

DARTDRONES



DARTdrones UAS Ground School
FAA Airman Knowledge Test Study Guide
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ACRONYMS AND ABBREVIATIONS

ADM: Aeronautical Decision Making	METARs: Surface Aviation Weather Observations
AFSS: Automated Flight Service Station	MOA: Military Operation Area
FSS: Flight Service Station	MSL: Mean Sea Level
AGL: Above Ground Level	MTR: Military Training Route
AIS: Abbreviated Injury Scale	MVFR: Marginal Visual Flight Routes
AOA: Angle of Attack	NACG: National Aeronautical Charting Group
ARINC: Aeronautical Radio, Incorporated	NAS: National Airspace Systems
ARTCC: Air Route Traffic Control Center	NAVAID: Navigation Aid
ASOS: Automated Surface Observing Systems	NM: Nautical Mile
ATC: Air Traffic Control	NOTAMS: Notices to Airmen
AWOS: Automated Weather Observing Systems	NSA: National Security Area
CB: Cumulonimbus (clouds)	NWS: National Weather Service
CG: Center of Gravity	PIC: Pilot-In-Command
COA: Certificate of Authorization	RF: Radio Frequency
CONUS: Continental United States	ROC: Regional Operations Center
CoW: Certificate of Waiver	SAO: Special Area of Operation
CRM: Crew Resource Management	SIDA: Security Identification Display Areas
CS: Control Station	SM: Statute Miles
CTAF: Common Traffic Advisory Frequency	sUAS: Small Unmanned Aerial System
DUATS: Direct User Access Terminal Service	TCU: Towering Cumulous
EFAS: En Route Flight Advisory Service	TFR: Temporary Flight Restrictions
EP: Emergency Procedure	TIBS: Transcribed Information Briefing Service
ETD: Estimated Time of Departure	TLOF: Touchdown and Liftoff
FAA: Federal Aviation Administration	TRSA: Terminal Radar Service Area
FATO: Final Approach and Take Off	UA: Unmanned Aircraft
FDC: Flight Data Center	UAS: Unmanned Aerial System
FSS: Flight Service Stations	UNICOM: Universal Integrated Community
FTP: Flight Termination Point	UTC: Coordinated Universal Time
GPS: Global Positioning System	VASI: Visual Approach Slope Indicator
ICAO: International Civil Aviation Organization	VFR: Visual Flight Rules
IFR: Instrument Flight Rules	VHF: Very High Frequency
ISA: International Standard Atmosphere	VLOS: Visual Line of Sight
LAHSO: Land and Hold Short Operations	VO: Visual Observer
LOC: Loss of Control	



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LESSON 1: SMALL UNMANNED AIRCRAFT REGULATIONS

PART 107 SUBPART A – GENERAL

- I. FAA's first small UAS [sUAS] rulemaking
- II. Covers:
 - i. Operational limitations
 - ii. Operator certificate
 - iii. Operator responsibilities
 - iv. Aircraft requirements

Applicability

- I. Part 107 does not apply to:
 - i. Model aircraft operated in accordance with Part 101
 - ii. Public aircraft operations
 - iii. Air carrier operations
 - iv. Amateur rockets
 - v. Unmanned free balloons
 - vi. Moored balloons
 - vii. Kites

Public Aircraft Operations

- I. Under this rule, a public aircraft operation can continue to operate under a COA or can voluntarily operate as a civil aircraft in compliance with Part 107. As stated in the NPRM, this rule will not apply to public aircraft operations of small UAS that are not operated as civil aircraft.

Definitions

- I. Small Unmanned Aircraft (UA) - Unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft
- II. Control Station (CS) - an interface used by the remote pilot to control the flight path of the small unmanned aircraft
- III. Small Unmanned Aircraft Systems (sUAS) - A small UA and its associated elements (including communication links and components that control the small UA that are required for the safe and efficient operation of the small UA in the national airspace system (NAS))
- IV. Remote Pilot in Command (PIC) - a person who holds a remote pilot certificate with a sUAS rating and has the final authority and responsibility of a sUAS operation conducted under Part 107.
- V. 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
- VI. Visual Observer – A person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground

Falsification (§ 107.5)

- I. No person may make or cause to be made:
 - i. Any fraudulent or intentionally false record or report that is required to be made, kept, or used to show compliance with any requirement under this Part
 - ii. Any reproduction or alteration, for fraudulent purpose, of any certificate, rating, authorization, record or report under this Part



- II. The commission by any person of an act prohibited under this section is a basis for any of the following:
 - i. Denial of an application for a remote pilot certificate or a certificate of waiver
 - ii. Suspension or revocation of any certificate or waiver issued by the Administrator under this Part and held by that person
 - iii. A civil penalty

PART 107 SUBPART B - OPERATING RULES

Registration (§ 107.13)

- I. Any person operating a civil sUAS greater than 0.55 lbs, for whatever reason, must register their aircraft in accordance with Part 47 (*Aircraft Registration*) or Part 48 (*Registration and Marking requirements for sUAS*)
- II. Registration markings are required to be displayed on the aircraft prior to flight, and must be a unique identifier number, legible and durable, and visible or accessible
- III. If the owner is less than 13 years old, the sUAS must be registered by a person at least 13 years of age

Safe Operation (§ 107.15)

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

Medical Conditions (§ 107.17)

- I. No person may manipulate the flight controls of a small unmanned aircraft system or act as a remote pilot in command, visual observer, or direct participant in the operation of the small unmanned aircraft if he or she knows or has reason to know that he or she has a physical or mental condition that would interfere with the safe operation of the small unmanned aircraft system
- II. 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:
 - i. The temporary or permanent loss of the dexterity necessary to operate the CS to safely control the small UA.
 - ii. The inability to maintain the required “see and avoid” vigilance due to blurred vision.
 - iii. 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.
 - iv. 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.
 - v. 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. (AC 107)

Remote Pilot in Command (§ 107.19)

- I. A remote PIC must be designated before or during the flight of the small unmanned aircraft



- II. The remote PIC is directly responsible for and is the final authority as to the operation of the small unmanned aircraft system
- III. The remote PIC must ensure that the small unmanned aircraft will pose no undue hazard to other people, other aircraft, or other property in the event of a loss of control of the aircraft for any reason
- IV. The remote PIC must ensure that the small UAS operation complies with all applicable regulations of this chapter
- V. The remote PIC must have the ability to direct the small unmanned aircraft to ensure compliance with the applicable provisions of this chapter

Hazardous Operations (§ 107.23)

- I. No person may:
 - i. Operate a small unmanned aircraft system in a careless or reckless manner as to endanger the life or property of another
 - ii. Allow an object to be dropped from a small unmanned aircraft in a manner that creates an undue hazard to persons or property

Moving Operations (§ 107.25)

- I. No person may operate a small unmanned system
 - i. From a moving aircraft or
 - ii. From a moving vehicle or waterborne vehicle unless the small unmanned aircraft is flown over a sparsely populated area and is not transporting another person's property for compensation or hire

Daylight Operations (§ 107.29)

- I. No person may operate a small unmanned aircraft system during night
- II. No person may operate small unmanned aircraft system during periods of civil twilight unless the small unmanned aircraft has lighted anti-collision lighting visible for at least 3 statute miles. The remote pilot in command may reduce the intensity of anti-collision lighting if he or she determines that, because of operating conditions, it would be in the interest of safety to do so.
- III. For purposes of the above bullet of daylight operations, civil twilight refers to the following:
 - i. Except for Alaska, a period of time that begins 30 minutes before official sunrise and ends at official sunrise
 - ii. Except for Alaska, a period of time that begins at official sunset and ends 30 minutes after official sunset
 - iii. In Alaska, the period of civil twilight as defined in the Air Almanac. The Air Almanac provides tables that 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>. (AC 107)

Visual Line of Sight (§ 107.31)

- I. With vision that is unaided by any device other than corrective lenses, the operator or visual observer must be able to see the unmanned aircraft throughout the entire flight in or visual observer must be able to see the unmanned aircraft throughout the entire flight in order to:
 - i. Know the unmanned aircraft's location
 - ii. Determine the unmanned aircraft's attitude, altitude, and direction of flight
 - iii. Observe the airspace for other air traffic or hazards
 - iv. Determine that the unmanned aircraft does not endanger the life or property of another
- II. Throughout the entire flight of the small unmanned aircraft, this ability must be exercised by either:



- i. The remote pilot in command and the person manipulating the flight controls of the small unmanned aircraft system
- ii. A visual observer

Visual Observer (§ 107.33)

- I. If a visual observer is used during the aircraft operation, all of the following requirements must be met:
 - i. The remote pilot in command, the person manipulating the flight controls of the small unmanned aircraft system, and the visual observer must maintain effective communication with each other at all times
 - ii. The remote pilot in command must ensure that the visual observer is able to see the unmanned aircraft in the manner specified in § 107.31.
 - iii. The remote pilot in command, the person manipulating the flight controls of the small unmanned aircraft system, and the visual observer must coordinate to do the following
 - a. Scan the airspace where the small unmanned aircraft is operating for any potential collision hazard; and
 - b. Maintain awareness of the position of the small unmanned aircraft through direct visual observation

Multiple sUAS Operations (§ 107.35)

- I. A person may not operate or act as a remote pilot in command or visual observer in the operation of more than one unmanned aircraft at the same time

Hazardous Material (§ 107.36)

- I. A small unmanned aircraft may not carry hazardous material. For purposes of this section, the term hazardous material is defined in 49 CFR 171.8

Right of Way Rules (§ 107.37)

- I. Each small unmanned aircraft must yield the right of way to all aircraft, airborne vehicle, and launch and reentry vehicles. Yielding the right of way means that the small unmanned aircraft must give way to the aircraft or vehicle and may not pass over, under, or ahead of it unless well clear
- II. No person may operate a small unmanned aircraft so close to another aircraft as to create a collision hazard

RIGHT OF WAY RULES (§ 107.37)

(b) No person may operate a small unmanned aircraft so close to another aircraft as to create a collision hazard



UAS **MUST** yield right-of-way to other aircraft,
manned or unmanned

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Operation Over People (§ 107.39)

- I. No person may operate a small unmanned aircraft over a human being unless that human being is:
 - i. Directly participating in the operation of the small unmanned aircraft
 - ii. Located under a covered structure or inside a stationary vehicle that can provide reasonable protection from a failing small unmanned aircraft

Operating Limitations (§ 107.51)

- I. An operator must comply with all of the following operating limitations when operating a small unmanned aircraft system:
 - i. The airspeed of the small unmanned aircraft may not exceed 87 knots (100 miles per hour)
 - ii. The altitude of the small unmanned aircraft cannot be higher than 400 feet above ground level, unless the small unmanned aircraft
 - a. Is flown within a 400 foot radius of a structure; and
 - b. Does not fly higher than 400 feet above the structures immediate uppermost limit
 - iii. The minimum flight visibility, as observed from the location of the ground control station must be no less than 3 statute miles. Flight visibility means the average slant distance from the control station at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night
 - iv. The minimum distance of the small unmanned aircraft from clouds must be no less than 500 feet below clouds and 2,000 feet horizontally away from clouds

PART 107 SUBPART C - OPERATOR CERTIFICATION

Eligibility (§ 107.51)

- I. Be at least 16 years old
- II. Be able to speak, read, write and understand the English language
- III. Pass an initial aeronautical knowledge test
- IV. Not have any physical or mental condition that would interfere with safe operations of a sUAS

Knowledge Recency (§ 107.51)

- I. A person may not operate a small unmanned aircraft system unless that person has completed one of the following within the previous 24 calendar months
 - i. Passed an initial aeronautical knowledge test covering the areas of knowledge specified in § 107.73(a)
 - ii. Passed a recurrent aeronautical knowledge test covering the areas of knowledge specified in § 107.73(b)

PART 107 SUBPART D - WAIVERS

Certificate of Waiver

- I. Allow an sUAS operation to deviate from certain provisions of Part 107
- II. Not all components of Part 107 are waivable
- III. A complete list of the waivable sections can be found in § 107.205

Application Process

- I. Follow the instruction at FAA.gov/uas
- II. Application must contain a complete description of the proposed operation and a justification
- III. Applicants are encouraged to submit applications at least 90 days prior to planned start



LESSON 2: NATIONAL AIRSPACE SYSTEM AVIATION BASICS

MSL Altitude

- I. Mean sea level (MSL) is a measure of the average height of the ocean's surface
- II. In aviation, an MSL altitude indicates height above sea level
- III. It does not take into account local topography

AGL Altitude

- I. Above Ground Level (AGL) altitude is measured with respect to the underlying ground surface
- II. Cloud heights are typically presented in AGL
- III. This is the typical altitude reference used for sUAS operations

Nautical Mile (NM)

- I. Standard measure of distance in aviation
- II. Equal to the length of 1 minute of latitude
- III. 1NM = 6,076 feet

Statute Miles

- I. Standard unit of measure for visibility and cloud clearance
- II. 1 SM = 5,280 feet
- III. 1 SM = .869 NM

Visual Flight Rules (VFR)

- I. Regulations under which a pilot operates in weather conditions clear enough to see where the aircraft is going
- II. Based on the principle of "see and avoid"
- III. sUAS operations are only conducted in VFR conditions

Instrument Flight Rules (IFR)

- I. Flights performed in bad weather conditions and/or poor visibility
- II. Pilots use aircraft instruments to navigate and are under full control of Air Traffic Control
- III. sUAS flights in IFR conditions are prohibited

Air Traffic Control (ATC)

- I. Ground-based controllers who direct aircraft in controlled airspace
- II. Primary purpose is to prevent collisions, organize and expedite the flow of air traffic, and provide information and support for pilots

Clearance

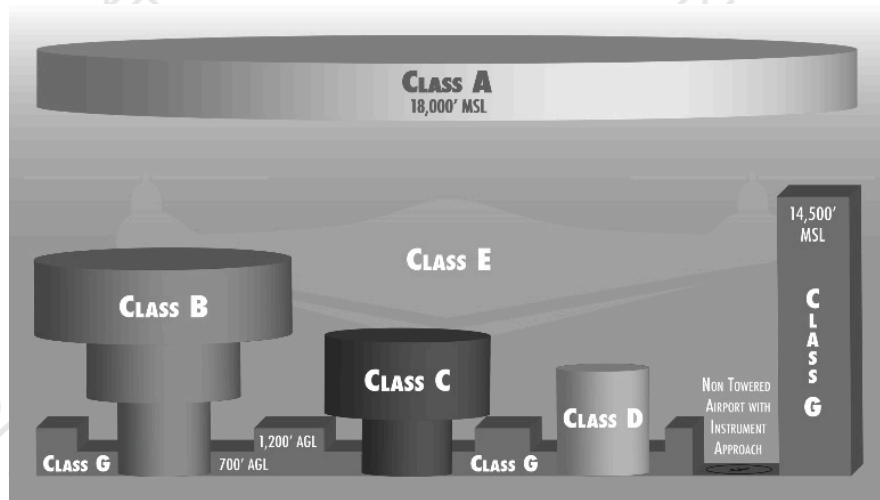
- I. An authorization by ATC for the purpose of preventing collision between aircraft
- II. Once received, allows an aircraft to proceed under specified conditions within controlled airspace

Sectional Aeronautical Charts

- I. Primary navigational reference for VFR pilots
- II. Designed for visual navigation of slow to medium speed aircraft



AIRSPACE CLASSIFICATIONS



FAR § 107.41

Airspace operating restrictions:

- I. A small unmanned aircraft may not operate in Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace designated for an airport unless the operator has prior authorization from the Air Traffic Control (ATC) facility having jurisdiction over that airspace.

Airspace Types

- I. Controlled
- II. Uncontrolled
- III. Special Use
- IV. Other Airspace

Controlled Airspace

- I. Airspace of defined dimensions within which ATC services are provided
- II. Higher weather minimums than in uncontrolled airspace
- III. Class A, B, C, D and E airspace

Class A

- I. 18,000' - 60,000' MSL
- II. En route, high-altitude environment used by IFR aircraft to transit from one area of the country to another
- III. sUAS flights are prohibited

Class B

- I. Surface to 10,000 feet MSL
- II. Surrounds the nation's busiest airports
- III. Consists of a surface area and two or more

Class B Equipment Requirements

- I. Two-Way Radio
- II. Altitude Transponder

Class C

- I. Surrounds airports with airport traffic control towers and radar approach control
- II. Typical Dimensions
 - i. 5 mile radius from surface to 4,000' AGL



- ii. 10 mile radius shelf from 1,200' to 4,000' AGL

Class C Equipment Requirements

- I. Two-Way Radio
- II. Altitude Transponder

Class D

- I. Surrounds airports with operational control tower
- II. Typically a circular area with radius of five miles around the primary airport
- III. Extends upward from the surface to 2,500 feet above airport elevation

Class D Equipment Requirements

- I. Two-Way Radio

Class E

- I. Any controlled airspace not classified as A, B, C or D
- II. IFR aircraft operating in Class E must be under the control of ATC
- III. Altitudes vary from surface to 18,000' MSL

Enroute Class E Airspace

- I. Begins at 700' or 1,200' AGL
- II. Found in populated areas with airports and IFR airways
- III. Most of the U.S. is under enroute Class E airspace

Class E Transition Areas

- I. Begins at either 700' or 1,200 AGL
- II. Often surrounds airports or groups of airports
- III. Designed to protect aircraft on approach or departure from an airport

Class E Surface Areas

- I. Extends from the surface to protect IFR aircraft at a non-towered airport
- II. sUAS aircraft must have authorization from ATC to operate
- III. Any Class E airspace not classified as enroute, transition or surface area begins at 14,500' MSL
- IV. VFR aircraft have no specific equipment or entry requirements for Class E airspace

Any Class E airspace not classified as enroute, transition or surface area begins at 14,500' MSL. VFR aircraft have no specific equipment requirements for Class E airspace.

Uncontrolled Airspace

- I. Airspace where ATC does not exercise authority over aircraft
- II. Class G

Class G

- I. All airspace not otherwise classified as controlled
- II. Typically the airspace very near the ground between Class B-D cylinders and beneath Class E airspace
- III. Most sUAS operations are conducted in Class G

Minimum Visibility (all classes)

- I. 3 statute miles

Cloud Clearances (all classes)

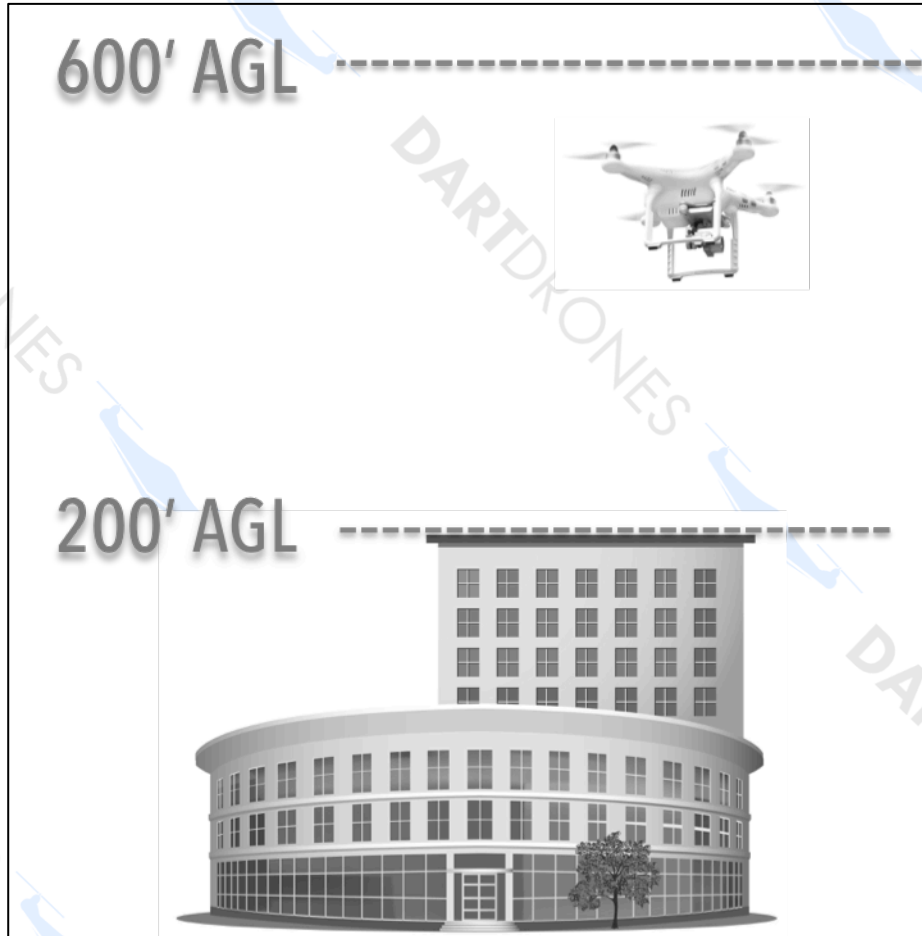
- I. 2,000' Horizontal
- II. 500' Below

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Maximum Altitude (all classes)

- I. 400' AGL unless flown within a 400' radius of a structure, and not higher than 400' above the structure's immediate uppermost limit





LESSON 3: FLIGHT RESTRICTIONS

Airspace Types

- I. Controlled
- II. Uncontrolled
- III. Special Use
- IV. Other Airspace

Special Use Airspace - defines areas where operations are occurring that would impose limitations on non-participating aircraft. They are often military in nature

- I. Restricted Areas
- II. Warning Areas
- III. Alert Areas
- IV. Military Operation Area (MOA)
- V. Controlled Firing Area

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

Prohibited Areas

- I. Designated airspace within which the flight of aircraft is prohibited
- II. Established in the interest of national security and welfare
- III. Begins at the surface and has defined dimensions

Restricted Area

- I. Areas where flight or aircraft, while not wholly prohibited, is subject to restrictions
- II. Denotes the existence of unusual, often invisible, hazards to aircraft
- III. Entrance into a restricted area without authorization may be extremely hazardous

Warning Area

- I. Similar in nature to restricted areas, but airspace covers international waters
- II. Extends 12 NM off the coast of the United States outward

Alert Area

- I. Areas that may contain a high volume of pilot training or unusual aerial activity
- II. Exercise caution
- III. All aircraft are equally responsible for collision avoidance

Military Operations Area

- I. Separates certain military training activities from IFR traffic
- II. No restrictions or requirements for VFR aircraft
- III. sUAS operators should still exercise extreme caution

Controlled Firing Areas

- I. Contains activities which could be hazardous to non-participating aircraft
- II. Participants are required to suspend activities when aircraft approach the area
- III. Non-participating aircraft do not need to change their flight path, thus these areas are not depicted on charts

Other Airspace

- I. Temporary Flight Restriction (TFR)
- II. Local Airport Advisory
- III. Military Training Route (MTR)
- IV. Parachute Jump Aircraft Operations
- V. Published VFR Routes
- VI. Terminal Radar Service Area (TRSA)



VII. National Security Area (NSA)

Temporary Flight Restriction

- I. A regulatory action issued in an flight data center (FDC) Notice to Airmen (NOTAM) that temporarily restricts aircraft operations within a defined area

Notice to Airmen (NOTAM)

- I. Notice containing information concerning the establishment, condition, or change of any component, service, procedure or hazard in the National Airspace System
- II. Indicates timely knowledge of this information is essential for pilots and operators

Reasons to Establish a TFR

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

§ 107.47 - Small UAS are prohibited from operations in airspace restricted by NOTAMs unless authorized by the ATC or a certificate of waiver or authorization has been issued by the FAA. This includes NOTAMs issued to designate a TFR.

All TFR NOTAMs begin with the phrase "FLIGHT RESTRICTIONS" and include the following information:

- I. Location of the TFR area
- II. Effective period
- III. Defined area
- IV. Altitudes affected
- V. FAA coordination facility and telephone number
- VI. Reason for the TFR
- VII. Agency directing relief activities (if applicable) & phone #
- VIII. Any other information considered appropriate

Identifying NOTAMs

- I. Flight Service Stations (FSS) are the official source of NOTAM information
- II. Web-based sources of NOTAM information should be used for preflight planning only

Note: ALWAYS contact the local FSS at 1-800-WX-BRIEF immediately before flight for the most up to date information for all NOTAMS in your area

Establishing sUAS NOTAMs

- I. No longer a requirement for commercial operators under Part 107, but still a good practice
- II. By phone - 1-800-WX-BRIEF
- III. Online - www.1800wxbrief.com

Other Airspace

- I. Temporary Flight Restriction (TFR)
- II. Local Airport Advisory
- III. Military Training Route (MTR)
- IV. Parachute Jump Aircraft Operations
- V. Published VFR Routes
- VI. Terminal Radar Service Area (TRSA)
- VII. National Security Area (NSA)

Local Airport Advisory

- I. Area within 10 SM of an airport where a control tower is not operating but a FSS is located

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- II. The FSS provides advisory service to arriving and departing aircraft
- III. Information on this service is found in the chart supplement

Military Training Route (MTR)

- I. Allows the military to conduct low-altitude, high-speed training
- II. Routes above 1,500 feet AGL are primarily IFR
- III. Routes 1,500 feet and less are VFR

Parachute Jump Area

- I. Published in the Chart Supplement
- II. Sites used frequently are shown on sectional charts

Published VFR Route

- I. Used to transition around, under or through certain complex airspaces
- II. Found on the back of VFR terminal area planning charts

Terminal Radar Service Area (TRSA)

- I. Areas where pilots can receive additional radar services to provide separation between IFR and participating VFR aircraft
- II. Participation NOT required for VFR aircraft
- III. Primary airport(s) within a TRSA become Class D airspace

National Security Area (NSA)

- I. Established where a requirement exists for increased security of ground facilities
- II. Flight may be temporarily prohibited via NOTAM
- III. Pilots are requested to voluntarily avoid flying in these areas



LESSON 4: AERONAUTICAL CHART INTERPRETATION

Sectional Charts

- I. Sectional charts are the most common charts used by pilots today.
- II. 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.
- III. The charts provide an abundance of information, including airport data, navigational aids, airspace, and topography. By referring to the chart legend, a pilot can interpret most of the information on the chart. A pilot should also check the chart for other legend information, which includes air traffic control (ATC) frequencies and information on airspace. These charts are revised semiannually except for some areas outside the conterminous United States where they are revised annually.
- IV. Geographical points are pinpointed by latitude and longitude

Longitude

- I. Meridians of longitude are drawn from the North Pole to the South Pole and are at right angles to the Equator. The "Prime Meridian" which passes through Greenwich, England, is used as the zero line from which measurements are made in degrees east (E) and west (W) to 180°. The 48 conterminous states of the United States are between 67° and 125° W longitude.
- II. 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.

Latitude

- I. 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 used to measure degrees of latitude north (N) or south (S) of the equator. The angular distance from the equator to the pole is one-fourth of a circle or 90°. The 48 conterminous states of the United States are located between 25° and 49° N latitude.

Chart Interpretation

- I. On VFR Sectional charts, latitude and longitude is expressed in Degrees Minutes (i.e. 35° 46')
- II. Each large tick mark represents 10', and each small tick mark is 1'

Online Charts

- I. FAA VFR raster charts
 - i. PDF or GEO-TIFF format
- II. Skyvector
 - i. Online interactive resource for aeronautical charts and airport data
 - ii. Good single stop shop

Key Legend Items

- I. Airspace
- II. Airport Data
- III. Communications
- IV. Hazards



LESSON 5: AIRPORT OPERATIONS

§ 107.43 Operation Near Airports

- I. No person may operate a small unmanned aircraft in a manner that interferes with operations and traffic patterns at any airport, heliport, or seaplane base

Preventing Interference

- I. Avoid operations in traffic patterns or published approach corridors
- II. If absolutely necessary to operate at a non-towered airport, sUAS operations should be conducted in a way so as manned aircraft do not need to alter their flight path

Types of Airports

- I. Towered
- II. Non-towered
- III. Heliport
- IV. Seaplane bases

Towered Airport

- I. Has an operating control tower
- II. ATC is responsible for managing the flow of air traffic
- III. Two-way communications are required at all times

Non-Towered Airport

- I. No operating control tower
- II. Two-way radio communications are not required, but it is good practice to transmit intentions on the common frequency when able

Heliports

- I. An area of land, water or a structure used for landing and takeoff of helicopters
- II. Most are relatively small and simple, and can be densely concentrated in urban areas

Seaplane Bases

- I. A dedicated area of water used for takeoff and landing of seaplanes, water taxiing, ramp service and shoreline or on-shore facilities

AIRPORT MARKINGS AND SIGNAGE

Runways

- I. Laid out according to local prevailing winds
- II. Markings vary depending on the type of operations conducted at the airport
- III. Runway numbers are the first two digits of the approach heading
- IV. For example, runway 03 means an aircraft on approach will be heading 030

Taxiways

- I. Used to transition from parking areas to the runway
- II. Identified by a continuous yellow centerline stripe
- III. Where a taxiway approaches a runway, there may be a holding position marker
- IV. Aircraft are required to hold at this spot until cleared onto the runway

DARTDRONES



Airport Sign Types

- I. Mandatory instruction signs
- II. Location signs
- III. Direction signs
- IV. Destination signs
- V. Information signs

Mandatory Instruction Signs

- I. Denotes an entrance to a runway, critical area, or prohibited area



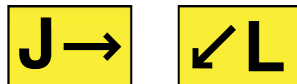
Location Signs

- I. Identifies a taxiway or runway location or the boundary of the runway



Direction Sign

- I. Identifies the designation of the intersecting taxiway(s) leading out of an intersection



Destination Signs

- I. Provides information on locating things, such as runways, terminals, cargo areas, and civil aviation areas



Information Signs

- I. Provides the pilot with information on such things as areas that cannot be seen from the control tower, applicable radio frequencies, and noise abatement procedures



SIDA (Ramp Area)

- I. Security Identification Display Areas
- II. Limited access areas that require a badge to enter
- III. Movement through or into these areas is prohibited without proper identification

Traffic Patterns

- I. Standard traffic flow is a box pattern
- II. Classified as either Left-Hand or Right-Hand, indicating the direction aircraft turn after takeoff

DARTDRONES



- III. Pattern altitudes generally extend from 600' AGL up to 1,500' AGL

Right of Way

- I. The Remote PIC has the responsibility to remain clear of and yield right-of-way to all manned aircraft
- II. To do this, the PIC must:
 - i. Know the location and flight path of own UA
 - ii. Be aware of other aircraft in the operating area
 - iii. Be able to maneuver the small UA to avoid other aircraft
 - iv. Avoid operating in areas that could interfere with airport operations

Scanning

- I. Effective scanning is accomplished with a series of short, regularly spaced eye moments
- II. Each movement should not exceed 10° and each area should be observed for at least 1 second

Aeronautical Charts

- I. Provides specific information on airports

Chart Supplement

- I. Formerly known as the Airport/Facility Directory
- II. Provides the most comprehensive information about a given airport, heliport or seaplane base
- III. Published in 7 books organized by regions

NOTAMS

- I. Provide time critical information about airports and any changes that affect the NAS
- II. Two types of civil NOTAMS
 - i. NOTAM-D (distant)
 - ii. Flight Data Center (FDC) NOTAMS

Note: Operating near airports can complicate sUAS flights. To ensure your compliance with Part 107, always use the planning resources available to you prior to takeoff. The more familiar you are with the airport you are operating around, the less likely you will interfere with manned operations.



LESSON 6: RADIO COMMUNICATIONS

Communications Around Airports

- I. Understanding airport radio communication procedures greatly improves a sUAS operator's situational awareness of manned aircraft operating nearby
- II. By monitoring common frequencies, the remote PIC will be better able to determine the position of manned aircraft so as to not interfere with airport operations

Note: The FAA expects that a number of small UAS operations will take place near an airport. That is why §107.43 prohibits a small unmanned aircraft from interfering with airport operations or traffic patterns. Understanding radio communication procedures will assist a remote pilot in command operating near a Class G airport in complying with this requirement. Knowledge of radio communication procedures will provide a remote pilot in command with the ability to utilize a valuable resource, CTAF, to help determine the position of nearby manned aircraft.

Towered Airport Communications

- I. Pilots operating in airspace governed by an operating control tower are required to maintain two-way radio communications with ATC
- II. All ATC instructions must be acknowledged and complied with
- III. Pilots must advise ATC if they cannot comply with the instructions issued and request amended instructions. A pilot may deviate from an air traffic instruction in an emergency, but must advise ATC of the deviation as soon as possible.

Note: 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.

ATIS

- i. The continuous broadcast of recorded non-control information for high traffic airports
- ii. Its purpose is to improve controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information. The information is continuously broadcast over a discrete VHF radio frequency or the voice portion of a local NAVAID.
- iii. Provides a summary of surface conditions, pertinent remarks and runway in use

Non-towered Airport

- I. The key to communicating at an airport without an operating control tower is selection of the correct common frequency
- II. Pilots communicate their intentions and obtain information over the Common Traffic Advisory Frequency (CTAF)
- III. A nontowered 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 transmit their intentions on the specified frequency for the benefit of other traffic in the area.
- IV. An airport may have a full or part-time tower or FSS located on the airport, a full or part-time 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.

CTAF

- I. Frequency designated for the purpose of carrying out airport advisory practices when operating from an airport without an operating control tower
- II. 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

DARTDRONES



Universal Integrated Community (UNICOM), MULTICOM, Flight Service Station (FSS), or tower frequency and is identified in appropriate aeronautical publications.

UNICOM

- I. Stands for Universal Integrated Community
- II. Nongovernment air/ground radio communication station which may provide airport information (weather, winds, runway, etc.) on pilot request
- III. May be designated the CTAF

Note: UNICOM is a nongovernment air/ground radio communication station which may provide airport information at public use airports where there is no tower or FSS. On pilot request, UNICOM stations may provide pilots with weather information, wind direction, the recommended runway, or other necessary information. If the UNICOM frequency is designated as the CTAF, it will be identified in appropriate aeronautical publications.

TALKING ON THE RADIO

Radio Technique

- I. Listen before you transmit
- II. Think before you speak
- III. Be concise in your communication
- IV. Use standard phraseology
 - i. Figure 122.1: One two two point one
 - ii. Altitude 12,000: One two thousand
 - iii. Altitude 12,500: One two thousand five hundred
 - iv. Speed 190: One niner zero knots

Phonetic Alphabet

A – Alpha	J – Juliet	S – Sierra
B – Bravo	K – Kilo	T – Tango
C – Charlie	L – Lima	U – Uniform
D – Delta	M – Mike	V – Victor
E – Echo	N – November	W – Whiskey
F – Foxtrot	O – Oscar	X – X-Ray
G – Golf	P – Papa	Y – Yankee
H – Hotel	Q – Quebec	Z – Zulu
I – India	R – Romeo	

Time

- I. The FAA uses Coordinated Universal Time (UTC) for all operations. The word “local” or the time zone equivalent must be used to denote local when local time is given during radio and telephone communications.

Aircraft Call Signs

- II. Civilian aircraft pilots should state the aircraft type, model or manufacturer's name, followed by the digits/letters of the registration number
- III. Example: Bonanza Six Five Five Golf
- IV. Example: Phantom Four Four Two One Sierra

Traffic Advisory Procedures

- I. Pilots of aircraft conducting operations to, from, or in the vicinity of an airport should monitor/communicate on the appropriate frequency while within a 10 NM radius

DARTDRONES



Self-Announce

- I. A procedure pilots use to broadcast their position or intentions on the designated CTAF
- II. Primarily used at airports without an on-airport FSS
- III. Should be used if a pilot is unable to communicate with the FSS on the designated CTAF

Note: If an airport has a tower and it is temporarily closed, or operated on a part-time basis and there is no FSS on the airport or the FSS is closed, use the CTAF to self-announce your position or intentions. Where there is no tower, FSS, or UNICOM station on the airport, use MULTICOM frequency 122.9 for self-announce procedures. Such airports will be identified in appropriate aeronautical information publications.

UNICOM Communications

- I. 10 miles from the airport, inbound pilots will report altitude, aircraft type and ID, location, intentions (landing or over flight) and request winds and runway in use
- II. At the airport, the pilot will report on downwind, base and final, as well as leaving the runway



LESSON 7: AVIATION WEATHER

Weather & Micro-Meteorology

- I. Weather is the state of the atmosphere at a given time and place

Atmosphere

- I. A blanket of air made up of a mixture of gases (primarily nitrogen and oxygen) and water vapor (ranging from 0 to 5%)
- II. This small amount of water vapor is responsible for major changes in the weather

Humidity

- I. Amount of water vapor in the atmosphere
- II. Water vapor is lighter than air, so air with high humidity is lighter (less dense)
- III. High humidity = less dense air
- IV. Low humidity = more dense air

Atmospheric Pressure

- I. The force exerted by the weight of air molecules
- II. Highest at the surface, decreasing with altitude
- III. A function of altitude, temperature and air density
- IV. Measured in inches of mercury (Hg)
- V. Standard sea level pressure is 29.92 "Hg
- VI. Forecasters track pressure trends to predict weather
 - i. Rising pressure typically indicates fair weather approaching
 - ii. Falling pressure usually indicates the approach of bad weather and possible severe storms

'Standard' Atmosphere

- I. Sea level pressure of 29.92 "Hg
- II. • Sea level temperature of 15 degrees Celsius
- III. • As altitude increases, air temperature decreases

Atmospheric Stability

- I. Stability depends on the ability of the atmosphere to resist motion
- II. Determined by a combination of moisture and temperature

Cool Dry Air

- I. Very stable
- II. Good and generally clear weather

Warm Moist Air

- I. Greatest instability
- II. Turbulent airflow, extensive vertical clouds and severe weather with convective activity

Temperature Inversion

- I. As altitude increases, air temperature increases, the inverse of a standard atmosphere
- II. Can occur on clear, cool nights when air close to the ground is cooled by the lowering temperature of the ground, resulting in a warmer layer of air above
- III. With high relative humidity, can result in low clouds, fog, and low visibility due to trapped dust and smoke

DARTDRONES



Air Masses

- I. Large bodies of air that take on the characteristics of that region where they originate
- II. Identified as polar or tropical based on temperature characteristics and maritime or continental based on a moisture content
 - i. i.e., a continental polar air mass forms over a polar region and brings cool, dry air

Stable Air Mass

- I. Air mass passing over a colder surface
- II. Poor surface visibility due to the inability of smoke, dust and other particles to rise out of the air mass
- III. Can produce low clouds and fog

Unstable Air Mass

- I. Air mass passing over a warmer surface
- II. Creates convective currents, results in good surface visibility, cumulus clouds, showers and turbulence

Fronts

- I. The boundary layer between two air masses that have different characteristics
- II. An approaching front always means a change to the weather
- III. Four different types
 - i. Warm front
 - ii. Cold front
 - iii. Stationary front
 - iv. Occluded front

Warm Front

- I. Occurs when a warm air mass replaces a colder body of air
- II. Slow moving (10-25 mph)
- III. Prior to and during front passage, low clouds, fog, and light to moderate precipitation likely
- IV. After front passage, conditions are typically cloudy, rainy and/or hazy

Cold Front

- I. Occurs when a cold, dense air mass replaces a warmer body of air
- II. Rapid moving (25-30 mph)
- III. During front passage, heavy rain showers form and may be accompanied with lightning, thunder, hail and possibly tornadoes
- IV. After front passage, conditions are typically cool and clear

Thunderstorms

- I. A result of atmospheric instability, vertical air movement and water vapor in the air mass
- II. Occur either at random due to unstable air or as a result of a frontal system
- III. Can produce a multitude of hazards to include: turbulence, lightning, icing, hail and tornadoes

Lightning

- I. Lightning can strike many miles away from a thunderstorm
- II. Operating a sUAS in the vicinity of lightning is potentially hazardous to both the aircraft and personnel
- III. If you see lightning while conducting sUAS operations, it is highly advisable to abort the flight

DARTDRONES



Icing

- I. Super cooled water that freezes on impact with an aircraft
- II. Can occur at any altitude above the freezing level
- III. Ice accumulation on aircraft rotors or wings can build up rapidly and severely impact flight
- IV. Pilots should be alert for icing anytime the temperature approaches 0° C and visible moisture is present

Hail

- I. The potential for hail should be anticipated with any thunderstorm, especially beneath the anvil of a large cumulonimbus cloud
- II. Even small hail can do significant damage to a small unmanned aircraft

Tornadoes

- I. Extremely concentrated rotating vortex with speeds that can exceed 200 knots
- II. Occur with both isolated and squall line thunderstorms, sometimes far from center of the storm
- III. Do not conduct sUAS operations if tornadoes are forecast

Fog

- I. A cloud that begins within 50 feet of the surface
- II. Fog is classified according to how it forms
- III. Radiation fog occurs when ground cools rapidly at night and the surrounding air temperature reaches its dew point
- IV. Advection fog occurs when warm, moist air moves over a cold surface

Dew and Frost

- I. Occurs when the air temperature drops below the dewpoint and moisture in the air condenses
- II. When temperature is below freezing, moisture is deposited as frost
- III. Frost can adversely impact sUAS performance

CLOUD CLASSIFICATIONS

Cumulus Clouds

- I. Heaped or piled clouds

Nimbus Clouds

- I. Rain bearing clouds

Cumulonimbus Clouds

- I. Caused by rising air currents
- II. Extremely turbulent
- III. Typically associated with thunderstorms

Standing Lenticular Clouds

- I. Created by barriers in the wind flow
- II. Lens shaped
- III. Wind blowing through can be very strong
- IV. Can result in very strong turbulence



WEATHER PLANNING

Small UAS Weather Limits (§ 107.51)

- I. Minimum Visibility
 - i. 3 Statute Miles
- II. Minimum Cloud Clearance
 - i. 500' below clouds
 - ii. 2000' horizontally away from clouds

Visibility

- I. The greatest horizontal distance at which prominent objects can be viewed with the naked eye

Ceiling

- I. Lowest layer of clouds reported as being broken or overcast, or vertical visibility into fog or haze
- II. Cloud coverage is reported in 1/8 increments

Weather Sources

- I. Automated Flight Service Station (AFSS)
- II. Transcribed Information Briefing Service (TIBS)
- III. Direct User Access Terminal Service (DUATS)

AFSS

- I. Primary source for preflight weather information

TIBS

- I. Continuous telephone recordings of meteorological and aeronautical information
- II. Intended as a preliminary briefing tool only
- III. Available 24 hours a day
- IV. Phone numbers found in the Chart Supplement

DUATS

- I. Allows anyone with a valid FAA airman certificate to access weather information via computer
- II. www.duats.com

Other Online Sources

- I. 1800wxbrief.com
- II. aviationweather.gov
- III. uavforecast.com

Weather Briefings

- I. Should be obtained prior to every flight
- II. For weather specialists to provide an appropriate briefing, they need to know:
 - i. Type of briefing requested (standard or abbreviated)
 - ii. Area of flight
 - iii. Estimated time of departure
 - iv. Flight altitude

Standard Briefing

- I. Most complete report
- II. Information of value to sUAS operators includes:
 - i. Synopsis



- ii. Current conditions
- iii. Adverse conditions
- iv. VFR flight not recommended
- v. NOTAMS

Abbreviated Briefing

- I. Shortened version of standard briefing
- II. Typically requested to update a previous briefing

AVIATION WEATHER REPORTS

AWOS

- I. Automated Weather Observing System
- II. Many different types of equipment, all with differing capabilities
- III. Reports at least once per minute

ASOS

- I. Automated Surface Observing System
- II. A single equipment type with more robust reporting capability than the majority of AWOS types
- III. Also reports at least once per minute

Data Distribution

- I. There are 3 ways to access ASOS or AWOS weather reports
 - i. Computer generated voice message broadcast over a radio frequency
 - ii. Computer generated voice message available over the telephone
 - iii. METARS

METAR

- I. Observations of current surface weather from individual ground stations across the U.S.
- II. Provide local weather conditions and other relevant information for a radius of 5 miles from a specific airport
- III. Issued hourly

Station Identifier

- I. A 4-letter code established by the International Civil Aviation Organization.
- II. In the contiguous U.S., unique three letter airport identifiers are preceded by a "K"

Modifier

- I. Denotes that the METAR came from an automated source or that the report was corrected

Data and Time

- I. Time is always given in coordinated universal time (UTC), denoted with a "Z"

Wind

- I. First 3 digits are wind direction reported in degrees True. If variable, reported as VRB.
- II. Last two digits are speed in knots, and a 'G' following wind speed indicates gusting.

Visibility

- I. Typically reported in statute miles (SM)



Weather

- I. Observations of current surface weather from individual ground stations across the U.S.
- II. Provide local weather conditions and other relevant information for a radius of 5 miles from a specific airport
- III. Issued hourly

Sky Condition

- I. Reported in the sequence of amount, height, and type or indefinite ceiling/height (vertical visibility)

Temperature/Dew Point

- I. Always given in degrees Celsius (C).

Altimeter

- I. Reported as inches of mercury

Remarks

- I. Information in this section may include wind data, variable visibility, pressure information and various other info

AVIATION FORECASTS

TAF

- I. Terminal Aerodrome Forecast
- II. Forecast established for 5 mile radius around an airport
- III. Updated 4 times a day (000Z, 0600Z, 1200Z, and 1800Z)

Valid Period

- I. First two numbers indicate date, second two the beginning time for the valid period (Z) and the last two are the ending time (Z)

Forecast Visibility:

- I. If forecast is greater than 6 mile it is coded as P6SM

Forecast Change Group

- I. Includes significant forecast weather changes with the anticipated time they will occur. 'FM' is a rapid change, 'BECMG' a gradual change and 'TEMPO' a temporary fluctuation

WEATHER CHARTS

Surface Analysis Chart

- I. Displays current surface weather
 - i. High and low pressure areas
 - ii. Fronts
 - iii. Temperatures and dew points
 - iv. Wind directions and speeds
 - v. Local weather
 - vi. Reporting point observations (station model)
- II. Transmitted every 3 hours

Weather Depiction Chart

DARTDRONES



- I. Displays surface conditions derived from METARS and other surface observations
 - i. Major fronts
 - ii. Areas of high or low pressure
 - iii. Graphic display of IFR, VFR and MVFR weather
 - iv. Modified station model with sky cover, cloud height, weather and obstructions
- II. Transmitted every 3 hours

Radar Summary Chart

- I. Graphic depiction of collected radar weather reports
- II. Displays areas of precipitation and their characteristics
- III. Published hourly at 35 minutes past the hour

MICROMETEOROLOGY

Surface Winds

- I. A critical factor in conducting safe sUAS operations is accurate information about surface wind direction, speed and turbulence
- II. All wind directions are reported in degrees True

Determining Winds

- I. Windsock or wind streamers
- II. Blowing dust
- III. Smoke
- IV. Natural vegetation
- V. Ponds or lakes

Turbulence

- I. Ground topography and large buildings break up the flow of wind
- II. Can create wind gusts that are unpredictable and change rapidly in speed and direction
- III. Intensity of the resulting turbulence depends on the size of the obstacle and the velocity of the wind

Low Level Wind Shear

- I. Sudden, drastic change in wind speed and/or direction over a very small area
- II. Can result in violent updrafts and downdrafts
- III. Commonly associated with passing frontal systems, thunderstorms and temperature inversions

Microbursts

- I. A type of wind shear associated with convective precipitation
- II. Occurs in a space less than 1 mile wide and within 1,000' vertically
- III. Averages about 15 minutes in duration
- IV. Can produce downdrafts of up to 6,000 feet per minute and wind direction changes of 45 degrees or more in seconds

Low Level Wind Shear

- I. Surface turbulence and wind shear can be particularly dangerous to small-unmanned aircraft due to their lightweight.
- II. Always be alert to the potential for both conditions, particularly when flying near obstacles or in the vicinity of thunderstorms and frontal systems.

Convective Currents

DARTDRONES



- I. Different surfaces radiate heat in varying amounts
- II. Uneven heating of the air creates small areas of local circulation called convective currents
- III. Updrafts are likely over pavement or barren land (due to heat release)
- IV. Downdrafts are likely over water or dense vegetation (due to heat absorption)
- V. When flying in an area with differing types of terrain, be on the alert for turbulence due to surface convection

What weather means to you

- I. Five major elements will impact your day-to-day flight operations: Temperature, moisture, wind velocity, visibility and barometric pressure

Extreme Temperatures

- I. Reduced performance
- II. Battery life
- III. Integrity of plastic parts
- IV. Reduced tactile sensation in cold weather
- V. Overall safety and health of flight crew

Mitigation

- I. Know the temperature limits of the system
- II. Perform UAS preflight in climate controlled area if able
- III. Use an electric LiPo battery warmer or air activated hand warmers in cold weather
- IV. Wear appropriate clothing and weather gear
- V. Use touchscreen gloves or transmitter cold air shield

Precipitation

- I. Damage to the UAV, gimbal, onboard sensors & control station
- II. Degraded takeoff and landing areas
- III. Ice accumulation on props or wings

Mitigation

- I. Unless your sUAS is waterproof or water resistant, do NOT fly in fog, rain, snow or hail
- II. Use vinyl landing pads or hard cases for takeoff and landing in snowy, muddy or dewy grass
- III. Apply a light even coat of silicone water repellent to props to resist icing

High Winds

- I. Faster battery drain
- II. Loss of positive control
- III. Greater accident potential
 - a. Launch and recovery
 - b. Obstacle collision

Mitigation

- I. Know wind limitations of the system
- II. Always determine wind speed and direction prior to takeoff (windsock, anemometer etc.)
- III. Takeoff & land into the wind (fixed-wing)
- IV. Have additional batteries available
- V. Affix prop guards

DARTDRONES



High Density Altitude

- I. High density altitude means air is thinner
- II. Negatively affects aircraft performance
 - i. Increased runway length for fixed wing takeoffs
 - ii. Decreased rates of climb
 - iii. Decreased engine and propeller efficiency
- VI. Even more significant performance reductions when operating in “hot & high” environments
- VII. Use longer props or props with steeper pitch when flying at higher altitudes
- VIII. Calculate local density altitude prior to flight

Note: Weather is an important factor that influences both aircraft performance and flying safety. Small UAS pilots should always gather as much information as possible about local areas conditions in order to make informed decisions regarding weather and flight safety before and during flight.



LESSON 8: MAINTENANCE AND PREFLIGHT PROCEDURES

§ 107.15 Condition for Safe Operation

- I. No person may operate a civil sUAS unless it is in a condition for safe operation. Prior to each flight, the remote PIC must check the sUAS to determine whether it is in a condition for safe operation
- II. No person may continue flight of the small unmanned aircraft when he or she knows or has reason to know that the sUAS is no longer in a condition for safe operation

Maintenance

- I. Includes overhaul, repair, inspection, modification, part replacement and software upgrades
- II. Each sUAS should be maintained in accordance with manufacturer's instructions, if available

Scheduled Maintenance

- I. Manufacturers may recommend a maintenance or replacement schedule for sUAS components
- II. If no such schedule exists, the operator should establish a scheduled maintenance protocol

Developing Maintenance Protocol

- I. Document any component repairs, modifications, overhauls, and replacements
- II. Record time in service of the component at the time of the maintenance procedure
- III. Build a maintenance schedule based on this data

Unscheduled Maintenance

- I. Maintenance required outside of the scheduled maintenance period
- II. Typically discovered during preflight
- III. Also includes any unscheduled system software updates required by the manufacturer to correct a deficiency

Performing Maintenance

- I. Some manufacturer's may require certain tasks be performed in-house or by a facility they specify
- II. If unable to comply, the operator should always verify the experience of maintenance personnel they use
- III. Use of certified maintenance providers is encouraged

Note: Complete all required maintenance before each flight, preferably in accordance with the manufacturer's instructions or, in lieu of that, within known industry best practices.

PREFLIGHT INSPECTION

Pre-Flight Requirements

- I. Prior to flight the Remote PIC must ensure:
 - i. All control links are working properly
 - ii. There is sufficient power for the intended operational time
 - iii. Any object attached or carried by the sUAS is secure and does not adversely affect the flight characteristics or controllability of the aircraft

Inspection Items

- I. All preflight inspections will include both visual and functional checks of components
- II. Preflight checklists help to ensure a thorough inspection is accomplished



Preflight Checklist

- I. Perform a visual inspection for overall condition
- II. Examine airframe structure, to include all flight control surfaces and linkages
- III. Verify registration markings are displayed and legible
- IV. Check moveable control surface(s)
- V. Check servo motor(s)
- VI. Check propulsion system, to include powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.
- VII. Check avionics, including control link transceiver, communication/navigation equipment and antenna(s)
- VIII. Perform a compass calibration as required
- IX. Verify the display panel, if used, is functioning properly
- X. Check ground support equipment, including takeoff and landing systems, for proper operation
- XI. Check that control link correct functionality is established between the aircraft and the CS
- XII. Check for control surface movement using the CS
- XIII. Check onboard navigation and communication data links
- XIV. Check flight termination system if installed
- XV. Verify communication with UAS and that the UAS has acquired GPS location from at least 4 satellites
- XVI. Check fuel for correct type and quantity
- XVII. Check battery levels for the aircraft and CS
- XVIII. Check that any equipment is securely attached
- XIX. Start the UAS propellers to inspect for any imbalance or irregular operation
- XX. Verify all controller operation for heading and altitude
- XXI. If required by flight path walk through, verify any noted obstructions that may interfere with the UAS
- XXII. At a controlled low altitude, fly within range of any interference and recheck all controls

Recordkeeping

- I. Can be highly beneficial for sUAS owners and operators and provides essential safety support
- II. Records may be hardcopy and/or electronic
- III. Should include periodic inspections, maintenance, repairs and alterations for all sUAS components

FAA Inspection and Testing (§ 107.7)

- I. Upon request, the sUAS must be made available to the FAA for inspection or testing
- II. In the event of an on-site FAA inspection, the following documentation must be readily accessible:
 - i. Pilot certificate
 - ii. Aircraft registration
 - iii. Waivers or exemptions (as required)
 - iv. Any other documentation related to operation

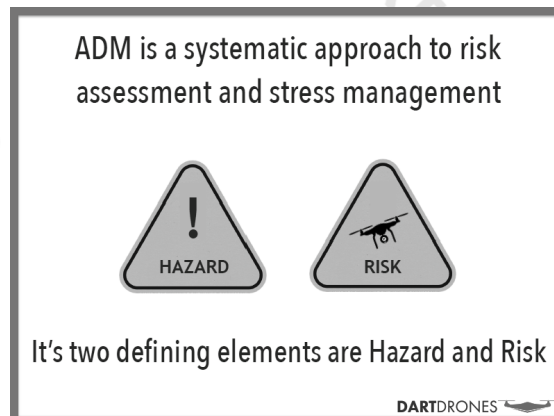
Note: Accurate and extensive record keeping helps ensure both safety of flight and compliance with FAA regulations and requirements.



LESSON 9: CREW RESOURCE MANAGEMENT [CRM] AND AERONAUTICAL DECISION MAKING [ADM]

ADM / CRM

- I. Aeronautical Decision Making - the 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
- II. Crew Resource Management - a component of ADM, where the pilot of sUAS makes effective use of all available resources: human resources, hardware, and information



Hazard

- I. A real or perceived condition, event, or circumstance that a pilot encounters.

Risk

- I. A pilot's assessment of the potential impact posed by a hazard

Note: When a pilot follows good decisions making practices, the inherent risk to flight can be reduced or even eliminated. The ability to make good decisions is based upon direct or indirect experience as well as education. Good judgment can be taught.

Steps for Good Decision making

- I. IDENTIFY personal attitudes hazardous to safe flight
- II. LEARN behavior modification steps
- III. LEARN how to recognize and cope with stress
- IV. DEVELOP risk assessment skills
- V. USE all available resources
- VI. EVALUATE effectiveness of one's ADM skills

The Decision Making Process

- I. Define the Problem
- II. Choose a course of action
- III. Implement a decision
- IV. Evaluate the outcome



The Decide Model

- I. Detect (the problem)
- II. Estimate (the need to react)
- III. Choose (a course of action)
- IV. Identify (solutions)
- V. Do (the necessary actions)
- VI. Evaluate (the effect of the solution)

Good ADM includes Risk Management:

- I. Risk management is a process that identifies hazards, assesses the degree of risk, and determines the best course of action

Risk Management Model

- I. Likelihood
- II. Severity

Risk Acceptance

- I. sUAS PICs are expected to develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management

Risk Matrix

- I. 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.
- II. Acceptable (Green): Where the assessed risk falls into the green area, it may be accepted without further action.
- III. Acceptable with mitigation (yellow): where the risk assessment falls into the yellow area, the risk may be accepted under defined conditions of mitigation

Mitigation

- I. Actions or strategies that reduce the level of risk
- II. Reduce risk at the lowest levels by performing a root cause analysis

IMSAFE Checklist

- I. Illness - Am I sick?
- II. Medication - Am I taking any meds that might affect my judgment or make me drowsy?
- III. Stress - Am I under psychological pressure from the job? Do I have money, health or family problems?
- IV. Alcohol - Have I been drinking within 8 hours? Within 24 hours?
- V. Fatigue - Am I tired and not adequately rested?
- VI. Eating - Have I eaten enough of the proper foods to keep adequately nourished during the entire flight?

PAVE Checklist

- I. P = Pilot in Command (PIC)
- II. A = Aircraft - what limitations will the aircraft impose upon the flight?
- III. V = enVironment - evaluate environmental factors, to include weather, terrain, airport, airspace, and time of day



- IV. E = External Pressures - External pressures are influences external to the flight that create a sense of pressure to complete a flight

Note: It is the responsibility of the PIC to ensure that all potential hazards and risks are identified and appropriate mitigations are put in place before each flight

Crew Resource Management (CRM)

- I. The effective use of all available resources (human, hardware, and information) prior to and during flight to ensure a successful outcome to the operation
- II. CRM includes not only the operator and visual observer, but the entire aircrew, ground crew, and all others who work together to operate the unmanned aircraft safely
 - i. Relies heavily upon crew communication and leadership

Key CRM Techniques

- I. Utilize leadership to delegate operational tasks and manage crewmembers
- II. Establish effective team communication procedures
- III. Recognize and address hazardous attitudes

PIC Leadership

- I. The remote PIC is the designated leader
- II. Retains the authority and responsibility for flight operations

PIC Tasks

- I. Assess the operating environment
- II. Determine the appropriate number of crewmembers
- III. Inform participants of delegated tasks
- IV. Set expectations
- V. Manage and supervise the crew

Effective Team Leaders

- I. Regulate information flow
- II. Direct and coordinate crew activities
- III. Motivate crewmembers
- IV. Spearhead decision making

Crew Coordination

- I. The FAA requires that the entire crew coordinate to:
 - i. Scan the airspace for potential hazards
 - ii. Maintain situational awareness of sUAS position

Situational Awareness (SA)

- I. The accurate perception and understanding of all factors and conditions that affect flight safety
- II. PIC fixation on a single perceived important item can reduce overall SA of the flight

Task Delegation

- I. Effective delegation of tasks by the PIC can reduce likelihood of fixation due to workload saturation
- II. For example, Visual Observers may be used to supplement situational awareness and visual line of sight responsibilities while the PIC is conducting other mission-critical duties (such as checking displays)

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Note: Whatever the crew composition, effective communication procedures are necessary to coordinate flight operations safely.

Tips for Effective Communication

- I. Clearly convey information in a timely manner
- II. Use standard terminology
- III. Advocate concerns assertively
- IV. Acknowledge communications
- V. Provide information as required
- VI. Repeat information if necessary
- VII. Ask for clarification when needed
- VIII. Resolve conflicts constructively

Attitude

- I. Attitude will affect the quality of decisions
- II. 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:

- I. Anti-authority - found in people who do not like anyone telling them what to do.
- II. Impulsivity - this is the attitude of people who frequently feel the need to do something, anything, immediately
- III. Invulnerability - These people know that accidents can happen to others, but never to them
- IV. Macho - Pilots who are always trying to prove that they are better than anyone else. Will try to prove themselves by taking risks in order to impress others.
- V. Resignation - 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.

Counteracting Hazardous attitudes

- I. Recognition
- II. Antidote Thoughts
 - i. Anti-authority: Follow the rules, they are usually right
 - ii. Impulsivity: not so fast, think first
 - iii. Invulnerability: it could happen to me
 - iv. Macho: taking chances is foolish
 - v. Resignation: I'm not helpless. I can make a difference



LESSON 10: SMALL UAS LOADING AND PERFORMANCE

Aerodynamic Forces

- I. Thrust - the forward force produced by the powerplant/propeller or rotor
- II. Drag - a rearward, retarding force caused by disruption of airflow by the wing, rotor, fuselage, and other protruding objects
- III. Lift - Opposes the downward force of weight, is produced by the dynamic effect of the air acting on the airfoil, and acts perpendicular to the flight path through the center of lift
- IV. Weight - the combined load of the aircraft itself, the crew, the fuel, and the cargo or baggage

Aircraft Load Factor

- I. Amount of force applies that deflects an aircraft from straight and level flight
- II. Defines as the ratio of the lift of an aircraft to its gross weight
- III. Measured in Gs

Flight Maneuvers

- I. Unaccelerated straight and level flight = 1G
- II. Any maneuvers other than straight and level flight will increase or decrease the load factor

Turns

- I. Increased load factors are a characteristic of all banked turns
- II. A result of two forces
 - i. Centrifugal force
 - ii. Gravity
- III. Bank angles exceeding 45 degrees produce increasingly high load factors and can negatively impact aircraft performance

Stalling

- I. Occurs when smooth airflow over an airplane's wing is disrupted due to the wing exceeding its critical angle of attack
- II. Lift degenerates rapidly
- III. High load factors increase aircraft stalling speed

Rough Air

- I. Gust load factors increase with higher airspeeds
- II. It is wise to reduce speed in rough air to limit additional loading to the aircraft

Weight

- I. Determination of total aircraft weight is a vital part of preflight planning
- II. Loading an aircraft beyond the manufacturer's recommended weight must be avoided

Balance

- I. The location of an aircraft's center of gravity (CG)
- II. The CG is the point about which an aircraft would balance if it were possible to suspend it at that point

Excessive Weight

- I. Excessive weight decreases aircraft performance
 - i. Reduces climb rate
 - ii. Lower maximum altitudes
 - iii. Shortens endurance
 - iv. Reduces maneuverability
- II. An overloaded aircraft may exhibit unexpected and unusually poor flight characteristics

Balance, Stability and Control

- I. Effects of adverse balance conditions are similar to those of excessive weight

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- II. Impacts both stability and control
- III. An out of balance loading condition decreases maneuverability as well as the ability of the aircraft to right itself after maneuvering or turbulence

Things that Impact W&B

- I. Extra radios or instruments
- II. Repairs or modifications
- III. Payload changes
- IV. Cargo

Prior to Flight

- I. The Remote PIC should verify correct UA loading
- II. The Aircraft's weight and balance restrictions must be closely followed
- III. If the specific weight and balance data for your aircraft is not available, apply general weight and balance principles to determine limits
- IV. Compliance with limits is critical to flight safety

External Factors

- I. Certain conditions may preclude launch at or near maximum gross takeoff weight. These include:
 - i. High density altitude
 - ii. High elevations
 - iii. High air temperatures
 - iv. High humidity
 - v. Runway/launch area length
 - vi. Surface
 - vii. Slope
 - viii. Surface wind
 - ix. Presence of obstacles

W&B Changes in Flight

- I. Fuel Burn
- II. Expendable Items

Performance Data

- I. Provided by the manufacturer in the form of an Aircraft Flight Manual, Pilot's Operating Handbook, or owner's manual
- II. If the manufacturer does not provide this data, it is good practice for the Remote PIC to collect and track operational data in order to establish a baseline for their particular system

Remote PIC

- I. Must ensure every flight can be accomplished safely, does not pose an undue hazard, and does not increase the likelihood of a loss of positive control
- II. Determining the performance capabilities and limitations of your sUAS and mitigating any associated risk falls within these responsibilities

Decision Making

- I. Always consider how your decisions impact aircraft performance
- II. You choose to fly in windy conditions. How might that impact performance
- III. You attempt to fly in wintry weather conditions. How might that impact performance?



LESSON 11: HAZARDS TO FLIGHT AND EMERGENCY PROCEDURES

Unmanned Balloons

- I. Most have a payload suspension device or trailing wire antenna that is very difficult to see
- II. Creates a potentially dangerous situation
- III. Avoid flight below at all times

Airborne Aircraft Inspection

- I. Close proximity, inflight inspection of another aircraft is uniquely hazardous
- II. Should only be attempted if absolutely necessary
- III. Must be accomplished with minimum risk to both aircraft

Precipitation Static

- I. The result of a buildup of negative particles on the skin of an aircraft
- II. Aircraft without static wicks discharge this static electricity all at once, known as a "corona"
- III. Each corona event has the potential to negatively impact avionics equipment
- IV. Known problems caused by P-Static:
 - i. Erroneous magnetic compass readings (30 percent in error)
 - ii. Loss of avionics
 - iii. Inoperative navigation system
 - iv. Erratic Instrument readouts
 - v. Weak transmissions and poor receptivity of radios

Laser Illumination

- I. FAA regulations prohibit the disruption of aviation activity by any person on the ground or in the air
- II. Laser illumination can create temporary vision impairment and produce permanent eye damage
- III. Report any laser illumination activity to ATC or FSS as soon as possible

Exhaust Plumes

- I. Visible or invisible emissions from power plants or other industrial production facilities
- II. Cause significant air disturbances which can damage aircraft
- III. Steer clear by flying on the upwind side of smokestacks or cooling towers

Overhead Wires

- I. May be virtually impossible to see under certain conditions
- II. Lines that do not exceed 200 AGL are not marked or lighted, thus are a particular danger to sUAS operations
- III. Before commencing flight, scan the area for any supporting structures that might indicate the presence of overhead wires

Birds and Wildlife

- I. Birds such as gulls, waterfowl, vultures, hawks, and blackbirds are a significant hazard to aircraft due to their size, abundance and habit of flying in flocks
- II. Due to the size of sUAS aircraft, even small birds can do considerable damage
- III. Avoid overflight of bird concentrations
- IV. If birds are encountered, climb to avoid collision
- V. Report any bird or other wildlife strike using FAA Form 5200
- VI. Available online or at any FSS

Emergency Procedures

- I. An inflight emergency is an unexpected and unforeseen serious occurrence or situation that requires urgent, prompt action

Common Accident Factors

- I. Inadequate preflight preparation and/or planning



- II. Failure to maintain direction control
- III. Failure to see and avoid objects or obstructions
- IV. Mismanagement of fuel
- V. Improper inflight decisions or planning
- VI. Misjudgment of distance and speed
- VII. Selection of unsuitable terrain
- VIII. Improper operation of flight controls

FAR § 107.19

- I. Responsibility of the operator:
 - i. The operator is directly responsible for, and is the final authority as to the operation of the small unmanned aircraft system
 - ii. The operator must ensure that the small unmanned aircraft will pose no undue hazard to other aircraft, people, or property in the event of a loss of control of the aircraft for any reason
- II. In case of an in-flight emergency, the remote PIC is permitted to deviate from any rule of part 107 as required to appropriately respond to the situation
- III. Upon FAA request, the remote PIC must send a written report to the FAA explaining the deviation

Note: Many emergency situations can be avoided with thorough preflight planning.

Preflight Assessment

- I. Define area of operation
- II. Identify local airspace and applicable restrictions
- III. Locate all persons and property within area of operation and assess ground hazards
- IV. Determine weather conditions
- V. Brief Crew

Crew Briefings

- I. Prior to flight, the PIC must ensure all persons directly involved in the sUAS operation receive a thorough brief

Briefing Checklist

- I. Roles and responsibilities
- II. General operating conditions
- III. Contingency operations
- IV. Potential hazards
- V. Emergency procedures
- VI. Alternative landing areas

Roles and Responsibilities

- I. PIC
- II. Secondary pilot(s)
- III. Observer(s)
- IV. Support personnel

General Operating Conditions

- I. Operational area (size, obstacles, people)
- II. Airspace considerations (restricted areas, controlling agencies, applicable frequencies)
- III. Timeline (preflight, takeoff, land)
- IV. Route of flight and planned altitude
- V. Payload and configuration
- VI. Aircraft weight and balance

Contingency Operations

- I. Alternate operating area
- II. Alternate flight route

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- III. Timeline constraints
- IV. Abort criteria

Potential Hazards

- I. To crew:
 - i. Moving propellers
 - ii. Hot surfaces
 - iii. Falling aircraft
- II. To Aircraft:
 - i. Weather
 - ii. Radio interference
 - iii. Obstacles
 - iv. Other aircraft
 - v. Exhaust plumes
 - vi. Wildlife

Emergency Procedures

- I. Takeoff and aborts
- II. En route
- III. Landing and waveoff
- IV. Systems
 - i. Lost link settings
 - ii. Battery management

Alternative Landing Areas

- I. Divert criteria
- II. Identified divert areas
- III. Landing area considerations

Note: Preflight briefing of operational details and hazards ensures all persons involved will be properly prepared for mechanical failure or loss of aircraft control.

Procedures

- I. A series of actions or operations that are executed in the same manner to obtain the consistent results under similar circumstances
- II. Central to safe and effective aircraft operation

Emergency Procedures (EPs)

- I. Developed in the form of a response checklist for each potential abnormal or emergency situation
- II. Varies by platform

Potential Abnormal Situations

- I. Lost link
- II. Battery low
- III. Aircraft malfunction

Potential Emergency Situations

- I. Fly-away
- II. Battery fire

Command and Control Link

- I. The connection between the control station (CS) and unmanned aircraft (UA) which allows the sUAS operator to control the aircraft from the ground
- II. An uplink transmits command instruction to the UA and a downlink transmits aircraft status to the pilot

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Frequency Spectrum (RF) Basics

- I. Most sUAS use the 2.4 GHz or 5.8 GHz band to connect the CS to the UA
- II. These R bands are considered line of sight only
- III. Any physical barriers between the CS and UA will impact the link
- IV. The 2.4 and 5.8 GHz bands are also used for wireless networks, which can lead to interference

Radio Interference

- I. Sources of interference include high voltage power lines, transmission antennas, Wi-Fi transmitters, radar dish antennas and other UAS
- II. Can render a sUAS uncontrollable
- III. The Pilot in Command must confirm no radio interference exists prior to operation

Lost Link

- I. Loss of the command and control link between the CS and the UA
- II. Aircraft responds by executing pre-set lost link procedures in order to ensure it
- III. Remains airborne in a predictable manner
- IV. Auto-lands if available, after a predetermined length of time
- V. Terminates the flight when the power source is depleted

Sample Lost Link Procedure

- I. Maintain visual contact with aircraft
- II. Verify remote controller is powered on
- III. Move toward aircraft if possible

If unable to reestablish link:

- I. Continue to maintain visual of aircraft
- II. Update ATC with aircraft position (as required)

Fly Away

- I. Begins as a lost link, but lost link procedures are either not established or not being executed by the aircraft
- II. A true emergency situation
- III. If fly away occurs while operating in controlled airspace, immediately notify ATC

Global Position System (GPS)

- I. The primary method of navigation for most sUAS
- II. Loss of GPS can result in a flyaway situation
- III. Always check NOTAMS before flight for any known GPS service disruptions

Sample Loss of GPS Procedure

- I. If GPS signal is lost in flight, "Return to home" and intelligent flight mode will not be functional
- II. IF UA is flying erratically but still linked, switch to "A" or "ATTI" mode to disable GPS
- III. Continue flight without GPS
- IV. Pilot the UA to a safe landing area aircraft
- V. Pilot the UA to a safe landing area aircraft
- VI. Perform a manual landing and shutdown

Lithium Batteries

- I. Highly flammable
- II. Can self-ignite when the battery short circuits or is overcharged, heated to extreme temperatures, mishandled or defective
- III. Subject to thermal runaway

Thermal Runaway

- I. A chain reaction leading to self-heating and release of a lithium battery's stored energy
- II. Once a cell is induced into thermal runaway, it generates enough heat to cause adjacent cells to do the same



- III. Leads to fire and possible explosion of the battery

Prevention

- I. Separate individual batteries
- II. Prevent contact with metal objects
- III. Prevent objects from crushing, puncturing, or applying pressure to the battery casing
- IV. Check for small nicks in the casing prior to use
- V. Monitor for bubbling or warping during charging

Fighting a Lithium Fire

- I. Extinguish using a Halon, Halon replacement or water extinguisher
- II. Once extinguished, douse battery with water or other non-alcoholic liquid to continue the cooling process

Sample Battery Fire Procedure

- I. EXECUTE flight termination procedures
- II. ATTEMPT to extinguish the fire
- III. ONCE EXTINGUISHED: use non-alcoholic liquid to continue to cool
- IV. If unable to extinguish: call 911

Battery Low

- I. Battery management is an essential part of sUAS operations, an short flight times can lead operators to push the envelope
- II. Make sure you are familiar with the battery low response for your particular sUAS
- III. Failure to respond to a battery low situation may result in an immediate landing at a site not of your choosing

Sample Battery Low Procedure

- I. MAINTAIN visual contact with aircraft
- II. IMMEDIATELY return aircraft to you for landing
- III. IF DISORIENTED: use "Home Lock" to bring aircraft back for landing
- IV. IF STRONG WINDS PREVENT RETURN FLIGHT: Use camera to locate suitable location and land the aircraft

Aircraft System Malfunction

- I. If your aircraft exhibits any abnormalities, execute a landing as soon as you can safely do so.
- II. This may or may not be at your designated landing location
- III. Survey the operating area throughout your flight for alternative landing locations in case of a malfunction

Flight Termination

- I. Intentional process of performing controlled flight to the ground
- II. Use if further flight cannot be safely achieved
- III. Based on the assumption of an unrecoverable system failure
- IV. Execute once all other contingencies are exhausted

Collision

- I. Maintain awareness of all obstacles in your operating area that could impact your flight
- II. Always keep your eye out for other aircraft
- III. Notify appropriate authorities if personnel are injured or property is damaged during the course of your flight

Sample Collision Procedure

- I. IMMEDIATELY release all control sticks
- II. IF AIRCRAFT REGAINS STABILITY AND HOVERS: maneuver aircraft away from object
- III. RETURN for a safe landing and aircraft inspection

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- IV. IF AIRCRAFT DOES NOT REGAIN STABILITY: initiate manual motor shutdown to reduce speed of impact and protect people and property

Accident Reporting (§ 107.9)

- I. 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:
 - i. Serious injury to any person or any loss of consciousness
 - ii. Damage to any property (other than the small UA) with a cost to repair or replace greater than \$500

Serious Injury

- I. Qualifies as Level 3 or higher on the Abbreviated Injury Scale (AIS) or the Association of the Advancement of Automotive Medicine (AAAM)
- II. It would be considered a “serious injury” if a person requires hospitalization but the injury is fully reversible
 - i. i.e. head trauma, broken bones, skin lacerations

Submitting the Report

- I. Electronically
 - i. www.faa.gov/uas
- II. By phone
 - i. Appropriate FAA Regional Operations Center
 - ii. Nearest Flight Standards District Office (FSDO)
- III. Certain sUAS accidents must also be reported to the National Transportation Safety Board (NTSB)

Mitigating Measures

- I. Emergency procedure checklists
- II. Map showing alternate landing sites
- III. 2-way radio (as required)
- IV. ATC and UNICOM frequency list
- V. Contact numbers for local emergency services such as fire, police, and EMS
- VI. Hand-held fire extinguisher

Note: A small UAS operator must continually assess weather conditions, airspace restrictions and the location of people to lessen risks in case control of the UAS is lost. Ultimately, the operator shall discontinue flight when continuing would pose a hazard to other aircraft, people or property.



LESSON 12: AVIATION PHYSIOLOGY

Stress

- I. Body's response to physical and psychological demands
- II. Acute vs. Chronic
 - i. Acute (Short Term): involves an immediate threat that is perceived as danger, triggers "fight or flight" response in an individual
 - ii. Chronic (Long Term): a level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply.
- III. Pilots who experience this level of stress are not safe and should not exercise their airman privileges.

Fatigue

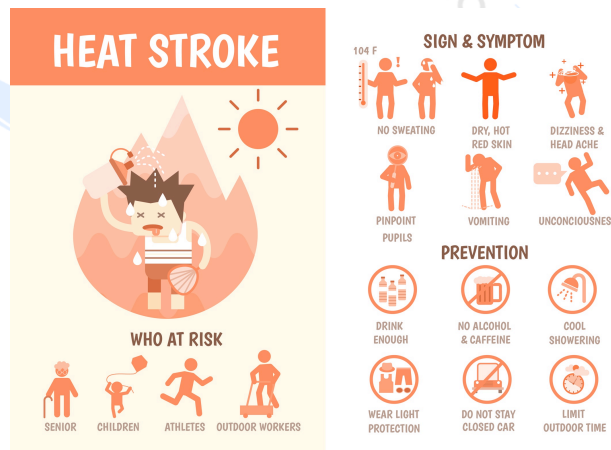
- I. Degrades attention, concentration and ability to communicate
- II. Seriously influences on decision making ability
- III. Adequate rest is the only prevention
- IV. Do not fly if you are experience acute fatigue
 - i. Acute Fatigue: physical stress, psychological stress, depletion of physical energy resulting from psychological stress, sustained psychological stress

Dehydration

- I. First noticeable effect is fatigue, mental and physical performance becomes difficult
- II. Can progress to dizziness, weakness, nausea, cramps, extreme thirst
- III. To help prevent dehydration, drink two to four quarts of water every 24 hours (this is only a guide because each person is physiologically different)
- IV. Other steps to prevent dehydration: carrying a container in order to measure daily water intake, staying head and not relying on the thirst sensation as an alarm, limiting daily intake of caffeine and alcohol

Heatstroke

- I. An inability of the body to control its temperature
- II. Is often only recognized by complete collapse
- III. Long sUAS operations on hot days have significant potential for dehydration and heatstroke
- IV. Always carry ample supplies of water and use whether thirsty or not



Hyperventilation

- I. Excessive rate of respiration leading to loss of carbon dioxide in the blood
- II. Can lead to visual impairment, dizziness and ultimately unconsciousness
- III. Treatment options: breathing normally, breathing into a paper bag, or talking aloud helps to overcome hyperventilation

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Factors affecting Vision

- I. Essential for safe sUAS operation
- II. Stress, fatigue, dehydration, heat stroke, and hyperventilation can ALL impact vision
- III. If a sUAS operator experiences any visual impairment, they should immediately end flight operations

FAA Drug and Alcohol Regulations

- I. Small UAS operators and visual observers must comply with all FAA alcohol and drug use prohibitions in Part 91
 - i. Small UAS Operators and visual observers would also be subject to the existing regulations of § 91.19, which prohibits knowingly carrying narcotic drugs, marijuana, and depressant or stimulant drugs or substances

FAR § 91.17 (a)

- I. No person may act or attempt to act as a crew member of a civil aircraft:
 - (1) Within 8 hours after the consumption of any alcoholic beverage
 - (2) While under the influence of alcohol
 - (3) While using any drug that affects the person's faculties in any way contrary to safety
 - (4) While having an alcohol concentration of 0.04 or greater in a blood or breath specimen.
Alcohol concentration means grams of alcohol per deciliter of blood or grams of alcohol per 210 liters of breath
- II. 8 hours from bottle to throttle

FAR § 91.19 (a)

- I. Carriage of narcotic drugs, marijuana, and depressant or stimulant drugs or substances:
 - i. No person may operate a civil aircraft within the United States with knowledge that narcotic drugs, marijuana, and depressant or stimulant drugs or substances as defined in Federal or State statutes are carried in the aircraft.
- II. Exception for authorized flights by federal or state authorities

Drug and Alcohol Offenses

- I. Any of the following:
 - i. Committing an act prohibited by § 91.17(a) or § 91.19(a)
 - ii. Refusal to submit to an alcohol test or to furnish test results (§ 107.59)
 - iii. A Federal or State drug conviction (§107.57)

Are grounds for....

1. Denial of an application for an unmanned aircraft operator certificate with a small UAS rating for a period of up to 1 year after the date of that act
2. Suspension or revocation of an unmanned aircraft operator certificate with a small UAS rating

Physiological Effects of Alcohol - Alcohol Can...

- I. Impair judgment
- II. Decrease sense of responsibility
- III. Affect coordination
- IV. Constrict visual field
- V. Diminish memory
- VI. Reduce reasoning power
- VII. Lower attention span

The Effect of Alcohol

- I. The average person eliminates $\frac{1}{3}$ to $\frac{1}{2}$ oz of pure alcohol per hour
- II. This rate of elimination is relatively constant, not impacted by numbers of drinks consumed

BAC effects for men and women

- I. The more alcohol that's consumed, the longer it takes his/her to get it out of their system

Continuing Effects of Alcohol

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- I. Impaired reaction time, reasoning, judgment and memory
- II. Double vision and difficulty focusing
- III. Dizziness and decreased hearing perception
- IV. Other variables (sleep deprivation, fatigue, etc.) magnify the negative effects

Physiological Effects of Drugs

- I. Pilot performance can be seriously degraded by both prescribed and over the counter medications, as well as by the medical conditions for which they are taken

Pain Killers

- I. Analgesics - Reduce Pain
- II. Anesthetics - deaden pain or cause loss of consciousness

Over the Counter (OTC) Analgesics

- I. Acetylsalicylic acid (Aspirin)
- II. Acetaminophen (Tylenol)
- III. Ibuprofen (Advil)
- IV. Operating a UAS usually is not restricted when taking these drugs

Prescription Analgesics

- I. Drugs such as Darvon, Percodan, Demerol, and Codeine
- II. May cause side effects such as mental confusion, dizziness, headaches, nausea, and vision problems
- III. Operating a UAS is almost always precluded when using prescription analgesics

Anesthetics

- I. Most local anesthetics used for minor dental and outpatient procedures wear off within a relatively short period of time
- II. The anesthetic itself may not limit flying so much as the actual procedure and subsequent pain

Stimulants

- I. Excite the central nervous system and produce an increase in alertness and activity
- II. Common uses of these drugs include appetite suppression, fatigue reduction, and mood elevation
- III. In certain cases, stimulants can produce anxiety and mood swings, both of which are dangerous when operating a sUAS
- IV. Amphetamines, caffeine and nicotine are all forms of stimulants

Depressants

- I. Lower blood pressure, reduce mental processing, and slow motor and reaction responses
- II. Include tranquilizers, motion sickness medication, some types of stomach medication, decongestants, and antihistamines
- III. The most common depressant is alcohol

FAA Regulation Review

- I. The Code of Federal Regulations prohibits sUAS operators and visual observers from performing crewmember duties while using any medication that affects the faculties any way contrary to safety

Fitness for Flight

- I. No personnel may participate in flight operations if they know of a physical or mental condition that could interfere with safe operation of the sUAS



LESSON 13: TAKING THE EXAM AND GETTING YOUR CERTIFICATE

Requirement Review

- I. Be at least 16 years old
- II. Be able to read, speak, write and understand English
- III. Be in a physical and mental condition that would not interfere with safe sUAS operation
- IV. Fulfill testing requirements

Finding a Test Center

- I. FAA.gov list
- II. CATS or PSI/LaserGrade Online lookup
- III. Be sure to verify the Site ID for the testing site you would like to use prior to registering
 - i. ABS##### is CATS
 - ii. LAS##### is Laser-Grade

Registering

- I. Online
 - i. CATS (Currently Registering)
 - ii. PSI/LaserGrade (not registering online yet)
- II. Phone
 - i. 1-800-211-2754 (PSI/Laser-Grade)
 - ii. 1-800-947-4228 (CATS)

Identification

- I. Applicant: US Citizens and Resident Aliens
 - i. Acceptable Forms of Identification – one of the following: driver permit or license issued by a State or US Territory, US Government ID Card, US Military Card, Passport, Alien residency card
- II. Applicant: Non-US Citizen
 - i. A passport AND one of the following: Driver permit or license issued by a State or US territory, identification card, issued by any government entity
- III. Applicant: Applicants under 18 years of age without acceptable identification
 - i. A parent or legal guardian may be required to accompany the applicant, present identification as described above and attest to the applicant's identity

Applying for the Certificate

- I. Online OR paper application to the FAA
- II. Submitting an online application using IACRA
 - i. You will receive an email notification to print and sign a temporary certificate via IACRA
 - ii. This temporary certificate will be valid until your permanent certificate arrives by mail
- III. Submitting a Paper Application
 - i. Complete FAA form 8710-13 and mail it to the original copy of your Knowledge Test Report to the FAA Airmen Certification Branch
 - ii. Paper applications delay issuance of a permanent certificate due to verification and processing times
 - iii. Your permanent certificate will arrive by mail