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Small Unmanned Aircraft Systems Flight Training Programs Through the Lens of a Traditional Flight Training University

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SMALL UNMANNED AIRCRAFT SYSTEMS FLIGHT TRAINING PROGRAMS THROUGH THE LENS OF A TRADITIONAL FLIGHT TRAINING UNIVERSITY

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According to CFR 14 Part 107, an RPC is issued strictly on the results of the Federal Aviation Administration's (FAA) knowledge test and background security check. This leaves commercial sUAS operators on their own to determine the training and proficiency required to fly safely and effectively. Regardless of the learning method, the question becomes, what knowledge and maneuvers should be learned, and to what proficiency level? This paper explores specific knowledge and skills which should be mandatory for all sUAS commercial pilots and recommends a probation period to gain experience before receiving an unrestricted RPC.

INTRODUCTION

The federal registration of small unmanned aircraft systems (sUAS) has already tripled the number of aircraft registered in the United States (US) despite the brief lifting of the registration requirement. As of January 2017, over 770,000 drones were registered and projections indicate that up to 3.55 million sUAS will be registered in the US by 2021.[1] However, unlike manned pilot qualifications which assess both knowledge and practical ability, sUAS commercial pilots are not required to demonstrate flight proficiency or have any experience to obtain a remote pilot certificate (RPC). According to CFR 14 Part 107, an RPC is issued strictly on the results of the Federal Aviation Administration's (FAA) knowledge test and background security check. This leaves commercial drone operators on their own to determine the training and proficiency required to fly safely and effectively. Regardless of the learning method, the question becomes, what knowledge and maneuvers are required, and to what proficiency level? This paper explores this question and proposes specific recommendations which should be mandatory for all sUAS pilots.

As the number of sUAS continue to increase, how will remote pilots develop their knowledge and skill? The FAA Flight School website (www.faaflightschool.com) reported there were 1,164 flight schools in the US for manned flight. The number of drone schools is more difficult to ascertain, but most online estimates are less than 100. However, sUAS operators have other options for training. They can attend an in-person flight school, learn from a friend or colleague, take informational courses online, train through simulation, or train themselves. Another option is to enroll in a community college or university program.

Collegiate programs tend to be more comprehensive in flight training, knowledge, procedures, safety, and experience; especially programs which have grown from institutions with manned flight schools such as Purdue University, University of North Dakota, Ohio State University, and Embry-Riddle Aeronautical University (ERAU). These educational degree programs concentrate on creating the professional aviation expert, not just a pilot.

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FLIGHT TRAINING AND REGULATIONS

The regulations regarding certification of pilots varies between manned aviation and sUAS. Even more significant is the variation between the practical skills and their assessment. While it is understandable that the FAA cannot (and probably should not) attempt to conduct checkrides for every drone pilot, there should be a standard set of skills each remote pilot must acquire. This section outlines the skills a student pilot pursuing a sport pilot license (the least rigorous of FAA pilot licenses) is required to master and discusses regulations and training required for the sUAS pilot.

Manned Flight

On September 1, 2004 a new FAA pilot certificate was added; the sport pilot license (SPL).[2] A new category of aircraft was also added, the light sport aircraft aircraft.[3] The SPL requires pilots to be age 16 or above and have either an FAA medical certificate or Unites States driver's license. The pilot must also be piloting an aircraft categorized as light sport aircraft (LSA) by the FAA.[4] Training is not as thorough as the training for a private pilot license. Obtaining a SPL requires both a knowledge and practical exam.

Before the SPL student can take the written knowledge test, they must have an endorsement by an authorized instructor. The aspiring pilot can be taught by an instructor or home study course. The requirements for the written test are listed in FAR 61.309. The applicant must know[5]:

- The rules and regulations for a sport pilot
- Accident reporting regulations of the National Transportation Safety Board
- How to use the aeronautical information manual and FAA advisory circulars
- How to read and use VFR aeronautical charts
- How to recognize weather patterns and problems
- How to safely and efficiently operate the aircraft
- The effects of density altitude
- How to perform weight and balance calculations
- Principles of aerodynamics
- Stall and spin awareness
- Preflight activities that include gathering runway data, weather data, fuel requirements, and alternatives in case the flight is delayed or cannot be completed.

Before taking the practical exam, the student pilot must accomplish the following.[4]

- 20 hours of flight time, 15 of which must be with an authorized instructor and 5 hours of solo flight in a single engine aircraft
- 2 hours of cross country flight training
- 10 takeoffs and landings to a full stop in an airport pattern
- One solo cross-country flight of at least 75 nautical miles (NM) with a full stop landing at a minimum of two airports with at least 25 NM between the takeoff and landing locations
- 2 hours of flight training that covers FAR 61.311:
    - Preflight procedures
    - Airport operations,
    - Takeoffs, and go-arounds
    - Performance maneuvers and speeds
    - Ground reference maneuvers

- Navigation
- Slow flight and stalls
- Emergency operations
- Post-flight procedures

Maneuvers that are tested for are steep turns, S turns, and slow flight. When testing for slow flight the SPL must be able to maintain a specific altitude (+/- 100 ft.) and demonstrate control of the aircraft during slow flight in straight and level flight as well as turns and climbs. The SPL must also demonstrate the ability to recover from power off and power on stalls, as well as recognize elements of a spin spin.[6] The student is instructed on emergency procedures including inflight fire, worsening weather, bird strikes, engine problems (high EGT, etc.), or fuel problems. Checklist use is an emphasis item throughout training.

Unmanned Flight

Flight authorization for sUAS is through either Public Law 112-95 Section 336 for recreational fliers, through 14 CFR Part 107 for commercial drone pilots, or the Certificate of Authorization or Waiver (COA) process. Section 336 allows recreational pilots to fly as long as they conform to safety guidelines provided by a community of practice, such as the Academy of Model Aeronautics (AMA). These AMA safety guidelines dictate where, and how recreational users can fly sUAS. The guidelines include altitude restrictions near airfields, flying over crowds, minimum distances from bystanders, radio frequency deconfliction, maintaining visual contact with the aircraft, maintaining control throughout the flight, and the catch-all, not operating in a careless or reckless manner.[7] The vast majority of drones in the U.S. are flown under Section 336.

Drone operators who are flying "for the furtherance of business" are required to obtain a remote pilot certificate from the FAA or apply through the COA process. The RPC is issued to current manned pilots (i.e., Part 61 certified pilot) after passing an online test which is correctable to 100%. [8] Non-current manned pilots, or those without a manned pilot certificate, are required to take an FAA written exam similar to other FAA written exams.[8] None of the avenues to receive an RPC require sUAS flight experience nor stipulate any required skills. However, all operators of sUAS must abide by 14 CFR Part 91.13 (a) which states that pilots must not "operate an aircraft in a careless or reckless manner so as to endanger the life or property of another" (Para 1).

The FAA Part 107 Knowledge Test covers several areas as discussed in the Remote Pilot-Small Unmanned Aircraft Systems Study Guide.[9] The list of topics is extensive and includes several areas that are similar to the knowledge required for the SPL. Specifically:

- Regulations
- Airspace, Operating Requirements, Flight Restrictions
- Weather
- Effects of Weather on sUAS Performance
- sUAS Aircraft Loading
- Emergency Procedures
- Crew Resource Management
- Radio Communication Procedures
- Performance
- Physiological Factors
- Aeronautical Decision Making
- Airport Operations
- Maintenance and Preflight [9]

There are several flight schools on the web that offer Part 107 test preparation, online courses, and/or in-person training. A quick look through the curriculums indicates there is flight skill development involved. For example, one drone educator offers eight hours of in-person training and three hours of hands-on flight instruction. This training includes lessons covering:

- Platforms and Components
- System Setup
- Flight App
- Flight Preparation
- Advanced Settings
- Mission Specific Settings
- Emergency Procedures
- Autonomous Flight

It is important to note that one make and model of sUAS may be used for this training but anyone can legally fly any sUAS without any experience. This can complicate the issue more than manned aircraft since there are no standards for these software driven drones.[10]

Several websites rank the best drone schools and Drone Training HQ (www.dronetraininghq.com) rates ERAU as the top rated school for unmanned systems. ERAU's Worldwide Campus' online catalog offers 18 different, 3 credit, UAS courses including a course titled sUAS Practical Application and Assessment.[11] The prerequisites to enter this course include a sUAS groundschool and an RPC. This course is focused on flight training only and includes activities based on:

- Basic Aircraft Control
- Advanced Aircraft Control
- Manual and Automatic Flight
- Checklist Procedures
- Emergency Procedures
- Flight Planning
- Multiple Aircraft Experience
- Aerial Photography
- Post Flight Data Processing
- Mobile Applications
- Crew Resource Management
- Practical Assessment (para 17)

DISCUSSION

There are obvious training differences between the SPL and the sUAS RPC. Comparing the subjects on the Part 107 knowledge test to the knowledge required for the SPL, it is apparent that the FAA desires remote pilots to have similar topic familiarity and depth.[6, 9] According to Perritt and Sprague[12] the FAA is aiming to align manned pilot knowledge standards with sUAS standards, but clearly, there is a gap between the two in reference to flight training. Table 1 offers a comparison between the sUAS Part 107, SPL, sUAS Flight Schools, and ERAU sUAS training.

Table 1. Flight Training Comparison.

Topic	FAA sUAS	FAA SPL	sUAS Flight School	ERAU
Preflight	YES	YES	YES	YES
Flight Planning	YES	YES	YES	YES
Takeoff and Landing	NO	YES	YES	YES
Basic Maneuvers	NO	YES	YES	YES
Advanced Maneuvers	NO	YES	UKN	YES
Minimum Flight Time	NO	YES	UKN	UKN
Checklist Procedures	YES	YES	YES	YES
Software Interface	NO	N/A	YES	YES
Emergency Procedures	YES	YES	YES	YES
Autonomous Flight	NO	N/A	YES	YES
Photography	NO	N/A	YES	YES
Post Flight	NO	YES	UKN	YES
Maintenance	YES	YES	UKN	YES
Flight Assessment	NO	YES	UKN	YES

Note: UKN=Unknown, or not enough information to determine. Data retrieved from www.dartdrones.com, www.erau.com, www.faa.gov.

The ERAU curriculum defines basic and advanced maneuvers. The basic maneuvers include profiles such as flying a box pattern with the aircraft facing away and toward the pilot. Advanced maneuvers include exercises such as flying a figure-8 with the aircraft always pointed in the direction of flight and yawing the aircraft 360 degrees while flying in a straight line. These maneuvers must be mastered prior to continuing through the training. While some may see this training as overkill, mastering these maneuvers is essential for aircraft control when GPS is lost or other abnormal situations occur. Also included in the curriculum is an FAA style practical exam comprised of an oral exam, flight planning session, and flight exam where the student demonstrates proficiency in checklist procedures, regulation compliance, safety assessment and mitigation, aircraft knowledge, and flight skill. The other sUAS flight training schools offer similar training which topics align with the FAA requirements for a SPL. However, a major difference between the sUAS training and the SPL is the time (experience) requirement. This brings up an interesting question, if the industry leaders in sUAS training and education require students to perform certain maneuvers to become proficient, why is there not a proficiency requirement to obtain an RPC?

Another area which is not covered by Part 107 is instructor qualification. Currently, an RPC instructor does not need to have any instructor qualifications or even flight experience with sUAS.[8] The manned commercial aviation culture is considered a professional culture; a culture which is partially policed from within due to high entry standards and expectations.[14] Without any requirements to be an instructor, how can the sUAS commercial pilot community established a standard of performance when the instructors are not required to meet any standards themselves? The SPL instructor on the other hand must be a certified flight instructor (CFI).[6] Additionally, if the CFI-SP is only qualified for SPL, they can only instruct in that catagory.[3] By providing skill-based proficiency requirements, minimum experience levels, and defining qualifications for sUAS instructors, the FAA may be able to increase safety associated with commercial use of sUAS.

Another aspect commonly overlooked are the different skills required for multi-rotor and fixed wing aircraft. Part 107 applies to both multi-rotor and fixed wing sUAS. The required skills and experience to master each aircraft category vary dramatically. While a typical multi-rotor operator can stop and hover when an issue occurs, the pilot of a fixed wing sUAS must continually clear the

flightpath and maneuver the aircraft to maintain line of sight and allow for maneuvering airspace. Takeoff and landing procedures, the influence of environmental conditions, route planning, and abnormal procedures can be much more challenging with fixed wing aircraft than a multi-rotor.

RECOMMENDATIONS

This paper examined the FAA training requirements for both the SPL and sUAS. There are significant differences between the two; particularly the experience requirements and instructor qualification standards. The SPL, although heavily restricted, mandates the SPL student fly the aircraft for at least 20 hours before being recommended for certification.[2] This is considered the minimum flight time that allows the student pilot to become familiar and proficient with the aircraft and procedures. During these training flights, the SPL student receives instruction and must adequately perform many maneuvers. There are no flight time requirements for sUAS pilots. To maximize the lessons already learned from manned aviation, it would benefit the aviation industry if there were minimum flight time and event requirements for RPC pilots and instructors.

The experience requirements could be met during a probation period for the sUAS pilot. During this probation, commercial remote pilots would only be allowed to fly within a defined horizontal and vertical distance from the takeoff point until the probation experience and event requirements are met. Considering that a sUAS could be a rotorcraft or fixed wing (or a hybrid), a separate probation period is recommended for each category. The authors recommend the following probation requirements as a starting point.

- A minimum of 5 hours of flight time piloting a sUAS. This equates to approximately 15 flights for a typical sUAS endurance profile
- A minimum of 15 takeoff and landings using both manual and automatic modes
- A minimum of 2 hours of maneuver training, including maneuvers designated as basic and advanced (which should be defined similarly to the way the FAA defines manned flight maneuvers)
- A minimum of 1 hour preforming abnormal/emergency procedures such as return to home, loss of command link, loss of visual line of sight, fly away, unexpected low battery alert, and loss of GPS
- A minimum of 1 hour preforming maneuvers commonly encountered during photography flights
- A minimum of 0.5 hours of manual flight (GPS off)

Knowledge testing should include topics such as on-site risk assessment and mitigation techniques, mission planning fundamentals, and radio spectrum management.

Also recommended is a minimum experience level and knowledge standard for qualification as an RPC instructor. Without holding instructors to a higher standard, students and future sUAS pilots will not benefit from an established performance standard. There are several methods to implement a sUAS instructor program including minimum time in category, an advanced knowledge test, or even certification through third part flight training organization.

CONCLUSION

The goal of aviation is safe and successful flight and unmanned aviation is no different. While several avenues exist to obtain an RPC, whether the remote pilot has the knowledge, skills, and abilities to operate safely is still in question. In 2013, Mirot[13] was concerned about qualifications for sUAS operators. While the FAA has made progress in regulating operations, there are still questions of safety and proficiency. As the FAA considers expanding the size and performance

categories for UAS, new pilot requirements must be included. As the weight, speed, and altitude increases, licensing requirements must get tougher; similar to how manned flight qualifications become more stringent as a pilot progresses from private pilot to instrument, commercial, and airline transport pilot.[13] Levying additional experience and event requirements on sUAS commercial operators and instructors will begin to add structure and standards to the unmanned community.

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