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How to Obtain a Certificate of Authorization from the Federal Aviation Administration for Small Unmanned Aircraft Systems Operations: A Student’s Guide

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Nomenclature

AGL = Above Ground Level
AMA = American Modeler’s Association
ARTS = Automated Radar Traffic Control System
ATC = Air Traffic Control
CAA = Civil Aeronautics Authority
CAB = Civil Aeronautics Boards
CG = Center of Gravity
COA = Certificate of Authorization
CFR = Code of Federal Regulations
DOT = Department of Transportation
ELT = Emergency Locator Transmitter
FAA = Federal Aviation Administration
FAR = Federal Acquisition Regulation
FCC = Federal Communications Commission
FPV Cam = First Person View Camera
GCS = Ground Control Station
IFR = Instrument Flight Rules
NAS = National Airspace System
Neaten = Next Generation Air Transportation System
NOTAM = Notice to Airmen
PIC = Pilot in Command
RF = Radio Frequency
RNP = Required Navigation Performance
RVSM = Reduced Vertical Separation Minima
SUAS = Small Unmanned Aircraft System(s)
TSA = Transportation Security Administration
TSO = Technical Standard Orders
VFR = Visual Flight Rules
VLOS = Visual Line of Sight
sm = Statute miles

I. Introduction

This paper aims to provide a detailed set of instructions on the correct approach to take for completing and committing a Certificate of Authorization (COA) application with the Federal Aviation Administration (FAA). The instructions particularly pertain to Small Unmanned Aircraft Systems, but the procedures and considerations can be applied to multiple aircraft and platforms.

The majority of the online COA application will be discussed in detail, along with the correct procedure to take for creating the supplemental documentation that will be submitted along with the application. The COA application that was submitted by the University of Alabama in Huntsville for project SPEAR 1 may be referenced to enhance

1 Undergraduate Honors Scholar Candidate, Aerospace Engineering, 301 Sparkman Drive, Student Member.
2 Project SPEAR (SUAS Platform for Environmental Aerial Research) is a Senior Design project undergone by the University of Alabama in Huntsville for the Fall 2014 and Spring 2015 semesters, and presented at the Region II AIAA Conference in Savannah, Georgia in April 2015.

American Institute of Aeronautics and Astronautics
II. Background

Most people involved in aviation know about the Wright brothers and their place in history as the pioneers of manned flight. Shortly after, planes were used by the military in World War I. Wartime pilots had an atrocious lifespan. Low flight (200-500 feet) was a common factor in death toll, because a pilot’s main means of navigation were a magnetic compass, and the roads and railways. Profitable commercial airlines were a product of The Air Mail Act of 1925. As a result, four airlines—United, American Easter, and Transcontinental and Western Air—dominated the market in 1930. An early attempt at improved safety involved the use of Flagmen, or individuals who waved flags in order to communicate with pilots. This kind of brings to mind aircraft marshalling, doesn’t it? Nevertheless, aircraft safety had much room for improvement at this time.\(^1\)

The first major movement towards common air safety regulations began with the Air Commerce Act of 1926. This law basically made it so that the Secretary of Commerce was in charge of all litigation and enforcement of the airways. The Aeronautics Branch handles all the primary aviation responsibilities, and eventually led to the establishment of air traffic control (ATC) centers. A radio link was not established, although telephone coordination was common, and the federal government soon took over control of ATC responsibilities. A couple of high-profile deaths caused by plane crash eventually lead to Franklin Roosevelt signing the Civil Aeronautics Act in 1938. This established a Civil Aeronautics Authority (CAA), with an eventual split off called the Civil Aeronautics Board (CAB). The CAB handles certification, safety, commerce, and accident investigation related to aviation. After World War II, ATC once again became a mostly federal endeavor. The post-World War II world also saw the creation and implementation of the commercial jet. A 1956 midair collision between two commercial airliners revealed that, even though ATC was large, they had many issues to address within the ever-growing airspace.\(^1\)

The 1958 Federal Aviation Act saw the CAA’s responsibilities given to the Federal Aviation Agency. The larger-than-ever Federal Aviation Agency began moving into a new Washington building, but Kennedy’s assassination all but destroyed the hype of moving to the new building.\(^1\)

President Johnson and Congress approved the creation of a Department of Transportation (DOT). The Federal Aviation Administration was now under the DOT, and became known as the Federal Aviation Administration.\(^1\)

The first hijackings in 1961 prompted the FAA to use armed guards. Officers were also trained for duty while on flights to combat threats. In addition, the economic boom in the 1960s forced the FAA to think about noise concerns, environment pollution, etc. The aviation industry is still booming, and thus airport safety and capacity issues needed to be addressed in order to keep revenue flowing, while maintaining the peace.\(^1\)

Also in the 1960s, the FAA began to automate its services. As a result, they developed the automated radar traffic control system (ARTS). The FAA then establishes the Central Flow Control Facility Headquarters. It opens in 1970, and its purpose is to collect traffic and weather data, detect hazardous areas, and offer solutions to avoid safety violations.\(^1\)

After labor unrest, the FAA realized it needed to come up with a viable, long-term play to modernize its infrastructure. Thus, they released the National Airspace System (NAS) Plan. This plan was a 20-year foundation for a modernized navigation, air traffic control solution to cope with the rapid influx of aircraft activity and demand. At the same time as working towards importing ATC system through small steps, the FAA works tirelessly on a Global Positioning System for the civilian side of the air industry. NAS is then replaced with a program called the Capital Investment Plan. Essentially, it incorporated some aspects of NAS, but wanted to see the implementation of radar, weather forecasting devices, and better communication devices. In addition to this shift of focus, they started studying safety risks like aging aircraft structures and the human aspect of safety. The FAA starts to hire engineers, scientists, and even psychologists to study anything from human factors, to runway improvements, to structural integrity studies.\(^1\)

In the mid-1990s, the DOT gave responsibility of commercial space launch over to the FAA. The FAA became responsible for ensuring safe space launches, and even issuing licenses for rocket launches.\(^1\)

For the first time in US history, the FAA immediately halted all air traffic. This day was September 11, 2001. A group of Muslim extremists working for a terror organization flew two airliners into the two World Trade Centers in New York City. They also flew an airliner into the Pentagon, and attempted to use a fourth airliner for an equally
The FAA worked around the clock to provide the FAA with as many details as possible about the hijackers, in an attempt to thwart a follow-up attack. After that, aircraft safety changed forever. A little over two months later, President George W. Bush signed the Aviation and Security act, which essentially formed the Transportation Security Administration (TSA) within the DOT. The TSA took over the FAA’s responsibility less than three months after the signing of the Aviation and Transportation Security Act. But in November of 2002, the Homeland Security Act would move TSA into the Department of Homeland Security. After Bill Clinton signed the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, the FAA began a major air traffic and research and acquisition change. Then, the Vision 100—Century of Aviation Reauthorization Act, was signed into law in December of 2003. It called for a Next Generation Air Transportation System (NextGen). Congested airspace surrounding some of the busier airports meant more flight delays. To counter the problem, the FAA introduced new concepts, such as the Required Navigation Performance (RNP) concept, which helped the NAS transition from airway reliance to point-to-point navigation. In addition, the FAA enacted the Reduced Vertical Separation Minima (RVSM). Instead of the previous minimum vertical separation of 2,000 feet, all properly equipped aircraft that fly between 29,000 and 41,000 feet only have to be separated by 1,000 feet vertically. The reduced separation increased the number of routes and altitudes available to pilots and allows for flight routes that were more efficient and saved time and fuel—which saved money.

The period of 2001-2007 was not only one of the busiest times in aviation history, but was also one of the safest as well. Excluding the 9-11 terrorist attacks, the number of fatal accidents in 2001, 2002, 2003, 2004, 2005, 2006, and 2007 were 3, 0, 2, 1, 3, 2, and 0, respectively. The FAA’s vigilance and attention to detail ensured that there was only 1 accident for every 10 million flight hours, or 18 accidents for every 10 million departures.

The United States, by far, has the most active airspace in the world. The FAA’s various rules and guidelines may seem like overkill at times, but the safety of everyone using the busiest airspace is top priority. Aviation has become a means for business and people to be linked both domestically and internationally. Air transportation has become not only a hobby, but a means of greatly decreasing the physical boundary between any two people or places. Not only has the FAA made our aviation industry the safest and most efficient in the world, but they have also made it the most reliable and convenient.

The FAA’s NextGen not only aims to continue this trend, but improve it as well. The FAA wants the NextGen system to be on that thrives on “lower costs, improved service, greater capacity, and smarter security measures” and “integrates achievements in safety, security, efficiency, and environmental compatibility.” In essence, the FAA wants to be adaptable to the ever-changing business and world environment of aviation. They will attempt to address such things as increased runway efficiency to help alleviate fuel prices, increased aircraft luxury standards in order to return flight to its former glory days of being the most luxurious form of transportation, and more efficient arrival and departure courses to help alleviate the delays that have plagued the larger airports in the United States. Without pause, it is safe to assume that the FAA will achieve all the incredible goals they have set for themselves in the years to come, continuing to make our airspace and aviation industry the safest and most productive in the world.

III. Importance

The COA process is a very in-depth process that not only required a lot of various aviation knowledge, but also a keen knowledge of hardware and software related to any engineering aspect of safety. The procedures and restrictions set forth by the FAA are stringent in detail, and require a very competent team of people to decipher and comply with them. The importance of aforementioned procedures and restrictions will be covered in detail in order to provide the reader with a comprehensive understanding of why the COA process is not only important, but necessary.

A. University Importance

Obtaining a COA is not strictly a university-oriented process. In fact, very few universities know, or even care about, the extensive knowledge and expertise required for obtaining a COA. Most university projects assume that they are allowed to fly university-funded UAS under the model airplane restrictions. However, this assumption is false, and could result in a very tiresome and nasty litigation process. For this reason, it is highly recommended that universities doing any sort of aviation-related research hire someone who is versed and familiar with the COA application process, to ease the responsibilities of student researchers so that they may focus on the actual research, while still learning about the COA process. You could spend an entire semester teaching students about the ins and outs of the COA application process, and would still have a lot of students that would not be able to successfully submit a COA application by themselves. In essence, the hiring of someone with COA knowledge would allow...
students to become familiar with the process, without having to struggle with the possibility of a denied COA that would mean the end of any research they wanted to conduct.

B. Professional Importance

Many government personnel responsible for aviation aspects of any program know about the COA, and its importance to safe and legal test and evaluation. In fact, the test and evaluation aspect of aviation is a very coveted circle for many people. Many aspects of the COA application process require an in-depth knowledge of testing limitations and expectations. Also, a very detailed roadmap of all the testing procedures and guidelines needs to be available for use by any member of the test and evaluation team. A deep knowledge of the procedures, expectations, and other various aspects of the testing and evaluation of the entire system, or subsystems of that system is necessary in order to provide a smooth flow of accurate analysis and results. All of this knowledge can be increased simply by learning about the correct way to apply a COA, and comply with the approved COA. Any student, or group of students, that have had experience in the aforementioned COA-related processes should add that experience to their Resumes. Many government, as well as private, aviation-oriented companies and operations rely on a group of people to obtain COAs for various operations. It might not sound like the dream job, but that experience could mean the difference between employment and unemployment. In addition, the experience coupled with excellent job performance could lead to a more lucrative (or more desirable) employment opportunity.

C. The “Aero” in “Aerospace”

Even though this report is not geared towards students from any particular major, it would not be wrong to assume that UAS research will be exclusively conducted by engineers of the “Aero” variety. If not exclusively, the research would probably be in coordination with said engineers. These statements are not made to step on toes, but merely to set up and important point: Being familiar with a COA application process will enable you to become familiar with various aspects of aircraft operations. Anyone who is interested in any aspect of aviation would benefit from becoming familiar with the COA application process. Students who wish to get accepted into flight school, or even just earn their Pilot’s license would already have the knowledge about safe air operations, ATC/Pilot phraseology, minimum safe altitudes, etc. that will be discussed in this report. Even if a person does not care to even step foot in an aircraft, but thinks they are one of the most awesome displays of engineering in the modern age (who could disagree?!), would benefit from the knowledge gained during the application process. For those reasons, it is highly recommended that any student project involving aerial operations should make an attempt to involve all of the students in various aspects of the COA application process.

D. Space-heads

Up to this point, all the space-lovers out there might be thinking, “So what? I don’t care about aircraft, I care about what happens after we go outside of the atmosphere!” The “air vs. space” argument is reminiscent of SpongeBob vs. Sandy and the “Air-breather!” vs. “Water sucker!” argument that precedes a long list of surprisingly humorous insult hurling. Nevertheless, even though this report focuses on aircraft safety, it is well known that many in the Aerospace community could care less about aircraft. But the same people would read this entire report for fun (hopefully) if it had anything to do with spacecraft or the space environment, or lack thereof (Sorry for the personal jab, but it had to happen sometime). In reality, the first job a student obtains will most likely not be leading NASA’s design group for a manned mission to Mars. At the risk of more booing and hissing, it is important to state that the funding for space research and operations is nowhere near what it used to be. The vast majority of engineers are discouraged by this fact, regardless of their stance on the “air vs. space” argument mentioned at the beginning of this paragraph. Therefore, it is good practice for a space-head to gain knowledge about aircraft systems whilst it is applicable to their research or professional activity. Hopefully, one day the time will come when a space-oriented company wants to hire those students, and do so because of their extensive knowledge of airspace safety, and their devotion to that knowledge. Even though it might not have been enjoyable, the hard-work devoted to mastering knowledge of the airspace and the safety of its aviation activities might cause that space exploration company to hire the student based on work ethic alone. Regardless of how much a person loves space, it is important to realize the importance of gaining knowledge and expertise that is very applicable to the field of study a student is a part of. Therefore, any immersion into the COA application process would allow for important knowledge to be obtained by a student, whether or not it is about his or her favorite aspect of engineering.
IV. Process

This portion of the report covers the actual COA application process. It is important to mention that the process that follows was recently used to successfully obtain a COA from the FAA. The COA application was submitted on 26 January, 2015 and approved April 10, 2015. This was less than 3 months total time, and approximately 50 business days. The total time waiting for, and corresponding and complying with changes to, the COA application and its subsequent approval is far less than the average. Therefore, strict adherence to the following processes should result the best outcome from a COA application.

A. Online COA Application

The first step in obtaining a COA is making the FAA aware of exactly the type of aircraft and payload you are attempting to fly. You will need to visit the online application website\(^3\) in order to start this process. The entire list of requirements will not be covered, but there are some important aspects of the online form. First, there will be no lights out operations (night flying), even though you will be required to affix the appropriate navigation lights—which will be discussed later, but can be seen in Figure 1.

![Aircraft Navigation Lights](https://ioeaaa.faa.gov/oeaaa/Welcome.jsp)

Figure 1. Aircraft Navigation Lights

The furthest the aircraft can be from the Pilot in Command (PIC) is 0.5 nautical miles (nm), which means that all flights must be under Visual Flight Rules (VFR) rather than Instrument Flight Rules (IFR). The VFR requires that the aircraft is clear of clouds, and does not exceed an altitude of 400 feet Above Ground Level (AGL). Also, the visibility must be at least 3 statute miles (sm), and the aircraft must remain within the Visual Line of Sight (VLOS) of either the PIC or the Visual Observers. Identify the class of airspace for the private land (more on this later), and make certain that your area of operations is at least 5 nm from the nearest airfield.

Now that some of the rules and regulations have been discussed, it is time to disclose other characteristics of the aircraft to the FAA. The form will ask you to answer whether or not the aircraft has an Emergency Locator Transmitter (ELT) or Transponder, which most small (non-military) UAS do not. The aircraft should have appropriate position/navigation and anti-collision lighting. Navigation lights are as follows: a continuous green light on the right wing tip, a continuous red light on the left wing tip, and a continuous white light on the tail (pointed backwards, positioned as close to the intersection of the vertical and horizontal stabilizer as possible). The bright white anti-collision light should blink in intervals of 1 second on, one second off, and should be positioned on top of the fuselage, pointed upwards. Another, more strenuous factor of aircraft identification is the tail number, or N-number. Instead of hastily describing the process for obtaining and complying with identification rules set forth by the FAA, I will let their own words describe the process:

**Aircraft Registration Requirements**

Title 49 §§ 44101-44104 prohibit operation of unregistered aircraft and establish the requirements for aircraft registration. The regulations implementing those requirements are found in 14 CFR part 47. Public Aircraft are not excepted from

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\(^3\) [https://ioeaaa.faa.gov/oeaaa/Welcome.jsp](https://ioeaaa.faa.gov/oeaaa/Welcome.jsp)
the registration requirements. Under § 47.3, aircraft owned by U.S. citizens, lawfully admitted permanent residents of the United States, and U.S. corporations are eligible for registration and operation. This includes U.S. Government, the District of Columbia, Puerto Rico, territories, or possessions of the United States and political subdivisions thereof. No registration is required for UAS owned by the Armed Forces or under temporary ownership of the Armed Forces. 49 USC § 44101(b)(2); 14 CFR §47.3(b) (3). If temporary ownership of UAS by the Armed Forces ceases, the UAS must be registered prior to operating in the NAS.

UAS Registration Process and Numbers
To register UAS, you must submit an Aircraft Registration Application, AC Form 8050-1, and evidence of ownership to the Aircraft Registration Branch (AFS-750). Registration costs $5.00. Complete details for registering UAS and reserving an N-number are provided online at www.faa.gov. For your convenience, instructions and a blank registration form are attached. UAS Registration Marking UAS must be marked with their U.S. nationality and registration marks (N-Number) in accordance with 14 CFR Part 45. Most full scale UAS are able to comply with the marking requirements, including size and location of the N-Number on the aircraft. Sub-scale or small UAS, or UAS of a non-conventional shape such as a multi-rotor (quad-copter, octo-copter, etc.) or ducted fan may not be able to comply with Part 45 or the guidance in AC 45-2D because of size or space limitations on the aircraft. In these cases, markings may be as large as practicable, or a person may apply to the FAA for an alternative marking procedure. See 14 CFR §§ 45.22(d); 45.29(f). Alternate marking approvals may be issued to public aircraft by FAA UAS Integration Office (AFS-80).

Instructions for Operators
Effective immediately, all UAS operated under a COA, other than those excepted by 49 USC § 44101(b), must be registered and marked. For those to be operated under a new COA, the UAS must be registered and marked prior to COA application. The aircraft registration number (N-number) must be entered into the “Aircraft Registration” field, of the System Description section in COA online. If alternative markings were required, a copy of the Alternative Marking approval letter should be attached to application in the “Aircraft Registration” field. Applications for registration must be submitted for aircraft currently operating under an existing COA within 45 days of the date of this letter. COA holders will confirm their aircraft have been registered by entering the registration number, (N-number) in the Monthly Operational Report, in the block labeled, “Describe any other Operational / Coordination Issued.” Failure to comply with the registration requirements within the prescribed timeframe may result in a suspension of the COA or a delay in the renewal of the COA.²

Lastly, the application will inquire as to what type of frequency band will be used during operations of the aircraft. So as to not congest the radio frequencies used by all types of aircraft in the area, the use of UHF and VHF bands must be limited to emergency situations only. As such, all communications must use 2.4 GHz or 5.8 GHz frequencies.
In addition to all the requirements listed for the aircraft, the PIC and Visual Observers (those responsible for making certain that the aircraft does not wander out of range, and that the weather and all other aspects of flight abide by the FAA regulations) have rules of their own. The PIC must pass the Private Pilot Ground School Written test (or an FAA approved equivalent), and take Drug and Alcohol compliance training in accordance with the Code of Federal Regulations Part 91 Section 17 (CFR 91.17). The observers must be familiarized with regulations for operations near other aircraft, aircraft right-of-way rules, minimum safe altitudes of flight (see Figure 2. Minimum Safe Altitudes).
Figure 2 below), basic VFR weather minimums (see Error! Reference source not found.), air traffic and radio communications (Pilot/ATC phraseology), and the appropriate section of the Aeronautical Information Manual (AIM). It is important to note that, since UAS operations are to be under 400 feet AGL, these minimum safe altitudes are mainly for observers knowledge regarding other aircraft in the airspace. Operations near other aircraft should be an extremely rare occurrence, but UAS should maintain a watchful eye on the air, and avoid flying anywhere close to other aircraft. In addition, the “lower and slower” right-of-way rule does not necessarily apply to UAS for university research. It would be good practice to land as soon as practical if there is any question as to whether or not the UAS is maintaining enough separation from other aircraft. Finally, both the Visual Observers and the PIC must obtain a Class II FAA Medical Certificate.

B. Aircraft Specific and Hardware/Software Specific Documents

The following supplemental attachments are covered in order to allow the reader to familiarize himself or herself with the documents that can be compiled before an airfield is chosen. Given that airfield selection is a lengthy process, which will be covered in more detail later in this report, the supplemental documents that do not require an airfield selection to be finalized are mentioned first. If, at any time and for any reason, the operations location, or airfield location, has to change, the documents in this section will not need to be modified.

<table>
<thead>
<tr>
<th>Altitude</th>
<th>Type of Airspace</th>
<th>Flight Visibility</th>
<th>Cloud Clearance</th>
</tr>
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<tbody>
<tr>
<td>10,000 MSL</td>
<td>E</td>
<td>5 statute miles</td>
<td>111</td>
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<tr>
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<td></td>
<td></td>
<td>+1,000 below,</td>
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<tr>
<td></td>
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<td>+1,000 above,</td>
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<td></td>
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<td>+1 sm horizontal</td>
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<tr>
<td>Below 10,000 MSL</td>
<td>C</td>
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<td>152</td>
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<td>+500 below</td>
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<td></td>
<td>+2,000 horizontal</td>
</tr>
<tr>
<td>Below 1,200 AGL</td>
<td>G (night)</td>
<td>3 statute miles</td>
<td>152</td>
</tr>
<tr>
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<td></td>
<td>+500 below</td>
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<td>Below 1,200 AGL</td>
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<td>1 statute mile</td>
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<td>G (night)</td>
<td>3 statute miles</td>
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<td>Clear of clouds</td>
</tr>
<tr>
<td>G (day)</td>
<td>1 statute mile</td>
<td></td>
<td>Clear of clouds</td>
</tr>
</tbody>
</table>

Figure 3. Basic VFR Weather Minimums

American Institute of Aeronautics and Astronautics
The first document that will be discussed is the **COA Aircraft System Image** document. This document gives a picture of the aircraft, with dimensions. For a more direct and professional COA application, the applicant might want to also indicate the location of the Center of Gravity (CG) on the body of the aircraft. Regardless, the person reviewing the submission should be very familiar with the size and design of the aircraft given only the submitted picture. A good example of a system image document, without dimensions or a CG identified and indicated is shown in Figure 4.

![Figure 4. COA System Image](image)

Figure 4. It is very important to note that the best option for submitting this airframe image is to submit it as a “.jpeg” file, which might require a file conversion.

Somewhat related to the system image document—and with a confusingly similar name—is the accompanying **Aircraft System** document. This document is responsible for highlighting and disclosing the aircrafts general features, dimensions, operation capabilities and flight characteristics, aircrafts supporting power system and its components and limitations, and the aircrafts operation frequencies. An important aspect of the general features includes airframe-specific features. Example of these unique characteristics are high wing-loading, inverted flight ability, all available control surfaces (including flaps), elliptical wing planform, short take-off and landing capabilities, etc. Other general features include whether the aircraft is fixed-wing or rotary, or what type of power supplies it is capable of supporting. Aircraft dimensions and characteristics should include dry and fully-loaded weight, max yaw angular velocity (degrees/s), max tilt angle (degrees), maximum ascent and descend speeds (knots or m/s), maximum flight speed (knots or m/s), wing span, wing planform area, longitudinal length, diagonal length, power consumption, flight time mean takeoff weight, operating temperatures (degrees Celsius), and the type of battery the airframe supports. This document must also disclose the battery type, capacity (e.g., 2700 mAh at 22.2 V), and the charging and discharging environment range (temperature, and pressure if possible). Finally, a brief description of the aircraft’s remote control capabilities should be mentioned. These capabilities include operating frequency (required to be 2.4 GHz DSM), the
maximum communication distance of the controller, the receiver sensitivity in decibel meters (dBm), the working current and voltage (similar to the format given for the batteries), and the type of battery the handheld controller operates on.

The next supplemental document that will be discussed is the **Communications** document. This attachment reports the specifics about the radio communications between the handheld controller, the ground station, and the aircraft. The antennas and other hardware of these communications is shown in Figure 5.

![Figure 5. Communication Antennas and Associated Hardware](image)

Figure 5. Communication Antennas and Associated Hardware

The aforementioned specifics are the Radio Frequency (RF) data range, the indoor and outdoor range (in meters) of the signal, the power of transmission, the receiver sensitivity (dBm), and the power consumption (both on the aircraft side, and on the ground side). In addition, the equivalent isotropic maximum radiated power, frequency band, serial data rate in bits per second (bps), what type of antennas are used, and the temperature operating range (in degrees Celsius) should be documented. In addition, it is good practice to write a short paragraph about the communication process and limitations. An excellent example of this type of reporting is the one written below by Nathan Stepp⁴:

> Independent from the communication of the handheld 2.4 GHz RC transmitter, these 915 MHz radios facilitate the telemetry communication between the aircraft and Ground Control Station (GCS). One of these radios will be situated on the

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⁴ Undergraduate student at the University of Alabama in Huntsville; his contributions to some of the examples of COA documentation ultimately lead to a quickly approved COA, which is why his contributions to the documentation will be repeatedly used in this report.
aircraft and connected to the Pixhawk Flight Controller (FC) while the other radio will be connected to a laptop situated on the ground with the appropriate GSC software. With this radio communication, telemetry information from the aircraft can be down-linked to the ground station, reporting information on the aircraft's status and location. This link can also be used to upload GPS Waypoint information to the FC for flight planning and waypoint navigation.

Again, the next supplemental document is very closely tied in with the previous one. This document is called the Control Station document, and should report the capabilities and limitations of the control station, and its role in the entire system of communications. If the UAS that a university is attempting to obtain a COA for does not have a GCS, only the handheld controller, its antennas and receivers, and the antennas and receivers on the aircraft side need to be documented. The first page of the control station should detail and document the handheld controller. An example of a handheld controller used for UAS operations is shown in Figure 6.

Figure 6. The aspects of the handheld controller that should be documented are the working frequency (2.4 GHz DSM), number of TX control channels, the communications range of the controller (in meters), minimum receiver sensitivity and power consumption of TX (both in decibel meters, dBm), and a restatement of the working current/voltage and type of batteries it uses (in addition to the document of the controller from the Aircraft System file). It is highly recommended that the group responsible for communications uses the same antennas for the ground control station as it does for the aircraft, so that the rest of the control station document is a simple “copy and paste” of the previous document, communications. Otherwise, all of the required specifications listed in the communications...
document for the antennas used must be documented for each of the different types of antennas used in each of the two documents.

If the aircraft is flying additional electronics, the person in charge of assembling and submitting the COA needs to create a document called Other Electrical Systems. This document is mainly for other flight electronics that have not already been documented in the COA, including payload. An example of other electrical equipment being documented is the case of a payload that involves optics, such as a FLIR camera or a GoPro. In addition, any transponders, additional forward-looking or side-looking cameras, emergency transmitters, etc. should be detailed in this attachment. It is recommended that you write a short paragraph about why you chose to include the specified electrical hardware in your aircraft system. It is also very important that you try to include as much information about each piece of electrical equipment as possible. The FAA does not specify which aspects of this type of hardware is required to be reported, but it is good practice to use manufacture information (from a website that sells the hardware, or other credible sources) in order to detail the various operations and limitations of all the extra electronics. Again, it is very important to discuss why the extra electronics were added, and what extra safety aspects must be taken into consideration as a result. For example, if the aircraft were to include a First Person View Camera (FPV Cam), as shown in Figure 7, the document should give all of the operational specs from the vender. In addition, it should state that the FPV Cam is added to ease PIC operations, and will not be used to record infrared or thermal video of surrounding apartment complexes. Just give the capabilities and limits of each of the extra pieces of hardware.

C. Location Specific Documents

The supplemental documents that will be discussed in this section are location-specific. Airfield selection is a lengthy, somewhat daunting process that involves many restrictions. In addition, it might be pertinent to involve the lawyers in order to make certain that, in the event of a mishap, the party responsible is held accountable (most likely the university for which the COA was approved). To reiterate the restrictions regarding airfield selection, the FAA requires that the land from which the operations will be based is privately owned, and is at least 5 nm from the nearest airfield. This 5 nm separation requirement will be covered in more detail when the flight operations map document is
discussed. For help identifying the airfield(s), refer to a VFR map.\(^5\) If the person responsible for the COA paperwork is not familiar with identifying airfields on a VFR map, it is recommended to ask a former or current pilot. If a pilot is not immediately available, join an online forum and ask around for assistance. It is extremely important to accurately prove to the FAA that your chosen location of operations is not too close to any air activity. If the spacing is not adequate, your COA will NOT be approved.

The first document that will be discussed in this section is the **Emergency Procedures** document. These are the procedures the PIC and Observers are required to follow if—resulting from any unexpected occurrences—the flight operations becomes a hazard to anyone or anything (including the aircraft). The PIC and all visual observers are required to be in possession of—and be trained in the operation of—cell phones and Very-High Frequency (VHF) radios. Both forms are required so that if one fails, there is a backup method of communication for contacting emergency responders should an emergency situation arise. Any additional forms of emergency communication should be highly considered, as reaching emergency personnel is critical if there is ever a situation that is serious enough to warrant contacting aforementioned personnel. This document should include the phone numbers of the following emergency personnel and responders: The nearest (1) fire department, (2) ambulance or emergency transportation service, (3) law enforcement department, (3) hospitals in the area, and (4) airfield. In addition, the name and phone number of the owner of the private land that the operations will be based out of should be listed in this document, as well as the frequencies of the nearest airfields. The multiple frequencies will be important if an emergency arises, but any Automated Weather Observations (AWOS) frequencies should be recorded and documented as well in order to allow the PIC and observers to be aware of any changes in weather that could affect flight operations. Finally, the document should include a short description of the actual emergency procedures that would be followed. For example, the author of the document should describe how cell phones and VHF radios will be used by a designated member of the flight crew in order to contact any emergency personnel. In addition to notification of an emergency, the flight conditions, heading, attitude, speed, nature of the emergency, etc. should be provided to emergency personnel. A clear description of the emergency procedures is a very important aspect of whether or not the COA is approved. A sloppy emergency procedures document is a clear indication of an ill-prepared or unprofessional flight crew, which the FAA has neither the time nor patience to provide step-by-step, or “hand-holding”, instructions to.

The second location-specific supplemental attachment that will be discussed is the **Flight Operations Map** document. The first step in compiling a good flight operations map document is deciding where the “home point” location is. The “home point” will be the approximate location of take-off and landing. This location needs to be documented by referring to the following two (example) forms of GPS coordinates: (1) Latitude 34.871167, Longitude -86.190167; (2) N34°52’ 16.2” W86°11’ 24.6’’). A good way of obtaining both coordinate notations is to first look up (search) the Latitude/Longitude position of the “home point” on Google Maps\(^6\), then use a Latitude/Longitude to Degrees/Minutes/Seconds converter\(^7\) If the flight crew is in possession of waypoint navigation capabilities with respect to the aircraft, the process of automated GPS navigation should be described. Otherwise, the flight crew should state that each location will be physically marked. A good example of a physical marking is a neon-painted metal pole that protrudes from the ground, possibly with a similarly colored flag or streamer position on top of the pole. The physical markers are not required. In fact, another good option would be to place a visual observer at each of the flight waypoints in order to confirm that each location is visited within the preset waypoint variance tolerance that is not to be exceeded. In other words, the ability to accurately fly the preset waypoints should be well documented, as it is an important part of the safety aspect of complying with the approved COA. The author of the operations map document should also state that the PIC will maintain VLOS at all times during the aircraft’s operations, will maintain an altitude of less than 400 feet AGL, and will maintain a flight radius of less than 0.5 nm from the “home point”, or take-off

\(^5\) A good example of a VFR map can be found at http://skyvector.com/
\(^6\) https://maps.google.com/
\(^7\) A Latitude/Longitude to Degrees/Minutes/Seconds converter from the Federal Communications Commission (FCC) can be found at http://www.fcc.gov/encyclopedia/degrees-minutes-seconds-tofrom-decimal-degrees
location. A visual depiction of this flight radius compliance should be depicted within the document.

Figure 8 gives an example of such a depiction. It should also be stated that the visual observers will be located at various locations throughout the operations area (within the boundaries of the private land) to monitor the aircraft in accordance with the duties and practices outlined in the visual observers document, which will be discussed later in this report. As was mentioned in a previous paragraph, the FAA requires that the private land is at least 5 nm from the

Figure 8. Operating Area with 0.5 nm Radius (Blue), Private Land (Red), and “Home” (Pink Dot) Depicted
As is shown in Figure 9, the nearest airfield is 12 nm away from the edge of the private land, which is well over the minimum separation distance required by the FAA. Even though the airfield is a private one, the 5 nm separation still applies. Make certain that the flight crew is able to contact any nearby airfields, even if they are privately owned and operated.

The next document that will be discussed in this section is the Launch Recovery document. The author should start by restating that the operations are to be within VLOS, remain within 0.5 nm of the PIC at all times, be conducted at 0 to 400 feet AGL, and be more than 5 nm from the nearest airfield. The launch recovery document could be separated into three stages to allow the reader to easily identify and understand the procedures. The first stage is the procedures done pre-launch. The first step, prior to launch, is for the PIC to ensure a temporary Notice to Airmen

Figure 9. VFR Map of Nearest Airfields The 12 nm distance to the nearest airfield is circled in black.
Telemetry, and communication devices are on and functioning. The UAS crew should then notify law enforcement (if it is required by the local law enforcement to do so) about the approximated time and nature of the UAS operations. Finally, the team should make certain that the aircraft has the proper N-number displayed, that the registration is in the aircraft logbook (in possession of the PIC), and that the pre-launch portion of the checklist is completed. The second portion of the launch recovery process is the actual aircraft launch. During this phase, the PIC should place the aircraft within 20 yards of the pre-disclosed “home point”. The PIC and observers should verify the area is clear of obstacles and/or unauthorized personnel. In addition, the PIC and observers should continually scan the sky to confirm it is clear of adverse weather and other air traffic. The handheld controller should be powered on, and its operation should be tested, including the security of the antenna(s). The aircraft is then placed on the ground and powered on. The flight controller should be confirmed to be communicating and locked on to the aircraft, and the ground station should accurately display the telemetry. It is the PIC’s responsibility to now confirm battery voltage and GPS quality and strength. The PIC must then perform an RF range check, then announce that the motor control circuits are now functional, preferably by loudly declaring “Clear prop!” The PIC should continue to check the surrounding ground area, as well as the sky, to confirm a continuous optimal operating environment. If the previous checks have been completed without an issue, the PIC should loudly declare “Take-off” and engage the motors. During climb-out, the PIC should confirm proper operation of the flight controls, battery powers and voltages, and any aircraft communication links and corresponding signal strengths. During flight, the PIC and observers should continually monitor the sky for any weather or other safety hazards (such as birds or other aircraft). One observers should constantly scan the telemetry data from the aircraft that monitors voltages, any communication signal qualities, altitude, attitude, GPS data (confirming its correctness), and then relay that information to the PIC in a concise and timely manner. The final stage of the launch recovery process is the aircraft recovery. During this phase, the landing should take place in the same location as (or as close as possible to) the take-off location. Once again, the PIC and observers should clear the immediate area of debris or unauthorized personnel. In addition, the PIC and observers should thoroughly scan the approach and landing area until the aircraft is not only safely on the ground, but also powered off and taken apart (if the UAS needs to be disassembled). Finally, the UAS team should notify any personnel involved with ensuring the safe operations of the team that the mission is complete. The personnel should also be given the flight time and mission objectives that were and were not met. The flight time should be logged in the PIC’s logbook, as well as the aircraft’s logbook. All of the information in this paragraph should be presented to the FAA, preferably as a numbered list for each section.

The next document is called the Lost Communication document, and is similar to the previous one in that it is used to convey safety procedures to the FAA. The author must describe the distinctions between normal and abnormal operations, with respect to the UAS and its components. For the normal operations section, the author of the document should describe whether or not the VHF radios will be regularly used throughout the operations. It is recommended that VHF radios are only used if the nearby airfields have requested them to be used to coordinate UAS operations conducted on behalf of a university. A representative from the team or university should contact any nearby airfields and discuss whether or not they would like to be communicated with over any of their frequencies. Since operations of these particular types of UAS are restricted to less than 400 feet AGL, it is highly unlikely that any airfield will request VHF communications to be conducted. However, at least one present observer must be trained and well versed in ATC phraseology. Second, it should be stated that all team members will communicate via handheld radios or cell phone when not within talking distance. Finally, it should be restated that normal operations require the constant monitoring of any forms of UAS communications, and that the flight is constantly within VLOS and 0.5 nm of the PIC. Now the author must dictate the lost communications procedures. It is best to begin this section by restating that, if any aircraft is observed near the UAS operations area, the UAS operations will immediately be terminated until that aircraft has cleared the area. The author should then state that any communications loss between members of the team (cell phone signal loss, broken radio resulting in a loss of communications, etc.) will result in an immediate termination of all operations until the problem no longer exists. Finally, the author should state that any loss of telemetry communication, or any other data communication other than control of the aircraft, will also result in an immediate termination of the operations until the problem is resolved. For concurrency and compliance purposes, the author should also state that the loss of aircraft control is not covered in this document, because the procedures for a lost link to the aircraft controls will be covered in another attachment. Once again, all of the information in this paragraph is best presented in a numbered list for each section.

The final location-specific document that will be discussed is the Lost Link Mission document. The author should first restate that, when the aircraft is first powered on, it will recognize the “home point” as the location of all take-offs and landings. It should also be restated that all take-offs and landing will be made within 20 yards of the “home point” (giving the GPS coordinates). In addition, it should be restated that all operations will be within the VLOS of
the PIC, below 400 feet AGL, and within 0.5 nm of the GPS “home point”. It is up to the UAS team to decide what the appropriate lost link procedures are, but Mr. Dave Arterburn” gives the following example of a good lost link procedure to follow:

If the PIC notes that communication has been lost with the SIG 110 RASCAL Plus aircraft, the PIC will call “Lost Link” to the observer and ground personnel. The PIC and observer will verify the aircraft is following the lost link protocol called out below.

a. If the transmitter signal is lost for more than 1 second, the aircraft will circle (or hover, in the case of a rotorcraft) at the current altitude in an attempt to regain signal link.

b. If the signal is lost for more than 3 seconds, the aircraft will continue circling in place and transition into “ready to go home” mode.

c. If link has not been restored after 3 seconds, the aircraft will begin to navigate back to its previously stored “Home Point”.

i. If the aircraft is above 60 feet AGL, it will stay at its current altitude and navigate back to the “Home Point”.

ii. If the aircraft is below 60 feet AGL when the signal is lost, the aircraft will ascend to 60 feet first (via the circling pattern), then navigate back to the “Home Point”.

iii. The 60 feet AGL fail safe altitude can be changed in the aircraft software if mission conditions require. While there is no intention to change the lost link procedures, at no time will this altitude be changed to an altitude greater than 200 ft AGL.

d. Once at the “Home Point”, the aircraft will circle for 15 seconds then slowly descend in a circling pattern, and land.

The author should then state that if the aircraft fails to enter into the lost link procedures as described, the PIC will monitor (and a visual observer will record) the aircraft's altitude and position until either the aircraft no longer poses a safety threat, or the link is restored. In the case of the link being restored, the PIC must immediately return the aircraft to the “home” location to assess the cause of the failure to enter proper lost link procedures. After a lost link procedure has been completed, the PIC, observers, and other crew will debrief to determine the cause of the lost link. In addition, the PIC will be required to fill out a Lost Link/Emergency report (drafted by the university), and provide it to the faculty overseer(s).

D. Certification and Training Documents

Obtaining the certifications and completing the training required by the FAA for university-sponsored UAS is a somewhat lengthy process. However, following the proper procedures for obtaining and completing these criterion are a very important pre-requisite for both obtaining an approved COA, and complying with the guidelines set forth by the approved COA. In addition, the training and certifications are very beneficial for anyone who want to consider flying model aircraft, UAS, or even general or commercial aviation.

The first document in this section is the Other Certified Training document. The first part of this document involves pilot requirements. In this document, the author should state that the PIC will obtain training in the aircraft type using the handheld controller before actual university research is conducted. If available, the PIC should receive flight training from the aircraft manufacturer, an American Modeler’s Association (AMA) trained pilot, or a flight simulation program provided by the manufacturer. If none of those options are available, the PIC must conduct three successful take-offs and landings, with an aircraft with similar performance and characteristics, within 90 days of any flight. In addition, the PIC must conduct three additional take-offs and landings with the actual UAS within 90 days of any mission. The PIC must also comply with the drug and alcohol use requirements of Federal Acquisition Regulation (FAR) Part 91, Section 91.17. The PIC must maintain a Class II medical Certificate issued by the FAA under 14 CFR part 67 (or an FAA-recognized equivalent), and comply with § 61.23. Finally, it is good practice to state that the PIC will also receive training in normal and abnormal (emergency, lost link, etc.) procedures in the specified aircraft. Also, that the PIC must receive any training in the specific research equipment associated with the UAS operations. The second part of this document involves the required certifications and training of the visual observers. First, it should be stated that all observers must obtain an FAA Class II medical FAR 91.17 training, normal/abnormal procedures, and specific research equipment training. All four of these requirements should be the

8 Director, Rotorcraft Systems Engineering and Simulation Center at the University of Alabama in Huntsville
same for both the PIC and the observers. In addition, the author should state that the visual observers will be trained in the following aspects of air operations:

- FAR Section 91.111, Operating Near Other Aircraft;
- FAR Section 91.113, Right-of-Way Rules: Except Water Operations;
- FAR Section 91.115, Right-of-Way Rules: Water Operations;
- FAR Section 91.119, Minimum Safe Altitudes: General; and
- FAR Section 91.155, Basic VFR Weather Minimums.

It should be stated that the observers will also be training in proper ATC/Pilot phraseology, and the appropriate sections of the Aeronautical Information Manual. The final section of this document should concern the maintenance of training records. This portion is mainly the approach decided upon by the university, but the author should state that all the records for all visual observers and pilots will be maintained by the department overseeing operations. Also, it is recommended to include that all persons involved with the training and maintenance of training records will sign the maintenance records.

The second document of this section is the Technical Standard Orders document. Technical Standard Orders (TSO) are performance standards for aircraft parts or materials used by applicants that are attempting to manufacture the parts or materials. As such, only UAS that are built by the university, or extensively modified are required to apply for a TSO. Therefore, most authors will simply state that the aircraft does not contain any TSO certified components.

The third and final document pertaining to this section is the Visual Observers document. This involves the documentation of both the people assisting in the visual aspect of the mission, and the hardware involved in the visual aspect of the mission. The first part of this document should be a restatement of the visual observers required certification and training that was detailed in the other certified training document. Then, the author should restate that the visual observers are meant to monitor and avoid adverse weather and other hazards, take care of any ATC communications that must be made, conduct testing of communication methods between members of the crew, and conduct and oversee any procedures and operations that might otherwise distract the PIC from its primary objective—aviation. For the hardware aspect of this document, a quick paragraph about each of the optics should be written. The capabilities of each optical device should be mentioned, but their intended purpose should be discussed, as well as what they are and are not intended to do. For example, a UAS that uses a GoPro to record images of the terrain should state that the GoPro is intended to record terrain images, but not intended to provide the PIC with a visual of obstructions that need to be cleared during flight.

E. Other Documents

Although all but two of the documents in this section are not required for the COA application, it is a good practice to keep them around. The reason this is mentioned is because, once the COA is approved, these documents will most likely all be required for documentation, concurrency, and compliance purposes. The documents in this list will only be briefly mentioned and described, but will be available in the appendices for the reader’s convenience.

The first document, which is required for the COA application, is the No Certificate document. Essentially, this document informs the FAA that the UAS does not have an Airworthiness Certificate, but will have to go through stringent evaluations before it is allowed to fly under the guidance of the university.

The second document, which is also required for the COA application, is the Declaration E document. Since this document has to do with litigation and regulation, it will most likely be drafted by university lawyers and sent to a politician on the university’s behalf. This is one of the main reasons it is only briefly mentioned, but the full version is available in an Appendix.

The third document is the Weight and Balance document. This certifies that the aircraft, with its entire payload, does not have a CG that is too far forward, or too far aft. This document will have to be recertified often for safety reasons.

The fourth document is the UAS “Dash 13” created by Chris Duling for the University of Alabama in Huntsville. This document is used to record faults, flights, and maintenance actions in the army. Mr. Duling simplified the document, and took away quite a bit so that it could be adapted to university UAS research.

The fifth document is the PIC Logbook. This is simply any pilot logbook that can be used to log flight hours and details.

The sixth, and final, document of this section is the Checklist. This document is last because it is by far the largest. This document basically outlines stringent procedures for checking various systems of the aircraft and its
associated hardware and software. The version that is appended to this report will be an adaptation of the Cessna 152 checklist, with Cessna speeds highlighted in yellow, and the definition of those speeds highlighted in red.

Now that all of the documents in this section have been given a brief introduction, their appended layout is as follows:

- **Appendix A**: No Certificate
- **Appendix B**: Declaration E
- **Appendix C**: Weight and Balance
- **Appendix D**: UAS “Dash 13”
- **Appendix E**: PIC Logbook

V. Conclusion

The processes and requirements outlined in this report are best used for university-funded and university-sponsored UAS research. Although a single student might be able to complete the COA application process, it is highly recommended that the university appoint a faculty member or assistant to handle coordination between students and the FAA. This is because the COA application process is lengthy and very specific in regards to what procedures to follow, what components to document, and what regulations must be cited and followed. As April 2015, the submission of this report, the COA application and subsequent approval is required for any and all outdoor university-funded research unless the FAA approves an exemption. Please adhere to this requirement unless the proposed sUAS guidelines, which were closed for comment on April 24, 2015 are subsequently approved and written into law.
Appendix A: No Certificate

January 22, 2015

Subject: Airworthiness Statement for SIG Rascal 110 Plus Aircraft Owned by the University of Alabama in Huntsville

To whom it may concern:

The SIG Rascal 110 Plus Aircraft is an off-the-shelf aircraft purchased, owned and operated by the Department of Mechanical and Aerospace Engineering (MAE) at the University of Alabama in Huntsville. The MAE Department will calibrate and test the functionality of the motors, verify proper blade rotation, conduct power-up and power-down functions and controls in an in house environment prior to flight. The MAE Department conducts the same thorough process when the payload is added in addition to flying the system while it is held in place prior to take-off. The MAE Department handles upgraded software downloaded from the vendor or any other source in a similar manner to validate functionality and safe flight operation.

Through specification research, lab testing and tethered parameter analysis, the SMAP Center has determined that the DJI Phantom is airworthy when used in accordance with the manufacturer’s procedures and documentation.

Please direct all technical questions to Mr. David Arterburn at (256) 824-6846 or email: arterbd@uah.edu.

Sincerely,

[Signature]
David R. Arterburn
Director, RSESC

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Approved/Disapproved

[Signature]
Ray Vaughn
Vice President for Research
University of Alabama in Huntsville
Appendix B: Declaration E (1/3)

June 27, 2014

Joseph Maibach
Air Traffic Control Specialist
Unmanned Aircraft Systems Integration Office
Federal Aviation Administration Headquarters
490 L’Enfant Plaza SW
Suite 3200
Washington, DC 20024

Mr. Maibach:

This letter supports the University of Alabama in Huntsville’s ("UAH") application for Certificates of Authorization from the Federal Aviation Administration to operate unmanned aircraft systems in the national airspace. UAH is a state-owned institution that was created by and exists under Alabama law. UAH is one of three campuses operated by the Board of Trustees of the University of Alabama. The state constitution establishes the Board of Trustees of the University of Alabama:

The state university shall be under the management and control of a board of trustees, which shall consist of two members from each congressional district in the state, an additional member from the congressional district which includes the site of the first campus of the university, the superintendent of education, and the governor, who shall be ex officio president of the board. The members of the board of trustees as now constituted shall hold office until their respective terms expire under existing law, and until their successors shall be elected and confirmed as hereinafter required. The additional trustees provided for by this amendment shall be elected by the existing members of the board, and confirmed by the senate in the manner provided below, for initial terms of not more than six years established by the board so that one term shall expire each three years in each congressional district. Successors to the terms of the existing and additional trustees shall hold office for a term of six years, and shall not serve more than three consecutive full six-year terms on the board; provided however that a trustee
shall retire from the board and vacate office at the annual meeting of the board following that trustee's seventieth birthday. Election of additional and successor trustees or of trustees to fill any vacancy created by the expiration of a term or by the death or resignation of any member or from any other cause shall be by the remaining members of the board by secret ballot; provided, that any trustee so elected shall hold office from the date of election until confirmation or rejection by the senate, and, if confirmed, until the expiration of the term for which elected, and until a successor is elected. At every meeting of the legislature the superintendent of education shall certify to the senate the names of all who shall have been so elected since the last session of the legislature, and the senate shall confirm or reject them, as it shall determine is for the best interest of the university. If it rejects the names of any members, it shall thereupon elect trustees in the stead of those rejected. No trustee shall receive any pay or emolument other than his actual expenses incurred in the discharge of his duties as such. Upon the vacation of office by a trustee, the board, if it desires, may bestow upon a trustee the honorary title of trustee emeritus, but such status shall confer no responsibilities, duties, rights, or privileges as such.

AL. CONST. of 1901, art. XIV, § 264 (amend 399).

The board forms a “body corporate” that is governed by state law:

The Governor and the State Superintendent of Education, by virtue of their respective offices, the trustees heretofore appointed from the different congressional districts of the state under the provisions of Section 264 of the constitution and such other members as may be from time to time added to the board of trustees and their successors in office are constituted a body corporate under the name of “the Board of Trustees of the University of Alabama,” to carry into effect the purposes and intent of the Congress of the United States in the grant of lands by the act of April 20, 1818, and of the act of March 2, 1819, to this state, to be by it held and administered for the benefit of a seminary of learning.
Appendix B: Declaration E (3/3)

Federal Aviation Administration
June 27, 2014
Page Three

 Ala. Code § 16-47-1 (1975); see all id. § 16-47-2 (setting forth the general powers of the Board of Trustees of the University of Alabama). See also Ala. Code § 16-48-4 (1975); see also id. § 16-48-4 et seq. (setting forth the corporate powers and responsibilities of the university).

Furthermore, the Alabama Supreme Court, the highest court of the State, consistently recognizes public universities—and the Board of Trustees of the University of Alabama, specifically—as part of the government of the State. See, e.g., Hutchinson v. Bd. of Trustees of the Univ. of Ala., 288 Ala. 20, 256 So.2d 281 (Ala. 1971) ("In Cox v. University of Alabama, 161 Ala. 639, 49 So. 814 (1909), this Court held that public institutions created by the State Purely [sic] for charitable or educational purposes are a part of the State...").

An aircraft owned by the Board of Trustees of the University of Alabama, for and on behalf of UAH, qualifies as a "public aircraft" as defined in 49 U.S.C. § 40102(a)(41) (2012). I understand that UAH intends to use unmanned aircraft systems for research, crew training and demonstrations and that UAH may obtain the aircraft(s) from any of the following sources: (1) the U.S. Government through a loan; (2) the State of Alabama; or (3) private companies through a lease of at least 90 days. 49 U.S.C. § 40102(a)(41)(A)-(D). Regardless of ownership, UAH’s unmanned aircraft systems will not be used for “commercial purposes” as defined in 49 U.S.C. § 40125(a)(1) (2012).

Thank you for your consideration of UAH’s application. Please let me know if I can be of any further assistance.

Sincerely,

Luther Strange
Attorney General

LS/BG:ssmm
Appendix C: Weight & Balance

APPENDIX 2 - WEIGHING RECORD

GIV-X (G450) WEIGHT AND BALANCE
(FORM A)

S/N: ________________________________
REGISTRATION MARKINGS: ________________________________
ACTUAL EMPTY WEIGHT AND BALANCE DATA

MAIN GEAR REACTION = A - 27 = _______ in.
NOSE GEAR REACTION = (A - B) - 27 = _______ in.
C.G. (%MAC) = \[
\frac{CG_{(arm)}}{166.22} - 387.7 \times 100%
\]

(AIRPLANE ON WHEELS / JACKS)

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EMPTY WEIGHT & C.G. DETERMINATION

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EMPTY WEIGHT

\[
\begin{align*}
\text{WEIGHED BY:} & \quad \text{WITNESSED BY:} \\
\text{DATE WEIGHED:} & \quad \\
\end{align*}
\]

Notes:
- AIRCRAFT WAS WEIGHED IN Appleton WI, U.S.
- REPAIR STATION: FAA CRS 81FR190Y
- SCALES USED: Evergreen Roadrunner S/N M1303Q; Cal. Exp. 09-10
- **DELETE AS APPROPRIATE:**
- **IF WEIGHED ON JACKS, USE ARM = 486.9 (MAIN), 48.1 (NOSE)
- **CORRECTED VALUES ARE COMPUTED AS FOLLOWS: READING - TARE - 1/2 RESIDUAL

DOCUMENT No.: GC450WR4151
PAGE A2.1 OF A2.1
Appendix D: UAS “Dash 13”

<table>
<thead>
<tr>
<th>Aircraft Serial Number</th>
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### Fault Information vs. Repair Information

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**Fault/Remarks**

**Repair Information**

<table>
<thead>
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<th>Aircraft Hours</th>
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**Mission Impact**

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**Repair Information**

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**Mission Impact**

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**Fault/Remarks**

**Repair Information**

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<th>Who completed the repair</th>
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</table>

**Mission Impact**

<table>
<thead>
<tr>
<th>Who inspected the repair</th>
</tr>
</thead>
</table>

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**Status**

- X  Non Mission Capable (Grounded)
- /  Partially Mission Capable (State restriction in Faults/Remarks block)
- +  Fully Mission Capable
Appendix E: PIC Logbook (1/2)

<table>
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<th>Date (d/m/y)</th>
<th>Make/Model</th>
<th>Registration</th>
<th>Pilot in Command</th>
<th>Co-pilot, student or passenger</th>
<th>Route</th>
<th>Remarks</th>
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<td>FFLY</td>
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Appendix E: PIC Logbook (2/2)

<table>
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<tr>
<th>Single Engine Aircraft</th>
<th>Multi Engine Aircraft</th>
<th>Cross Country</th>
<th>Instrument</th>
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<td>Day</td>
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<tr>
<td>Dual</td>
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<td>Dual</td>
<td>PIC</td>
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<tr>
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SIG Rascal 110 Checklist

Preflight

1) CABIN
   1. Check Discrepancies and Inspections
   2. Required Papers with PIC/Observers
   3. Master Switch ............... ON
   4. Batteries .................... CHARGED
   5. Wings ........................... ATTACH (LEFT/RIGHT)
   6. Flaps .......................... 30°
   7. Master Switch ............... OFF

2) FUSELAGE AND EMPENNAGE
   1. Left Fuselage ................. CHECK CONDITION
   2. Batteries ....................... CHECK CONDITION
   3. Batteries ....................... CHECK CONNECTION
   4. Fuselage to Empennage ....... CHECK CONDITION
   5. Control Surfaces .............. CHECK Attachment & Movement
   6. Stabilizers ................. CHECK CONDITION
   7. Rudder and Elevator . . . . . CHECK CONDITION
   8. Empennage to Fuselage ....... CHECK CONDITION

3) RIGHT WING TRAILING EDGE
   1. Flap ................................ CHECK Attachment, Movement, Rollers, and Hinges
   2. Aileron .......................... CHECK Attachment, Movement, Rollers, and Hinges

4) RIGHT WING
   1. Undercarriage/Tire ............. CHECK Condition, Inflation, Wear, and Brakes
   2. Wing Surface .................... CHECK CONDITION
   3. Wing Tip .......................... CHECK CONDITION
   4. Leading Edge .................... CHECK CONDITION
   5. Windshield ....................... CLEAN

5) NOSE
   1. Prop/Spinner .................... CHECK CONDITION
   2. Cowling and Intakes .......... CHECK CONDITION, MAKE SURE UNOBSSTRUCTED
   3. Motor Compartment ............ CHECK CONDITION
   4. Cooling Ports/Vents .......... UNOBSSTRUCTED
   5. Landing Light ................. CLEAN
   6. Air Filter ........................ UNOBSSTRUCTED
   7. Wheel Strut/Tire ............... CHECK Condition, Inflation, and Wear
   8. Static Port ...................... UNRESTRICTED

6) LEFT WING
   1. Pitot Tube ...................... UNRESTRICTED/CLEAR
   2. Stall Warning ................. OPERATION
   3. Vents/Ports ..................... CHECK CONDITION, MAKE SURE UNOBSSTRUCTED
   4. Leading Edge .................... CHECK CONDITION
   5. Wing Tip .......................... CHECK CONDITION
   6. Wing Surface .................... CHECK CONDITION

7) LEFT WING TRAILING EDGE
   1. Aileron .......................... CHECK Attachment, Movement, Rollers, and Hinges
   2. Flap ................................ CHECK Attachment, Movement, Rollers, and Hinges
   3. Undercarriage/Tire ............. CHECK Condition, Inflation, and Brakes
# SIG Rascal 110 Checklist

## Normal Operating Procedures

### BEFORE STARTING ENGINE
1. Preflight Inspection ................. COMPLETE
2. PIC/Observers Briefing ............... COMPLETE
3. Payload/Component Straps ........... ADJUSTED/FASTENED
4. Doors/Hatches ....................... CLOSED
5. Brakes ............................. TEST, SET
6. Avionics ............................ OFF

### STARTING ENGINE
1. Master Switch ...................... ON
2. Beacon/Strobes ..................... ON
3. Key ................................. IN IGNITION
4. Throttle ............................ STARTUP SETTING
5. Brakes ............................. HOLD
6. Propeller Area ..................... YELL “CLEAR PROP!” AND WAIT 5-10 SECONDS
7. Motor .............................. START
8. Throttle ............................ IDLE
9. Flaps .............................. UP
10. Altimeter ......................... SET
11. Heading Indicator ................. SET
12. Artificial Horizon ................. SET
13. Magnetic Compass ................. CHECK
14. Radios/Avionics ................. ON and Frequency Set
15. Taxi to Run-Up Area

### TAXI CHECKS
1. Flight Controls .................... POSITION FOR WIND
2. Brakes ............................. TEST
3. Instruments ....................... CHECK FOR CORRECT MOVEMENT

### ENGINE RUNUP BEFORE TAKEOFF
1. Outer Doors/Hatches ............... CLOSED and LATCHED
2. Front Wheels ....................... FACE WIND & CENTER TAIL WHEEL
3. Brakes ............................. HOLD
4. Trim ................................ TAKEOFF POSITION
5. Throttle ............................ RUNUP SETTING
   a. Motor Monitoring ............... CHECK
6. Throttle ............................ IDLE
7. Throttle ............................ SLIGHTLY ABOVE IDLE
8. Flight Controls ................. FREEDOM OF MOVEMENT
   a. Roll left ....................... LEFT AILERON UP & RIGHT AILERON DOWN
   b. Roll right ...................... RIGHT AILERON UP & LEFT AILERON DOWN
   c. Pitch up/down ................. ELEVATOR DEFLECTS UP/DOWN (RESPECTIVELY)
   d. Yaw (crab) left/right ......... RUDDER DEFLECTS LEFT/RIGHT (RESPECTIVELY)
9. Flight Instruments ............... RF-CHECK & SET
   a. Attitude Indicator .............. CHECK
   b. Heading Indicator .............. CHECK
   c. Altimeter ......................... CHECK
10. Radios & Nav Aids .......... SET & CHECKED
SIG Rascal 110 Checklist
Normal Operating Procedures

BEFORE TAKEOFF
1. Lost Link Test ................. SECURE AIRCRAFT
   a. Climb/Descend .......... ELEVATOR UP/DOWN
   b. Circling ................. PRESET ALTITUDE ADJUSTMENT
   c. Return home ............... HEADING SET FOR GPS “HOME”
      ONE AILERON UP, ONE DOWN
      ATTEMPTS DESCENT TO LAND
2. Throttle ....................... ADJUST AS NEEDED
3. Belts & Harnesses ............. CHECK
4. Doors/Hatches ................. CLOSED AND LATCHED
5. Flaps ......................... UP OR AS REQUIRED (10°)
6. Landing Light ................. ON (IF DESIRED)
7. Strobe Light .................. ON (IF AVAILABLE)
8. Radio ......................... BROADCAST INTENTIONS
9. Heading Indicator .......... RUNWAY HEADING
10. Flight Controls ............... POSITION FOR WIND
11. Takeoff Time .................. NOTE & LOG

AIRSPEEDS (KIAS)
V_{1}E .......... 149
V_{1}Q .......... 111
V_{A} .......... 93-104
V_{TE} .......... 85
V_{X} .......... 67 @ S.L
V_{X} .......... 54 @ S.L
V_{II} .......... 40
V_{SO} .......... 35

Note: Refer to POH for further details or precise numbers.

NORMAL TAKEOFF & CLIMB
1. Trim .............. TAKEOFF POSITION
2. Wing Flaps ............... 0°-10°
3. Throttle .................. FULL/OPEN (MAX SETTING)
4. Elevator Control ............ ROTATE @ 50 KIAS (V_{x})
5. Climb Airspeed .......... 65-75 KIAS (normal climb)

SHORT FIELD TAKEOFF
1. Wing Flaps ............... 10°
2. Brakes .................. APPLY
3. Throttle .................. MAX SETTING
4. Brakes .................. RELEASE
5. Elevator Control ............ ROTATE @ 50 KIAS (V_{x})
6. Climb Airspeed .......... 54 KIAS (Until Obstacles Cleared) (V_{x})
7. Wing Flaps ................ RETRACT SLOWLY @ 60+ KIAS (Useable Flaps)

SOFT FIELD TAKEOFF
1. Wing Flaps ............... 10°
2. Elevator .................. FULL BACK POSITION
3. Brakes .................. NONE—ROLLING FROM TAXI
4. Throttle .................. MAX SETTING
5. Ground Roll ............... HOLD TAIL WHEEL OFF RUNWAY (UNLESS NOT STABLE)
6. Elevator Control .......... REMAIN IN GROUND EFFECT UNTIL V_{x}
7. Climb Airspeed .......... V_{x} (Until Obstacles Cleared), THEN V_{x} (OR NORMAL CLIMB)
8. Wing Flaps ................ RETRACT SLOWLY @ 60+ KIAS (Useable Flaps)

ENROUTE CLIMB
1. Airspeed ................. 75 KIAS (70 – 80 KIAS) (V_{I})
2. Throttle .................. MAX SETTING
3. Landing Light ............... OFF

American Institute of Aeronautics and Astronautics
**SIG Rascal 110 Checklist**

**Normal Operating Procedures**

### CRUISE
1. Motor Monitoring: **CHECK**
2. Pitch: **LEVEL FLIGHT**
3. Power: **SET TO CRUISE**
4. Trim: **ADJUST AS NECESSARY**

### DESCENT
1. Motor Monitoring: **CHECK**
2. Power: **AS REQUIRED**

### APPROACH
1. Undercarriage: **GOOD TIRE INFLATION**
2. Prop: **FIXED**
3. Flaps: **AS REQUIRED**
4. Switches: **LIGHTS AS REQUIRED**

### NORMAL LANDING
1. Belts & Harnesses: **FASTENED & ADJUSTED**
2. Landing Light: **ON**
3. Flaps: **AS REQUIRED or AS DESIRED**
4. Airspeed: **60-70 KIAS (Approach speed) Flaps Up** or **55-65 KIAS (Flaps 30°)**
5. Touchdown: **MAIN WHEELS FIRST**

### SHORT FIELD LANDING
1. Airspeed: **60-70 KIAS (Flaps Up)**
2. Wing Flaps: **30° (OR AS LOW AS POSSIBLE)**
3. Airspeed: **MAINTAIN 55 KIAS (Flaps down, approx. Flaps extended)**
4. Power: **IDLE (After Obstacle Clearance)**
5. Touchdown: **MAIN GEAR FIRST**
6. Brakes: **APPLY HEAVILY**
7. Wing Flaps: **RETRACT IMMEDIATELY**

### SOFT FIELD LANDING
1. Airspeed: **60-70 KIAS (Flaps Up)**
2. Wing Flaps: **30° (OR AS LOW AS POSSIBLE)**
3. Airspeed: **MAINTAIN 55 KIAS (Flaps down, approx. Flaps extended)**
4. Power: **PRE-SET FOR SHORT FIELD**
5. Touchdown: **SMOOTHLY AT MINIMUM DECENT RATE**
6. Landing Ground Roll: **HOLD TAIL WHEEL OFF RUNWAY UNLESS UNSTABLE**
7. Throttle: **POWER AS NEEDED AND FULL BACK ELEVATOR**

### BALKED LANDING (GO AROUND)
1. Throttle: **MAX SETTING**
2. Wing Flaps: **RETRACT TO 20°**
3. Climb Airspeed: **Vx OR Vy (WHICHEVER IS NEEDED)**
4. Attitude: **NOSE DOWN TO CORRECT FOR PITCH UP TENDENCY**
5. Wing Flaps: **SLOWLY RETRACT AFTER SAFE AIRSPEED**
## SIG Rascal 110 Checklist
### Normal Operating Procedures

#### AFTER LANDING
1. Wing Flaps ............. UP
2. Nonsenseual Elec. Equip. OFF
3. Landing Light ........... OFF
4. Trun ....................... TAKE OFF POSITION
5. Flight Controls ........ POSITION FOR WIND
6. Landing Time ........... NOTE & LOG

#### SHUTDOWN
1. Parking Brake ........... SET
2. Throttle .................... SHUTDOWN SETTING
3. Electrical Equipment .... OFF (EXCEPT BEACON)
4. Master Switch ............ OFF

#### SECURING AIRCRAFT
1. Radios, Electrical ....... OFF
2. Main Wheels ............... CHOCKED OR STOPPED
3. Motor Plug Covers ........ INSTALLED (IF AVAILABLE)
4. Flap Cover ............... INSTALLED (IF AVAILABLE)
5. Throttle .................... SET RUNDOWN
6. Power ....................... OFF
7. Master Switch ............ OFF
8. Control Lock ............. ON
9. Batteries ................. CHECK CHARGE
10. Power Plant Status ...... RECORDED
11. Belts & Harnesses ...... REMOVED/STOWED
12. Doors/Hatches .......... CLOSED & LOCKED
13. Windscreen/Windows .... CLOSED & LOCKED
14. Secure ..................... TAKE APART
- REMOVE WINGS
  PUT AWAY
15. Flight Plan ............... CLOSE
Appendix F: Checklist (6/11)

SIG Rascal 110 Checklist

EMERGENCY PROCEDURES

NOTE: ALSO SEE EMERGENCY PROCEDURES PAPERWORK

ENGINE FAILURE
DURING TAKEOFF RUN
1. Throttle ................. IDLE
2. Brakes ................. APPLY
3. Flaps ................. RETRACT
4. Power ................. OFF
5. Master Switch ........... OFF
IMMEDIATELY AFTER TAKEOFF
1. Airspeed ................. 60 KIAS [best glide, full flaps]
2. Power ................. OFF
3. Flaps ................. AS REQUIRED
4. Master Switch ........... OFF
DURING FLIGHT
1. Airspeed ................. 60 KIAS [best glide, full flaps]
2. Best Field ................. SELECTED
FORCED LANDING
WITHOUT ENGINE POWER
1. Airspeed ................. 65 KIAS (Flaps Up) [best glide]
2. Power ................. OFF
3. Flaps ................. AS REQUIRED
4. Master Switch ........... OFF
5. Doors/Hatches ............ UNLATCH ASAP
6. Touchdown ............... SLIGHTLY TAIL LOW
7. Brakes ................. APPLY HEAVILY

WITH ENGINE POWER
1. Airspeed ................. 60 KIAS [best glide, flaps down]
2. Flaps ................. 30°
3. Final Airspeed ........... 55 KIAS [low end of approach, flaps extended]
4. Master Switch ........... OFF
5. Doors/Hatches ............ UNLATCH ASAP
6. Touchdown ............... SLIGHTLY TAIL LOW
7. Ignition Switch ........... OFF
8. Brakes ................. APPLY HEAVILY
SIG Rascal 110 Checklist

**EMERGENCY PROCEDURES**

**NOTE: ALSO SEE EMERGENCY PROCEDURES PAPERWORK**

**DITCHING**

1. **Radio**
   - TRANSMIT MAYDAY on 121.5 MHZ, giving location and intentions, make sure to identify as SUAS
2. **Heavy objects**
   - SECURE OR JET TISON
3. **Approach**
   - High winds, heavy seas INTO THE WIND
   - Light winds, heavy seas PARALLEL TO SWELLS
4. **Wing flaps**
   - 30°
5. **Power**
   - ESTABLISH 300 FT/MIN DESCENT AT 55 KIAS.
   - Descend rate at low end of approach at flap extended
6. **Cabin doors**
   - UNLATCH ASAP after TOUCHDOWN
7. **Touchdown**
   - LEVEL ATTITUDE AT 300 FT/MIN DESCENT (descend rate at low end of approach with flap extended)
8. **Flap**
   - CUSHION at touchdown if possible, but STAY CLEAR
9. **Airplane**
   - If necessary, open windows and flood cabin to equalize pressure so doors can be opened

**FIRE DURING START ON GROUND**

If engine starts:

1. **Power**
   - Low power for a few minutes.
2. **Motor**
   - SHUTDOWN and inspect for damage. If engine fails to start:
3. **Fire extinguisher**
   - OBTAIN (have ground worker obtain if not installed)
4. **Engine**
   - SECURE
   - A. Master switch
   - B. Power
5. **Fire**
   - EXTINGUISH using fire extinguisher, wool blanket, or dirt
6. **Fire damage**
   - INSPECT, repair damage or replace damaged components or wiring before conducting another flight.

**ENGINE FIRE INFLIGHT**

1. **Master switch**
   - OFF
2. **Vents**
   - Leave OPEN unless speed insufficient to blow flames out
3. **Airspeed**
   - 55 KIAS (if fire is not extinguished, increase glide speed to find an airspeed which will best help extinguish flames)
4. **Forced landing**
   - EXECUTE (as described in Emergency Landing Without Engine Power)
Appendix F: Checklist (8/11)

SIG Rascal 110 Checklist

EMERGENCY PROCEDURES

NOTE: ALSO SEE EMERGENCY PROCEDURES PAPERWORK

FIRES (CONT)
ELECTRICAL FIRE IN FLIGHT
1. Master Switch .......... OFF
2. All other switches ...... OFF (except Power)
3. Vents/Cabin Air/Heat .... CLOSED
4. Fire Extinguisher ......... ACTIVATE (if available)
5. Aircraft Cabin .......... VENTILATE

If fire appears out and electrical power is necessary for continuance of flight:

6. Master Switch .......... ON
7. Radio/Electrical Switches . ON one at a time, with delay after each until short is localized.
8. Vents/Cabin Air/Heat ..... OPEN when it is ascertained that fire is completely extinguished.

CABIN FIRE
1. Master Switch .......... OFF
2. Vents/Cabin Air/Heat .... CLOSED (to avoid drafts).
3. Fire Extinguisher ......... ACTIVATE (if available).
4. Aircraft Cabin .......... VENTILATE
5. Land the airplane as soon as possible to inspect for damage.

WING FIRE
1. Navigation Light Switch . OFF
2. Strobe Light Switch ...... OFF (if installed)
3. Pilot Heat Switch ........ OFF (if installed)

NOTE—Perform a side slip to keep the flames away from the batteries, motor and cabin, and land as soon as possible, with flaps retracted.

LANDING WITH A FLAT MAIN TIRE
1. Wing Flaps .............. AS DESIRED
2. Approach ............... NORMAL
3. Touchdown ............. GOOD TIRE FIRST, hold airplane off flat tire as long as possible.

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS
AMMETER SHOWS EXCESSIVE RATE OF CHARGE (full scale deflection)
1. Nonessential Electrical Equipment . OFF
2. Flight ...................... TERMINATE as soon as practical.
Appendix F: Checklist (9/11)

SIG Rascal 110 Checklist

EMERGENCY PROCEDURES

NOTE: ALSO SEE EMERGENCY PROCEDURES PAPERWORK

NOTE—Illumination of the low-voltage light may occur during low RPM conditions with an electrical load on the system such as during a low RPM taxi. Under these conditions, the light will go out at higher RPM. The master switch need not be recycled since an over-voltage condition has not occurred to de-activate the alternator system.

LOW-VOLTAGE LIGHT ILLUMINATES (IF INSTALLED) DURING FLIGHT (Ammeter Indicates Discharge)

1. Radios .......................... OFF
2. Master Switch ...................... OFF (both sides) 4.
3. Master Switch ...................... ON
5. Radios .......................... ON

If low-voltage light illuminates again:
6. Alternator ........................ OFF
7. Nonsential Radio and Electrical Equipment OFF
8. Flight .......................... TERMINATE as soon as practical.

ICING ENCOUNTER

1. Turn pitot heat switch ON (if installed).
2. Turn back or change altitude to obtain an outside air temperature that is less conducive to icing.
3. Pull cabin heat control full out to obtain maximum defrost air temperature. For greater air flow at reduced temperatures, adjust the cabin air control as required.
4. Increase the throttle to increase engine speed and minimize ice buildup on propeller blades.
5. OBSERVERS: Continue to monitor for signs of icing.
6. Plan a landing at the nearest field. With an extremely rapid ice build-up, select a suitable “off airport” landing site.
7. With an ice accumulation on the wing leading edges, be prepared for significantly higher stall speed.
8. Leave wing flaps retracted. With a severe ice build-up on the horizontal tail, the change in wing wake airflow direction caused by wing flap extension could result in a loss of elevator effectiveness.
9. Perform a landing approach using a forward slip, if necessary, for improved visibility.
10. Approach at 65 to 75 KIAS normal climb depending upon the amount of ice accumulation.
11. Perform a landing in level attitude.
### SIG Rascal 110 Aircraft Information

(All speeds in KIAS)

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<th>Parameter</th>
<th>Value</th>
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<td>Best Angle of Climb ($V_s$)</td>
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</tr>
<tr>
<td>Stall Speed</td>
<td></td>
</tr>
<tr>
<td>Power Off, Flaps Up ($V_{fl}$)</td>
<td>48</td>
</tr>
<tr>
<td>Power Off, Flaps 30° ($V_{fl}$)</td>
<td>43</td>
</tr>
<tr>
<td>Approach Speed (Normal Landing)</td>
<td></td>
</tr>
<tr>
<td>Flaps Up</td>
<td>60 - 70</td>
</tr>
<tr>
<td>Flaps 30°</td>
<td>55 - 65</td>
</tr>
<tr>
<td>Maximum Flaps Extended Speed ($V_{fl}$)</td>
<td>85</td>
</tr>
<tr>
<td>Maximum Structural Speed ($V_{no}$)</td>
<td>111</td>
</tr>
<tr>
<td>Never Exceed Speed ($V_{ne}$)</td>
<td>149</td>
</tr>
<tr>
<td>Maximum Takeoff Weight</td>
<td>1670 lbs</td>
</tr>
<tr>
<td>Full Oil</td>
<td>6 qts</td>
</tr>
<tr>
<td>Fuel</td>
<td></td>
</tr>
<tr>
<td>Full</td>
<td>26 gal</td>
</tr>
<tr>
<td>Useable</td>
<td>24.5 gal</td>
</tr>
<tr>
<td>Maximum Gross Weight ($MGW$)</td>
<td>1670 lbs</td>
</tr>
<tr>
<td>HP</td>
<td>110 HP</td>
</tr>
<tr>
<td>Maximum Crosswind</td>
<td>12</td>
</tr>
</tbody>
</table>
Appendix F: Checklist (11/11)

SIG Rascal 110 Aircraft Photo
Acknowledgments

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