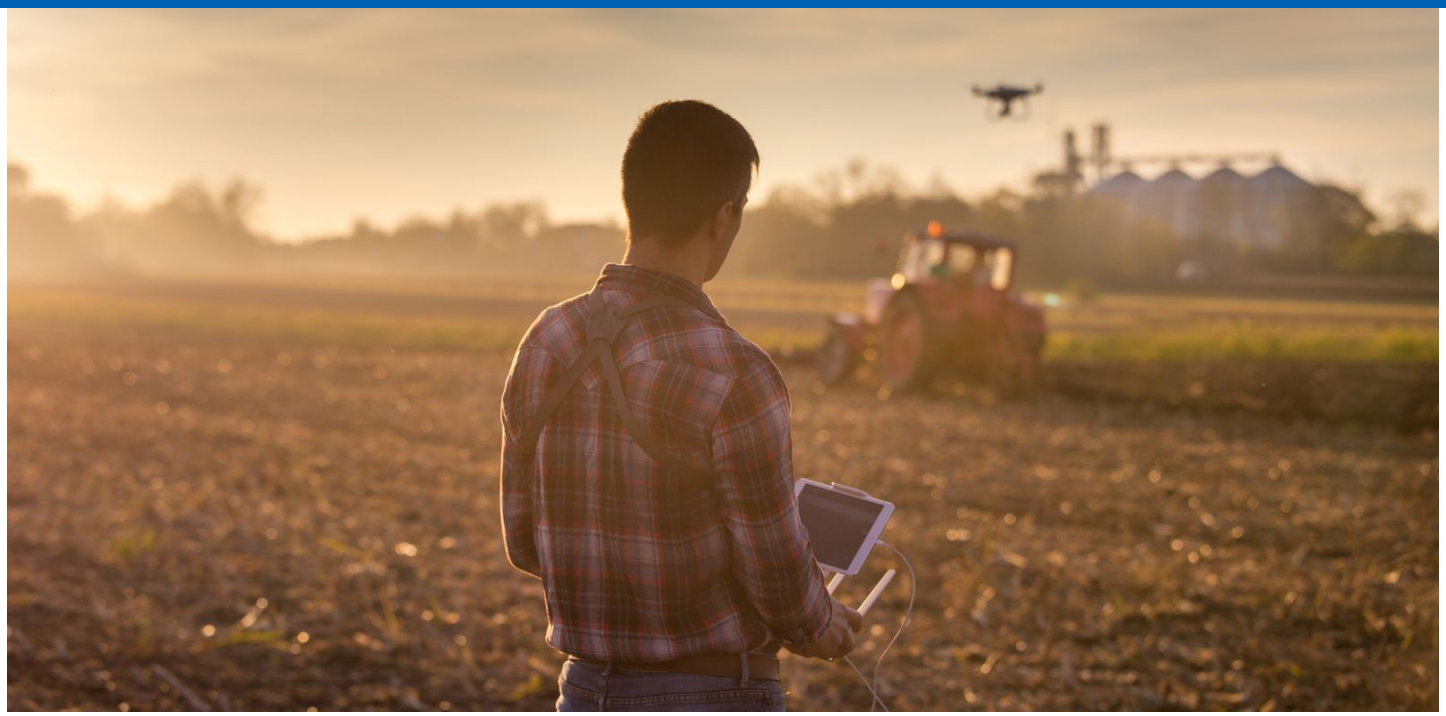
Eno
Center for
Transportation

Bridging the Gap

Sustaining UAS Progress While Pursuing a Permanent Regulatory Framework

AUGUST 2020



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About the Aviation Working Group

The Aviation Working Group is an advisory group on all matters related to aviation policy and practice. The group is made up of diverse experts and stakeholders. It provides Eno with insights, knowledge, feedback, and guidance on how to continue to lead the world in aviation safety, modernization, and innovation. The group is co-chaired by former Secretary of Transportation Jim Burnley and former United States Senator Byron Dorgan.

About the Eno Center for Transportation

The Eno Center for Transportation is an independent, nonpartisan think tank whose vision is for a transportation system that fosters economic vitality, advances social equity, and improves the quality of life for all. The mission of Eno is to shape public debate on critical multimodal transportation issues and build an innovative network of transportation professionals.

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Executive Summary

Unmanned Aircraft Systems (UAS) offer a stunning range of capabilities to connect people with goods and services that may normally be inaccessible to them. They can replace the human element for dangerous inspections, monitor environmental changes in remote locations, and potentially reduce the carbon footprint of portions of the transportation network.

Yet until the UAS industry gains the full trust of the American public, these and other advances cannot be fully realized. If the history of general and commercial aviation offers any insight into the public mindset it is that safety and a culture of safety define the foundation of public trust in an industry. Another insight is that the public must also be assured that the regulator, in this case the Federal Aviation Administration (FAA), has the job of regulation and enforcement well in hand.

The data gathered in writing this report highlight that the rapid development of UAS technologies contrasts with the relatively slow evolution of laws and regulations to ensure their safe use. As a result, oversight currently functions largely on a "by-exception" basis while policymakers and the aviation industry slowly work toward the vision of integrating UAS into a permanent regulatory framework. This report proposes several concrete steps to build that framework, while honing the existing one to save resources, speed development, and ensure safety in the meantime.

Today, designers, manufacturers, and operators of UAS must comply with the operating rules, aircraft requirements, and pilot requirements contained in the Federal Aviation Regulations (FARs). Or if they cannot, which is most often the case, seek relief from the FAA by requesting exemptions, deviations, and waivers. These are granted when the applicant demonstrates an equivalent level of safety may be achieved using methods other than those found in the restriction and the specific regulation stipulates that these alternatives are available to the FAA Administrator.[1]

The process of comparing new methods against long established restrictions makes it very difficult to define what constitutes an equivalent level of safety. New methods often rely on breakthrough technologies never before seen and the long-established restrictions are framed around manned aviation. The end result is often part administrative translation, precedent setting, and compromise. While today's decision frameworks have achieved safety goals, they are not sustainable for the long-term.

The Eno Center for Transportation has gathered the aviation community's top leaders, influencers, and policymakers to inform future research and develop specific steps that can be taken to advance the integration of UAS into the National

Airspace System (NAS). The first phase of this work involved reviewing the regulatory frameworks governing UAS production and operations. This report contains practical and actionable recommendations to sustain the UAS revolution as it transitions from the current regulatory paradigm of regulation "by-exception" to one based on a permanent framework.

These recommendations are grounded in:

- Uncompromising insistence on safety
- Pathfinding ways to faster and safer UAS operations
- Establishing the United States as the global leader in safety and innovation

Each imperative and recommendation put forward can only be fully actualized if policymakers set the goal of an end state characterized by a permanent regulatory framework for UAS operators and manufacturers focusing on safety and transparency. This requires a comprehensive national strategy to move out of today's era of UAS regulation by exemption, deviation, and waiver, which is not sustainable for the long-term, and into a regulatory framework mirroring those used by traditional modes of general and commercial aviation.

1.0 Introduction and Background

Transformational change on economic, demographic, and technological fronts challenge all transportation sectors in America. None more so than aviation, as an unprecedented number of highly advanced UAS have already begun to operate within the NAS. As of August 2020, the FAA's count of all unmanned aircraft systems revealed 1,683,266 in total, with 1,194,293 identified as recreational and 485,488 as commercial.[2] The FAA estimates that the number of commercial UAS could grow to over 831,000 by 2023.[3]

UAS bring with them a range of capabilities to save lives, safely inspect critical infrastructure, move goods, and track changes to our environment. Major firms like Amazon and UPS envision commercial package delivery as key parts of their future business models. The defense industry converts UAS systems developed for military programs to commercial civil use. Each of these systems will have differing levels of human control, from UAS that require human piloting to those flying completely autonomously.[4]

These newcomers to the airspace will need to be integrated into the existing regulatory frameworks to establish a level of public safety and set rules for their operations alongside other aircraft. The responsibility for promulgating and enforcing regulations to safely integrate UAS into the NAS resides with the FAA. Yet the traditional focus of the FAA has been manned aircraft operations within the context of technological advances that occur at a predictable pace. This includes the

assessment of risk, ability to prevent injury to those on the ground, and durability of the aircraft and its components. The UAS industry presents to regulators unique paradigms.

Such paradigms include aircraft development cycles measured in months and not years, technologies for which many have no analog in manned aviation, and new procedures whose level of risk may not be understood. Aligning the design, construction, and operations of the nascent UAS industry within existing regulatory structures represents one of the biggest, if not the biggest challenge in this transformation for the NAS.

As industry and regulators begin to become familiar with each other's concerns and priorities, both have been working together collaboratively to build safety structures and rules to ensure UAS can be tested and operated with the lowest risk. We are in the middle of a transformation.

In this interim period, where there is not strict alignment between existing regulation and this new industry, the FAA has initiated a series of foundational rulemaking procedures to enable some of the most sought after UAS capabilities. These operations include flight over people, flying UAS beyond visual line of sight (BVLOS), and even flights fully integrated into the NAS. Current rulemaking incrementally addresses the core components of these activities. In 2019, the Operation of Small Unmanned Systems Over People NPRM and External Marking Requirements for Small Unmanned Aircraft Rule were released.[5] Most recently and significantly, the FAA published the long-awaited Remote Identification of Unmanned Aircraft Systems NPRM.[6]

For their part, designers, manufacturers, and operators of UAS must either operate under these new rules or conform with existing regulations for manned aircraft. When they cannot, they must seek deviations, exemptions, and waivers from the FAA by demonstrating that the UAS can be operated with an equivalent level of safety as offered in current rules. But in the process, incompatibilities between manned and unmanned rules often get magnified.

For example, the FAA requires that aircraft have seatbelts and operating manuals inside them while operating. By definition, UAS do not have a pilot on board, thus negating the need for a seatbelt and without a pilot on board, there is no one to read a manual. While these are two stark examples, numerous other incompatibilities arise between the current regulations and the nature of UAS.

These gaps need to be identified and bridged in the near term to allow the UAS industry to succeed and the FAA to maintain the highest levels of safety. In the long term, insight into these incompatibilities can be leveraged to develop the standard

procedures, policies, safety assurance frameworks, risk management, and safety promotion that will form the basis of an updated regulatory structure.

Contemporaneously, Safety Management Systems (SMS) principles and decision-making tools used to address underlying organizational issues that may result in crashes or incidents can be brought into new entrant UAS organizations.[7] SMS promotes development of an effective, corporate safety culture focused on promoting safety from administrative functions all the way to flight operations. It creates a quality assurance cycle around data management, operations, risk control, hazard identification, and effectiveness. It complements the processes contained in regulation. SMS serves as the safety foundation for many commercial and general aviation aircraft operations and could be valuable to enhancing the safety of UAS operations.

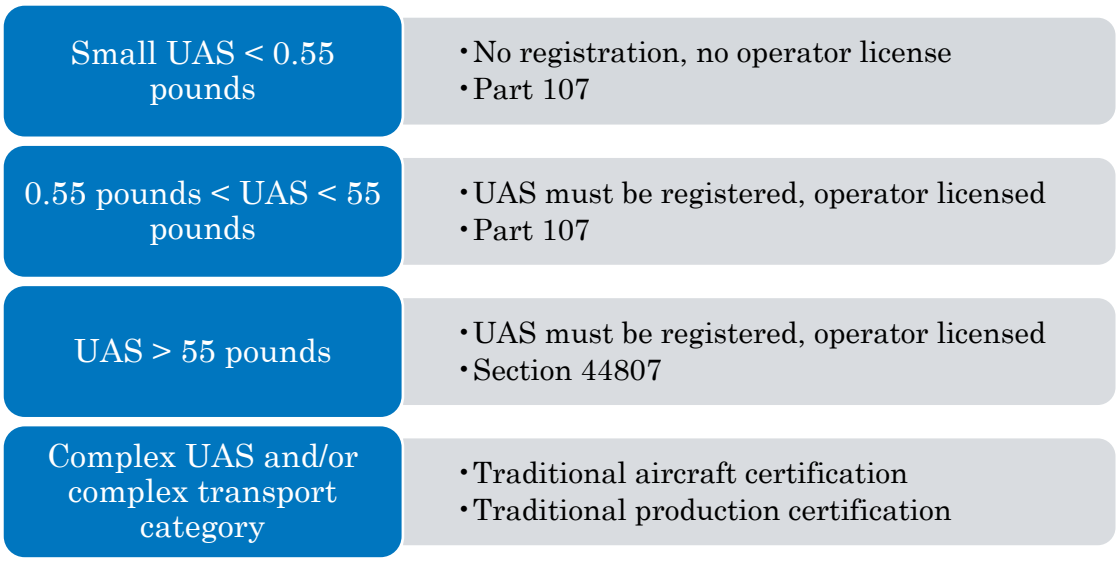
1.1 Current UAS Regulatory Framework Overview

The ability for designers, manufacturers, and operators of UAS to petition the FAA for deviations, exemptions, waivers, and certifications is contained both in federal statute and FAA regulations. The FAA regulates UAS under a number of authorities granted to it by Congress. These most notably include Public Law 112-95 (The FAA Modernization and Reform Act of 2012), Public Law 114-90 (The FAA Extension, Safety, and Security Act of 2016), and Public Law 115-254 (FAA Reauthorization Act of 2018).

These and other authorities require that as a UAS operator seeks to increase the complexity of a vehicle and/or extend its operations into heavily used airspace, the FAA assumes a larger role in the process. This results in increasing levels of regulatory oversight and application of a wider range of FARs to the vehicle, manufacturer, and operator.

As shown in Figure 1, small UAS vehicles weighing 250 grams (.55 pounds) or less need not register with the FAA. Small UAS operated by recreational flyers and Community Based Modeler Organizations (CBO) follow a small set of safety guidelines associated with altitudes, airspace, and flight over people.[8] UAS under 55 pounds flown for work or business require the operator to become a certified UAS pilot and follow 14 CFR Part 107 (Part 107). Conversely, transport category size UAS vehicles that will traverse the National Airspace System, cooperatively fly among manned traffic, and operate via complex and highly automated flight control systems may need to go through aircraft and production certifications, much in the same way as manned aircraft. Another way to understand this paradigm is that as risk is increased, FAA oversight is increased.

Figure 1: Current UAS Regulatory Regime

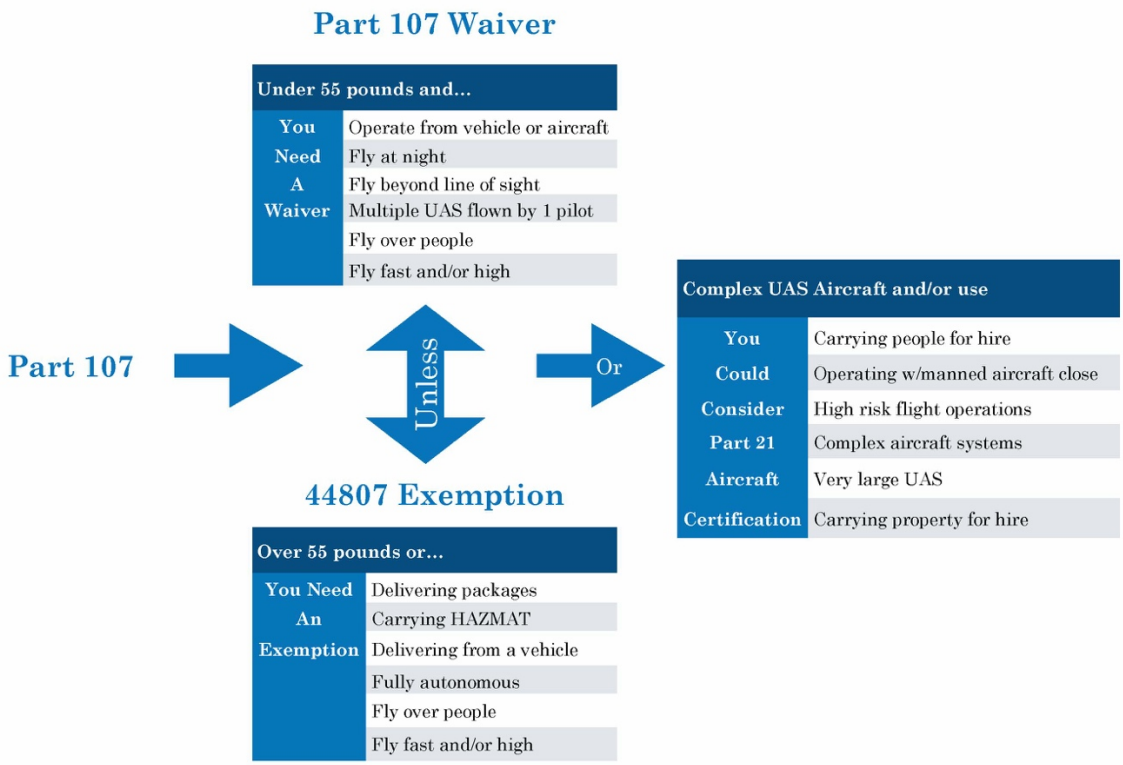


The FAA exercises regulatory authority of UAS systems through the FARs. These include: 14 CFR Part 107, Small Unmanned Aircraft Systems, which includes the main body of regulations for UAS systems under 55 pounds and 14 CFR part 21 Certification and Production Certification.[9] In addition to meeting the requirements in the appropriate section, applicants must also receive the necessary certificate of authorization (COA) to fly in a particular airspace and to operate communications systems in certain spectrum bands.[10] The type of UAS vehicle and its proposed operation largely dictate which of these regulatory provisions govern manufacture and use.

Those that cannot operate under the provisions of Part 107 must navigate the deviation, exemption, waiver, and certification processes as outlined in Figure 2. There are a number of provisions under Part 107 that can be waived. However, there are others that specifically cannot be waived by the FAA, including carrying hazardous agricultural chemicals, flying a UAS that weighs more than 55 pounds, and package delivery. In these cases, the operator must seek an exemption from the governing FARs under the Special Authority for Certain Unmanned Aircraft Systems under 49 U.S.C. Section 44807 (legacy Part 333) for their operations.

Every other UAS airframe and operation must be approved through the traditional certification process. Aircraft and production certification refer to the formal processes established under 14 CFR part 21 for manned aircraft. Certification is required for UAS to participate in highly controlled airspace, carry people or products for hire, and all operations defined as high risk by the FAA.[11] UAS entering these processes are evaluated much in the same way as their manned aircraft analogs. Specific certification FARs dedicated to UAS do not exist under these processes but the FAA has bridged this with a series of orders to assist applicants.[12]

Figure 2: Navigating Deviations, Exemptions, Waivers, and Certifications



These examples illustrate that today's regulatory oversight of UAS largely relies on an "exception to the rules" paradigm rather than a regulatory framework designed exclusively for UAS. The following sections summarize the specific regulatory process available to UAS operators and manufacturers.

1.2 Part 107 Waivers

14 CFR Part 107 contains the set of rules for operating all civil UAS systems that weigh under 55 pounds and for commercial purposes in the United States. It requires that a UAS operator obtain a Remote Pilot Certificate (RPIC) and follow a broad set of operational rules. However, UAS flown for recreation or under the rules of a community-based modeling organization (CBO) qualify to be operated under the Exception for Limited Recreational Operations of Unmanned Aircraft.[13] Under this smaller set of rules, operators are not required to obtain a RPIC nor can they operate for commercial purposes.

Part 107 provides conditions for the business, education, and public safety use of UAS. In general, the vehicle must remain in the line of sight of the operator, fly at speeds less than 100 mph, and altitudes under 400 feet.[14] There are nine specific types of operations under Part 107 that cannot be performed unless the RPIC obtains a waiver from the FAA:

- Operating a UAS from a moving automobile or aircraft (Section 107.25)
- Flying a UAS at night (Section 107.29)

- Flying beyond visual line of sight (BVLOS) (Section 107.31)
- Flying long distances without a visual observer (Section 107.33)
- A single RPIC operating multiple UAS (Section 107.35)
- Changing the manner in which a UAS yields the right of way to manned aircraft (Section 107.37)
- Flying UAS over people (Section 107.39)
- Operating in certain controlled airspace (Section 107.41)
- Exceeding the operating limitations found in Part 107 (Section 107.51)

Note that the FAA limited the type of waivers that may be sought under Part 107 to the nine listed above. Part 107 cannot be waived in its entirety, nor can other non-listed provisions be waived. Carriage of property of another by aircraft for compensation or hire (parcel delivery) is prohibited as well. The 55 pounds vehicle weight restrictions cannot be waived. In that case, the operator must seek an exemption to applicable FARs (not Part 107) through the Section 44807 exemption process (legacy Section 333).

1.3 Section 44807 Exemptions

In order to fly a UAS that weighs 55 pounds or more, engages in an operation not specifically allowed for in Part 107, is not eligible for a waiver, or carries HAZMAT, operators need to apply for an exemption under the Special Authority for Certain Unmanned Systems (49 U.S.C. §44807).[15] This section grants the Secretary of Transportation the authority to use a risk-based approach to determine whether an airworthiness certificate is required for a UAS to operate safely in the NAS. Under this authority, the Secretary may grant exemptions to the applicable operating rules, aircraft requirements, and pilot requirements for a specific operation on a case-by-case basis.

Prior to the creation of Part 107, the Section 333 exemption process was the primary regulatory device used by the FAA to evaluate all UAS operator special use requests. From September 2014 until the Section 333 process closed in September 2016, 5,551 exemption petitions were granted.[16] Public Law 114-90 (The FAA Extension, Safety, and Security Act of 2016) created the Section 44807 process and revoked Section 333.[17]

The creation of the Section 44807 exemption process combined with the availability of waivers under Part 107 dramatically reduced the need for operators to seek exemption relief under the new Section 44807. For example, Eno recorded 75 total unique exemption requests for the period of December 2018 to September 2019.[18]

A UAS operator seeking an exemption must comply with traditional FARs written for manned aircraft to include Part 21, Part 43, Part 45, Part 61, Part 91, Part 119, Part 135, and Part 137 or ask for an exemption to the applicable FAR. The exemption process relies on the operator's ability to document for the FAA how the UAS will be operated with the same level of safety and risk mitigation using

methods different than those found in existing rules and restrictions. The operator must also specifically ask for exemptions for certain manned requirements pertaining to onboard systems and procedures that are not applicable to UAS. For example, UAS operators must ask the FAA for an exemption to FARs such as Part 137.42 which mandates aircraft must have seat belts.[19]

Exemptions sought under Section 44807 remain flexible in that they can be used in lieu of the full aircraft certification process. Operators seeking authority to operate a UAS for agricultural purposes or simple weight increases above the Part 107 weight limit of 55 pounds represent the bulk of Section 44807 requests to date.[20]

1.4 Aircraft Certification

For everything else, certification is the process by which the FAA formally reviews the design, manufacture, and safe operation of an aircraft. It is designed to minimize risk and protect public safety. This has been one of the FAA's most important safety pillars for manned aviation. The current unmanned aircraft certification framework traces its origins back to 2005, with the determination by the FAA that limited access to the NAS could be achieved through the certification process.[21]

UAS entered into the aircraft certification process are designed to fly complex missions with little human intervention. They often involve complex systems for command and control and automatic flight and may be transport category size aircraft operating within a wide flight envelope.

Three distinct certifications affirm that FAA requirements have been met by the vehicle and manufacturer.

- **Type certificate:** approval of the design of the aircraft and all component parts including airframe, powerplant, and control systems.
- **Production certificate:** approval to manufacture multiple copies of an FAA approved aircraft design.
- **Airworthiness certificate:** aircraft can be operated safely and is in a safe condition.

There are two types of airworthiness certifications that unmanned aircraft manufacturers may pursue. *Standard* allows the aircraft to be operated and used with minimal restrictions and for compensation or hire. *Special* consists of severely limited operations and use of the aircraft. In these processes, the vast majority of unmanned aircraft can only meet the requirements for Special Airworthiness Certification and not Standard Airworthiness Certification. The Standard Certificate requires the issuance of a type certification, which has requirements that unmanned systems have not met. The most common category of *Special* certificates is experimental. These can be issued for research and development, showing compliance with regulations, crew training, exhibition, and market survey.

2.0 Data and Methods

Sections 3, 4, and 5 of this report examine ways in which the deviation, exemption, waiver, and aircraft certification processes are being used and provide recommendations on how these mechanisms can be enhanced to promote safety of the NAS and adopt to modern industry development cycles. To do so, the research relies on data gathered from several distinct sources:

Part 107: Eno/Catalyst-Go produced and distributed an electronic survey asking UAS operators details of their experience applying for waivers under Part 107. Two notifications via email were sent to 59,329 individual recipients likely involved in Part 107 operations to solicit responses for a total of 118,658 email contact attempts.

In preparation of this survey, researchers reviewed the questions presented in the survey conducted by the FAA's Drone Advisory Committee (DAC). Duplicate questions were eliminated except those necessary for statistical validation. The Eno/Catalyst-Go survey focused on the specifics of the waiver requested, specific additional information requested by the FAA, impact of the waiver on the organization's bottom line, hiring, and overall user satisfaction with the process. Each question was mapped against the preparation material provided to applicants by the FAA.

Additionally, researchers reviewed a representative sample of the 880 granted waivers contained in the FAA's Part 107 Waivers issued website. Finally, researchers conducted in-person interviews with senior industry executives responsible for filing waivers for their organization.

Section 44807 (legacy 333) exemption process: Eno manually reviewed all exemption petitions and FAA decisions on the federal docket for the period of December 18, 2018 to September 18, 2019. These were reviewed for completeness and duplicates and resubmissions were removed. In each petition and decision, researchers collected and evaluated 884 specific FAR exemption requests for which an action was taken and cataloged the result. Questions on Section 44807 were included as well in the electronic survey conducted by Eno/Catalyst-Go. Finally, we conducted in-person interviews with senior industry executives leading filings of Section 44807 exemption petitions for their organization.

Aircraft and production certification: Eno conducted in-person interviews with senior industry executives leading UAS aircraft and production certification for their respective companies and clients. Each had direct knowledge of these process and was actively involved in a recent certification application.

Note on survey data: In analyzing the results of the electronic surveys, we were struck by the low number of respondents both for the Eno/Catalyst-Go survey (84) and the DAC Survey (630). Eno worked with several prominent trade publications to solicit news articles detailing the survey with an associated links. Distribution of these journals typically exceeded 10,000 per each issue as reported by the publication. Posts were also made to popular UAS forums/groups on Reddit, LinkedIn, Facebook, and Twitter with links to the survey. In addition, several industry trade associations informed their members of the survey as well as prominent UAS test sites.

Yet, both surveys were not able to capture a larger portion of the thousands of individuals and organizations that have applied for Part 107 or Section 44807 deviations, exemptions, and waivers. This population set has been very vocal in the media about perceived issues not only with these processes, but also wedge issues facing the UAS community. Lower-than-expected response rates could be from frustration that a survey would not be able to produce tangible improvements, or that the current rules are so complex and disjointed that people believe more fundamental change is needed and that a survey suggests incremental instead of wholesale change. Certainly, general "survey fatigue" could play into these low response rates, as the DAC survey was conducted in summer 2019.

Regardless, we did find that both surveys statistically agree with few discrepancies in similarly asked questions. We are confident in the quality of the data collected by them and the conclusions drawn from them in this report.

3.0 Optimizing the Current Part 107 Waiver Process

Data Highlights

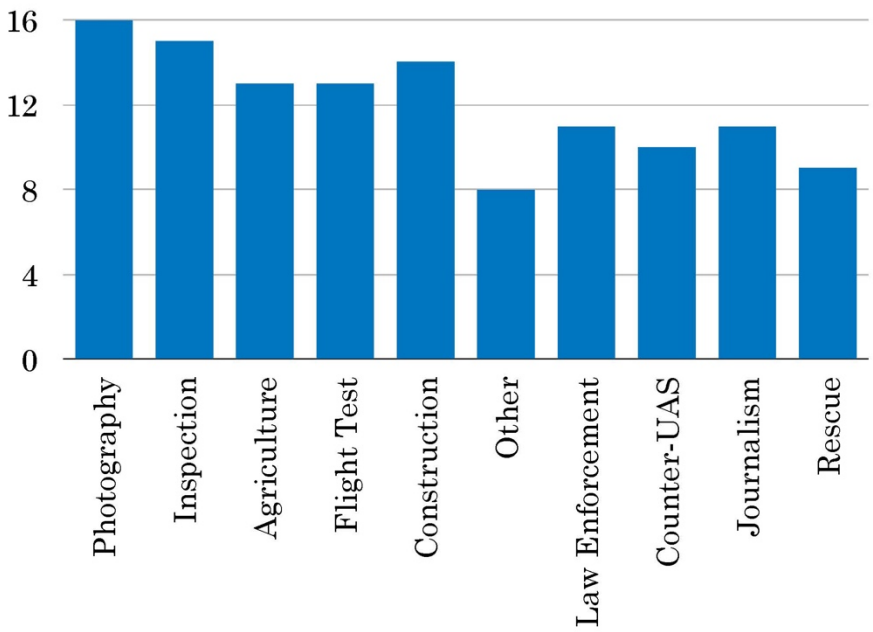
- The FAA provides data only on issued waivers, with no information on denials, and limits data to four fields.[22]
- While FAA self-reports that 87 percent of all waivers issued for night operations, 64 percent of survey respondents report seeking waivers other than those for night operations.[23]
- Cinematic/photography, agriculture, inspection services, and flight testing represented the most popular operations for which an operator submitted a Part 107 Waiver.
- 60 percent of waivers were approved in 60 days or less.[24]
- 78 percent report the waiver application taking 40 hours or less to complete.[25]

75 percent of applicants for Part 107 waivers under the standard US Government definition, identify themselves a small business either by annual revenue (38 percent) or by number of employees (45 percent).[26] Reported revenue from

respondents ranged from zero to 100+ million annually, with the majority (64 percent) reporting one million or less in revenue.[27] Data from the FAA ARC reveals that (61 percent) of applicant companies have been in business three years or less and (88 percent) employ 1-4 remote operators.[28] 85 percent of applicants in our survey prepared their own application.[29]

When asked to describe the intended use of their UAS, respondents chose photography, inspection, agriculture, and flight testing led the most frequent uses.[30] This data aligns with the information collected by the DAC.[31]

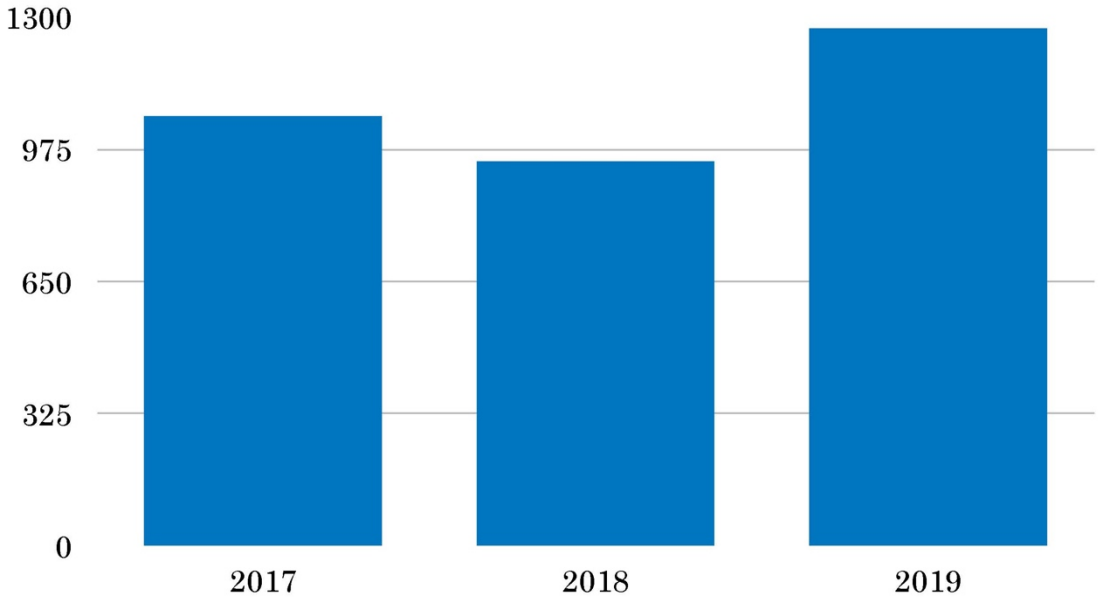
Figure 3: Top 10 Uses for UAS



Source: Eno Survey Q1, "Indicate primary uses of your UAS," Weighted scoring across 17 choices

From 2016 to 2019, FAA data shows that the number of Part 107 waiver approvals has remained relatively constant, with a mean of 1,091 approved waivers each year (Figure 4).[32] However, these figures provide only a partial glance into the full scope of waiver activity conducted by the FAA. While FAA publishes data for approved waivers, it does not provide a similar dataset for denied waivers. This necessitates the need to directly survey waiver applicants.

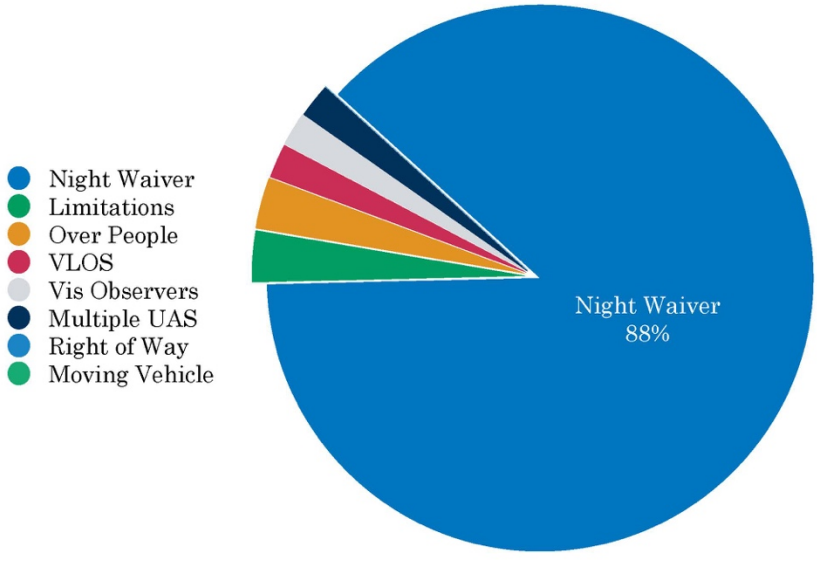
Figure 4: Total Number of Approved Part 107 Waivers by Year



Source: "Part 107 Waivers Issued," Federal Aviation Administration, 2019.

Of the approved waivers recorded by FAA in the data collection period, 88 percent (794) of those issued were for operating a UAS system at night (FAR 107.29) (Figure 5). [33] The FAA did not approve any waivers for FAR 107.25 (operating from a moving vehicle or aircraft) and FAR 107.37 (rules for yielding the right of way).

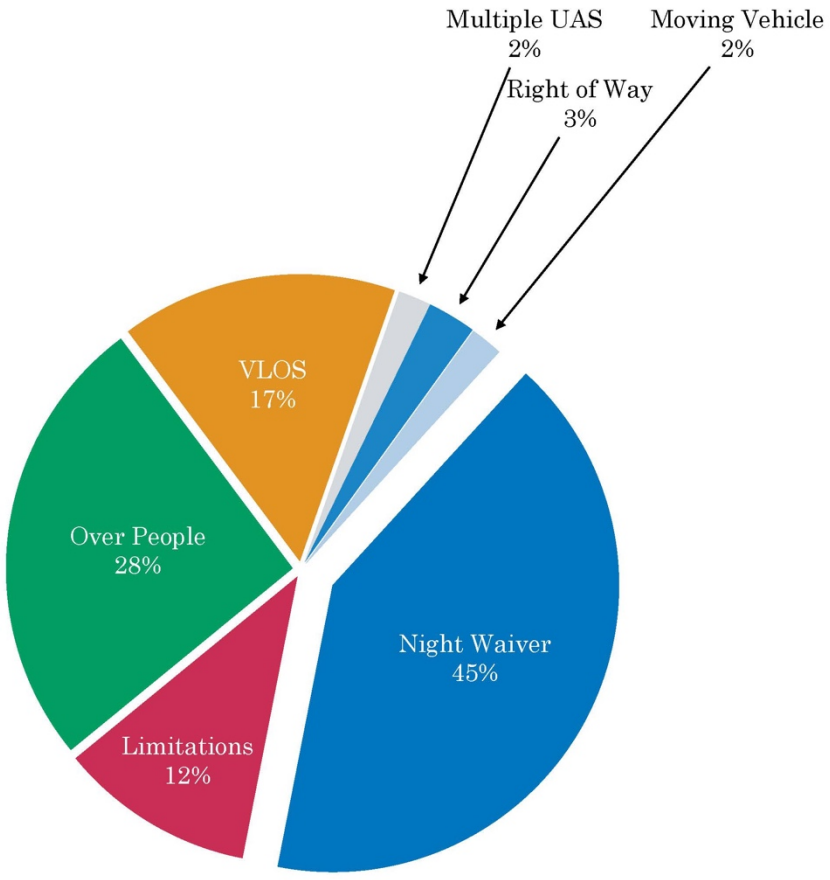
Figure 5: Approved Part 107 Waivers by Type



Source: "Part 107 Waivers Issued," Federal Aviation Administration, 2019.
Note: This chart includes a breakdown of waivers sought in compound waiver request.

While night operations waivers represent the largest single category of waiver applied for and waiver granted by FAA, an equally large number of requests are being made for waivers other than night (Figure 6). Yet, these are not being approved in similar proportions. The Eno survey found 64 percent of survey respondents applying for waivers other than those for night operations or in addition to a night waiver.[34]

Figure 6: Requested Part 107 Waiver by Type



Source: "Part 107 Waivers Issued," Federal Aviation Administration, 2019.
Note: In reviewing the Eno/Catalyst survey it was discovered that Part 107.33 (Visual Observer) was inadvertently omitted from the questionnaire.

This disparity in approval percentages between the night waiver process (107.29) and other categories of waivers may be attributed to several factors.

- FAA's better understanding of night operations hazards and risk mitigation procedures.
- Higher risk activities are present in other categories and receive greater scrutiny.
- FAA waiver processing is optimized for night waivers.

One interviewee with significant experience with Part 107 waivers directly addressed the domination of approved waiver requests for night operations. The executive felt that UAS operators perceive these as easy to obtain from the FAA and take the least amount of administrative overhead to process. The executive noted that one could find on the internet numerous examples of boilerplate text from successful night waiver requests and that this process had become a "cut and paste" exercise for both the FAA and the applicant. This was confirmed by subsequent inquiries.

Another executive noted that it is a common perception of the FAA in the waiver process that the Agency will not set precedent with a Part 107 waiver approval nor accept "soft" procedural mitigations for identified risks. Therefore, applicants use the Part 107 waiver process for only straightforward waivers. More complex operations are either not performed at all or most likely done without the required regulatory approval.[35]

How Long Does It Take for The FAA to Process a Waiver Request?

In the Eno/Catalyst-Go survey 60 percent of respondents reported that the FAA took between 0-60 days to approve their waiver request. This compares to findings in the DAC survey where 62 percent reported waiting 60 days or less.

How Long Does It Take an Applicant to Prepare the Initial Waiver Request?

78 percent of respondents reported that it took between 0-40 person hours to complete their initial waiver application. Only two of the survey respondents said the waiver application took longer than 120 hours.

FAA Requests for Additional Information

The Eno/Catalyst-Go online survey of Part 107 asked applicants to identify areas of their waiver application in which FAA sought additional information. 18 percent of survey participants reporting receiving one to three requests for additional information.[36] This data varies slightly from the FAA DAC report in which only 38 percent reported receiving such a request.[37]

Preparation of supplemental information requested by the FAA during the waiver application process required 0-40 person hours as reported by 78 percent of respondents. One respondent reported needing in excess of 240 hours.

The survey data highlighted that waiver applicants often receive requests for additional information outside of the specific section where regulatory relief is sought. Table 1 shows several examples of waiver requested mapped against additional information requested.

Table 1: Additional Information Requested by the FAA for Part 107 Waiver

Waiver Requested	Additional FAR Information Sought by FAA
107.29 Daylight Operations	107.25, 107.29, 107.31, 107.35 107.39
107.31 Visual Line of Sight	107.25, 107.29, 107.31, 107.35 107.39
107.37 Right of Way	107.37 107.51
107.39 Flight Over people	107.25, 107.29, 107.31, 107.35 107.39
107.51 Limits	107.31

Source: "Eno Survey" Questions 17 -23

Confusion was expressed in interviews and survey comments by applicants wondering why a waiver request for one section of a rule triggered additional information requests by the FAA in a seemingly unrelated section of the rule. Our data demonstrates that this is clearly happening.

One causal factor may be that the procedures and mitigations applicants submit for a waiver in one section of Part 107 may inadvertently involve procedures and considerations restricted by an unrelated section of Part 107. This triggers the FAA to request additional information from the applicant to cover theses sections. Another factor found in the research is that the instructions provided by the FAA for a Part 107 application do not include a method to cross check an application against all of the factors that the FAA might evaluate while considering a waiver. Finally, the FAA provides only limited insight into specific alternate procedures that an applicant can use to attain a waiver for a specific section of Part 107.

The FAA provides instructions and guidance material to assist applicants in preparing a Part 107 waiver request. These contain minimum areas needing to be addressed for each section of Part 107 for which relief is requested. This research mapped the FAA guidance material against requests for additional information from the FAA to see if any trends could be identified. 43 requests for additional information were mapped. Of these, six areas counted for the highest number of information requests and are summarized below.

PART 107 Analysis

Available FAA data on Part 107 waiver applications contains only a limited set of reference information from which to understand the scope of the process and more importantly extract vital safety trends. A full understanding requires access not only to successful waivers, but unsuccessful ones as well. While these applications may contain proprietary information, FAA has experience in producing anonymous reports and releasing de-identified data. Frameworks covering data collected from the Commercial Aviation System Team (CAST) and the Aviation Safety Reporting System (ASRS) could provide valuable insights into converting Part 107 applications and decisions data into valuable safety trend information.

Research interviews and survey data strongly suggest that the Part 107 waiver process appears to be dominated by filling out an application based on publicly available templates. Success seems to depend on producing the right words, which does not help create an organizational culture of safety. FAA does not produce widely available best practices, approved procedures to demonstrate compliance, risk management frameworks, and hazard identification aimed at the Part 107 operator. Research indicates that these operators want to be safe but have young companies with limited to no aviation industry experience. Part 107 operators still need to better seek out operational knowledge and not assume that if a topic is not found in the application materials that it is not important to them, but the process is not facilitated by the federal government.

Looking across the nine operations requiring a waiver under Part 107, the Eno/Catalyst-Go survey identified six areas experiencing the highest number of requests from the FAA for supplemental information. These include six areas:

- **Hazard and risk evaluation:** Both general information related to the operation of a UAS and specific information related to operation under the particular section under waiver consideration.
- **Visual Line of Sight (VLOS):** Procedures to clearly determine the orientation, location, and trajectory of a UAS while mitigating risks to other aircraft, people, and structures on the ground.
- **See and Avoid:** Acceptable methods to identify the presence of people not involved In the UAS operation and ensure their safety during flight operations.
- **Physiology:** Acceptable methods to identify human performance issues and mitigations involved in operating UAS at night and unfavorable weather conditions.
- **Required Equipment:** Identification of specific equipment (lights/emitters) that would allow for a UAS operator to comply with provisions of Part 107.
- **Operational limits:** Better understanding and explanation of the hazards and risks associated with UAS operation parameters involving speed, altitude, acceleration, and system limitations.

As the initial pathway to many UAS flight operations, Part 107 provides a unique opportunity for the FAA to define principles of safe flight for operators. The new guidance material and educational opportunities recommended, will promote the establishment of a culture of safety in young UAS organizations, ensure that risks and hazards are properly identified, and enhance their understanding of FAA regulation as it relates to everyone's safety.

Finally, well understood operations with high rates of approval, such as night operations (Daylight Operations Waiver 107.29) should be considered for blanket waivers. We believe that FAA resources could be better applied to higher risk activities as represented by other categories of Part 107 waivers.

Recommendations Based on PART 107 Data:

- The FAA should make Part 107 waiver applications and decisions available to the public in a de-identified format for the purpose of identifying safety trends, knowledge gaps, and ensuring efficient administration of the waiver system.

- The FAA should expand the body of aeronautical safety knowledge made available to operators so that they can implement standard hazard and risk mitigation programs for UAS operations. This knowledge should specify acceptable means of complying with waiver provisions sought under Part 107.

- The FAA should enhance application instructions in the six areas identified by this research, providing a larger body of foundational knowledge in guidance material.

- The FAA should immediately address UAS operators needs for additional information related to Hazard and risk evaluation, VLOS, See and Avoid, Physiology, Required equipment, and Operational limits.

- The FAA should make use of blanket waivers for well understood Part 107 operations with high rates of approval including Daylight Operations (Night Waiver), Operating from a Moving Vehicle, and Right of Way.

4.0 Optimizing the Current Section 44807 Exemption Process

Data Highlights

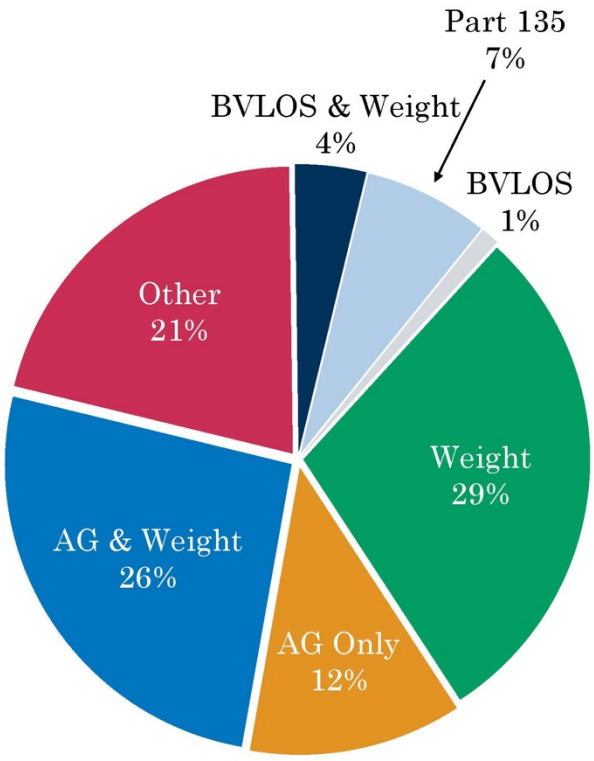
- All data must be manually extracted from the Federal Docket Management System, as FAA no longer provides summary or trend information.
- The most common categories of petitions for which an applicant seeks a Section 333/44807 waiver is to operate a vehicle for agricultural use (38 percent) or to solely operate a vehicle in excess of 55 pounds (29 percent).
- Petitions related to commercial package delivery totaled seven percent.
- FAA processes approved petitions in 145 days (median).
- FAA processes denied petitions in 179 days (median).
- The median time for applications pending at the close of the survey was 238 days.
- The most commonly requested weight exemption is for a vehicle weighing between 55 pounds and 100 pounds
- Each Section 44807 waiver applications contains an average of 13 exemptions requests.
- Exemptions prepared by the applicant have a higher denial rate (32 percent) than third party (five percent).
- 884 individual FAR exemption requests covering 83 sections of the FARs were submitted to FAA.
- 14 sections of the FARs form the bulk of requests and are most commonly granted.
- 18 sections of the FARs form the bulk of requests that are most commonly denied.[38]

75 unique Section 333/44807 exemption petitions and 48 FAA decisions were identified in this research for the time period of December 2018 to September 2019.[39] Each was manually extracted from the federal docket management system.[40] In the exemption process, each petitioner was required to cite the specific FAR by section for which a request was being made and justification for relief sought. The petitioners presented 884 individual requests for specific exemptions to sections of the FARs. Manual review of this data was necessitated by the fact that since September 28, 2016, the FAA has not published summaries nor status of petitions received. The FAA simply publishes a link to the federal docket management system with a search term.[41] This search term is predicated and contains an incomplete argument for the search engine and does not return appropriate data. In comparison to a similar time period during which FAA published data (December 2016 to September 2016) 3,238 exemption requests were approved.[42]

Most Commonly Sought Section 44807 Exemptions by Category

Exemptions for using UAS for agricultural purposes (38 percent) and operating a UAS weighing in excess of 55 pounds (29 percent) dominated the Section 333/44807 exemption process (67 percent). Part 135 commercial operations (seven percent) and BVLOS (five percent) were the smallest use categories identified in the survey. The remaining (21 percent) categorized as "other use" represent one-off activities not fitting other common uses or categories.

Figure 7: Category of 44807 Exemption Sought



Source: FAA 44807 Data

Processing Time for Exemption Petitions

Of the petitions reviewed, 51 percent were granted, 13 percent were denied, and 36 percent were still in process at the time of this survey. The mean number of exemptions sought per petition was 13, with a maximum of 60.

The FAA took 145 median days to approve an exemption petition and 179 days mean to deny, shown in Table 2. At the close of the survey 27 petitions were still pending action for a median of 238 days. Those petitions with earlier actioning related to emergency requests for use in disaster relief operations. The reason for the longest petition outstanding of 1,449 days is not reflected in the docket and attempts to contact the petitioner were not successful.

Table 2: Days for FAA Action on 44807 Petition

For Petitions:	Shortest	Median	Longest
Days if Pending	165	238	1,449
Days if Approved	43	145	1,111
Days if Denied	24	179	1,301

Source: FAA 44807 Data

Approval/Denial by Preparer

Figure 8 shows 65 percent of petitions were prepared by the applicant and 35 percent by a third party. But a third-party preparer seems to make a significant difference in approval rates. Figure 9 shows petitions prepared by a third party have a significantly lower denial rate.

Figure 8: 44807 Petition by Preparer

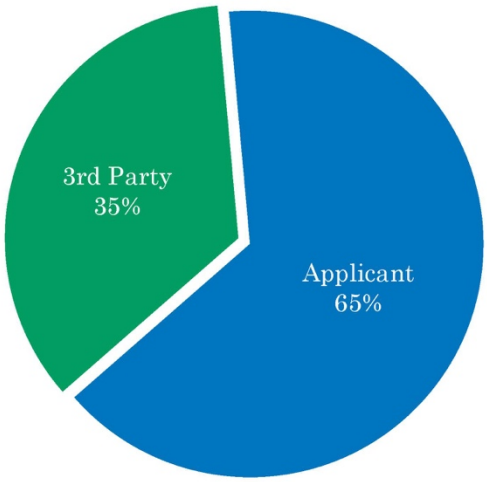
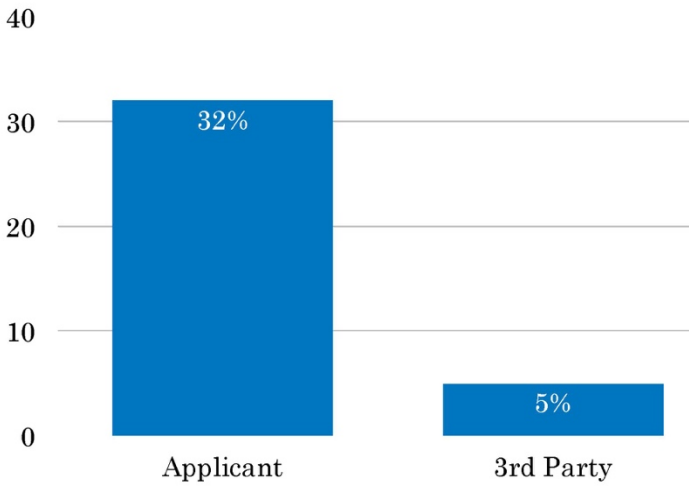


Figure 9: 44807 Denial Rate by Preparer

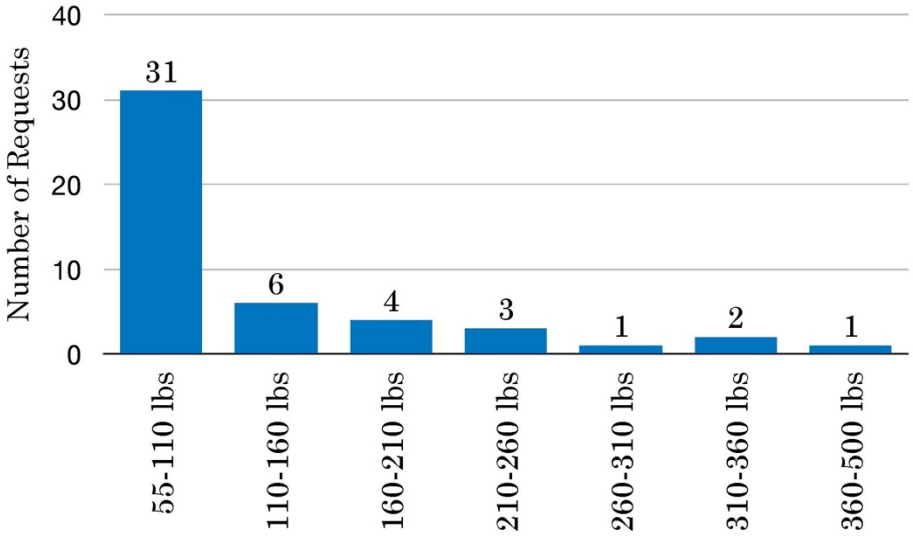


Source: FAA 44807 Data

Most Frequent FAR Exemption Request

One of the most common exemption requests is for a UAS vehicle to exceed the (Part 107) 55 pounds weight limitation.[43] The majority of these requests are to operate a vehicle weighing between 60 pounds and 110 pounds. The majority of the requests for heavy weight operations seek exemptions for the agricultural use of hazardous materials (typically for agriculture) and carriage of photographic equipment (67 percent). The approval rate for these is 94 percent.[44]

Figure 10: Distribution of Weight Exemption Requests

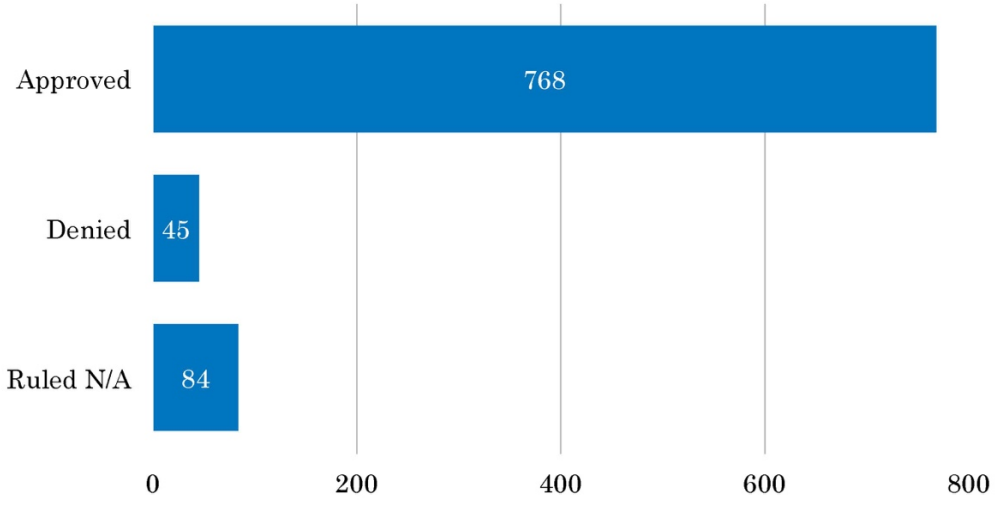


Source: FAA 44807 Data

Summary of All FAR Exemption Requests: Approved/Denied

During this time period, petitions to the FAA for exemptions contained 884 individual requests for action on specific sections of the FARs, of which 768 approved and 45 were denied.

Figure 11: Exemption Determination by Individual FAR



Source: FAA 44807 Data

Appendix B shows that there are at least 83 different sections of the FARs for which applicants have petitioned for exemptions. These include Part 21, Part 27, Part 43, Part 45, Part 61, Part 91, Part 107, Part 119, Part 135, and Part 137.

15 FAR sections form the bulk of exemptions requests and also are granted in the highest proportion by FAA. Table 3 lists the 15 sections that have more than 20 requests and approval ratings of over 90 percent. These FARs pertain to policies, procedures, and equipment that are required in the manned aircraft certification process but have no analog in unmanned aircraft. For instance, FAR 137.42 and FAR 137.33 contain requirements for equipage of aircraft with seatbelts and carriage of an operating certificate. Petitioners view these FAR exemption requests as "cookie cutter" and are normally done through standardized and commonly accessible templates.[45]

Table 3: Most Commonly Approved FAR Exemptions

FAR	Exemption Category	Approval Rate
61.3 (a)1(i)	Requirements for certificates and	100%
137.19	Certification requirements	100%
137.31	Aircraft Requirements	100%
137.33	Carrying of Certificate	100%
137.41	Personnel, PIC	100%
137.42	Seat belts	100%
91.407(a)(1)	Maintenance Required	98%
91.409(a)(1)(2)	Inspections	98%
91.417 (a)(b)	Maintenance Records	98%
91.119 (C)	Operations below 500'	98%
91.121	Baro Altimeter setting	96%
91.405	Maintenance Required	96%
91.7(a)	Civil airworthiness	96%
91.151(a)	Fuel for VFR Flight	94%
61.113 (a) (b)	Private Pilot PIC Limitations	93%

Source: FAA 44807 Data

The most commonly rejected FAR exemption requests center of sections related to using UAS for commercial purposes under Part 135, shown in Table 4. Generally, these are associated with commercial carriage of packages. We note that instructions on acceptable means of complying with these provisions are not provided by the FAA.

Table 4: Most Commonly Denied FAR Exemptions

FAR	Exemption Category	Denial Rate
91.126 (D)	Airport class G	100%
91 127	Vicinity airport	100%
91.130 C,D	Class C airspace	100%
91.155 A,C	VFR Mins	100%
119.71 A-F	Mgmt personnel requirements	100%
135.93	Min alt autopilot	100%
135.109b	PIC and SIC	100%
135.227 a-f	Icing limitations	100%
135.415	Service Difficulty Reports	100%
135.417	Interruption reports	100%
135.429	Required Inspection Personnel	100%
135.435	Certificate requirements	100%
135.437	Authority to approve maintenance	100%
135.443	Airworthiness release	100%
91.119 (a)	Min Safe Alt	56%
PART 107		53%

Source: FAA 44807 Data

The most striking findings in our research on Section 44807 were found in the migration of petitions away from this section to Part 107. Under the old framework, which was repealed by the 2018 FAA Reauthorization Act (PL 115-254), more than 3,238 petitions were approved by FAA, while in a comparable timeframe under the new framework only 38 were approved. It was expected that new regulations would drive activity away from 44807, but the magnitude of the migration was surprising. Also surprising was that agriculture (38 percent) and heavy weight photography platforms (about 29 percent) usage dominates this section as opposed to uses such as commercial package delivery.

The reduction in exemption petitions submitted to the FAA may be attributable to several factors:

- Creation of the Part 107 waiver process and grandfathering of Section 333 exemptions.[46]
- Operators choosing to ignore regulatory requirements and operate without authorization.[47]
- Lack of enforcement mechanisms by the FAA.[48]
- Lack of liability for organizations that contract with a 3rd party UAS operator choosing to ignore regulatory requirements.[49]

We have also found that the current 44807 dataset provides an incomplete picture of the exemption process. For example, neither macro nor petition specific data are provided on material deficiencies, improper procedures, or improper hazard identification found by the FAA in the exemption process. A greater understanding

of these can inform the creation of safety education programs to develop mitigation measures.

The 15 most commonly sought exemptions under 44807 involve "cookie cutter" requests to remove regulatory language that applies exclusively to manned aircraft, such as seatbelt equipage and the carriage of operating manuals. This research was not able to identify an effect on safety, suggesting a decreased workload for FAA if these were subject to blanket approvals.

The data and interviews suggest that agricultural operations and heavy weight operations represent a lower risk operation due to use in rural environments with low population density. Commonly manufactured agricultural UAS systems fall in the 55 to 75 pounds range. While a collision damage assessment is out of the scope of this paper, the risks of an increased operating weight seem to be well understood by FAA as demonstrated by their 94 percent exemption approval rates.

We also understand that the 44807 process has a direct impact on flight testing. Currently, adding a new aircraft to an exemption request will trigger a do-over and restart of the process, thus slowing down flight testing for a company.[50] We believe efficiencies will be gained for the FAA and applicant by having to prepare only one program letter and supporting documents that covers basic features of the program and test site. Any additional aircraft can be added to an appendix to this document and approved by local FAA offices with no effect on safety.

As part of the research methodology for this survey, Eno interviewed leading industry UAS legal, program management, and development executives with experience in preparing and submitting Section 44807 (legacy Section 333) process. We learned:

- The median waiting periods for all categories of exemption (approved, disapproved, or pending) found in this survey for an exemption to be processed does not align with industry development cycles and is often the limiting factor in UAS vehicle development. Note that this time period includes many of the most straightforward approvals.[51]
- Rapid development cycles require frequent modification of UAS platforms and additional flight testing. Currently, a new exemption must be submitted for each major change to a vehicle even if that vehicle is tested at a previously approved test site with an airspace authorization.[52]
- Because the exemption process takes so long, the biggest additional expense a company faces is maintaining a project team while awaiting a decision from the FAA. Once an exemption is received, special provisions usually do not result in additional FTE hiring or revenue, these have already been included in the company's financial calculations.[53]
- Participants in the UAS Integration Pilot Program (IPP) are perceived to have a competitive advantage in receiving exemption requests with a higher

chance of being granted than non-participants. In addition, IPP participants are perceived to have an advantage in access to FAA decision makers who process these requests.[54]

- The shortcomings of the exemption process have created an industry around preparation of applications and the ability to fast track them to FAA decisionmakers.[55]
- FAA analysis of waivers for Part 135 commercial operations tend to focus on door to door delivery and not take into account hub to hub delivery.[56]

Recommendations Based on This Data

- The FAA should better explain the advantages and disadvantages of seeking an exemption under Section 44807 in lieu of full aircraft and production certification.

- The FAA should publish a comprehensive listing of all Section 44807 petitions received, status of any actions taken, and identification of trends.

- The FAA should provide applicants with a robust set of tools to assist in preparation of their exemption request.

- The FAA should establish a streamlined process for granting exemptions for UAS weighing between 55 pounds to 100 pounds for agricultural purposes and provide population density risk guidelines for use in other circumstances.

- The FAA should standardize the exemption process for the 15 most commonly sought and approved exemptions and consider a blanket exemption process for these.

- The FAA should prioritize providing applicants with explicit instructions on acceptable means of complying with the eighteen most commonly denied FAR exemptions in Section 44807. These are directly associated with package delivery.

- The FAA should proactively identify the specific risks that need to be mitigated for package delivery operations and cooperatively work on acceptable measures that will, if possible, achieve an acceptable level of safety.

- The FAA should implement a separate approval process for conduction UAS flight testing under Section 44807.

5.0 Optimizing Aircraft and Production Certification

Commercial UAS aircraft and production certification remains largely a specialized activity conducted by only a small number of organizations in the United States.[57] In contrast, thousands of Part 107 waivers and Section 44807 (legacy Section 333) exemptions have been submitted to the FAA. As a result, certification activities do not lend themselves to statistical analysis through surveys. Information in this section was informed by existing literature and interviews with leading industry UAS program management and development executives with experience in leading certification initiatives for their organizations.

General Observation from Interviews

The FAA continues to view UAS certification through the lens of manned aviation. This translation process of one set of requirements to another needlessly impedes certification.[58] Across the board, interviewees believe that the FAA provides inadequate guidance on UAS certification.[59]

Flight Testing

In the certification process the Original Airworthiness Certificate for aircraft and/or UAS is issued by the FAA Manufacturing Inspection District Offices (MIDO). An experimental certificate to allow for research and development is good for one year after the date of issue or renewal, unless a shorter period is deemed necessary. Order 8130.34d allows Airworthiness Aviation Safety Inspectors (ASIs) from Flight Standards District Offices (FSDOs) to issue recurrent certifications. Multiple interviewees perceive that there might be reluctance for FSDOs to take on this activity.

FAA continues to treat UAS certification programs as they would for full type certification of an aircraft and not certification of an experimental aircraft for test purposes. In general, the Product Certification process used by UAS was originally intended for a Part 25 large commercial transport category aircraft.

Despite complaints about having to navigate the existing certification processes, interviewees in general felt that the processes in place for giving and receiving feedback to the FAA works well. But vehicle manufacturers experience a greater than expected re-assignment and turnover of FAA oversight personnel. Assignments are viewed as being “ad hoc” in nature which often results in the wrong set of skills brought to the position by the FAA representative.[60]

Components and Subsystems

UAS systems developed and accepted through Department of Defense (DOD) processes often contain components designed to military specifications (MIL-SPEC).[61] However, differing standards between MIL-SPEC components and FAA approved parts impedes transitioning military systems to civil use. Converting such

components for commercial certification and acceptance purposes by FAA remains a relatively slow process because the FAA may not have the necessary in-house experience with MIL-SPEC.

Currently, each subsystem component of military origin, but adapted to commercial use in a UAS must be approved for use in each airframe in which it is placed. Organizations surveyed suggested a process whereby once a subsystem or component is approved it would not need subsequent approval across different airframes.[62] Additionally, this activity is perceived to not be adequately funded or resourced by the FAA.

Most UAS use common off-the-shelf (COTS) parts and these are not meant to be labeled and tracked like regular transport category aircraft parts. The FAA needs to identify which are the most critical parts in need of tracking and provide guidance on that process. Manufacturers need to perform a GAP analysis on the COTS parts they use and assess their criticality in the airframe they wish to certify. [63]

MIL-SPEC components have demonstrated compliance with DOD requirements for safety and durability and the ability to safely operate in the NAS. Many of these are analogous to commercial components. With a pathway provided by Congress and FAA for using these components in commercial UAS, the safety of the NAS will not be compromised.

RF Spectrum and Detect and Avoid

The FAA is perceived as treating spectrum and Detect and Avoid (DAA) issues as "out of scope" under the current deviation, exemption, waiver, and certification processes. Rather, interviewees suggest that these should be integral to these processes. Additionally, interviewees see value in having the FAA provide applicants with guidance as how to coordinate and comply with associated spectrum and DAA requirements.

The ability to receive authorizations from the FCC to transmit in radio frequency spectrum allocated for aviation safety purposes remains a very slow and complicated process. Interviewees perceive confusion within the FAA spectrum office as to what procedures and frequencies should be used for approval of UAS aircraft systems. Several interviewees perceive that the radio frequency band 5030-5091 MHz approved and reserved for command and control of UAS vehicles is underutilized because of inaction by the FCC and FAA.

Safety Certification for Durability and Reliability

Durability and reliability requirements recently introduced for UAS by FAA are generally perceived as good first steps by those interviewed. These 19 requirements contained in Part 21.17B read better and appear to be more applicable to UAS platforms than those they replaced. In addition, on February 3, 2020, the FAA published an NPRM, Type Certification of Unmanned Aircraft Systems, that

proposes that some UAS may be type certified as a "special class" of aircraft under 21.17 (b). However, an interviewee noted several issues that impact their certification efforts.[64]

First, the baseline reliability requirements appear to be based on an airframe model (electric powerplant) that may not be common among manufacturers. Manufacturers developing internal combustion powered vehicles are placed in a position of having to negotiate for performance requirements off of a non-applicable baseline vehicle. It is felt that there should be separate models for evaluating electric and fuel powered vehicles. Second, the algorithms used in this process are not transparent to industry.

The Part 21.17B process contains a population density model for calculating the risks to people on the ground from a vehicle failure that may not be applicable to most US operations. The FAA Modernization and Reform Act of 2012 mandated that the FAA collaborate with industry on UAS. Interviewees generally thought this was happening. The number of Pathfinder programs is too small to accommodate gathering all of the necessary lessons to learn to promote safe adoption of UAS into the NAS. These programs result in enhanced collaboration between FAA and industry.

Certification Analysis

This report underscores the importance of modernizing the existing code of federal regulations which reflects decades of valuable learning in aircraft and production certification. To the greatest degree possible, this effort should be made inclusive of both manned and unmanned aircraft. While it may be too impractical for some portions such as pilot training, there are others, Part 23, Part 27, and Part 25, as examples where an update of the section could address the UAS gap through increased use of performance-based regulations.

The FAA has long used ODA with manned aircraft certification. But this research acknowledges that the FAA Administrator and Congress are currently reviewing the use and application of ODA for all certification purposes. UAS can be part of that review. Doing so will ensure that at such point ODA is applied to UAS, it will share the same foundation as the revised ODA for manned aircraft. As a result, policies and procedures will be in place from the ground floor so that ODA is used by participating persons and organization without decreasing the safety of the NAS.

Organization Designation Authorization

Under Title 49, the FAA may delegate issuing certificates, or those related to the examination, testing, and inspection necessary to issue a certificate on behalf of the FAA Administrator. This Organization Designation Authorization (ODA) program is the means by which the FAA grants designee authority to organizations or companies. Currently, ODA is only used for manned aircraft operations, but has application for current and future UAS certification.

The Section 44807 research findings and those in aircraft certification appear to align in that significant administrative obstacles exist for operators who wish to develop and flight test successive generations of the same UAS. Most notably, manufacturers are frustrated with having to restart the clock with each design iteration and required new application. Separating the flight test from certification processes would allow manufacturers greater flexibility during testing and development to incorporate safety designs in successive iterations of aircraft. It would also ensure that UAS manufacturers have a clear understanding and pathway to applicable regulations.

Another question facing the industry is how should UAS built for military programs be treated for certification purposes. Many of these programs have volumes of operational and safety data associated with them that that can be leveraged during certification. However, many of these systems are built to military specifications with military specification parts (MIL-SPEC) that have no analog in commercially available parts. As conversion of military parts for commercial purposes would be a new effort for the FAA, it is unclear whether sufficient funds exist for this expanded FAA function.

Allocation of spectrum is critical to the safe operation of UAS within the NAS. However, current regulations do not properly integrate it into the aircraft and production certification processes, nor is there sufficient TSO guidance.

Finally, UAS manufacturers developing internal combustion powered UAS are placed in a disadvantageous position of having to negotiate with the FAA for performance requirements while using specifications of non-similar vehicles. This could be alleviated without introducing additional risks by the FAA promulgating separate specification models tailored to evaluating electric and fuel powered vehicles. This research did not find risks to the safety of the NAS.

Recommendations Based on this Data

- The FAA should modernize the existing code of federal regulations for aircraft and production certification and to the greatest degree possible. This effort should be made inclusive of both manned and unmanned aircraft.

- The FAA Administrator should approve, as appropriate, ODA designee authority to organizations and companies involved with the construction of UAS systems.

- The FAA should create guidelines and processes to handle certification of UAS for flight test and separate this activity from the full type certification process.
- Congress should authorize and appropriate additional funding for the FAA to expand their acceptance program of military components (MIL-SPEC) converted for commercial use.

- The FAA should pro-actively protect civil UAS frequencies from interference.

- The FAA should integrate Command and Control (C2) and Detect and Avoid (DAA) requirements into the deviation, exemption, waiver, and certification processes.

- The FAA should publish TSO guidance to enable the manufacture, certification and use of avionics for UAS platforms in the 5GHz frequency range.

- The FAA should release to industry for peer review the algorithm and population density models used to generate the durability and reliability requirements contained in draft Advisory Circular 21.17B.

6.0 Optimizing the Overarching Policy Framework

Based on the analysis of waivers, exemptions, deviances, and certification, this research identified four policy areas and associated recommendations to close gaps in the current deviation, exemption, waiver and certification processes. The FAA does not need to start from scratch. Existing aeronautical practices combined with the specific procedures approved to date by the FAA as equivalent in granted deviations, exemptions, waivers, and certifications provide a solid foundation to achieve these recommendations.

Establish a UAS Safety Culture. Air carriers, business aircraft operators, and general aviation benefit from implementable safety principles tightly woven into every corner of regulation. This allows for the development and promulgation of standard procedures, policies, safety assurance frameworks, risk management, and safety promotion. In parallel, SMS, broadly supported by the aviation industry and mandated by FAA for certain operators, provide organizational accountabilities and decision-making tools to proactively address underlying organizational issues that may result in accidents or incidents.[65] SMS is also an enabler for safety information sharing. Both frameworks establish a culture of safety in manned aviation.

For unmanned aircraft, standard procedures and risk mitigation are defined by deviation, exemption, and waiver processes, instead of a cohesive body of regulations embodying these as safety best practices. As a primary regulatory mechanism, deviations, exemptions, and waivers accomplish little more than providing a pass/fail determination to the operator. They do not assist an operator in understanding safety principles, assessing risk, or developing best practices. Further, without the benefit and support of SMS, organizations employing UAS may not have the tools to identify underlying internal safety issues.

- The FAA should promulgate specific risk mitigation measures and operational methods that it will accept for compliance purposes from users wishing to conduct many common UAS operations.

- The FAA should develop a long-term strategic roadmap, including regulatory requirements and voluntary programs, to develop a culture of safety and accountability among UAS operators.

- The FAA should consider adapting and scaling portions of SMS to benefit the full range of UAS operators from individual to commercial.

Share Best Practices on Hazard Identification and Risk Management. General and commercial aviation benefit from FAA developed aeronautical reference materials such as the FAA Aeronautical Information Manual (AIM), Advisory Circulars, and Aircraft Handbooks and Manuals. These provide operating techniques and procedures to operators and manufacturers. UAS operators would benefit from similar guidance during application or petition preparation, operational planning, and flight operation.

The FAA also supports voluntary training and safety programs. These include programs such as the Aviation Safety Action Program (ASAP), Aviation Safety Reporting System (ASRS), Flight Operations Quality Assurance (FOQA), Internal Evaluation Program (IEP), Line Operational Safety Audit (LOSA), and Voluntary Disclosure Reporting Program (VDRP). Largely developed for air carriers, these programs help stakeholders identify potential precursors to accidents. Each of these programs can be assessed for tools that can be made available to the UAS industry.

UAS operators are generally eager to demonstrate compliance and operate safely. But they largely come from industries and organizations outside of traditional aviation. Application instructions, safety explanation guidelines, and feedback encountered in filing for a deviation, exemption, or waiver often fall short of all the administrative and operational information an operator needs to know to manage safety risks.

- The FAA should expand the body of aeronautical reference material and tools to include knowledge of aviation safety and operation principles applicable to UAS operators and manufacturers.

Transition to a Permanent Regulatory Framework. The current system of deviations, exemptions, and waivers must transition from being the primary entry point to safety and accountability to one reserved for addressing unique circumstances. In many instances the current body of FARs are suitable for safety oversight of UAS manufacturers and operators. In other cases, new sections may need to be added to the FARs to cover the unique circumstances of UAS.

Fully understanding and documenting the gaps between the existing FARs and the capabilities inherent to UAS should be an imperative. This study notes foundational work performed by the FAA's UAS Aviation Rule Making Committee (ARC), which recommended revising many FARs to reflect typical UAS capabilities.[66] However, the FAA Strategic Plan for FY 2019-2022 emphasizes a continuation of the current system with a focus on "enabling the approval of complex waivers and precedent-setting exemptions."[67] In addition, FAA must provide a path forward as 49 U.S. Code 44807 terminates on September 30, 2023.

- The FAA should develop a strategic plan to eliminate the routine use of deviations, exemptions, and waivers for all but exceptional UAS use cases and transition to a permanent regulatory framework.

Help Users Better Identify the Regulations They Need to Follow. UAS operators and manufacturers encounter a complex web of rules, restrictions, deviations, exemptions, waivers, and certifications leading up to and continuing through deployment of their systems. The data collected suggests a great deal of continued industry confusion regarding which rules apply to many common UAS operations. The lines especially blur when choosing between Section 44807 and aircraft/production certification. To a lesser degree, confusion exists between Part 107 and Section 44807 selection. These misunderstandings often result in the submission of materially defective applications or petitions and/or documents submitted to the inappropriate mechanism. All of which unnecessarily task FAA resources.

- The FAA needs to define better pathways for applicants to choose between Part 107, Section 44807, and aircraft/production certification.

This study also examined the specific ways in which operators and manufacturers use the deviation, exemption, waiver, and aircraft certification processes. In general, analysis of Part 107 and Section 44807 was hindered by the limited availability of data from the FAA to examine these processes. Interviews and survey data suggest the typical applicant represents a small, newly-formed company with limited to no aviation industry experience. These operators report that they want to be safety-oriented but are frustrated by lack the information and guidance material from FAA to inform operations in their organizations.

As the initial pathway to many UAS flight operations, Part 107 provides a unique opportunity for the FAA to define principles of safe flight for operators. The new guidance material and educational opportunities recommended will promote the establishment of a culture of safety in young UAS organizations, ensure that risks and hazards are properly identified, and enhance their understanding of FAA regulation as it relates to everyone's safety.

The research also reveals well-understood and low-risk UAS operations with high rates of Part 107 waiver approval. Additionally, the research found numerous

examples of the FAA requiring pro forma requests to waive restrictions that apply only to manned aircraft. Generally, these involve required aircraft equipment such as seat belts and operator's manuals. Research suggests low risk operations and pro forma administrative requests are best processed through other mechanisms, such as blanket waivers. Doing so will allow FAA to concentrate resources on more hazardous and higher risk operations.

- The FAA should develop blanket waivers for operations/procedures that are low risk or when dealing with pro forma administrative issues in the regulations.

High Section 44807 exemption denial rates were noted for petitioners seeking to perform commercial package delivery. Reasons focused on petitioners' inability to identify the specific risks that need to be mitigated and define measures that would achieve acceptable levels of safety. An associated theme found in examining these petitions is lack of FAA guidance on acceptable means of complying with the FAR requirements.

With regard to aircraft and production certification, commercial activity remains largely a specialized pursuit conducted by only a small number of organizations in the United States.[68] In contrast, thousands of Part 107 waivers and Section 44807 exemptions have been submitted to the FAA. Even though certification represents a top end activity for the aviation industry, across the board the research found the FAA provides inadequate guidance on UAS certification.[69]

The common theme throughout the interviews, research, and surveys behind this study remains that the UAS regulatory process needs to look more like those traditional regulatory structures in general and commercial aviation that have kept the public safe for the last 100 years. These form the basis for the American public to maintain support of aviation activities. Today's job is to bridge the gap so that we sustain the UAS revolution while pursuing that permanent regulatory framework.

Conclusion

When policy recommendations are put forward on critical national issues, industry and government often have predictable responses. Industry says, "This is so important we can't wait for the government." Government replies, "We don't have the resources to accomplish these measures." Conscious of this dynamic, the imperatives and recommendations set forth in this report are designed to leverage the large body of existing work performed by the FAA and do not need to be cut from whole cloth.

To date, the FAA has approved well in excess of 8,500 deviations, exemptions, and waivers for UAS operators. In these, the FAA has made determinations of risk, approved best practices, judged safety cases, recognized operating procedures, and assessed pilot qualifications. Largely keeping these to themselves at the behest of industry. All of these forms a body of knowledge from which aeronautical learnings, means of compliance and safety protocols can be extracted and made available to operators. These can and should illuminate the path to a new regulatory framework.

But leveraging this treasure trove of knowledge will require mutual trust replace the wall of trade secrecy that surrounds and in a large manner drives the deviation, exemption, and waiver processes. That's why very little information is made available on the federal docket or in waiver applications. While it makes sense to keep lines of software code proprietary, it makes no sense to keep the procedures, identified risks, and training that underlie these applications and petitions so.

That is why UAS regulation bears only passing resemblance to the rest of general and commercial aviation where everything is out in the open. Our aviation system would not be as safe and successful as it is if we didn't share, publish, and engage in the peer review of the procedures that keep airplanes from colliding.

Greater openness as we bridge the gap will benefit the safety of the National Airspace System.

Appendix A: Compilation of Recommendations

General Recommendations

- The FAA should promulgate specific risk mitigation measures and operational methods that it will accept for compliance purposes from users wishing to conduct many common UAS operations.
- The FAA should develop a long-term strategic roadmap, including regulatory requirements and voluntary programs, to develop a culture of safety and accountability among UAS operators.
- The FAA should consider adapting and scaling portions of SMS to benefit the full range of UAS operators from individual to commercial.
- The FAA should expand the body of aeronautical reference material and tools to include knowledge of aviation safety and operation principles applicable to UAS operators and manufacturers.
- The FAA should develop a strategic plan to eliminate the routine use of deviations, exemptions, and waivers for all but exceptional UAS use cases and transition to a permanent regulatory framework.
- The FAA needs to define better pathways for applicants to choose between Part 107, Section 44807, and aircraft/production certification.
- The FAA should develop blanket waivers for operations/procedures that are low risk or when dealing with pro forma administrative issues in the regulations.

Part 107 Waiver Process

- The FAA should make Part 107 waiver applications and decisions available to the public in a de-identified format for the purpose of identifying safety trends, knowledge gaps, and ensuring efficient administration of the waiver system.
- The FAA should expand the body of aeronautical safety knowledge made available to operators so that they can implement standard hazard and risk mitigation programs for UAS operations. This knowledge should specify acceptable means of complying with waiver provisions sought under Part 107.
- The FAA should enhance application instructions in the six areas identified by this research, providing a larger body of foundational knowledge in guidance material.
- The FAA should immediately address UAS operators needs for additional information related to Hazard and risk evaluation, Visual Line of Sight (VLOS), See and Avoid, Physiology, Required equipment, and Operational limits.
- The FAA should make use of blanket waivers for well understood Part 107 operations with high rates of approval including Daylight Operations (Night Waiver), Operating from a Moving Vehicle, and Right of Way.

Section 44807

- The FAA should better explain the advantages and disadvantages of seeking an exemption under Section 44807 in lieu of full aircraft and production certification.
- The FAA should publish a comprehensive listing of all Section 44807 petitions received, status of any actions taken, and identification of trends.

- The FAA should provide applicants with a robust set of tools to assist in preparation of their exemption request.
- The FAA should establish a streamlined process for granting exemptions for UAS weighing between 55 pounds and 100 pounds for agricultural purposes and provide population density risk guidelines for use in other circumstances.
- The FAA should standardize the exemption process for the 15 most commonly sought and approved exemptions and consider a blanket exemption process for these.
- The FAA should prioritize providing applicants with explicit instructions on acceptable means of complying with the eighteen most commonly denied FAR exemptions in Section 44807. These are directly associated with package delivery.
- The FAA should proactively identify the specific risks that need to be mitigated for package delivery operations and cooperatively work on acceptable measures that will, if possible, achieve an acceptable level of safety.
- The FAA should implement a separate approval process for conduction UAS flight testing under Section 44807.

Aircraft and Production Certification

- The FAA should modernize the existing code of federal regulations for aircraft and production certification and to the greatest degree possible this effort should be made inclusive of both manned and unmanned aircraft.
- The FAA Administrator should approve, as appropriate, ODA designee authority to organizations and companies involved with the construction of UAS systems.
- The FAA should create guidelines and processes to handle certification of UAS for flight test and separate this activity from the full type certification process.
- Congress should authorize and appropriate additional funding for the FAA to expand their acceptance program of military components (MIL-SPEC) converted for commercial use.
- The FAA should pro-actively protect civil UAS frequencies from interference.
- The FAA should integrate Command and Control (C2) and Detect and Avoid (DAA) requirements into the deviation, exemption, waiver, and certification processes.
- The FAA should publish TSO guidance to enable the manufacture, certification and use of avionics for UAS platforms in the 5GHz frequency range.
- The FAA should release to industry for peer review the algorithm and population density models used to generate the durability and reliability requirements contained in draft Advisory Circular 21.17B.

Appendix B: Exemption Petitions by Individual FAR

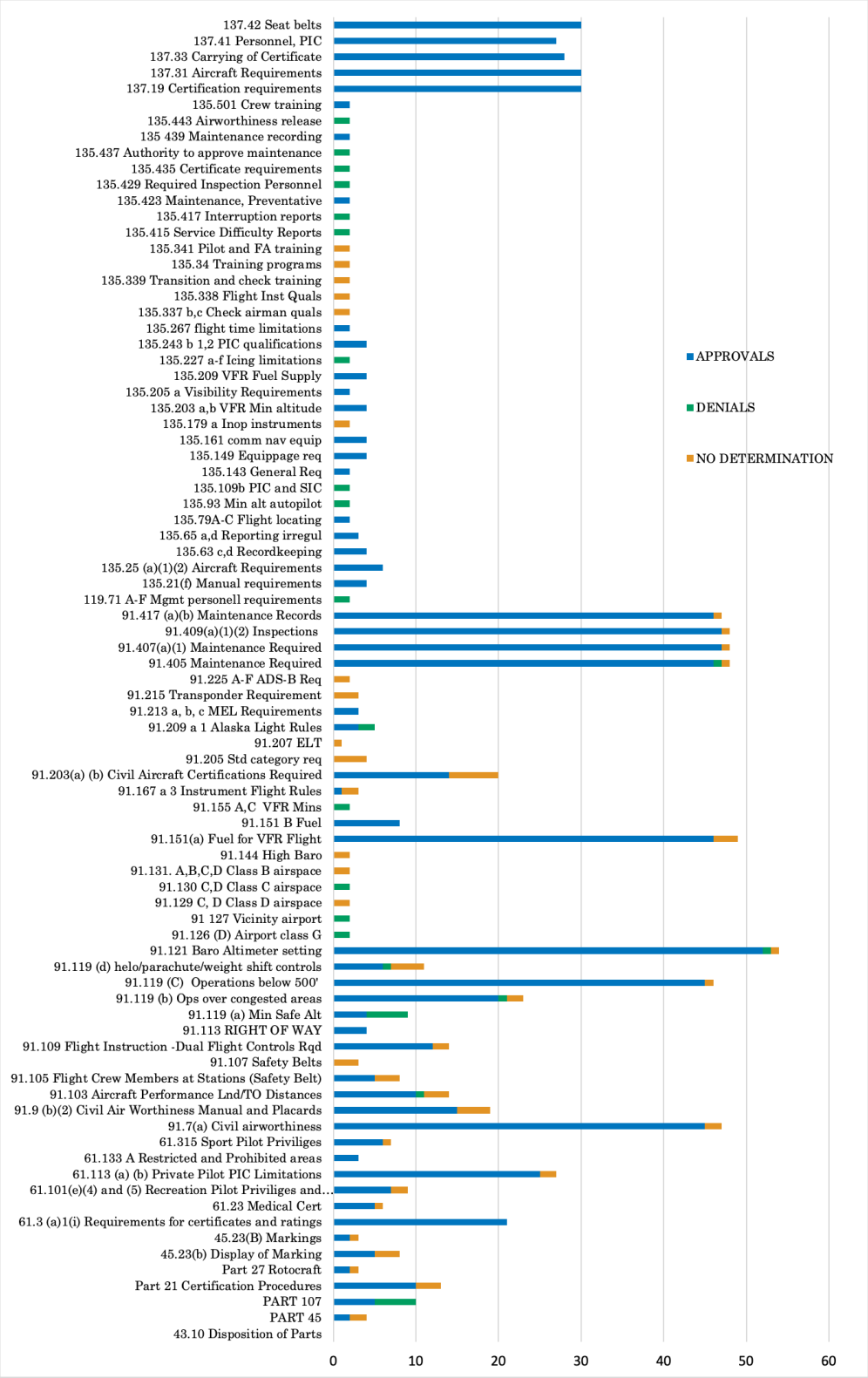


Table Appendix B: FAR Petitions by Part and by Result

Endnotes

[1] FAA Document 8900.1 CHG 658 4/18/19 Vol 3, Chapter 2 Exemptions, Deviations, Waivers, and Authorizations
[2] Federal Aviation Administration, "UAS by the Numbers," 2019.
[3] Jonathan Corning and others, "FAA Aerospace Forecast: Fiscal Years 2019-2023," Federal Aviation Administration, TC19-0002, 2019.
[4] These UAS systems are more formally called Remotely Piloted Aircraft System (RPAS) by ICAO
[5] Operation of Small Unmanned Aircraft Systems Over People, Docket No.: FAA-2018-1087; External Marking Requirement for Small Unmanned Aircraft, Docket No. FAA-2018-1084.
[6] Remote Identification of Unmanned Aircraft Systems, Docket No.: FAA-2019-1100
[77] National Policy Order 8000.369B "Safety Management Systems" Federal Aviation Administration, March 18, 2016. SMS provides the framework for an organization to make decisions on allocating resources and conducting safety oversight using safety management principles. It is required by the International Civil Aviation Organization (ICAO) as a Standard and Recommended Practice (SARP) and has been used by the aviation industry for more than two decades.
[8] FAA, "UAS – Recreational Fliers," 2019.
[9] 14 CFR Part 107, Electronic Code of Federal Regulations, Updated October 31, 2019;
[11] James D. Seipel, "Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft," Federal Aviation Administration, Order 8130.34C, 2 August 2013.
[12] James D. Seipel, "Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft," Federal Aviation Administration, Order 8130.34C, 2 August 2013.
[13] Exception for Limited Recreational Operations of Unmanned Aircraft, 5/17/2019 FAA-2019-0364
[14] "Summary of Small Unmanned Aircraft Rule (Part 107)," FAA News, Federal Aviation Administration, June 21, 2016.
[15] "Special Authority for Certain Unmanned Aircraft Systems (Section 44807)," Federal Aviation Administration, December 14, 2018.
[16] "Special Authority for Certain Unmanned Aircraft Systems (Section 44807)," Federal Aviation Administration, December 14, 2018.
[17] Ibid
[18] Eno Center for Transportation Section 44807 Survey, September 2019
[19] 14 CFR Subpart C, Electronic Code of Federal Regulations, Updated October 31, 2019.
[20] Eno Center for Transportation Section 44807 Survey, September 2019
[21] James D. Seipel, "Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft," Federal Aviation Administration, Order 8130.34C, 2 August 2013, pg. E-1

[22] "Part 107 Waivers Issued," Federal Aviation Administration, 2019.
[23] Eno Center for Transportation/Catalyst-Go Part 107 Waiver Survey, September 2019
[24] Eno/Catalyst survey Q12
[25] Eno/Catalyst survey Q 16
[26] Eno survey Questions Q2, Q4, Q8
[27] Eno survey Question Q2
[28] FAA ARC Survey Q20, Q22
[29] Eno/Catalyst survey Q10
[30] Eno Survey Q1
[31] DAC Q22
[32] Eno Center for Transportation/Catalyst-Go Part 107 Waiver Survey, September 2019
[33] "Part 107 Waivers Issued," Federal Aviation Administration, 2019.
[34] Eno Center for Transportation/Catalyst-Go Part 107 Waiver Survey, September 2019
[35] Interview with executive "E"
[36] Eno/Catalyst Survey Q15
[37] FAA DAC Survey Q4
[38] All of the data insights were extracted from the Eno Center for Transportation/Catalyst-Go Section 44807 Exemption Survey, September 2019
[39] This period represents YTD 2019 as some information from 12/2018 crosses over into 1/2019 and would be otherwise lost if not included.
[40] Regulations.gov
[41] "Section 333 Authorization Granted," Federal Aviation Administration, 2019
[42] "Section 333 Authorization Granted," Federal Aviation Administration, 2019, For the period 12/18/2015-9/28/2016. Note: This data does not contain the number of waiver requests that were denied by the FAA during the same time period, as FAA only publishes approvals.
[43]Eno Center for Transportation/Catalyst-Go Section 44807 Waiver Survey, September 2019
[44] Eno Center for Transportation/Catalyst-Go Section 44807 Waiver Survey, September 2019
[45] Eno Center Interview findings
[46] Operation and Certification of Small Unmanned Aircraft Systems Final Rule, June 28, 2016 p 83-84
[47] This factor has been extracted from various interviews with Subject Matter Experts
[48] Ibid
[49] Ibid
[50] Interview with Executive A
[51] Ibid
[52] Ibid
[53] Ibid

[54] This viewpoint was shared by the majority of interview subjects; Note: the IPP brings together state, local, and tribal governments together with private sector entities, such as UAS operators or manufacturers, to test and evaluate the integration of civil and public drone operations into our national airspace system.
[55] Interview with executive "A"
[56] Interview with executive "A"; Note: UAS package delivery to residential and commercial addresses represent one of the highest risk activities in unmanned aviation. However, industry representatives relate that the best business cases envision hub to hub UAS deliveries in lower density population areas. These are two different scenarios which interviewees believe are being lumped together unnecessarily by regulators.
[57] Eno/Catalyst-Go Interview findings
[58] Common observation shared by all executives interviewed.
[59] Common observation shared by all executives interviewed.
[60] Interview with executive "D"
[61] MILSPEC Standardization refers to DOD standardization in achieving interoperability, ensuring products meet certain requirements, commonality, reliability, total cost of ownership, compatibility with logistics systems, and similar defense-related objectives.
[62] Interview with executive "B"
[63] Interview with executive "C"
[64] Interview with executive "C"
[65]Final Rule, Safety Management Systems for air carriers operating under 14 CFR Part 121, Document Number FAA 2015-00143. This rule requires air carriers operating under 14 CFR part 121 to develop and implement a safety management system (SMS) to improve the safety of its aviation-related activities. SMS is a comprehensive, process-oriented approach to managing safety throughout an organization. SMS includes an organization-wide safety policy; formal methods for identifying hazards, controlling, and continually assessing risk and safety performance; and promotion of a safety culture. SMS stresses not only compliance with technical standards but also increased emphasis on the overall safety performance of the organization.
[66] The UAS ARC was chartered in 2011 and delivered its final report to the FAA in 2015.
[67] FAA Strategic Plan| FY2019-2022, p36, Feb 2018
[68] Eno/Catalyst-Go Interview findings
[69] Common observation shared by all executives interviewed.

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