# Remote UAS Pilots and Possible National Airspace Risk

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The proliferation of Unmanned Aircraft Systems (UAS) in the United States National Airspace System (NAS) has resulted in an increasing number of close encounters between manned aircraft and UAS, which correlates with the increasing number of remote pilots in the Federal Aviation Administration (FAA) airmen database.

aviation GIS spatial analysis unmanned aircraft systems drones safety FAA airmen database

## 1. Introduction

Over the past decade, Unmanned Aircraft Systems (UAS) have rapidly evolved from a disruptive technology, associated with RC hobbyists, to what is now an established and growing commercial segment of the aviation industry. UAS are becoming an increasingly integrated and essential component of the National Airspace System (NAS). In 2021, the UAS market size was estimated at USD 22.1 billion and is forecast to reach USD 43.4 billion by 2027 [1]. Advanced Air Mobility (AAM) is the next progression of UAS and is expected to further increase the volume of air traffic. Morgan Stanley Research predicts the AAM market value nearing USD 1.5 trillion by 2040 [2].

Consequently, there has been an exponential increase in UAS operations across a diverse population of users and applications. As of December 2022, there were about 871,000 registered UAS in the United States (U.S.) [3]. Almost 334,000 of these UAS are registered for commercial use, which far exceeds the approximate 250,000 registered manned aircraft [3][4]. In 2017, the FAA [5] established the Low Altitude Authorization and Notification Capability (LAANC), which provides UAS operators with automated airspace authorizations to operate in the controlled airspace surrounding the airport. To date, LAANC services are available at 732 U.S. airports and have issued over 1 million authorizations allowing UAS pilots to safely operate in this busy airspace [5][6]. Increasingly, airports themselves are using UAS to support their operations across a number of use cases, such as runway/taxiway inspections, wildlife management, and perimeter security [7][8][9][10]. These UAS operations near or on an airport may be conducted safely, but are not without risk, so long as they are conducted by properly trained operators, in accordance with regulatory policy, and operators exercise proper safety management practices [7][8][9][10]. Additionally, the projected increases in commercial air traffic, UAS operations, and the maturation of AAM technologies will further exacerbate the demand for the FAA's air traffic control (ATC) resources [7][11][12].

The FAA's Airmen Certification Branch manages the Civil Aviation Registry (AVS Registry), which serves as the national repository for airmen certification records and provides the central services necessary for the control of these records [13]. The basic pilot certificates issued by the FAA are (a) student; (b) sport; (c) recreational; (d) private; (e) commercial; (f) airline transport; (g) and remote (FAA, 2022e). **Table 1** provides a breakdown of the AVS Registry pilot population by certificate along with a brief description of each certificate [14][15][16][17].

**Table 1.** Pilot Certification Population and Description.

| Pilot Certificate | Description | Total Population |
|---|---|---|
| Student | Designed for the initial training period of flying. Must have a flight instructor present. May fly solo after instructor endorsement. | 252,452 |
| Recreational | Limited to certain aircraft, number of passengers, distance, and types of airports. | 79 |
| Sport | Limited to light-sport aircraft. | 6837 |
| Private | May carry passengers and provides for limited business use of an airplane. | 168,971 |

| Pilot Certificate | Description | Total Population |
|---|---|---|
| Commercial | May conduct some operations for compensation and hire. | 108,083 |
| Airline Transport | Required to fly as captain by some air transport operations. | 164,112 |
| Remote Pilot | May operate a UAS under the FAA's Small UAS Rule (Part 107). | 307,049 |

uperseded [18] g., private, recreational, or sport), and approximately 80% of student pilots drop out of flight training; therefore, a large number of the student pilot population is likely inactive [19][20].

The rapid growth of UAS would be significant in any industry and remains unprecedented within aviation. The U.S. issued its first manned pilot certificate in 1927 [21]. In contrast, since the FAA enacted Title 14 Part 107 of the Code of Federal Regulation (CFR) for small UAS in August of 2016, it has issued over 307,000 remote pilot certificates, which already comprises over 20% of the total pilot population [16][22]. A remote pilot certificate allows a person to operate a small UAS (below 55 lbs) for work or business in accordance with Part 107 regulations [23][24]. This remote pilot data, coupled with the number of UAS registered for commercial use, suggests a significant number of remote pilots are engaged in commercial operations.

## 2. Concerning Events Around Airport Operating Areas

The increasing number of UAS in the NAS and the lack of a mature regulatory framework have led to several concerning events around airport operating areas (AOAs). For example, in 2019 two UAS operating near Newark Liberty International Airport delayed 43 flights and caused nine others to divert to another airport [25]. Similar events at London Gatwick [26] and Dubai airports [27] halted airport operations for a significant time and exemplify the potential hazards small UAS (below 55 lbs) pose to airports.

Airport boundary intrusions, airport threats, airspace disruption, air traffic controllers' increased workloads, and runway incursions are just some of the hazards presented by small UAS. Risks due to UAS at an airport can be significant in terms of aircraft delays and inconvenience [7]. Overall, the number of close encounters between UAS and manned aircraft is on the rise. Pyrgies [28] conducted a quantitative analysis of 139 UAS incidents and categorized 24 of these incidents to be a near mid-air collision with manned aircraft, two UAS resulted in a mid-air collision, ten UAS resulted in airport closure, and one UAS was sighted inside the airport premises. Since the FAA first started collecting UAS sightings reports in 2016, there has been a steady rise in the number of sightings. For example, a review of this data found that during the period from April through June 2021 there were 958 sightings, an increase of 79% over the same 3-month period in 2016 [29]. Such issues highlight the need for innovative safety risk management strategies to better manage commercial UAS operations.

Spurred by these safety concerns, recent research has investigated the frequency and location of these events. One study used FAA Reported Sightings Data from November 2014 until January 2016 to create an interactive map [30]. This research found the following:

- In the U.S., the State of California had the most sightings,
- Out of 1346 reported sightings,
  - 1009 were above the legal limit of 400 feet,
  - 491 were within five miles of an airport,
  - 73 were within 250 feet of manned aircraft,
  - 27 were at the same altitude as the manned aircraft,
  - 260 were within Class B and C airspace,
  - 25 required manned aircraft to take evasive action to avoid a collision.

These UAS sighting reports however are limited in that the location information is not a specific geographical location but is reported as general compass heading, area, and/or distance from the aircraft, navigational aid, airport, or city. This does not allow for easy interpretation or comparison to other GIS data, such as airport location, or pilot address.

Huang et al. [31] investigated the sociodemographic factors of UAS users and their relationship with regulatory compliance. As part of this research, researchers attempted to determine the respondents' locations by their IP address and asked them to select their location across four undefined categories (large city, rural, small city, or suburb). Their research found that over 50% of participants indicated they lived near a large city. However, the survey did not utilize any formal techniques to spatially locate respondents within a GIS. Results from the survey mainly determined how respondents utilized UAS, with 85% of respondents indicating they were recreational users, and the research did not report on whether the respondents held any FAA airmen certificates. The researchers go on to suggest that location data may assist the FAA in developing more effective safety strategies.

Furthermore, the UAS sighting research did not explore related data, such as pilot demographics, population data, or UAS registration data. Another limitation of these sighting data is that the FAA does not investigate nor confirm most of these reported sightings, which may not involve a UAS but instead may be a case of mistaken identity, such as a balloon or bird [32]. Subsequent research attempted to address this limitation by using the DJI Aeroscope, which is a UAS detection technology that identifies the location of UAS manufactured by DJI and provides flight information such as the direction of travel, speed, and altitude [33]. Using the Aeroscope, researchers observed UAS activity within 10.78 miles of Tampa, Florida, over a 19-day period. Analyses of this data found multiple instances of UAS operations that posed a potential safety hazard to manned aircraft.

While this research aided in validating some sighting reports, it was limited to a small time frame and a limited geographical area, it was limited to only DJI-manufactured UAS, and it did not investigate other types of pilot or UAS data. Similarly, a review of the LAANC services data found no publicly available data where the location of airspace authorizations may be correlated with a specific geographical location, therefore limiting any comparison with sightings data and validating whether the UAS was in fact an unknown hazard. For example, a UAS reported as a sighting may have been authorized to operate in the area and was operated in coordination with local ATC.

Additionally, the federal government is faced with a record budget deficit nearing USD 3 trillion [34][35], which naturally impacts the FAA operating budget [36]. Likewise, the current and projected shortage of qualified aviation professionals further strains the human resources of both the FAA and the industry [37][38][39]. Coupled with the FAA's increasing work scope, which includes the proliferation of AAM technology and commercial space operations, the FAA's workload focus and oversight processes need to evolve given these resource limitations [40][41].

To help address these resource challenges, in 2017 the FAA developed the Integrated Oversight Philosophy (IOP) [42]. The IOP identifies principles for evolving safety oversight systems to better enable the FAA in meeting the challenges of a rapidly changing U.S. aerospace system. The IOP is part of the FAA's culture shift to be proactive and collaborative in using safety management principles to address risk [43][44]. Integral to this policy is the FAA's Risk-Based Decision Making (RBDM) Strategic Initiative, which leverages the use of consistent, data-informed approaches that may enable the FAA to make smarter, system-level, risk-based decisions [42][44][45]. RBDM emphasizes the review of safety data to integrate risk into decision making processes, developing risk-based models to more efficiently allocate the FAA's limited oversight resources. The application of geospatial analysis within a GIS may provide data that contribute towards the FAA's move towards RBDM by improving safety-related decision making and more efficient resource allocation.

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