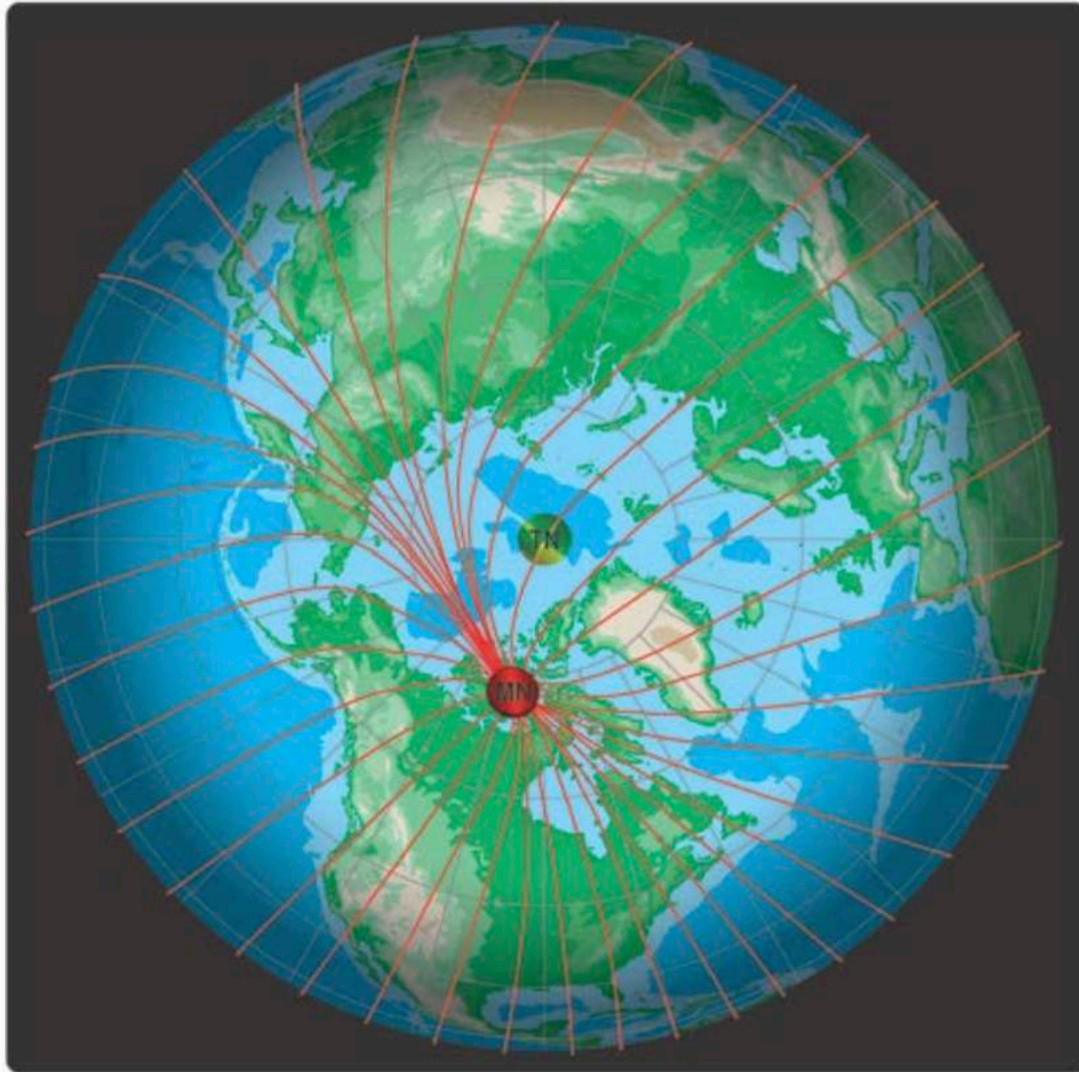


Figure 11-4. *Magnetic meridians are in red while the lines of longitude and latitude are in blue. From these lines of variation (magnetic meridians), one can determine the effect of local magnetic variations on a magnetic compass.*

Actually, the Earth is not uniformly magnetized. In the United States, the needle usually points in the general direction of the magnetic pole, but it may vary in certain

geographical localities by many degrees. Consequently, the exact amount of variation at thousands of selected locations in the United States has been carefully determined. The amount and the direction of variation, which change slightly from time to time, are shown on most aeronautical charts as broken magenta lines called isogonic lines that connect points of equal magnetic variation. (The line connecting points at which there is no variation between TN and MN is the agonic line.) An isogonic chart is shown in Figure 11-5. Minor bends and turns in the isogonic and agonic lines are caused by unusual geological conditions affecting magnetic forces in these areas.

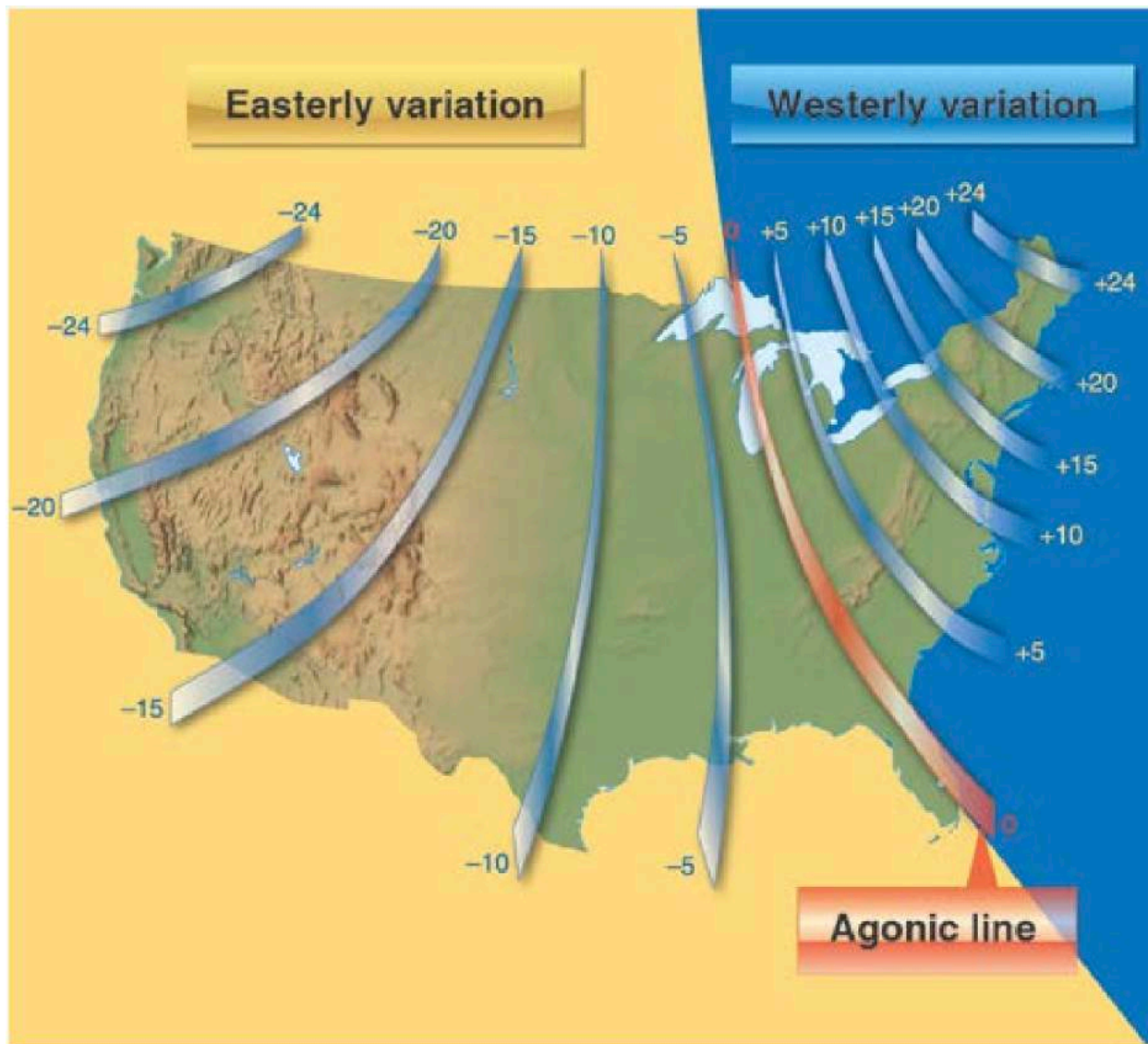


Figure 11-5. *Note the agonic line where magnetic variation is zero.*

Antenna Towers

Extreme caution should be exercised when flying less than 2,000 feet AGL because of numerous skeletal structures, such as radio and television antenna towers, that exceed 1,000 feet AGL with some extending higher than 2,000 feet AGL. Most skeletal structures are supported by guy wires which are very difficult to see in good weather and can be invisible at dusk or during periods of reduced visibility.

These wires can extend about 1,500 feet horizontally from a structure; therefore, all skeletal structures should be avoided horizontally by at least 2,000 feet.

Additionally, new towers may not be on your current chart because the information was not received prior to the printing of the chart.

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Chapter 12: Maintenance and Preflight Inspection Procedures

Inspection Procedures

Maintenance and Preflight Inspection Procedures can be found in chapter 7 of [Advisory Circular 107-2](#).

Part 107 Advisory Circular

Chapter 1. General

1.1 Purpose. This advisory circular (AC) provides guidance in the areas of airman (remote pilot) certification, aircraft registration and marking, aircraft airworthiness, and the operation of small Unmanned Aircraft Systems (sUAS) in the National Airspace System (NAS) to promote compliance with the requirements of Title 14 of the Code of Federal Regulations (14 CFR) part 107, Small Unmanned Aircraft Systems. It does not provide, nor is it intended to provide, a legal interpretation of the regulations. Remote pilots are encouraged to use this information as best practice methods for developing operational programs scaled to specific small unmanned aircraft (UA), associated system equipment, and operations. Use of this AC is intended to assist the remote pilot in meeting the requirements of applicable 14 CFR regulations.

1.1.1 Acceptable Means of Compliance (AMC). This AC uses mandatory terms, such as “must,” only in the sense of ensuring applicability of these particular methods of compliance when using the AMC described herein. This AC is not mandatory and does not constitute a regulation. This AC does not change, add to, or delete regulatory requirements or authorize deviations from regulatory requirements.

1.1.2 Part 107 Provisions. This AC is not intended to cover every provision of part 107. Rather, this AC is intended to provide guidance on those provisions of part 107 where additional information may be helpful. The Federal Aviation Administration (FAA) emphasizes, however, that persons subject to part 107 are responsible for complying with every applicable provision of part 107, regardless of whether the provision is discussed in this AC.

1.1.3 Privacy-Related Laws. Part 107 operators should be aware that state and local authorities may enact privacy-related laws specific to Unmanned Aircraft System (UAS) operations. The FAA encourages sUAS operators to review those laws prior to operating their UAS. The National Telecommunications and Information Administration (NTIA) has also published the Voluntary Best Practices for UAS Privacy, Transparency, and Accountability (https://www.ntia.doc.gov/files/ntia/publications/voluntary_best_practices_for_uas_privacy_transparency_and_accountability_0.pdf). This document outlines and describes voluntary best practices that UAS operators could take to advance UAS privacy, transparency, and accountability for the private and commercial use of UAS.

1.2 Request for Information. Direct comments and suggestions for improving this publication to:

Chapter 2. References

2.1 Related Code of Federal Regulations (CFR) Parts. The following regulations and parts can be found at http://www.faa.gov/regulations_policies/faa_regulations/.

- Title 14 CFR Part 1, Definitions and Abbreviations.

- Title 14 CFR Part 48, Registration and Marking Requirements for Small Unmanned Aircraft.
- Title 14 CFR Part 71, Designation of Class A, B, C, D, and E Airspace Areas; Air Traffic Service Routes; and Reporting Points.
- Title 14 CFR Part 73, Special Use Airspace.
- Title 14 CFR Part 91, General Operating and Flight Rules.
- Title 14 CFR Part 93, Special Air Traffic Rules.
- Title 14 CFR Part 101, Moored Balloons, Kites, Amateur Rockets and Unmanned Free Balloons.
- Title 14 CFR Part 107, Small Unmanned Aircraft Systems.
- Title 47 CFR Part 87, Aviation Services.

2.2 Notices to Airmen (NOTAM). Information on how to obtain NOTAMs can be found at <https://pilotweb.nas.faa.gov/PilotWeb/>.

2.3 Related Reference Material. The following listed reference materials contain additional information necessary to ensure safe operations in the NAS. An sUAS operator may want to consider seeking out additional publications to supplement the lists below.

2.3.1 FAA ACs, Notices, and Orders (current editions). You can find the current editions of the following publications on the FAA Web sites: http://www.faa.gov/regulations_policies/advisory_circulars/ and http://www.faa.gov/regulations_policies/orders_notices/.

- AC 00-6, Aviation Weather.
- AC 00-45, Aviation Weather Services.
- AC 60-28, FAA English Language Skill Standards Required by 14 CFR Parts 61, 63, and 65.
- AC 120-92, Safety Management Systems for Aviation Service Providers.
- FAA Order JO 7110.10, Flight Services.
- FAA Order JO 7110.65, Air Traffic Control.
- FAA Order JO 7210.3, Facility Operation and Administration.
- FAA Order JO 7400.9, Airspace Designations and Reporting Points.
- FAA Order 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft.
- FAA Order 8900.1, Flight Standards Information Management System (FSIMS).

2.3.2 Additional FAA Online/Mobile Sources.

- UAS Web site: <https://www.faa.gov/uas/>.
- UAS Registration Web site: <https://registermyuas.faa.gov/>.
- B4UFLY mobile app.

2.3.3 FAA Handbooks, Manuals, and Other Publications. You can find the following handbooks, manuals, and other publications on the FAA Web site at http://www.faa.gov/regulations_policies/handbooks_manuals.

- Aeronautical Information Manual (AIM): http://www.faa.gov/air_traffic/publications/.
- Aeronautical Charts (Hardcopy): <http://faacharts.faa.gov/>.
- Aeronautical Charts (Digital): http://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/.
- Pilot/Controller Glossary: http://www.faa.gov/air_traffic/publications/.
- Pilot's Handbook of Aeronautical Knowledge: http://www.faa.gov/regulations_policies/handbooks_manuals/aviation/pilot_handbook/.
- General Aviation Pilot's Guide to Preflight Weather Planning, Weather Self-Briefings, and Weather Decision Making: www.faa.gov/nextgen/update/media/ga_weather_decision_making.pdf.
- Risk Management Handbook: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/risk_management_hb_change_1.pdf
- FAA Small Unmanned Aircraft Systems Airman Certification Standards: (TBD).

2.3.4 RTCA, Inc. Documents (current editions). Copies of the current editions of the following RTCA, Inc. documents are available for purchase online at <http://www.rtca.org>.

- DO-178, Software Considerations in Airborne Systems and Equipment Certification.
- DO-304, Guidance Material and Considerations for Unmanned Aircraft Systems.

2.3.5 Public Law (PL). PL 112-95, Title III, Subtitle B—Unmanned Aircraft Systems

Chapter 3. Background

3.1 PL 112-95, Title III, Subtitle B. 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

3.2 Part 107—A Regulatory First Step. The FAA addresses aviation safety in three key areas: personnel, equipment, and operations. The FAA assesses each of these areas both independently to meet current regulations and standards, as well as collectively to ensure no conflicts exist overall that would create an unsafe condition. This approach allows the FAA to be flexible in responding to the needs of the aviation community while still being able to establish standards for future growth and development. To that end, part 107 contains subparts that focus on each of these key aviation safety areas specific to sUAS, and the chapters in this AC are organized in the same manner.

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Chapter 4. Part 107 Subpart A, General

4.1 Applicability. This chapter provides guidance regarding the applicability of part 107 to civil small UA operations conducted within the NAS. However, part 107 does 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; and

8. Air carrier operations.

4.2 Definitions. The following defined terms are used throughout this AC:

4.2.1 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.

4.2.2 Corrective Lenses. Spectacles or contact lenses.

4.2.3 Model Aircraft. A UA that is:

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

4.2.4 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.

4.2.5 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.

4.2.6 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.

4.2.7 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.

4.2.8 Unmanned Aircraft (UA). An aircraft operated without the possibility of direct human intervention from within or on the aircraft.

4.2.9 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.

4.3 Abbreviations/Acronyms Used in the Advisory Circular.

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. VO: visual observer.

4.4 Falsification, Reproduction, or Alteration. The FAA relies on information provided by owners and remote pilots of sUAS when it authorizes operations or when it has to make a compliance determination. Accordingly, the FAA may take appropriate action against an sUAS owner, operator, remote PIC, or anyone else who fraudulently or knowingly provides false records or reports, or otherwise reproduces or alters any records, reports, or other information for fraudulent purposes. Such action could include civil sanctions and the suspension or revocation of a certificate or waiver.

4.5 Accident 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.

4.5.1 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 4-1, 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.

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Figure 4-1. FAA Regional Operations Centers Telephone List

FAA REGIONAL OPERATIONS CENTERS	
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

4.5.2 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.nts.gov.

Chapter 5. Part 107 Subpart B

5.1 Applicability. 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.

5.2 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:

- **5.2.1 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. Guidance regarding remote pilot certification is found in Chapter 6, Part 107 Subpart C, Remote Pilot Certification. Again, the remote PIC will have the final authority and responsibility for the operation and safety of an sUAS operation conducted under part 107.

- **5.2.1.1** 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.

5.2.2 Person Manipulating the Flight Controls. A person who does not hold a remote pilot certificate or a remote pilot 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”).

5.2.3 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.

- **5.2.3.1** 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.

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

5.3 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.

5.4 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.

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5.4.1 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>.

5.5 sUAS Maintenance, Inspections, and Condition for Safe Operation. An sUAS must be maintained in a condition for safe operation. Prior to flight, the remote PIC is responsible for conducting a check of the sUAS and verifying that it is actually in a condition for safe operation. Guidance regarding how to determine that an sUAS is in a condition for safe operation is found in Chapter 7, sUAS Maintenance and Inspection.

5.6 Medical Condition. 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.

5.6.1 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.

5.7.1 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.

5.7.2 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.
-
- **5.7.2.1** 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.
 - **5.7.2.2** 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.

5.8 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 equipment 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. (For suggested references, please see paragraph 2.3.)

- **5.8.1 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.
- **5.8.1.2** 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.

5.8.2 Air Traffic Organization (ATO). The ATO does not have the authority to deny sUAS operations on the basis of equipment that exceeds the part 107 requirements. Because additional equipment 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 (see paragraph 5.19).

5.8.3 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.

5.8.4 Temporary Flight Restrictions. Certain temporary flight restrictions (<http://tfr.faa.gov/tfr2/list.html>) may be imposed by way of a NOTAM (<https://pilotweb.nas.faa.gov/PilotWeb/>). 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.

5.8.5 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.

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5.9 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 (see paragraph 5.20). Additionally, all remote pilots are encouraged to review FAA publications (see paragraph 2.3).

5.9.1 Prior to Flight. The remote PIC must:

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

- Local weather conditions,
- 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).

5.9.2 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, which are discussed in paragraphs 5.11 and 5.12. Appendix A provides additional guidance on how to conduct an overall safety risk assessment.

5.10 Operating Limitations for Small UA. 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;
- 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.

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5.10.1 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).

5.10.2 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.

5.10.3 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.

5.11 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.

5.12 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.

5.13 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.

5.13.1 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.

5.13.2 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 hazardedly 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.

5.13.3 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.

5.14 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.

5.14.1 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.

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

5.15 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

5.15.1 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.

5.16 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. The link for the Naval Observatory is <http://aa.usno.navy.mil/publications/docs/aira.php>.

5.16.1 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.

5.17 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.

5.18 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.

5.19 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.

- 5.19.1 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.

5.20 Supplemental Operational Information. Appendix B, Supplemental Operational Information, contains expanded information regarding operational topics that should be considered prior to operations.

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Chapter 6. Part 107 Subpart C

6.1 Applicability. This chapter provides guidance regarding 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). In the aviation context, the FAA typically refers to “licensing” as “certification.”

6.2 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.

6.3 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.faa.gov. For more information concerning aeronautical knowledge tests and training, see paragraph 6.6.

6.4 Application Process. This paragraph provides guidance on how a person can apply for a remote pilot certificate.

6.4.1 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/>). The applicant must have already passed an initial aeronautical knowledge test. Once registered with IACRA, he or she will login with their username and password. Click on “Start New Application” and, 1) Application Type “Pilot”, 2) Certifications “Remote Pilot,” 3) “Other Path Information,” and 4) “Start Application.” Continue through the application process and, when prompted, the applicant will enter the 17-digit Knowledge Test Exam ID from the knowledge test in IACRA. It may take up to 48 hours from the test date for the knowledge test to appear in IACRA. The KTC test proctor will be the one that verified the identity of the applicant. Once the applicant completes the online application in IACRA, he or she will sign the application electronically and submit it to the Airman Registry for processing. No FAA representative will be required to sign the application if the applicant was able to self-certify.

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

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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.

6.4.2 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.

6.5 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.

6.6 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.

6.6.1 Initial Test. As described in paragraph 6.4, 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);

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Figure 6-1. 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.

6.6.2.2 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.

6.6.3 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.

6.7 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.

6.7.1 Initial Training Course. As described in paragraph 6.4, 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

6.7.2 Recurrent Training Course. After a pilot 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. As a renewal process, the remote pilot must complete either a recurrent training course or a recurrent knowledge test within 24 calendar-months of passing either an initial or recurrent aeronautical knowledge test. Figure 6-2, Recurrent Training Course Cycle Examples, illustrates an individual's possible renewal cycles.

Figure 6-2. Recurrent Training Course Cycle Examples

Person passes an initial aeronautical knowledge test on September 13, 2016.	then	Recurrent training course must be completed no later than September 30, 2018, which does not exceed 24 calendar-months.
Person does not complete recurrent training course 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 course is completed. The next recurrent training course must be completed no later than October 31, 2020, which does not exceed 24 calendar-months.
Person elects to complete recurrent training course prior to October 2020. The recurrent training course is taken and completed on July 15, 2020.	then	The next recurrent training course must be completed no later than July 31, 2022, which does not exceed 24 calendar-months.

6.7.2.1 The recurrent training course areas are as follows:

1. Applicable regulations relating to sUAS rating privileges, limitations, and flight operation;
2. Emergency procedures;
3. CRM; and
4. Maintenance and preflight inspection procedures.

Chapter 7. sUAS Maintenance and Inspection

7.1 Applicability. 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. Additionally, Appendix C, sUAS Maintenance and Inspection Best Practices, contains expanded information and best practices for sUAS maintenance and inspection.

7.2 Maintenance. 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. See paragraph 7.3.5 for suggested benefits of recordkeeping.

7.2.1 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.

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7.2.1.1 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.

7.2.2 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.

7.2.3 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.

7.2.3.1 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.

7.3 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.

7.3.1 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.

7.3.2 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.

7.3.3 Title 14 CFR Part 43 Appendix D Guidelines. Another option and best practice may include the applicable portions of part 43 appendix D as an inspection guideline correlating to the UA only. System-related equipment, such as, but not limited to, the CS, data link, payload, or support equipment, are not included in the list in appendix D. Therefore, these items should be included in a comprehensive inspection program for the UAS.

7.3.4 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;

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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.

Appendix A. Risk Assessment Tools

A.1 Purpose of this Appendix. The information in this appendix is a presentation of aeronautical decision-making (ADM), Crew Resource Management (CRM), and an example of a viable risk assessment process. This process is used to identify hazards and classify the potential risk that those hazards could present in an operation. It also provides examples of potential criteria for the severity of consequences and likelihood of occurrence that may be used by an sUAS remote pilot in command (PIC).

A.2 Aeronautical Decision-Making (ADM). The ADM process addresses all aspects of decisionmaking in a solo or crew environment and identifies the steps involved in good decisionmaking. These steps for good decisionmaking are as follows:

A.2.1 Identifying Personal Attitudes Hazardous to Safe Flight. Hazardous attitudes can affect unmanned operations if the remote PIC is not aware of the hazards, leading to such things as: getting behind the aircraft/situation, operating without adequate fuel/battery reserve, loss of positional or situational awareness, operating outside the envelope, and failure to complete all flight planning tasks, preflight inspections, and checklists. Operational pressure is a contributor to becoming subject to these pit-falls.

A.2.2 Learning Behavior Modification Techniques. Continuing to utilize risk assessment procedures for the operation will assist in identifying risk associated with the operation. Conducting an attitude assessment will identify situations where a hazardous attitude may be present.

A.2.3 Learning How to Recognize and Cope with Stress. Stress is ever present in our lives and you may already be familiar with situations that create stress in aviation. However, UAS operations may create stressors that differ from manned aviation. Such examples may include: working with an inexperienced crewmember, lack of standard crewmember training, interacting with the public and city officials, and understanding new regulatory requirements. Proper planning for the operation can reduce or eliminate stress, allowing you to focus more clearly on the operation.

A.2.4 Developing Risk Assessment Skills. As with any aviation operation, identifying associated hazards is the first step. Analyzing the likelihood and severity of the hazards occurring establishes the probability of risk. In most cases, steps can be taken to mitigate, even eliminate, those risks. Actions such as using visual observers (VO), completing a thorough preflight inspection, planning for weather, familiarity with the airspace, proper aircraft loading, and performance planning can mitigate identified risks. Figure A-1, Hazard Identification and Risk Assessment Process Chart, is an example of a risk assessment tool. Others are also available for use.

A.2.5 Using All Available Resources with More Than One Crewmember (CRM). A characteristic of CRM is creating an environment where open communication is encouraged and expected, and involves the entire crew to maximize team performance. Many of the same resources that are available to manned aircraft operations are available to UAS operations. For example, remote PICs can take advantage of traditional CRM techniques by utilizing additional crewmembers, such as VOs and other ground crew. These crewmembers can provide information about traffic, airspace, weather, equipment, and aircraft loading and performance. Examples of good CRM include:

- **A.2.5.1 Communication Procedures.** One way to accomplish this is to have the VO maintain visual contact with the small UA and maintain awareness of the surrounding airspace, and then communicate flight status and any hazards to the remote PIC and person manipulating the controls so that appropriate action can be taken. Then, as conditions change, the remote PIC should brief the crew on the changes and any needed adjustments to ensure a safe outcome of the operation.
- **A.2.5.2 Communication Methods.** The remote PIC, person manipulating the controls, and VO must work out a method of communication, such as the use of a hand-held radio or other effective means, that would not create a distraction and allows them to understand each other. The remote PIC should evaluate which method is most appropriate for the operation and should be determined prior to flight.
- **A.2.5.3 Task Management.** Tasks vary depending on the complexity of the operation. Depending upon the area of the operations, additional crewmembers may be needed to safely operate. Enough crewmembers should be utilized to ensure no one on the team becomes overloaded. Once a member of the team becomes over worked, there's a greater possibility of an incident/accident.

- A.2.6 Evaluating the Effectiveness of One's ADM Skills.** Successful decisionmaking is measured by a pilot's consistent ability to keep himself or herself, any persons involved in the operation, and the aircraft in good condition regardless of the conditions of any given flight. As with manned operations, complacency and overconfidence can be risks, and so there are several checklists and models to assist in the decisionmaking process. Use the IMSAFE checklist to ensure you are mentally and physically prepared for the flight. Use the DECIDE model to help you continually evaluate each operation for hazards and analyze risk. Paragraph A.5.5 and the current edition of AC 60-22, Aeronautical Decision Making, can provide additional information on these models and others.

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Figure A-1. Hazard Identification and Risk Assessment Process Chart



A.4 Risk Analysis and Assessment. The risk assessment should use a conventional breakdown of risk by its two components: likelihood of occurrence and severity.

A.5 Severity and Likelihood Criteria. There are several tools which could be utilized in determining severity and likelihood when evaluating a hazard. One tool is a risk matrix. Several examples of these are presented in Figure A-2, Safety Risk Matrix Examples. The definitions and construction of the matrix is left to the sUAS remote PIC to design. The definitions of each level of severity and likelihood need to be defined in terms that are realistic for the operational environment. This ensures each remote PIC's decision tools are relevant to their operations and operational environment, recognizing the

extensive diversity which exists. An example of severity and likelihood definitions is shown in Table A-1, Sample Severity and Likelihood Criteria.

Table A-1. Sample Severity and Likelihood Criteria

Severity of Consequences			Likelihood of Occurrence		
Severity Level	Definition	Value	Likelihood Level	Definition	Value
Catastrophic	Equipment destroyed, multiple deaths.	5	Frequent	Likely to occur many times	5
Hazardous	Large reduction in safety margins, physical distress, or a workload such that crewmembers cannot be relied upon to perform their tasks accurately or completely. Serious injury or death. Major equipment damage.	4	Occasional	Likely to occur sometimes	4
Major	Significant reduction in safety margins, reduction in the ability of crewmembers to cope with adverse operating conditions as a result of an increase in workload, or as result of conditions impairing their efficiency. Serious incident. Injury to persons.	3	Remote	Unlikely, but possible to occur	3
Minor	Nuisance. Operating limitations. Use of emergency procedures. Minor incident.	2	Improbable	Very unlikely to occur	2
Negligible	Little consequence.	1	Extremely Improbable	Almost inconceivable that the event will occur	1

A.5.1 Risk Acceptance. In the development of risk assessment criteria, sUAS remote PICs are expected to develop risk acceptance procedures, including acceptance criteria

and designation of authority and responsibility for risk management decisionmaking. The acceptability of risk can be evaluated using a risk matrix, such as those illustrated in Figure A-2. Table A-2, Safety Risk Matrix—Example shows three areas of acceptability.

Risk matrices may be color coded; unacceptable (red), acceptable (green), and acceptable with mitigation (yellow).

A.5.1.1 Unacceptable (Red). Where combinations of severity and likelihood cause risk to fall into the red area, the risk would be assessed as unacceptable and further work would be required to design an intervention to eliminate that associated hazard or to control the factors that lead to higher risk likelihood or severity.

A.5.1.2 Acceptable (Green). Where the assessed risk falls into the green area, it may be accepted without further action. The objective in risk management should always be to reduce risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is.

A.5.1.3 Acceptable with Mitigation (Yellow). Where the risk assessment falls into the yellow area, the risk may be accepted under defined conditions of mitigation. An example of this situation would be an assessment of the impact of an sUAS operation near a school yard. Scheduling the operation to take place when school is not in session could be one mitigation to prevent undue risk to the children that study and play there. Another mitigation could be restricting people from the area of operations by placing cones or security personnel to prevent unauthorized access during the sUAS flight operation.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Figure A-2. Safety Risk Matrix Examples

Severity Likelihood			Higher Lower		
↑				Unacceptable	
		Acceptable with Mitigation		Unacceptable	
More Less					
↓		Acceptable			

Table A-2. Safety Risk Matrix—Example

Risk Likelihood		Risk Severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely Improbable	1	1A	1B	1C	1D	1E

Note: The direction of higher/lower and more/less scales on a matrix is at the discretion of the remote PIC.

A.5.2 Other Risk Assessment Tools for Flight and Operational Risk

Management. Other tools can also be used for flight or operational risk assessments and can be developed by the remote PICs themselves. The key thing is to ensure that all potential hazards and risks are identified and appropriate actions are taken to reduce the risk to persons and property not associated with the operations.

A.5.3 Reducing Risk. Risk analyses should concentrate not only on assigning levels of severity and likelihood, but on determining why these particular levels were selected. This is referred to as root cause analysis, and is the first step in developing effective controls to reduce risk to lower levels. In many cases, simple brainstorming sessions among crewmembers is the most effective and affordable method of finding ways to reduce risk. This also has the advantage of involving people who will ultimately be required to implement the controls developed.

- **A.5.3.1** It is also very easy to get quite bogged down in trying to identify all hazards and risks. That is not the purpose of a risk assessment. The focus should be upon those hazards which pose the greatest risks. As stated earlier, by documenting and compiling these processes, a remote PIC can build an arsenal of safety practices that will add to the safety and success of future operations

A.5.4 Sample Hazard Identification and Risk Assessment.

- **A.5.4.1 Example.** I am the remote PIC of an sUAS in the proximity of an accident scene shooting aerial footage. Much like pilots in manned aircraft must adhere to preflight action (part 91, § 91.103), I must adhere to preflight familiarization, inspection, and aircraft operations (§ 107.49). Let's say that there is an obvious takeoff and landing site that I intend to use. What if, while I am operating a manned aircraft (emergency medical services (EMS) helicopter) requires use of the same area and I am not left with a suitable landing site? Furthermore, I am running low on power. If I consider this situation prior to flight, I can use the Basic Hazard Identification and Mitigation Process. Through this process, I might determine that an acceptable level of risk can be achieved by also having an alternate landing site and possibly additional sites at which I can sacrifice the UA to avoid imposing risk to people on the ground or to manned aircraft operations. It is really a simple process: I must consider the hazards presented during this particular operation, determine the risk severity, and then develop a plan to lessen (or mitigate) the risk to an acceptable level. By documenting and compiling these processes, I can build an arsenal of safety practices that will add to the safety and success of future operations. The following are some proven methods that can help a new remote PIC along the way:
- **A.5.4.2 Hazard Identification.** Using the Personal Minimums (PAVE) Checklist for Risk Management, I will set personal minimums based upon my specific flight experience, health habits, and tolerance for stress, just to name a few. After

identifying hazards, I will then input them into the Hazard Identification and Risk Management Process Chart (Figure A-1).

A.5.4.2 Hazard Identification. Using the Personal Minimums (PAVE) Checklist for Risk Management, I will set personal minimums based upon my specific flight experience, health habits, and tolerance for stress, just to name a few. After identifying hazards, I will then input them into the Hazard Identification and Risk Management Process Chart (Figure A-1).

1. **Personal:** Am I healthy for flight and what are my personal minimums based upon my experience operating this sUAS? During this step, I will often use the IMSAFE checklist in order to perform a more in-depth evaluation:

- **Illness** – Am I suffering from any illness or symptom of an illness which might affect me in flight?
- **Medication** – Am I currently taking any drugs (prescription or over-the-counter)?
- **Stress** – Am I experiencing any psychological or emotional factors which might affect my performance?
- **Alcohol** – Have I consumed alcohol within the last 8 to 24 hours?
- **Fatigue** – Have I received sufficient sleep and rest in the recent past?
- **Eating** – Am I sufficiently nourished?

2. **Aircraft:** Have I conducted a preflight check of my sUAS (aircraft, control station (CS), takeoff and landing equipment, etc.) and determined it to be in a condition for safe operation? Is the filming equipment properly secured to the aircraft prior to flight?

3. **EnVironment:** What is the weather like? Am I comfortable and experienced enough to fly in the forecast weather conditions? Have I considered all of my options and left myself an “out?” Have I determined alternative landing spots in case of an emergency?

4. **External Pressures:** Am I stressed or anxious? Is this a flight that will cause me to be stressed or anxious? Is there pressure to complete the flight operation quickly? Am I dealing with an unhealthy safety culture? Am I being honest with myself and others about my personal operational abilities and limitations?

A.5.5 Controlling Risk. After hazards and risks are fully understood through the preceding steps, risk controls must be designed and implemented. These may be additional or changed procedures, additional or modified equipment, the addition of VOs, or any of a number of other changes.

A.5.6 Residual and Substitute Risk. Residual risk is the risk remaining after mitigation has been completed. Often, this is a multistep process, continuing until risk has been mitigated down to an acceptable level necessary to begin or continue operation. After these controls are designed but before the operation begins or continues, an assessment must be made of whether the controls are likely to be effective and/or if they introduce new hazards to the operation. The latter condition, introduction of new hazards, is referred to as substitute risk, a situation where the cure is worse than the disease. The loop seen in Figure A-1 that returns back to the top of the diagram depicts the use of the preceding hazard identification, risk analysis, and risk assessment processes to determine if the modified operation is acceptable.

A.5.7 Starting the Operation. Once appropriate risk controls are developed and implemented, then the operation can begin.

Appendix B. Supplemental Information

B.1 Determining Operational Performance. The manufacturer may provide operational and performance information that contains the operational performance data for the aircraft such as data pertaining to takeoff, climb, range, endurance, descent, and landing. To be able to make practical use of the aircraft's capabilities and limitations, it is essential to understand the significance of the operational data. The use of this data in flying operations is essential for safe and efficient operation. It should be emphasized that the manufacturers' information regarding performance data is not standardized. If manufacturer-published performance data is unavailable, it is advisable to seek out performance data that may have already been determined and published by other users of the same sUAS manufacturer model and use that data as a starting point.

B.2 sUAS Loading and Its Effects on Performance.

1. Weight and Balance (W&B). Before any flight, the remote PIC should verify the aircraft is correctly loaded by determining the W&B condition of the aircraft. An aircraft's W&B restrictions established by the manufacturer or the builder should be closely followed. Compliance with the manufacturer's W&B limits is critical to flight safety. The remote PIC must consider the consequences of an overweight aircraft if an emergency condition arises.

- Although a maximum gross takeoff weight may be specified, the aircraft may not always safely take off with this load under all conditions. Conditions that affect takeoff and climb performance, such as high elevations, high air temperatures, and high humidity (high density altitudes) may require a reduction in weight before flight is attempted. Other factors to consider prior to takeoff are

runway/launch area length, surface, slope, surface wind, and the presence of obstacles. These factors may require a reduction in weight prior to flight.

- Weight changes during flight also have a direct effect on aircraft performance. Fuel burn is the most common weight change that takes place during flight. As fuel is used, the aircraft becomes lighter and performance is improved, but this could have a negative effect on balance. In UAS operations, weight change during flight may occur when expendable items are used on board (e.g., a jettisonable load)

2. Balance, Stability, and Center of Gravity (CG). Adverse balance conditions (i.e., weight distribution) may affect flight characteristics in much the same manner as those mentioned for an excess weight condition. Limits for the location of the CG may be established by the manufacturer. The CG is not a fixed point marked on the aircraft; its location depends on the distribution of aircraft weight. As variable load items are shifted or expended, there may be a resultant shift in CG location. The remote PIC should determine how the CG will shift and the resultant effects on the aircraft. If the CG is not within the allowable limits after loading or do not remain within the allowable limits for safe flight, it will be necessary to relocate or shed some weight before flight is attempted.

B.3 Sources of Weather Information for Small UA Operations. Remote PICs are encouraged to obtain weather information prior to flight from Flight Service by using the Web site www.1800wxbrief.com. Remote PICs can create a free account in order to use the briefing service. While Flight Service does offer a telephone-based service, it is intended for manned aircraft pilots only.

B.3.1 National Weather Service (NWS). Remote PICs are also encouraged to visit the NWS's Aviation Weather Center (AWC) at www.aviationweather.gov. This free, Web-based service does not require registration and offers all of the weather products important to a remote PIC, such as Aviation Routine Weather Reports (METAR) and Terminal Aerodrome Forecast (TAF). While reviewing the weather for your intended operation, it is also critical that the remote PIC review any temporary flight restrictions (TFR) at the FAA's TFR Web site, which can be found at <http://tfr.faa.gov>.

B.4 Weather and the Effects on Performance. Weather is an important factor that influences aircraft performance and flying safety. Atmospheric pressure and density, wind, and uneven surface heating are factors that affect sUAS performance and must be considered prior to flight.

B.4.1 Wind. Wind speed and direction are important as they affect takeoff, landing, and cruise of flight operations. Geological features, trees, structures, and other anomalies can affect the wind direction and speed close to the ground. In particular, ground topography, trees, and buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed. The remote PIC should be vigilant when operating UAS near large buildings or other man-made structures and natural obstructions, such as mountains, bluffs, or canyons. The intensity of the turbulence associated with ground obstructions depends on the size of the obstacle and the primary velocity of the wind. This same condition is even more noticeable when flying in mountainous regions. While the wind flows smoothly up the windward side of the mountain and the upward currents help to carry an aircraft over the peak of the mountain, the wind on the leeward side does not act in a similar manner. As the air flows down the leeward side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of a mountain. The stronger the wind, the greater the downward pressure and turbulence become. Due to the effect terrain has on the wind in valleys or canyons, downdrafts can be severe.

B.4.2 Surface Heat. Different surfaces radiate heat in varying amounts. Plowed ground, rocks, sand, and barren land give off a larger amount of heat, whereas water, trees, and other areas of vegetation tend to absorb and retain heat. The resulting uneven heating of the air creates small areas of local circulation called convective currents, which creates bumpy, turbulent air. Convective currents, with their rising and sinking air can adversely affect the controllability of the small UA.

B.5 Battery Fires. Lithium-based batteries are highly flammable and capable of ignition. A battery fire could cause an in-flight emergency by causing a LOC of the small UA. Lithium battery fires can be caused when a battery short circuits, is improperly charged, is heated to extreme temperatures, is damaged as a result of a crash, is mishandled, or is simply defective. The remote PIC should consider following the manufacturer's recommendations, when available, to help ensure safe battery handling and usage.

B.6 sUAS Frequency Utilization. An sUAS typically uses radio frequencies (RF) for the communication link between the CS and the small UA.

1. Frequency spectrum (RF) Basics. The 2.4 GHz and 5.8 GHz systems are the unlicensed band RFs that most sUAS use for the connection between the CS and the small UA. Note the frequencies are also used for computer wireless networks and the interference can cause problems when operating a UA in an area (e.g., dense housing and office buildings) that has many wireless signals. LOC and flyaways are some of the reported problems with sUAS frequency implications.

- To avoid frequency interference, many modern sUAS operate using a 5.8 GHz system to control the small UA and a 2.4 GHz system to transmit video and photos to the ground. Consult the sUAS operating manual and manufacturers recommended procedures before conducting sUAS operations.
- It should be noted that both RF bands (2.4 GHz and 5.8 GHz) are considered line of sight and the command and control link between the CS and the small UA will not work properly when barriers are between the CS and the UA. Part 107 requires the remote PIC or person manipulating the controls to be able to see the UA at all times, which should also help prevent obstructions from interfering with the line of sight frequency spectrum.

2. Spectrum Authorization. Frequency spectrum used for small UA operations are regulated by the Federal Communications Commission (FCC). Radio transmissions, such as those used to control a UA and to downlink real-time video, must use frequency bands that are approved for use by the operating agency. The FCC authorizes civil operations. Some operating frequencies are unlicensed and can be used freely (e.g., 900 MHz, 2.4 GHz, and 5.8 GHz) without FCC approval. All other frequencies require a user-specific license for all civil users, except federal agencies, to be obtained from the FCC. For further information, visit <https://www.fcc.gov/licensing-databases/licensing>.

Appendix C. sUAS Maintenance

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

[illegible]

Table C-1. sUAS Condition Chart

Conditions that may be found may include, but are not limited to, the following:

Condition	Action
1. Structural or skin cracking	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
2. Delamination of bonded surfaces	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
3. Liquid or gel leakage	Further inspect to determine source of the leakage. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
4. Strong fuel smell	Further inspect to determine source of the smell. Leakage exiting the aircraft may be present and/or accumulating within a sealed compartment. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
5. Smell of electrical burning or arcing	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures,

	aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
6. Visual indications of electrical burning or arcing (black soot tracings, sparking)	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
7. Noticeable sound (decibel) change during operation by the propulsion system	Further inspect entire aircraft with emphasis on the propulsion system components (i.e., motors and propellers) for damage and/or diminished performance. Assess the need and extent of repairs that may be needed for continued safe flight operations.
8. Control inputs not synchronized or delayed	Discontinue flight and/or avoid further flight operations until further inspection and testing of the control link between the ground control unit and the aircraft. Ensure accurate control communications are established and reliable prior to further flight to circumvent possible loss of control resulting in the risk of a collision or flyaway. Assess the need and extent of repairs that may be needed for continued safe flight operations.
9. Battery casing distorted (bulging)	Further inspect to determine integrity of the battery as a reliable power source. Distorted battery casings may indicate impending failure resulting in abrupt power loss and/or explosion. An electrical hazard may be present, posing a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
10. Diminishing flight time capability (electric powered propulsion systems)	Further inspect to determine integrity of the battery as a reliable power source. Diminishing battery capacity may indicate impending failure due to exhausted service life, internal, or external damage. An electrical hazard may

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the General Aviation and Commercial Division (AFS-800) at 9-AFS-800-Correspondence@faa.gov or the Flight Standards Directives Management Officer.

Subject: AC 107-SMALL, Small Unmanned Aircraft Systems (sUAS)

Date: _____

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph _____ on page _____.

☐ Recommend paragraph _____ on page _____ be changed as follows:

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

☐ Other comments:

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____

Quiz 8

The model aircraft is limited to not more than _____ pounds.

- 55
- 25
- 30
- 80

The small UA cannot be flown faster than a groundspeed of _____ knots.

- 87
- 95
- 43
- 55

The small UA cannot be flown higher than _____ feet above ground level (AGL).

- 400
- 600
- 800
- 750

Which of the following is a way to ensure that 87 knots is not exceeded?

- All answers are correct.
- Installing a GPS device.
- Timing the groundspeed of the small UA.
- Using the UA's design limitations.

Which of the following can determine a small UA's altitude above the ground?

- All answers are correct.
- Installing a calibrated altitude reporting device.
- Installing a GPS device on the small UA.
- Using the known height of local rising terrain.

Which of the following is required during a preflight inspection?

- All answers are correct.
- Visual condition inspection of the UAS components.
- Calibrate UAS compass prior to any flight.
- Check ground support equipment.
- Check onboard navigation.

What condition affects takeoff and climb performance?

- High elevations
- Low air temperatures
- Low humidity
- Low density altitudes

What topic does A.2.1 of Appendix A. cover?

- Identifying Personal Attitudes Hazardous to Safe Flight.
- Aeronautical Decision-Making (ADM).
- Learning How to Recognize and Cope with Stress.
- Developing Risk Assessment Skills.

Which of the following topics does A.2.4 of Appendix A. cover?

- Developing Risk Assessment Skills.
- Learning Behavior Modification Techniques.
- Aeronautical Decision-Making (ADM).
- Identifying Personal Attitudes Hazardous to Safe Flight.

Which of the following topics does A.2.5.2 of Appendix A. cover?

- Communication Methods.
- Communication Procedures.
- Task Management.
- Developing Risk Assessment Skills.

Which of the following topics does A.3 of Appendix A. cover?

- Hazard Identification.
- Risk Analysis and Assessment.
- Severity and Likelihood Criteria.
- All answers are incorrect.

What topic does B.1 of Appendix B. cover?

- Determining Operational Performance.
- sUAS Loading and Its Effects on Performance.
- National Weather Service (NWS).
- Weather and the Effects on Performance.

Which of the following topics does B.6 of Appendix B. cover?

- sUAS Frequency Utilization.
- Battery Fires.
- National Weather Service (NWS).
- Determining Operational Performance.

Which of the following topics does A.5.4.2 of Appendix A. cover?

- Hazard Identification.
- Controlling Risk.
- Residual and Substitute Risk.
- Starting the Operation.

Which of the following is a recurrent aeronautical knowledge test area?

- All answers are correct.
- Emergency procedures
- ADM and judgment
- Airport operations
- Preflight inspection procedures

Which of the following topics does 6.4.2 of Part 107 cover?

- Applicants with Part 61 Certificates.
- Security Disqualification.
- Aeronautical Knowledge Tests.
- Applicants Without Part 61 Certificates.

What topic does 5.2 of Part 107 cover?

- Aircraft Operation.
- Person Manipulating the Flight Controls.
- Autonomous Operations.
- Aircraft Registration.

What must be included in a remote PIC assessment?

- All answers are correct.
- Local weather conditions
- Local airspace and any flight restrictions
- The location of persons and property on the surface.

Note Users should reference the current edition of the reference documents listed below.

Reference	
14 CFR part 47	A
14 CFR part 48	F
14 CFR part 71	D P
14 CFR part 107	C
AC 00-6	A
AC 150/5200-32	F
AC 107-2	S
AIM	A
FAA-CT-8080-2	A
FAA-G-8082-20	F
FAA-H-8083-1	V
FAA-H-8083-2	F
FAA-H-8083-25	F
FAA-S-ACS-10	F
SAFO 09013	F
SAFO 10015	F
SAFO 10017	F
SAFO 15010	C

Registration and Marking Requirements

Applicants must be familiar with all of the information in [14 CFR part 48](#), Registration and Marking Requirements for Small Unmanned Aircraft, especially the sections listed in the following table:

Section	Title
48.15	Requirement to register
48.20	Eligibility for registration
48.25	Applicants
48.100	Application

Abbreviations and Acronyms

The following abbreviations and acronyms are used in this course.

Abb./Acronym	Definition
14 CFR	Title 14 of the Code of Federal Regulations
AC	Advisory Circular
ACS	Airman Certification Standards
ADDS	Aviation Digital Data Services
ADIZ	Air Defense Identification Zone
ADM	Aeronautical Decision-Making
AFM	Airplane Flight Manual
AFS	Flight Standards Service
AGL	Above Ground Level
AIRMET	Airman's Meteorological Information
AOA	Angle of Attack
ATC	Air Traffic Control
ATD	Aviation Training Device
CB	Cumulonimbus
CFA	Controlled Firing Areas
CFR	Code of Federal Regulations
CG	Center of Gravity
CP	Center of Pressure
CRM	Crew Resource Management
CTAF	Common Traffic Advisory Frequency
CTP	Certification Training Program
DPE	Designated Pilot Examiner
DVFR	Defense VFR
EMS	Emergency Services
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
FDA	Federal Drug Administration
FDC	Flight Data Center
FL	Flight Level
FRZ	Flight Restriction Zone

Abb./Acronym	Definition
FS	Flight Service
FSDO	Flight Standards District Office
IAP	Instrument Approach Procedures
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IR	Instrument Routes (sectional charts)
ISA	International Standard Atmosphere
LAA	Local Airport Advisory
MAP	Missed Approach Point
MDA	Minimum Descent Altitude
MEL	Minimum Equipment List
MFD	Multi-functional Displays
MOA	Military Operation Areas
MSL	Mean Sea Level
MTR	Military Training Route
NACG	National Aeronautical Charting Group
NASA	National Aeronautics and Space Administration
NAS	National Airspace System
NM	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NSA	National Security Area
OTC	Over-the-Counter
PAVE	PIC – Aircraft – environment – External pressures
POH	Pilot's Operating Handbook
SAO	Special Area of Operation
SIGMET	Significant Meteorological Information
SOP	Standard Operating Procedures
TCU	Towering Cumulus
TFR	Temporary Flight Restrictions
TN	True North
TRSA	Terminal Radar Service Area
TUC	Time of Useful Consciousness
UNICOM	Aeronautical Advisory Communications Stations

Final Quiz

The angular distance from the equator to the pole is one-fourth of a circle or _____.

- 90°
- 55°
- 45°
- 75°

The 48 conterminous states of the United States are located between 25° and _____ latitude.

- 49° N
- 25° N
- 49° S
- 15° N

The 48 conterminous states of the United States are between 67° and _____ W longitude.

- 125°
- 75°
- 55°
- 90°

The north magnetic pole is located close to _____ N latitude.

- 71°
- 50°
- 45°
- 75°

The north magnetic pole is located close to _____ W longitude.

- 96°
- 45°
- 75°
- 35°

According to 14 CFR part 107 the remote pilot in command (PIC) of a small unmanned aircraft planning to operate within Class C airspace _____.

- is required to receive ATC authorization
- must use a visual observer
- is required to file a flight plan

To ensure that the unmanned aircraft center of gravity (CG) limits are not exceeded, follow the aircraft loading instructions specified in the _____.

- Pilot's Operating Handbook or UAS Flight Manual
- Aeronautical Information Manual (AIM)
- Aircraft Weight and Balance Handbook

When operating an unmanned airplane, the remote pilot should consider that the load factor on the wings may be increased any time _____.

- the airplane is subjected to maneuvers other than straight-and-level flight
- the CG is shifted rearward to the aft CG limit
- the gross weight is reduced

A stall occurs when the smooth airflow over the unmanned airplane's wing is disrupted and the lift degenerates rapidly. This is caused when the wing _____.

- exceeds its critical angle of attack
- exceeds the maximum speed
- exceeds maximum allowable operating weight

The north magnetic pole is located close is about _____ miles from the geographic or true north pole.

- 1,300
- 1,500
- 900
- 1,100

Which is true regarding the presence of alcohol within the human body?

- Judgment and decision-making abilities can be adversely affected by even small amounts of alcohol.
- A small amount of alcohol increases vision acuity.
- Consuming an equal amount of water will increase the destruction of alcohol and alleviate a hangover.

When using a small UA in a commercial operation, who is responsible for briefing the participants about emergency procedures?

- The remote PIC.
- The FAA inspector-in-charge.
- The lead visual observer.

To avoid a possible collision with a manned airplane, you estimate that your small UA climbed to an altitude greater than 600 feet AGL. To whom must you report the deviation?

- Upon request of the Federal Aviation Administration.
- Air Traffic Control.
- The National Transportation Safety Board.

Extreme caution should be exercised when flying less than _____ feet AGL because of numerous skeletal structures.

- 2,000
- 1,000
- 1,500
- 3,500

Under what condition should the operator of a small UA establish scheduled maintenance protocol?

- When the manufacturer does not provide a maintenance schedule.
- UAS does not need a required maintenance schedule.
- When the FAA requires you to, following an accident.

According to 14 CFR part 107, the responsibility to inspect the small UAS to ensure it is in a safe operating condition rests with the _____.

- remote pilot-in-command
- visual observer
- owner of the small UAS

Identify the hazardous attitude or characteristic a remote pilot displays while taking risks in order to impress others?

- Macho
- Impulsivity
- Invulnerability

You are a remote pilot for a co-op energy service provider. You are to use your UA to inspect power lines in a remote area 15 hours away from your home office. After the drive, fatigue impacts your abilities to complete your assignment on time. Fatigue can be recognized _____.

- as being in an impaired state
- easily by an experienced pilot
- by an ability to overcome sleep deprivation

Which of the following is included in the risk management process?

- All Answers are correct.
- Identify Hazards.
- Assess Risks.
- Analyze Controls.
- Make Control Decisions.

When adapting crew resource management (CRM) concepts to the operation of a small UA, CRM must be integrated into _____.

- all phases of the operation
- the flight portion only
- the communications only

You have been hired as a remote pilot by a local TV news station to film breaking news with a small UA. You expressed a safety concern and the station manager has instructed you to 'fly first, ask questions later.' What type of hazardous attitude does this attitude represent?

- Impulsivity
- Machismo
- Invulnerability

Which of the following hazardous attitudes involves doing something immediately without thinking?

- Impulsivity
- Anti-Authority
- Invulnerability
- Macho

Which of the following hazardous attitudes involves the "I can do it" belief?

- Macho
- Anti-Authority
- Impulsivity
- Resignation

What is the antidote to the impulsivity hazardous attitude?

- Not so fast. Think first.
- Follow the rules.
- It could happen to me.
- Taking chances is foolish.

What is the antidote to the macho hazardous attitude?

- Taking chances is foolish.
- I'm not helpless.
- It could happen to me.
- Not so fast. Think first.

The most comprehensive information on a given airport is provided by _____.

- the Chart Supplements U.S. (formerly Airport Facility Directory)
- Notices to Airmen (NOTAMS)
- Terminal Area Chart (TAC)

According to 14 CFR part 107, who is responsible for determining the performance of a small unmanned aircraft?

- Remote pilot-in-command
- Manufacturer
- Owner or operator

Updrafts reach a maximum with speeds possibly exceeding _____ feet per minute.

- 6,000
- 2,500
- 1,500
- 3,000

The Cumulus Stage has a _____ mile height.

- 3-5
- 5-10
- 5-7
- 3-10

The Mature Stage has a _____ mile height.

- 5-10
- 3-8
- 2-5
- 5-7

The Dissipating Stage has a _____ mile height.

- 5-7
- 3-7
- 5-10
- 3-5

An aircraft that can be held in a _____° banked slipping turn is capable of straight knife-edged flight.

- 90
- 45
- 55
- 75

According to 14 CFR part 107, what is required to operate a small UA within 30 minutes after official sunset?

- Use of anti-collision lights.
- Must be operated in a rural area.
- Use of a transponder.

Banking an aircraft greater than 72° in a steep turn produces a load factor of _____.

- 3
- 10
- 1
- 7

Which of the following is a symptom of hyperventilation?

- Tingling sensations
- Mild hypoxia
- Physical stress
- Heatstroke

What are characteristics of a moist, unstable air mass?

- Turbulence and showery precipitation.
- Poor visibility and smooth air.
- Haze and smoke.

What are the characteristics of stable air?

- Poor visibility and steady precipitation.
- Good visibility and steady precipitation.
- Poor visibility and intermittent precipitation.

Which of the following factors can be an external pressure?

- All answers are correct.
- The desire to demonstrate pilot qualifications.
- The desire to impress someone.
- The pilot's general goal-completion orientation.

What is a reason that would cause a NOTAM to be issued?

- All answers are correct.
- Flights by important people such as heads of state.
- Inoperable lights on tall obstructions.
- Temporary erection of obstacles near airfields.

You have been hired by a farmer to use your small UA to inspect his crops. The area that you are to survey is in the Devil's Lake West MOA, east of area 2. How would you find out if the MOA is active?

- Refer to the chart legend.
- This information is available in the Small UAS database.
- Refer to the Military Operations Directory.