U.S. Department of Transportation

FEDERAL AVIATION ADMINISTRATION

NOTICE OF PROPOSED RULEMAKING REGULATORY EVALUATION

Small Unmanned Aircraft Systems
14 CFR Part 107

OFFICE OF AVIATION POLICY AND PLANS

ECONOMIC ANALYSIS DIVISION

George Thurston

February 2015

TABLE OF CONTENTS

LISTS OF ABBREVIATIONS

AC	Advisory Circular
AMA	Academy of Model Aeronautics
ARC	Aviation Rulemaking Committee
AUVSI	Association for Unmanned Vehicle Systems International
CFI	Certificated Flight Instructors
COA	Certificate of Waiver or Authorization
DPE	Designated Pilot Examiner
FAA	Federal Aviation Administration
FSDO	Flight Standards District Office
IRS	Internal Revenue Service
KTC	Knowledge Test Center
NAS	National Air Space
NPRM	Notice of Proposed Rule Making
P.L.	Public Law
PTO	Permit to Operate
sUAS	Small Unmanned Aircraft System
UAS	Unmanned Aircraft System
U.S.C.	United States Code
VSL	Value of Saved Life

I. EXECUTIVE SUMMARY

The FAA is proposing to amend its regulations to adopt specific rules to allow the operation of small unmanned aircraft system (small UAS) operations in the National Airspace System (NAS). These changes would address the operation of small UAS, certification of their operators, registration, and display of registration markings. The proposed requirements would allow small UAS to operate in the NAS while minimizing the risk they may pose to manned aviation operations and the general public. Lastly, the proposed rule would prohibit model aircraft from endangering the safety of the NAS.

If the proposed rule were adopted, operators would be permitted to participate in certain non-recreational activities from which they are currently prohibited. The proposed requirements are intended to enable the opportunity for the private sector to conduct research and development, develop commercial small UAS businesses, and facilitate legal and safe operations. Currently commercial activity using a small UAS is prohibited by federal regulation unless the civil aircraft has an airworthiness certificate in effect or operations are approved by the FAA on a case by case basis via an exemption from the pertinent regulations.[1]

Due to the proliferation of recreational unmanned aircraft, the technological advancements enabling these aircraft to operate commercially, and the societally-beneficial uses of non-recreational small UAS operations, the FAA began its small UAS rulemaking in 2005. On April 10, 2008, the FAA chartered the small UAS Aviation Rulemaking Committee (ARC) to address the incorporation of small UAS in the NAS. On April 1, 2009, the ARC provided the FAA with recommendations on how small UAS could be safely integrated in the NAS.[2]

---

[1] We also note that under the current regulations, even if a small unmanned aircraft has an airworthiness certificate, that aircraft's operator still needs to obtain an exemption from the non-airworthiness regulations, such as the see-and-avoid provisions of § 91.113 in order to operate the aircraft.

[2] A copy of the small UAS ARC Report and Recommendations can be found in the docket for this rulemaking.

On February 1, 2012, Congress gave a statutory direction to the Department of Transportation in the "FAA Modernization and Reform Act of 2012" (Public Law 112-95). In section 333 of Public Law 112-95, Congress directed the Secretary of Transportation to determine whether "certain unmanned aircraft systems may operate safely in the national airspace system". To make this determination under section 333, the Secretary[3] must assess "which types of unmanned aircraft systems, if any, as a result of their size, weight, speed, operational capability, proximity to airports and populated areas, and operation within visual line of sight do not create a hazard to users of the national airspace system or the public or pose a threat to national security".[4] The Secretary must also determine whether airworthiness certification is necessary to mitigate the public risk posed by the unmanned aircraft systems that are under consideration.[5] If the Secretary determines that certain unmanned aircraft systems may operate safely in the NAS, then the Secretary must "establish requirements for the safe operation of such aircraft systems in the national airspace system."[6]

In its initial approach, the FAA utilized a regulatory structure similar to the one that we use for manned aircraft. Utilizing this approach, the FAA found several unique issues associated with unmanned aircraft that hindered the development of this rulemaking.[7] In Appendix 5, the FAA discusses several of the alternatives that we considered in developing this NPRM. As a result of the ARC meetings, its reports, and the issues from our initial approach, the FAA has

---

[3] The primary authority for this rulemaking is based on section 333 of Public Law 112-95 (Feb. 14, 2012). In addition, this rulemaking also relies on FAA statutory authorities. Thus, for the purposes of this rulemaking, the terms "FAA," "the agency," "DOT," and "the Secretary," are used synonymously throughout this document.

[4] Pub. Law 112-95, § 333(b)(1).

[5] Id. § 333(b)(2).

[6] Id. § 333(c).

[7] Those issues were: (1) different frame of reference for seeing and avoiding other aircraft; and (2) possible loss of positive control. Both of these issues are discussed in more detail in the NPRM preamble.

decided to proceed with the new proposed part 107 by allowing low-risk small UAS operations to be incorporated into the NAS.[8]

Currently non-recreational UAS operations that do not have an airworthiness certificate or an FAA exemption are prohibited regardless of where they take place in the United States. This proposed rule would allow small UAS that weigh less than 55 pounds, to be operated non-recreationally in the NAS. This operation would be conducted in accordance with the limitations set forth in proposed Part 107.[9]

The FAA has analyzed the benefits and the costs associated with this proposed rule. The estimated out-of-pocket cost for a small UAS operator to be FAA-certified is less than $300. As this proposal enables new businesses to be established, the private sector expected benefits exceed private sector expected costs when new entrepreneurs enter. As more opportunities increase, so will the social benefits. In addition, if the use of a small UAS replaces a dangerous non-UAS operation and saves one human life, that alone would result in benefits outweighing the expected costs of this proposed rule.

We determined that this proposed rule would: have benefits that would justify its costs; would potentially have an economic impact of greater than $100 million per year in terms of benefits (which might be derived from new small UAS businesses and applications) and thus would be an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866; be "significant" as defined in DOT's Regulatory Policies and Procedures; have a significant positive economic impact on a substantial number of small entities; may create obstacles to international trade and we request comment; and not impose an unfunded mandate on state, local, or tribal governments, or on the private sector.

---

[8] See NPRM preamble in the docket for more details.

[9] See "Operational Scope" section in Preamble for more detail.

II. INTRODUCTION/BACKGROUND

Due to technological advances, UAS have changed from remotely piloted vehicles with limited capabilities to semi and fully autonomous vehicles that could expand and enable new potential commercial applications. This proposed rule would allow certain small UAS non-recreational (e.g. commercial) operations to operate within a regulatory framework by providing a safe operating environment for small unmanned aircraft weighing less than 55 pounds (25 kilograms). This proposed rule also addresses aircraft registration and marking, NAS operations, operator certification, the use of visual observers, and operational limits in order to maintain the safety of the National Airspace System (NAS).

UAS are called many things, for example, model aircraft, radio-controlled aircraft, drones, unmanned aerial vehicles, remotely piloted vehicles, etc. Regardless of what they have been called, all small UAS addressed by this proposal have two characteristics in common. The first characteristic is small UAS are aircraft that have no onboard pilot/operator. The second characteristic is small UAS are remotely operated, either manually by a person using a communications link or by a computer using data link communications.

Traditionally, most small UAS were operated recreationally as model aircraft. This pattern is changing because small UAS manufacturers are developing more sophisticated aircraft based to a large extent on drones developed for military and government use. This rulemaking is necessary to enable the safe non-recreational operation of these aircraft in the NAS.

The U.S. government also uses unmanned aircraft for military combat, surveillance, and reconnaissance. The Department of Defense is consolidating and expanding its efforts to explore the potential of UAS technology. In 2010, combined Department of Defense UAS procurement, research and development, operations, and maintenance spending totaled approximately $5.4 billion.[10] The Pentagon currently purchases more UAS than manned fighters and bombers.[11]

Recently, the commercial industry and the military have also developed drones to be operated in special use airspace with FAA approval. Currently, the FAA has granted about 300 Certificates of Waiver or Authorization (COA) to allow Federal, state, and local governments to operate small UAS in the NAS under strictly limited conditions. These COAs must be renewed every two years. As these types of small UAS operations are government activities, they would not affect the economic analysis of the proposed rule. However, this proposed rule would provide public aircraft operations with greater flexibility by giving them the option to declare their operation to be a civil operation and comply with the provisions of proposed part 107 instead of seeking a COA from the FAA.

Although commercial operations not specifically authorized by the FAA are reported to exist today, most of these existing operations do not comply with current requirements to possess airworthiness certification,[12] airman (pilot) certification,[13] aircraft registration, and marking requirements.[14] These operations also do not meet the NAS operating requirements.[15] Specifically, as discussed in the preamble to the notice of proposed rulemaking (NPRM), these operations do not meet the requirement to "see and avoid other aircraft"[16] because there is no one onboard an unmanned aircraft to exercise this "see and avoid" function.

Therefore, small UAS non-recreational operations are not in compliance with FAA federal aviation regulations without an FAA-issued exemption. While commercial small UAS

---

[10] http://www.militaryaerospace.com/articles/2009/05/unmanned-vehicle-spending-in-the-2010-dod-budget-to-reach-54-billion.html
[11] http://www.sps-aviation.com/story_issue.asp?Article=1278
[12] 49 U.S.C. §44711 (a)(1) and 14 CFR part 21
[13] 14 U.S.C. §44711 (a)(2)(A)) and 14 CFR part 61
[14] 14 U.S.C. §44101 and 14 CFR parts 45 and 47 respectively
[15] 14 CFR part 91
[16] 14 CFR 91.113(b)

operations are being operated without FAA regulatory approval, the FAA has no method to quantify their historical usage. However, as civil applications of UAS develop, a demand for legal and safe access to the NAS for commercial and other non-recreational purposes has emerged. This proposed rule announces our plan to work with the emerging UAS industry to build a safe environment; eventually leading to the inclusion of small UAS into the NAS for commercial and other non-recreational purposes as well as satisfying the congressional direction from P.L. 112-95.

Our cost estimates are based on assessments and discussions with the small UAS Aviation Rulemaking Committee (ARC), industry subject matter experts, and FAA expert judgment.

In this analysis, the FAA first discusses general assumptions and data used in our estimation of the benefits and costs. Next, we discuss the benefits of this proposed rulemaking. We then discuss our estimate of the proposed rule's potential costs that would be incurred by operators of small UAS and the costs incurred by the government. Next, we discuss the alternatives to this proposed rule. Lastly, we summarize the estimated benefits and costs for the proposed rule.

III. ASSUMPTIONS AND DATA

The FAA's estimated benefits and costs are based on assessments of the small UAS Aviation Rulemaking Committee (ARC) and the opinions of FAA and industry subject matter experts. We remind the reader that since legal operation of commercial small UAS in the NAS constitutes a new market, available data for these operations is sparse. The benefit and cost analysis for the regulatory evaluation is based on the following factors/assumptions:

- Because the commercial small UAS industry is not yet established and may evolve differently from current expectations, the FAA determined that a five-year time frame of analysis would be appropriate.
- The base year is 2013.
- We use a seven percent discount rate for the benefits as prescribed by OMB in Circular A-4.[17]
- In the small UAS future fleet forecast, the FAA assumes that 20 percent of the fleet would retire or leave the fleet every year.[18]
- Because only one operator is required to operate a small UAS, we assume that there would be one qualified FAA-approved operator per registered and operating small UAS. Even though 20 percent of the small UAS equipment leaves the fleet each year, we expect that small UAS operators, once tested and certificated, would remain certificated

[17] http://www.whitehouse.gov/omb/circulars_a004_a-4

[18] A copy of the forecast can be found in the rulemaking docket. The FAA notes that a small UAS could incur a cost for registration and then retire or leave the fleet during the analysis interval. The FAA also notes that our small UAS forecast may be understated if operators choose to own more than one FAA-registered aircraft (for example, as a backup in case one aircraft is disabled). To account for this possibility, as a sensitivity analysis, if there were an additional 20 percent increase in our small UAS forecast, then the costs in Table 7 and Table 10 would increase by 20 percent. We request comments, with supporting documentation on this sensitivity analysis.

operators. Operators would incur a cost for recurrent knowledge testing every 24 months.

- The FAA assumes that the failure rate of applicants[19] taking the small UAS initial and recurrent knowledge based test would be 10% percent.[20] However, applicants and operators who fail are assumed to pass the knowledge test on the second attempt.
- Since this proposed rule allows knowledge test centers (KTC) to administer small UAS operator initial or recurrent knowledge tests, the FAA assumes that the KTC would collocate themselves with a Designated Pilot Examiner (DPE), Certificated Flight Instructor (CFI) or Other Designated Authority to validate an applicant's identity, accept the knowledge test results and the small UAS operator application for review and submission to the FAA AFS-760 Airman Certification Branch for processing.
- The cost to administer an FAA approved small UAS knowledge test, including compliance fees, to a small UAS applicant or operator is $150.[21]
- The FAA estimates that a small UAS operator applicant would need to travel 19 miles one way to reach their closest KTC location.[22]
- The 2014 published IRS variable cost mileage rate of $0.235 per mile is used to estimate the cost of Vehicle usage.[23]
- The FAA assigns the hourly value for personal time to equal $25.09 for Year 1.[24]

---

[19] The FAA notes that a person first must apply to become a small UAS operator. During the application process, this analysis will refer to a person applying to become a small UAS operator as an applicant. After the applicant has successfully passed the application process, this analysis will refer to the person as a small UAS operator.
[20] The FAA has not yet created or administered the knowledge test proposed in the NPRM. However, the weighted average failure rate for all categories of airman taking knowledge tests in 2013 was 10%. See Appendix 3 for details.
[21] http://www.catstest.com/airman-testing-exams/recreational-private-pilot.php
[22] See "Travel Expense" section for methodology and source information.
[23] http://www.irs.gov/2014-Standard-Mileage-Rates-for-Business,-Medical-and-Moving-Announced

- The FAA assigns the hourly value for travel time to equal $24.68 for Year 1.[25]
- The FAA assigns the hourly value of FAA or KTC clerical time to $20.06 by calculating the mean for a Level 2 (FG 5/6) Clerical Support person from the Core Compensation Plan Pay Bands, effective January 12, 2014 working in the Washington D.C. locality.[26] We then divide the mean of the annual salaries by 2,080 for an hourly rate.
- The FAA assigns the value of $28.00 as the estimate for the FAA's cost to register an aircraft. This estimate is based on an internal cost model developed in September 2014 by the FAA civil aviation registry to use for managerial estimates.
- The FAA uses a $50 fee to validate the identity of an applicant.

The FAA requests comments, with supporting documentation, on each of these assumptions and data values.

---

[24] Source: Revised Departmental Guidance on The Valuation of Travel time in Economic Analysis (published June 9, 2014) (Table 3, Local Travel - Personal). Per this guidance, median Household income divided by 2,080 hours is used to establish a wage rate. This wage rate, as noted in this guidance, serves as an approximate value for leisure time. Consistent with this guidance wage rates are augmented by 1.2 percent per year to reflect projected annual growth of real median household income. Year 1 (2012$) wage rates estimates are calculated as $\$24.50*1.012^2$=$25.09; Year 2 as $\$24.50*1.012^3$=$25.39; Year 3 as $\$24.50*1.012^4$=$25.70; Year 4 as $\$24.50*1.012^5$=$26.01; and Year 5 as $\$24.50*1.012^6$=$26.32.

[25] Source: Revised Departmental Guidance on The Valuation of Travel time in Economic Analysis (published June 9, 2014) (Table 4, Local Travel - Business). Per this guidance future Travel Time Saving estimates are also augmented by 1.2 percent per year to reflect projected annual growth of real median household income. Year 1 (2012$) travel time savings estimates are calculated as $\$24.10*1.012^2$= $24.68; Year 2 as $\$24.10*1.012^3$=$24.98; Year 3 as $\$24.10*1.012^4$=$25.28; Year 4 as $\$24.10*1.012^5$=$25.58; and Year 5 as $\$24.10*1.012^6$=$25.89.

[26] https://my.faa.gov/content/dam/myfaa/org/staffoffices/ahr/program_policies/policy_guidance/hr_policies/hrpm/comp/comp_ref/media/core_salary_with_conversion.xls.

IV. BENEFITS

IV.A. Introduction

This proposed rule would create an enabling business environment which would encourage the growth of private sector activity in the manufacturing and operating of small UAS. Therefore, the major benefit of this proposed rule is that it would enable new non-recreational aviation activities for small UAS in the NAS where such operations are currently not permitted without an FAA-issued exemption. The private benefits would exceed the private costs if there is only one UAS and that UAS operation earns a profit.

The FAA's estimated benefits are based on assessments of the small UAS ARC and the opinions of FAA and industry subject matter experts. We remind the reader that since legal operation of commercial small UAS in the NAS constitutes a new market, available data for these operations is sparse. Accordingly, the FAA has not quantified the aggregate benefits of this proposed rule because we cannot reasonably predict how the market will develop for individual commercial uses of small UAS.

The proposed rule could provide safety benefits by allowing the substitution of small UAS operations for operations that pose a higher level of public risk. In the "Substituting Unmanned Aviation Activities for Laborers Working at Heights" section below, we discuss that between 2004 and 2012, there were 95 fatalities involving climbers working on cell and other towers.[27] If the proposed rule would avert only one fatality by using a small UAS instead of a tower climber, then the $9.2 million dollar[28] cost of an averted fatality would exceed the costs of

[27] http://www.wirelessestimator.com/generaldoc.cfm?ContentID=9
[28] Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Economic Analyses-2014 Adjustment (June 13, 2014), *available at* http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf

this proposed rule.[29] Lastly, a benefit of this proposed rule is the FAA would satisfy Congressional direction to allow safe commercial operation of small UAS in the NAS. We now discuss these potential benefits and cost savings.

IV.A.1. Benefit Discussion of Enabling New Commercial Small UAS Activities

In March 2013, the Association for Unmanned Vehicle Systems International (AUVSI) released "The Economic Impact of Unmanned Aircraft Systems Integration in the United States" report. The report estimated the economic benefit of UAS integration could create more than 70,000 jobs in the United States with an economic impact of more than $13.6 billion in the first three years of integration and could grow to $82.0 billion by 2025.[30] Although small UAS would be a fraction of this growth, this proposed rule is the first step to integrating small UAS into the NAS that could enable the job and economic growth envisioned by AUVSI. In January 2014, AUVSI reported that each day the integration of UAS is delayed would lead to $27 million in lost economic impact.[31] Although the FAA neither supports nor endorses the AUVSI report, the study illustrates the enabling benefits of allowing UAS to operate in the NAS, which would add new jobs and potential new markets. We also note that the AUVSI report is based on the assumption of an unconstrained airspace, which currently does not exist and also would not exist under this proposed rule. We invite comment on how the conclusions of the AUVSI report would differ under the current constraints of the NAS and the constraints proposed in this rule.

As no legal commercial small UAS market currently exists, future markets may evolve differently from what the FAA expects in our small UAS fleet forecast. According to the

---

[29] See Appendix 2 for the value of averted fatalities.
[30] http://www.auvsi.org/econreport
[31] http://higherlogicdownload.s3.amazonaws.com/AUVSI/958c920a-7f9b-4ad2-9807-f9a4e95d1ef1/UploadedFiles/1%2027%2014%20Letter%20on%20sUAS%20NPRM%20Delay.pdf

Unmanned Vehicle University, there are 300 potential markets, many of which could generate revenue from small UAS applications and be enabled by this proposal.[32] These markets could originate from substituting a small UAS for manned aerial operations, tower or bridge climbers, or by operating in new markets where aviation has never been used.

In this benefit analysis we explore only four of the many potential small UAS markets this proposal could enable. The four potential small UAS markets are:

1. Aerial photography,
2. Precision agriculture,
3. Search and rescue/law enforcement, and
4. Bridge inspection.

These four examples show that this proposal would not only enable new technologies for these markets and other new marketplace opportunities, but utilizing a small UAS in place of a manned aircraft would save costs and improve safety. The following analysis investigates the potential economic benefits in these four markets that could be realized through the use of small UAS. The FAA estimates the potential qualitative benefits based on discussions and the opinions of knowledgeable industry experts.

IV.A.1.a. Aerial Photography

Small UAS industry experts have informed the FAA that a proposed rule could enable a viable market for small UAS aerial photography. Current commercial prices for manned aerial photography depend on the site location and the nature of the job. Small unmanned UAS can

[32] http://www.uxvuniversity.com/fluxx/uploads/2013/02/300P.png

operate much lower and closer to the object being photographed. The FAA and industry experts believe that small UAS could become both a viable and less costly substitute for manned aerial photography and could also create new sources of demand for aerial photography. These unmanned aircraft operators would likely specialize in low-altitude aerial photography and video. Consequently, once a small UAS aerial photography market becomes established, it would increase safety by substituting an unmanned aviation operation using a very light aircraft for a more complex manned aviation operation that uses a much heavier aircraft. A heavier manned aircraft would pose more risk to the public in the event of an accident. This market would also generate significant cost savings to the economy. At this time, however, we are unable to estimate the cost savings of using small unmanned aircraft for these types of operations given that the cost-savings occur by the reduction in cost for existing manned aviation aerial photography. The scope and costs of manned aviation aerial photography operations vary greatly depending on the location and nature of the operation. The FAA requests information and data regarding the expected rate of substitution and cost savings that may result from authorizing the use of small UAS for aerial photography operations.

IV.A.1.b. Precision Agriculture

A second potential market for small UAS this proposal could enable is precision agriculture. Precision agriculture uses detailed, site-specific information to manage production inputs. Information technologies enable segmenting a farm into smaller units to determine the characteristics of each individual segment. For example, the AUVSI cites the explosive growth of the use of UAS for agriculture in Japan.[33] The UAS being used in Japan to apply pesticides and fertilizers are much larger than the small UAS that would be authorized to operate under part

[33] http://www.pacbiztimes.com/2013/03/22/farms-may-feast-on-drone-technology-test-results/

107. Although the small UAS this proposal addresses would not be involved in the direct application of pesticides and fertilizers, it can be used to monitor applications and yields. Thus, given the weight and operational limitations of this proposed rule, current agricultural use of UAS in other countries is not indicative of the development of small UAS in the United States.

Manned agricultural aviation is used to provide observations about the state of crops in the United States. There are commercial manned aviation businesses that perform aerial imagery analysis over various time periods in precision agriculture. These images are then correlated with what is happening on the ground. These businesses (along with the individual farm manager) analyze the data available from aerial images acquired through manned aviation operations, and develop a prescription to vary the inputs based on their analysis. This knowledge of the soil and crop characteristics, unique to each section of the field, allows farm managers to optimize their production inputs within small portions of the field.

This proposed rule would enable commercial remote-sensing small UAS technology to photograph and analyze field images over time. These observations would be made by operators using a small UAS platform that has a self-contained digital camera. Low initial investment and high potential return could be very attractive to commercial operators who might provide this service to farmers. Potential precision small UAS agricultural markets include water management, insecticide application management, and nutrient management. The results of the analyses provide data to help determine the areas of a farm that might need treatment. More efficient use of chemicals saves the farm money, increases productivity, and by using fewer chemicals, would have a positive impact on the environment. Once the data are mapped, the farmer would employ a custom spray operator to apply the correct amount of chemicals only where they are needed. In addition, the spray operator would be able to provide a permanent record to the field manager with GPS data of where and when the treatment took place that correlates with small UAS photographs.

A good agricultural example would be a cotton farm, as cotton farms continually monitor and regulate the growth of cotton as well as use harvesting aids. Also, cotton must be defoliated for it to be harvested and as cotton grows at different rates, aerial images can be used to detect those areas with higher growth rates. Variable amounts of defoliant would be used for different parts of the field, thereby providing more efficient use of defoliant. The crop conditions may include such things as weed patches (type and intensity), insect or fungal infestation (type, species and intensity), crop nutrient status, and eroded areas.

The profitability of precision agriculture varies from area to area and depends on the crop that is being produced. Studies have shown that, for granular fertilizer applications on high yielding corn, costs can be reduced by $5 to $15 per acre by precision agriculture.[34] In 2007 there were 309,607,601 acres of harvested cropland in the United States and the average farm size was 418 acres.

At only a $5 per acre cost reduction, this proposal could save billions of dollars in precision agriculture alone. Utilizing a small UAS to determine granular fertilizer applications would not only enable a new commercial opportunity but could also improve safety over using a manned aircraft due to the far smaller weight of the small unmanned aircraft.

IV.A.1.c. Search and Rescue/Law Enforcement

A potential third market this proposal would enable includes search and rescue operations and disaster relief, as well as law enforcement use. These types of small UAS missions can create significant cost savings to federal, state, and local government entities. Industry expects

[34]Searcy, Stephen W., (1997). Precision Farming: A New Approach to Crop Management.

that a significant number of public entities will contract the services of a small UAS operator. In addition, small UAS can be deployed more quickly than a manned aerial operation, which could help in providing disaster relief and assisting in search and rescue operations. These types of small UAS missions can create significant cost savings to local government entities who currently may be using manned aircraft for these operations, or create new methods of search and rescue or law enforcement responses. The FAA and industry expect that some of the larger public entities would train their own operators and purchase and operate their own small UAS. The majority of the smaller public safety departments that could not afford to train their officers to fly a small UAS would contract these services out to commercial small UAS enterprises as the need arises.

The FAA received a separate estimate of the actual monetary savings from using a small UAS rather than a manned aircraft from a law enforcement agency. A law enforcement agency currently hires a local helicopter service at $650 an hour. This agency has been able to obtain Certificate of Authorizations (COA) for some small UAS operations. The agency has informed us that these small UAS operations cost approximately $100/hour. Using a small UAS has saved the law enforcement agency $550 an hour, which is about an 85 percent savings. For a six month period, this law enforcement agency contracted a local operator who flew 10 small UAS mission hours with a total savings of $5,500, which would be an $11,000 annual savings for this law enforcement agency. It should be noted that most police helicopter missions cannot be substituted with a small UAS under the proposed regulations. Nevertheless, if we were to extrapolate these cost savings for those operations that can be substituted and to new small UAS operations to other law enforcement agencies across the country, this proposal could enhance search and rescue operations. The FAA requests comments, with supporting documentation on the $650 hourly rate to hire a helicopter service and the potential savings of using a small UAS by law enforcement agencies.

We recognize that some law enforcement agencies are currently using small UAS under COAs and may continue to do so rather than operate under the provisions of part 107. However, some public agencies may choose to operate in accordance with proposed part 107 rather than continue under a COA. The FAA requests comments on the potential substitution of small UAS operations for manned aircraft operations.

IV.A.1.d. Bridge Inspection

The fourth category of potential benefits from the proposed rule would be from using small UAS to inspect bridges. The National Bridge Inspection Standards (NBIS) can be found in the Code of Federal Regulations, 23 CFR part 650, subpart C. The NBIS sets the national standard for the proper safety inspection and evaluation of bridges. Routine inspections are performed at 24-month intervals. The routine inspections identify the current structural and hydraulic adequacy and condition of the bridge. A report is prepared with repair recommendations and recommendations for further analysis or investigation. As summarized in Table 1, there were a total of 596,800 bridges in the United States in 2006.

Table 1
Number of Bridges in the United States by Owner in 2006

Owner	Number of Bridges
Federal	8,355
State	284,668
Local	301,912
Private/railroad	1,490
Unknown/unclassified	375
TOTAL	**596,800**

To get close enough for an adequate inspection can be difficult, dangerous, and expensive. With a 24-month inspection interval, we estimate about 300,000 bridges need to be inspected each year. Bridge inspection companies across the United States are interested in the potential use of small UAS for bridge inspection. Whether a small UAS could be used for a bridge inspection would depend upon the bridge and its environment. Currently, depending on the size of the bridge, bridge access equipment ("snoopers") is sometimes required. A snooper is a hydraulic mobile crane that provides reach capabilities for bridge inspections. Industry experts from the ARC estimate that the average cost of an inspection using a snooper is $3,250.[35]

Cable bridges are much more expensive to inspect because they often require a 200 ft. aerial lift to perform a proper inspection. Overall, the industry estimates that roughly 15% of all bridge inspections require additional equipment such as snoopers and aerial lifts. The FAA and industry believe that this subgroup of the bridge inspection market is especially viable for commercial small UAS. Based on the industry estimates, about 45,000 annual bridge inspections could utilize some form of small UAS. Industry has informed us that the use of a small UAS

[35] The FAA believes this industry-provided price may be low because we found prices for bridge inspections that were 10 times what industry provided. The costs for bridge inspections included closing down multiple lanes of the highway for the snooper, the price of free climbing and repelling inspectors, and other costs such as licensing. We request comment, with supporting documentation, on our estimate of the average cost of $3,250 to conduct an inspection with a snooper.

would significantly decrease costs of renting a snooper or a manned aircraft. The proposed line-of-sight requirement may hamper substitution between a snooper and a small UAS operation.

Therefore, utilizing a small UAS for bridge inspections could not only enable a new commercial opportunity but could also result in cost savings and improve safety over current methods of bridge inspection. To the extent that a small UAS substitutes for a snooper, or any existing service, the societal savings equals the price of existing service minus small UAS service.

IV.B. Safety Benefits

In this section, we describe the potential qualitative safety benefits from allowing small UAS to safely operate commercially. This analysis uses anecdotal data to evaluate past accidents that may have been prevented had a small UAS been used. The anecdotal safety discussion focuses on the potential safety benefits from substituting a small UAS for a manned aerial photography activities or tower inspections that can present a hazard to the pilot, the climber, or the photographer. Without this proposed rule, non-recreational small UAS operation would be categorically prohibited without an FAA exemption.

IV.B.1 Safety Benefits from Aerial Photography Activities

We anticipate small UAS operations could be substituted for manned aviation operations, such as some aerial photography. Safety benefits would arise from this proposed rule by allowing certain types of unmanned aerial observational operations to replace manned aerial photography operations that are currently being conducted under potentially hazardous conditions. Not many manned aerial photography activities lend themselves to small UAS use.

For example, aerial photography activities such as those flown for pipeline inspections, high-voltage power line inspections, commercial photographers covering action events, and wildlife observation of birds and other animals would not be practical by the proposed rule due to the proposed line-of-sight requirements. However, small UAS could be used in photography operations such as photographing real estate, commercial buildings, certain towers, bridges, or parks.

In determining the potential hazard for manned aerial aviation photography, the FAA reviewed 17 aerial aviation photography accidents and incidents that occurred between 2005 and 2009.[36] Of these accidents, the FAA determined that a small UAS could have substituted for the manned operation in the following two cases.

NTSB Accident Investigation Number: WPR09LA160: 3/20/2009

> The helicopter pilot was circling over a residential structure to allow his passenger to take photographs. He failed to maintain adequate rotor rpm while maneuvering at a low altitude and crashed the helicopter resulting in no fatalities and no injuries. The hull sustained "substantial damage."[37]

NTSB Accident Investigation Number: MIA07CA004: 10/11/2006

> The helicopter pilot maneuvered the helicopter so that the photographer could take photos of a house at the water's edge. He lost control during a crosswind and crashed into the water resulting in no fatalities and no injuries. The hull was destroyed.[38]

These photography activities could have ended in fatalities and could have been performed by a small UAS rather than by a manned helicopter. As small UAS technological capabilities advance, small UAS could be substituted for other types of commercial aviation

[36] See Appendix 1.
[37] The "Aircraft Bluebook Price Digest" reports that the damaged rotorcraft is valued at between $47,000 to $285,000 and was built between 1979 to 2012.
[38] The "Aircraft Bluebook Price Digest" has no data on the destroyed rotorcraft.

activities as well as in public safety operations. The FAA anticipates that when this rule becomes effective, small UAS would be substituted for a few manned aviation operations, thereby reducing the potential for aviation accidents with fatalities, injuries and property damage.

IV.B.2. Substituting Unmanned Aviation Activities for Laborers Working at Heights

The FAA and industry believes that small UAS could be substituted for certain activities now requiring the use of climbers. The proposal would also allow certain types of unmanned aerial observation operations to replace laborers working on high towers or certain other hazardous locations. Climbers working on cell, TV, microwave, radio, government communications towers, and bridges have a fatality rate that is approximately 10 times that of construction workers.[39]

Between 2004 and 2012, there were 95 fatalities involving climbers working on cell and other towers.[40] One example of such an accident occurred in 2008, in Southwest Indiana, involving a tower climber who was photographing antennas on a cell tower that were to be replaced when the cell network was upgraded. The climber's safety equipment failed and he died in a 150 foot fall. A small UAS may have performed that photography, thereby creating a safety benefit by substituting an unmanned aerial operation for the climber.[41] Although many tower climbing falls occur during actual construction activities, for which a small UAS could not be used, falls occurring during tower inspections that could use a small UAS may be reduced.

---

[39] http://www.propublica.org/article/cell-tower-fatalities
[40] http://www.wirelessestimator.com/generaldoc.cfm?ContentID=9
[41] Public Broadcasting Service, Frontline, May 22, 2012. www.pbs.org/wgbh/pages/frontline/cell-tower-deaths.

IV.C. Benefit Summary

The Unmanned Vehicle University has identified hundreds of possible small UAS markets that could be enabled as a result of the proposed rule. We provided more detailed discussion for four potential markets. For any commercial operation occurring as a result of this rule, the operator or owner of the small UAS will have determined the expected revenue stream of the flights exceeds the cost of the flights operation. In each such case, this rule helps enable new markets to develop. Lastly, we identified how the proposed rule could improve the safety of the NAS when small UAS are operated in place of a manned operation or a laborer working at heights. If this proposed rule would avert only one fatality by using a small UAS instead of a tower climber then the $9.2 million dollar benefit of an averted fatality would exceed the costs of this proposed rule.

To help further define markets and costs savings that are discussed generally in this aggregate benefit estimate for small UAS operations, the FAA requests comments on the analysis, supported by data and documentation.

V. COSTS

V.A. Introduction

Although it is difficult to estimate the potential costs of this proposed rulemaking because many of the proposed requirements rely on market forces for a market that does not yet exist, our cost estimates are based on assessments of the small UAS ARC, industry subject matter experts, and FAA expert judgment.

Most of the compliance costs for the proposed rule would occur in the application process for a small UAS operator. During the application process, we expect that an applicant would have to drive to a Knowledge Test Center (KTC) to take a FAA-approved knowledge test, pay a fee to take an aeronautical knowledge test, and then pay a fee to obtain positive identification verification from a Designated Pilot Examiner (DPE), Certificated Flight Instructor (CFI), or other designated authority at the KTC. We assume that the failure rate of applicants taking the knowledge test is 10 percent; therefore, where applicable, total costs will increase by 10% for applicants who apply to become FAA-approved small UAS operators. The proposed rule would also require the owner of a small UAS to pay a registration fee for the aircraft. The application process would impose paperwork costs for the time it takes to fill out the proposed positive identification verification form, the aeronautical knowledge test, the physical capability form, the knowledge test application, and the small UAS registration form. After the application process, the proposed rule could also add paperwork costs for the time to fill out the change of address, or name forms, or accident-reporting forms.

Lastly, the Transportation Security Administration (TSA) would incur costs for a security threat determination and the FAA for processing small UAS certifications to the small UAS operators.

In order to estimate the costs of this proposed rule, we first discuss the FAA small UAS fleet forecast. Using the FAA small UAS fleet forecast, we then develop the number of small UAS operators and applicants who would become small UAS operators. Next, we discuss the estimated costs for compliance to the proposed rule as just identified. We conclude with a discussion on the special rule Congress issued for model aircraft.

This analysis will distinguish the difference between the operator costs relative to the registration of their small UAS and the operator costs relative to their testing requirements, travel, positive identification, TSA vetting, and paperwork. The FAA notes the development of the number of aircraft and operators relative to each of the cost categories are different and explain our forecast and estimated number of operators and small UAS aircraft that pertain to each section in the discussions below.

The FAA requests comments, with supporting documentation, on the cost estimates and forecasts presented in the following sections.

V.B Small UAS Fleet Forecast

The small UAS fleet forecast is based upon the constraints of the regulatory and airspace requirements. Once small UAS operations are conducted within the proposed regulatory framework and in commercial markets, we anticipate a surge in the application of the aircraft's services. Due to safety considerations over the use of a small UAS, operators would most likely develop new non-recreational applications. When this rule becomes effective, the preferences of operators will be revealed by their decisions, but until then the resulting fleet and markets must be based on expert judgment.

In addition to the AUVSI forecast discussed above, the FAA is aware of other UAS projections such as the proprietary "World Unmanned Aerial Vehicle Systems; 2014 Market

Profile and Forecast" conducted by the Teal Group Corporation. These forecasts generally assume growth, but none of them have the insight of knowing what we are proposing as a regulatory scheme. In light of the requirements proposed in this rulemaking, the FAA invites commenters to provide data to help inform the forecasting in the final rule.

The FAA small UAS fleet projection covers only those potential legal commercial activities that use small UAS weighing less than 55 lbs (25 kgs). The FAA estimates that approximately 7,550 commercial small UAS would be operating at the end of five years after the effective date of the final rule.[42] Industry experts from the ARC estimated that there could be up to 39 separate manufacturers and about 200 different small UAS designs that will make up the affected future fleet. The industry estimated the total applications based upon the sum across individual markets thought viable with a legal framework in place.

As seen in Table 2, the FAA and industry experts anticipate there will be an initial surge in applications to operate about 3,200 small UAS annually during each of the first 3 years after the final rule becomes effective. While the markets could absorb a quicker surge of new applications, the newness of the commercial opportunity and the lack of infrastructure were thought to spread the demand over the first three years. The FAA and industry experts also expect that 20 percent of the net fleet would retire or leave after the first year.[43] The FAA and industry experts anticipate that in Year 4 and Year 5, new commercial small UAS entering the fleet would decrease to about 1,400 per year. Thus, as seen in Table 2, the FAA projects that approximately 7,550 commercial small UAS would be operational after five years. The future

---

[42] http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2014-2034/media/Unmanned_Aircraft_Systems.pdf

[43] We note that the Small Business Administration (SBA) reports new firms with employees tend to have an annual failure rate of 10 to 12 percent where new firms without employees have failure rates about 30 to 36 percent. As this is an entirely new industry, the failure rate may be towards the higher end of the range. We find that the FAA's forecast of 20 percent is consistent with the SBA's failure rate of new business. http://www.sba.gov/sites/default/files/FAQ_Sept_2012.pdf

fleet depends on the regulatory structure finally adopted, technology, and the cost structure of the industry as it evolves.[44]

The FAA requests comment, with supporting documentation on the five year small UAS fleet forecast. We request information about the number of manufacturers and models, production plans, and information about the range of businesses and markets these new commercial small UAS may serve. We remind commenters that proprietary or confidential business information should not be filed in the docket. Additional information on how to submit such information is contained in the "Additional Information" section of the preamble to the NPRM.

Table 2
Small UAS Commercial Fleet Forecast

Year	New Small UAS Fleet	Small UAS Leaving Fleet	Cumulative Fleet
1	3,236	-	3,236
2	3,236	647	5,825
3	3,236	1165	7,896
4	1,387	1579	7,704
5	1,387	1541	7,550

* Details may not add to row or column totals due to rounding.

The fleet forecast in Table 2 will be used below to estimate the costs of small UAS registration and their associated fees. In the "Number of Small UAS Operators" section below, we will use the small UAS fleet forecast as a basis to estimate the number of small UAS operators and the costs relative to their testing requirements, travel, positive identification, TSA vetting, and paperwork.

The FAA realizes that some manned aircraft flights could be displaced by a small UAS; however, we expect such substitution would be small because of the proposed operating

[44] Ibid

limitations on small UAS applications. We request comments, with supporting documentation, on how small UAS could displace manned aircraft flight.

The FAA notes that since the benefits of this proposed rule are enabling those who choose to purchase a small UAS as a new business opportunity, if the fleet increases above our forecast, the benefits and costs would increase proportionately. Conversely, if the fleet decreases below our forecast, the benefits and costs would decrease proportionately. As an enabling rule, the private sector benefits would exceed costs when the private sector first commercial operations occur as that entrepreneur has decided his expected revenue will exceed his costs.

V.C. Number of small UAS Operators and Applicants

Proposed §§ 107.13(a) and 107.61(c) would require an applicant to pass an aeronautical knowledge test to obtain an unmanned aircraft operator certificate with a small UAS rating from the FAA before operating a small UAS. In order to maintain operator certification, the FAA proposes to require that applicants for this certificate demonstrate their aeronautical knowledge by passing an initial written test and a recurrent test every 24 months thereafter. The choice of an interval for retesting involves a tradeoff between the cost of retesting and the potential that either the operators may forget some information in the interim if they do not regularly use the information or the information may be updated. In the case of manned aircraft, pilots must be retested every two years. On the other hand, many states do not require drivers to take recurrent knowledge tests. FAA seeks data from commenters to assist with the assessing the appropriate period of time between tests.

Under the FAA's proposal, unless a small UAS operator leaves for other opportunities, an applicant would have to take an initial knowledge test in Year 1 to become a small UAS operator and then take a recurrent test in Year 3. Similarly, applicants in Year 2 would have to take an initial knowledge test to become a small UAS operator and then take a recurrent test in Year 4, and applicants in Year 3 would have to take an initial knowledge test to become a small UAS operator and then take a recurrent test in Year 5. Thus, for two years after passing their initial or recurrent knowledge test, small UAS operators would not incur any additional cost in order to maintain their certification under this proposed rule.

In order to estimate the potential compliance cost that would result from proposed §§ 107.13(a) and 107.61(c), we estimate the number of operators based on our small UAS fleet forecast from Table 2. The estimate of the number of small UAS operators calculated in this section will also be used below to estimate costs for travel, positive identification, TSA vetting, and paperwork.

To keep the analysis simple, the FAA assumes there would be one qualified operator per small UAS. We further assume that the failure rate of applicants taking the aeronautical knowledge test is 10 percent, but they then pass the knowledge test on the second attempt. Even though 20 percent of the small UAS equipment leaves the fleet, in Year 1 through Year 3, we expect that operators once tested and certificated would remain employable and some would take jobs as small UAS operators in the following years of the analysis interval.

A person first must apply to become a small UAS operator. During the application process, this analysis will refer to a person applying to become a small UAS operator as an applicant. After the applicant has successfully passed the application process, this analysis will refer to the person as a small UAS operator.

As the fleet increases in Year 1 through Year 3, the number of small UAS operators would also increase. As shown in Table 2, when the cumulative fleet starts to decline in Year 4, operators would start leaving the market place for other opportunities. These operators could find opportunity in later years of the analysis interval by either re-entering the market on their own or finding employment with a company that owns small UAS aircraft.

In estimating the total costs for this proposal, we now develop the methodology to estimate the number of applicants and operators who would require initial and recurrent knowledge testing, travel, positive identification, TSA vetting, and paperwork.

For Year 1, every applicant shown in the "Cumulative Fleet" column from Table 2 would need initial knowledge testing (3,236). For Year 2, we calculate the number of new small UAS applicants that need initial knowledge testing by subtracting the total fleet (from Table 2) operating in Year 2 from the total fleet operating in Year 1 (5,825 – 3,236). Similarly for Year 3, we calculated the number of new applicants needing initial testing by subtracting the total fleet operating in Year 3 (from Table 2) from the total fleet operating in Year 2 (7,896 – 5,825). Since a small UAS operator must pass a recurrent test every 24 months, every operator operating a small UAS in Year 1 would also need recurrent knowledge testing in Year 3. Therefore, the total number of small UAS applicants and operators who would need either initial or recurrent testing in Year 3 would be 5,307 (2,071 + 3,236). For Year 4, Table 2 shows the cumulative fleet starts to decline; therefore 192 (7,704 – 7,896) operators would leave for other opportunities. Also, for Year 4, the number of operators who would require recurrent testing would be the number of operators in Year 2 minus the number of operators who left for other opportunities (2,589 – 192). Likewise, 154 (7,550-7,704 from Table 2) operators would also leave in Year 5. The number of operators who would require recurrent testing in Year 5 would be the number of operators in Year 3 minus the number of operators who left (2,071 – 154).

The "Total who Incur Costs" column from Table 3 shows the FAA estimate of the total number of small UAS operators and applicants who would incur costs from this proposal's requirements for initial and recurrent knowledge testing, travel, and paperwork. We note that only applicants would incur costs from positive identification and TSA vetting because once the applicant has been identified and vetted, they do not need to repeat the process.

Table 3
Number of Small UAS Operators or Applicants Who Incur Costs

Year	Cumulative Fleet	Number of sUAS Applicants or Operators		
		Initial Applicants	Recurrent Operators	Total who Incur Costs
1	3,236	3,236	-	3,236
2	5,825	2,589	-	2,589
3	7,896	2,071	3,236	5,307
4	7,704	-192	2,397	2,397
5	7,550	-154	1,917	1,917

* Details may not add to row or column totals due to rounding.

V.D. Small UAS Applicant, Operator, and Owner Costs

The following section discusses the fees to applicants who become operators of small UAS and the owners of small UAS aircraft.

V.D.1. Travel Expense

As stated in the "Assumption and Data" section, the FAA assumes that a KTC would offer the service to administer a small UAS knowledge exam to either an applicant taking an initial knowledge test or a small UAS operator taking a recurrent knowledge test. The applicant (or small UAS operators in the case of recurrent knowledge tests) would then visit a DPE, CFI, or other designated authority aligned with the KTC office, and that person would then accept the application and verify the identity of the applicant. Therefore, the FAA estimates that there would be a travel cost to the applicant for driving to a KTC.[45]

[45] The FAA notes that although the KTC cannot accept a UAS operator airman certificate application, as stated in the "Assumptions and Data" chapter, there would be ACR, CFI, and DPEs at the same facility that can accept the

The FAA used zip code information for student pilots from the FAA's Airmen Certification Database to estimate the small UAS applicant population who would travel to a KTC. The student pilot zip codes, with the KTC zip codes, were used with zip code matching software that takes two lists of locations then sorts and calculates the geographic distance from one another. The FAA then calculated a weighted average to estimate the average distance for an applicant to travel to reach the closest KTC. On average, the FAA calculated that a small UAS operator or applicant would need to travel 19 miles one way (or 38 miles round trip) to reach their closest KTC location. The FAA seeks comment on whether UAS operators are likely to have the same geographic distribution as student pilots.

The FAA estimates that this rulemaking would add mileage costs to each small UAS operator or applicant, shown in the "Total who Incur Costs" column from Table 3, to drive to a KTC to complete the initial or recurrent knowledge based test. To estimate these travel costs, we multiply the number of small UAS operators and applicants from Table 3 by the mileage rate from the "Assumptions and Data" section and then by the number of round trip miles to travel to and from the KTC location and then by 10 percent to account for the failure rate.

Table 4 shows these calculations and the proposed rule's total estimated mileage cost over the five year analysis interval.

---

airman certificate application after the person passes the knowledge test. However, the proposed rule would not limit positive identification services to only the ACRs, CFIs, and DPEs that are co-located at KTCs.

Table 4
Small UAS Operators and Applicants Travel Expense
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Mileage Rate	Number of Round Trip Miles	Application Failure Rate	Total Costs (000)	7 % Present Value (000)
1	3,236	$0.235	38	1.1	$31.8	$29.7
2	2,589	$0.235	38	1.1	$25.4	$22.2
3	5,307	$0.235	38	1.1	$52.1	$42.6
4	2,397	$0.235	38	1.1	$23.5	$18.0
5	1,917	$0.235	38	1.1	$18.8	$13.4
Total					**$151.7**	**$125.9**

* Details may not add to row or column totals due to rounding.

V.D.2. Knowledge Test Fees

Under the proposed rule, the person who manipulates the flight controls of a small UAS would be defined as an "operator." Proposed § 107.61 would require an applicant to pass an initial aeronautical knowledge test and obtain an unmanned aircraft operator certificate with a small UAS rating from the FAA before legally operating a small UAS in the NAS for non-recreational purposes. In order to maintain his or her small UAS operator certification, the FAA proposes to require that applicants demonstrate their aeronautical knowledge by passing a recurrent test every 24 months thereafter.

The proposed rule would require an applicant to demonstrate knowledge of the following information to pass an initial aeronautical knowledge written test:

- applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation;
- airspace classification and operating requirements, obstacle clearance requirements, and flight restrictions affecting small unmanned aircraft operation;

- effects of weather on small unmanned aircraft performance;
- small unmanned aircraft system configuration management;
- emergency procedures;
- crew resource management;
- radio communication procedures;
- determining the performance of small unmanned aircraft;
- physiological effects of drugs and alcohol;
- aeronautical decision-making and judgment; and
- airport operations.

The recurrent test covers less areas of knowledge than the initial test. The specific areas of knowledge required for the recurrent test for a small UAS operator are:

- applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation;
- airspace classification and operating requirements, obstacle clearance requirements, and flight restrictions affecting small unmanned aircraft operation;
- sources of weather;
- emergency procedures;
- crew resource management;
- aeronautical decision-making and judgment; and
- airport operations.

Currently the FAA Regulations and the "Aeronautical Information Manual" contain 80 percent of the information that a small UAS operator or applicant would need to pass a knowledge test.[46] The other 20 percent would be found in Advisory Circulars (AC) and online FAA website material. The FAA assures that by the time this rule is published, all the information necessary for an applicant to obtain a small UAS operator certificate would be available online.

The FAA anticipates that it will not need to develop new original content for most of the areas of knowledge that would be tested on either the initial or recurrent knowledge test being proposed in part 107. The FAA plans to use its existing knowledge tests for manned-aircraft operations as a source of questions for general aeronautical and aviation knowledge, such as right of way requirements and airspace limitations that would be tested under part 107. Consequently, the only area of knowledge on the initial or recurrent test for which the FAA would have to create new original content would be test questions that test the person's understanding of the legal requirements imposed by part 107. Therefore, the FAA anticipates that there would be minimal costs with the development of the initial and recurrent tests.

We also note that, as with all of current FAA knowledge tests, the FAA will also conduct a periodic review on the quality and efficacy of the small UAS initial and recurrent knowledge tests as part of its overall continuing quality assurance program. This is an existing program that applies to all of the FAA's knowledge tests and the small UAS tests would simply be a marginal addition to this program.

Although a flight school could be an option for learning the required material, the proposed rule does not require applicants to attend flight school, or otherwise require initial or recurrent knowledge test training, as the FAA would offer all the information necessary to pass a

[46] http://www.faa.gov/regulations_policies/handbooks_manuals/aviation

knowledge test online. The FAA believes that little preparation would be necessary for applicants with existing pilot or UAS operator experience. Because the aeronautical background/experience of each UAS operator certificate applicant is different, the amount of time needed to study to prepare for the knowledge test will vary accordingly. For example, a prospective UAS operator who currently holds an airman certificate for manned-aircraft aviation would already possess a significant amount of general aviation knowledge. This person would only need to become familiar with the UAS-specific areas of knowledge that would be tested under part 107 in order to acquire sufficient knowledge to pass that test. Conversely, an applicant with no prior aeronautical experience would also need to acquire general aviation knowledge in addition to UAS-specific knowledge in order to pass the test that would be required under part 107. Regardless, this proposed rule would leave the specific method of study up to the applicant's discretion, and it would not mandate initial or recurrent training prior to taking the small UAS knowledge test. While the FAA believes the preparation time to take an initial or recurrent knowledge test would be minimal, this estimate may be revised at the final rule stage. We request comments, with supporting documentation, on small UAS applicant's background, experience, knowledge, and skill level and their estimated study time for a small UAS knowledge test.

Upon successfully completing a knowledge test and vetting by TSA, an operator would be issued an unmanned aircraft operator certificate with a rating for small UAS and may begin utilizing a small UAS for non-recreational operations.

There are many existing private FAA-approved knowledge testing centers that administer knowledge tests for currently-existing airman certificates. These test centers are located by airports in every state throughout the United States, and under this proposed rule, they may choose to also administer knowledge tests for an operator certificate. The FAA assumes that the cost of a KTC to administer an FAA approved small UAS knowledge test, including compliance fees, is $150.[47]

In estimating the proposed rule's cost for initial and recurrent administering knowledge based tests, we use $150 regardless of whether the test is an initial or a recurrent test. The FAA notes that we are proposing to allow pilots with military experience operating unmanned aircraft to meet the more limited recurrent written test requirements in order to be eligible for an unmanned aircraft operator certificate with a small UAS rating. For a conservative cost estimate, we also use the $150 knowledge test fee for pilots with military experience because the FAA is not aware of how many pilots with military experience will apply for a small UAS operator certificate.[48]

The FAA has determined that proposed § 107.61 would impose compliance costs to all small UAS applicants and operators to pass initial and recurrent aeronautical knowledge written tests. In the "Number of small UAS Operators and Applicants" section, we explain the derivation of the number of small UAS operators and applicants and calculate the number that would take either an initial or recurrent knowledge test. We multiply the number of small UAS operators' or applicants' costs from Table 3 by $150 and then by 10 percent to account for the small UAS operator or applicant failure rate.

Table 5 shows the proposed rule's total estimated cost for the initial and recurrent knowledge test fees over the five year analysis period.

---

[47] http://www.catstest.com/airman-testing-exams/recreational-private-pilot.php

[48] We note that military pilots might be able to take the test for free at a joint testing center, but again the FAA is not aware on how many pilots with military experience would exercise this option.

Table 5
Small UAS Operators and Applicants Knowledge Test Fee Cost
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Knowledge Test Cost	Adjustment Factor	Total Costs (000)	7 % Present Value (000)
1	3,236	$150	1.1	$533.9	$499.0
2	2,589	$150	1.1	$427.2	$373.1
3	5,307	$150	1.1	$875.7	$714.8
4	2,397	$150	1.1	$395.5	$301.7
5	1,917	$150	1.1	$316.3	$225.5
Total				**$2,548.6**	**$2,114.2**

* Details may not add to row or column totals due to rounding.

V.D.3. Positive Identification of the Applicant Fee

TSA is required to conduct a security threat assessment for all persons holding a FAA pilot certificate. As operators of small UAS would hold FAA airmen certificates, all applicants for such certificates must be vetted by TSA. To comply with this requirement, FAA currently requires all applicants for a manned pilot certificate to apply in person and present positive identification at the time of application. The positive identification includes an official photograph of the applicant, the applicant's signature, and the applicant's residential address, if different from the mailing address. Proposed § 107.63 would require an applicant for a small unmanned aircraft operator certificate with a small UAS rating to submit the application to any persons authorized by the Administrator. The person accepting the application submission would be required to verify that the identity of the applicant matches the identity that is provided on the application, as described above for a pilot certificate.

FAA assumes that applicants would present identification for validation at the same location that they go to in order to take the knowledge test. Thus, we assume that applicants incur no additional travel fees for TSA vetting.

FAA experts also estimate that the person doing the positive identification would charge a processing fee that would range from $25 to $50 to validate identification. Because the DPE, CFI or other designated authorized personnel at the KTC already have experience verifying an applicant's identity, this proposed rule would also allow these personnel to accept an application for an unmanned aircraft operator certificate with a small UAS rating and verify the identity of the applicant. For this analysis, the FAA conservatively will use a $50 fee to validate identification. We multiply the initial number of applicants who incur costs from Table 3 by $50 to acquire the positive identification fee costs and then by 10 percent to account for the applicant failure rate of the aeronautical knowledge test. The FAA notes the proposed rule would require identification validation only during the initial certification process, and thus, small UAS operators from Table 3 who required recurrent testing in Year 3 through Year 5 would not have to have their identification validated again when they take the recurrent knowledge test. The FAA also notes that the small UAS operators from Table 3 who left for other opportunities (192 in Year 4 and 154 in Year 5) are not included in this cost estimate.

Table 6 shows the proposed rule's total estimated cost for the positive identification of the applicants over the five year analysis period.

Table 6
Small UAS Applicants Positive Identification Fee Cost
(Thousands of Current Dollars)

Year	Number of sUAS Applicants	Positive Identification Fee	Application Failure Rate	Total Costs (000)	7 % Present Value (000)
1	3,236	$50	1.1	$178.0	$166.3
2	2,589	$50	1.1	$142.4	$124.4
3	2,071	$50	1.1	$113.9	$93.0
4	0	$50	1.1	$0.0	$0.0
5	0	$50	1.1	$0.0	$0.0
Total				**$434.3**	**$383.7**

* Details may not add to row or column totals due to rounding.

V.D.4. Small UAS Registration Fee

Section 107.89 would require each small UAS aircraft to be registered with the FAA and listed in the Aircraft Registration database in order to operate within the NAS. The FAA Aircraft Registration database provides a means for the public and the FAA to identify the owner and operator of any US-registered aircraft. In particular, this information is necessary for FAA Aviation Safety Inspectors to perform their routine checks or to investigate an incident or accident. The FAA notes that all registrations must be renewed every three years. Therefore, unless a small UAS leaves the fleet, the small UAS that registered in Year 1 would have to renew its registration in Year 4. Similarly, unless a small UAS leaves the fleet, the small UAS that registered in Year 2 would have to renew its registration in Year 5.

Section 47.17 provides for a $5 registration fee to an owner of any aircraft. Therefore this analysis will also use $5 for the cost to a small UAS owner to register or renew the registration for a small UAS aircraft. The $5 cost to the small UAS owner is transferred to the FAA to cover a portion of the cost of its services.

The FAA uses the "New Small UAS Fleet" and "Small UAS Leaving Fleet" columns from Table 2 to estimate the number of initial and recurrent small UAS aircraft that are required to register under this proposal. The number of initial registrations for each of the first three years would be the number of new small UAS aircraft in each of those years. In Year 4, the number of initial and recurrent renewal registrations would be the number of new small UAS aircraft in the Year 4 plus the number of small UAS aircraft registration renewals, which would be the number of small UAS in Year 1 minus the number of small UAS aircraft that left the fleet in Year 2. Similarly, the number of new and renewal registrations in Year 5 would be the number of new small UAS aircraft in Year 5 plus the number of small UAS aircraft registration renewals, which would the number of small UAS in Year 2 minus the number of small UAS aircraft that left the fleet during the Year 3.[49] These calculations are shown in detail below and are summarized in Table 7 in the "Number of Initial and Recurrent Small UAS Registrations" column.

We note the initial and recurrent small UAS aircraft registrations from Table 7 will also be discussed later to estimate costs for sections "FAA Costs for Registration Fee Processing" and "Small UAS Registration Form".

We assume that the renewal registration cost would be the same as the cost for the initial small UAS registration. We then multiply the yearly data in the "Number of Initial and Recurrent Small UAS Registrations" column by the $5 FAA registration fee. The "Total Costs" column in Table 7 shows these results, in thousands of dollars, over the five year analysis period.

[49] For ease of computation, we assumed that all of the retirements in the second year would happen to those applicants who applied in the first year and that that all of the retirements in the third year would happen to those applicants who applied in the second year. We request comment, with supporting data, on this assumption.

TABLE 7
Initial and Recurrent Registration Costs for Small UAS
(Thousands of Current Dollars)

Year	New sUAS Fleet (Table 2) Initial Registration	sUAS Leaving Fleet (Table 2)	sUAS Recurrent Registrations	sUAS Leaving Fleet	Number of Initial and Recurrent sUAS Registrations	Registration Fee	Total Costs (000)	7 % Present Value (000)
1	3,236	-	-	-	3,236	$5	$16.2	$15.12
2	3,236	647	-	-	3,236	$5	$16.2	$14.13
3	3,236	1,165	-	-	3,236	$5	$16.2	$13.21
4	1,387	1,579	3,236	647	3,976	$5	$19.9	$15.17
5	1,387	1,541	3,236	1,165	3,458	$5	$17.3	$12.33
Total							**$85.7**	**$70.0**

* Details may not add to row or column totals due to rounding.

As discussed earlier in the "Small UAS Fleet Forecast" section, the FAA notes that our small UAS forecast may be understated if operators choose to own more than one FAA-registered aircraft (for example, as a backup in case one aircraft is disabled). To account for this possibility, the FAA conducted a sensitivity analysis and assumes that an additional 20 percent increase in our small UAS forecast would result in the total costs in Table 7 increasing by 20 percent to about $102,900.

V.E. Government Costs

The following section discusses the costs to the TSA for a security threat determination and the costs to the FAA for a certification of qualification to operate a small UAS.

V.E.1. Transportation Security Administration (TSA) Costs

The following section discusses the estimated costs to the TSA for a security threat determination fee. Under section 46111 of Title 49 of the United States Code, a person may not hold an aircraft operator certificate if the TSA has notified the Administrator, in writing, that the person poses a security threat.[50] Since this proposed rule adds new small UAS operators, the TSA would acquire a new cost to determine if the operators pose a security threat. The TSA considers someone to be a security threat when he or she is known to pose or is suspected of posing a threat to national security, to transportation security, or of terrorism.

In estimating the proposed rule's cost for the TSA security threat determination, we use $130 per applicant.[51] The proposed rule does not require the applicant to pay a fee for a security threat determination; although at some point in the future these costs may be passed directly to the operator.

As in the "Positive Identification of the Applicant Fee" section, the FAA notes that small UAS applicants from Table 3 who required recurrent testing in Year 3 through Year 5 would not be subject to another security threat determination. The FAA also notes that the operators from Table 3 who left for other opportunities (192 in Year 4 and 154 in Year 5) are not included in this cost estimate. The FAA notes that once vetted, small UAS operators may continue to be screened by TSA for other security concerns.

We multiply the number of small UAS applicants, by year, by $130. Table 8 shows the proposed rule's total estimated cost for the TSA security threat determination over the five year analysis period.

---

[50] http://codes.lp.findlaw.com/uscode/49/VII/A/IV/461/46111

[51] The FAA believes that the $130 is reasonable because the cost has been identified as a vetting fee during conversations with TSA and the FAA registration office. In addition, TSA charges $130 to vet foreign student pilots: https://www.flightschoolcandidates.gov/afsp2/?acct_type=c&section=WN#C8 .

Table 8
TSA Security Threat Determination Cost for Small UAS Applicants
(Thousands of Current Dollars)

Year	Number of sUAS Applicants	Threat Determination Fee	Total Costs (000)	7 % Present Value (000)
1	3,236	$130	$420.7	$393.2
2	2,589	$130	$336.6	$294.0
3	2,071	$130	$269.2	$219.8
4	0	$130	$0.0	$0.0
5	0	$130	$0.0	$0.0
Total			**$1,026.5**	**$906.9**

* Details may not add to row or column totals due to rounding.

V.E.2. FAA Costs for a Small UAS Operator Certificate

In addition to passing an initial aeronautical knowledge test, proposed § 107.63 would require a small UAS applicant to obtain an unmanned aircraft operator certificate with a small UAS rating from the FAA before operating a small UAS. An unmanned aircraft operator certificate would be a new type of airman certificate created by this proposed rule and therefore would constitute a paperwork cost.

The FAA estimates that, for a small UAS operator certificate, this provision would add one page for each applicant to provide personal information such as name, address, date of birth, height, weight, eye and hair color. This certificate would also include test information such as test identification number and passing grade. For each small UAS applicant, the FAA estimates that it will take 0.25 hours to process the paperwork to issue the certificate.

In the "Number of small UAS Operators and Applicants" section we discuss our estimate of the number of small UAS applicants. This estimate is shown in Table 3 in the "Initial Applicants" column and is also used in Table 9 to estimate the total costs for a small UAS FAA certificate to an applicant. To estimate the FAA costs for a small UAS certification of qualification, we multiply the annual number of small UAS applicants from Table 3 by the time it takes the FAA to process the paperwork (0.25 hours), and then by the hourly value of an FAA support person from the "Assumption and Data" section. Table 9 shows the estimate costs to the FAA for processing a certification of qualification over the five year analysis interval. Although these are estimated as government costs, at some point in the future these costs may be passed directly to the operator.

Table 9
Small UAS Operators and Applicants FAA Certification of Qualification Costs (Thousands of Current Dollars)

Year	Number of sUAS Applicants	Applicant Time (Hours)	FAA Support Hourly Wage	Total Costs (000)	7 % Present Value (000)
1	3,236	0.25	$20.06	$16.2	$15.2
2	2,589	0.25	$20.06	$13.0	$11.3
3	2,071	0.25	$20.06	$10.4	$8.5
4	0	0.25	$20.06	$0.0	$0.0
5	0	0.25	$20.06	$0.0	$0.0
Total				**$39.6**	**$35.0**

* Details may not add to row or column totals due to rounding.

V.E.3. FAA Costs for Registration Fee Processing

In the "Small UAS Registration Fee" section we estimated the number of initial and recurrent small UAS aircraft registrations and provided estimates of the total costs of the $5 registration fee in Table 7. In Table 10 below, we estimate the remaining FAA costs to register a small UAS based on our estimate of the number of initial and recurrent small UAS registrations shown in Table 7. Currently the FAA's preliminary estimate of the FAA's cost to register an aircraft is $28. We calculated this estimated cost based on 2012 direct costs from the FAA Cost Accounting System (CAS) (both labor and contract direct costs) and overhead and then divided by the 2012 total number of registrations. Because under the existing fee structure the operator would incur a $5 fee to register the aircraft, the FAA estimates our unreimbursed cost to register a small UAS is $23 ($28 - $5).[52] We multiply the yearly data in the "Number of Initial and Recurrent Small UAS Registrations" column by the FAA unreimbursed cost to register a small UAS fee of $23.

The "Total Costs" column in Table 10 shows these results over the five year analysis period. Although these are estimated as government costs, at some point in the future these costs may be passed directly to the operator.

Table 10
Small UAS FAA Registration Costs
(Thousands of Current Dollars)

Year	Number of Initial and Recurrent Small UAS Registrations	Registration Fee Processing Cost	Total Costs (000)	7 % Present Value (000)
1	3,236	$23	$74.4	$69.6
2	3,236	$23	$74.4	$65.0
3	3,236	$23	$74.4	$60.8
4	3,976	$23	$91.4	$69.8
5	3,458	$23	$79.5	$56.7
Total	[redacted]		**$394.3**	**$321.8**

* Details may not add to row or column totals due to rounding.

The FAA notes that our small UAS forecast from the "Small UAS Fleet Forecast" section may be understated if operators choose to own more than one FAA-registered aircraft (for example, as a backup in case one aircraft is disabled). To account for this possibility, as a sensitivity analysis the FAA estimated an additional 20 percent increase in the small UAS forecast would result in the total costs in Table 10 increasing by 20 percent to about $473,100.

[52] As this is a preliminary estimate of the registration fee the FAA may charge, the FAA also conducted a sensitivity analysis for a $50 small UAS Registration fee and have estimate the costs would total about $850,000 over the five year analysis interval.

V.F. Time Resource Opportunity Costs

Time is a valuable economic resource. In this section, we estimate the costs for the travel time to a KTC, the paperwork costs for the time to fill out the applications and forms required by this proposed rule, and the time to take the aeronautical knowledge test. The FAA notes that these estimates are not for out-of-pocket costs to small UAS operators or applicants; rather they are opportunity costs for their time.

V.F.1. Travel Time

In the "Travel Expense" section, we estimated the cost that a small UAS operator or applicant would incur travel 19 miles one way to reach the closest KTC location and the number of applicants who take either an initial or recurrent test. In this section we estimate the time it takes the small UAS operator or applicant to travel the 19 miles one way to reach their closest KTC location and quantify that time as a cost of this proposal.

A round trip of 38 miles (19 * 2), would take an applicant 41.45 minutes of driving time ((38 miles / 55 MPH) * (60 minutes / 1 hour)). We multiply the total number of small UAS operators and applicants from Table 3 by the 41.45 minute driving time, and then by the hourly value for travel time from the "Assumptions and Data" section and then by 10 percent to account for the applicant failure rate. Table 11 shows the total estimate costs for the time it takes applicants and operators to drive to a KTC over the five year analysis interval.

Table 11
Small UAS Operators and Applicants Travel Time Cost
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Driving Time (minutes)	Hourly Wage (Travel Time)	Application Failure Rate	Total Costs (000)	7 % Present Value (000)
1	3,236	41.45	$24.68	1.1	$60.7	$56.7
2	2,589	41.45	$24.98	1.1	$49.1	$42.9
3	5,307	41.45	$25.28	1.1	$101.9	$83.2
4	2,397	41.45	$25.58	1.1	$46.6	$35.5
5	1,917	41.45	$25.89	1.1	$37.7	$26.9
Total					**$296.1**	**$245.3**

* Details may not add to row or column totals due to rounding.

V.F.2. Knowledge Test Application

Proposed §107.67 would require a small UAS operator or applicant to complete a knowledge test application in order to be able to take the knowledge test necessary to obtain an operator certificate.

The FAA estimates it would take about 0.25 hours (15 minutes) to complete the application. In order to estimate the paperwork costs, we multiply the annual number of applicants who would take both the initial and recurrent knowledge test from Table 3 by 0.25 hours and then by the hourly value for personal time from the "Assumptions and Data" section. We then multiply the knowledge test application costs by 10 percent to account for the applicant failure rate. Table 12 shows the proposed rule's total estimated cost to complete the application over the five year analysis interval.

Table 12
Small UAS Operators and Applicants Knowledge Test Application Costs
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Applicant Time (hours)	Hourly Wage (Personal Time)	Application Failure Rate	Total Costs (000)	7 % Present Value (000)
1	3,236	0.25	$25.09	1.1	$22.3	$20.9
2	2,589	0.25	$25.39	1.1	$18.1	$15.8
3	5,307	0.25	$25.70	1.1	$37.5	$30.6
4	2,397	0.25	$26.01	1.1	$17.1	$13.1
5	1,917	0.25	$26.32	1.1	$13.9	$9.9
Total					**$108.9**	**$90.2**

* Details may not add to row or column totals due to rounding.

V.F.3. Physical Capability Certification

A person seeking to be a small UAS operator could have a medical condition that would interfere with the safe operation of a small UAS. In § 107.63, the FAA proposes that the small UAS applicant be required to make a certification that they have no physical or mental condition that would interfere with the safe operation of a small UAS. The certification of physical capability would be a preprinted statement on the small UAS operator certificate application (8710-xx) and when the applicant signs the 8710-xx, they would also be attesting that they meet the requirement to operate a small UAS safely.

In the "Number of small UAS Operators and Applicants" section we discuss our estimate of the number of small UAS applicants. This estimate is shown in Table 3 in the "Initial Applicants" column and is also used in Table 13 to estimate the total costs for a small UAS FAA certificate to an applicant.

The FAA estimates that this provision would take less than 0.1 hours (6 minutes) to complete the physical capability certification. We multiply the number of small UAS applicants from Table 3 by the time it takes to complete the physical capability certification form and then by the hourly value for personal time from the "Assumptions and Data" section. Table 13 shows the estimate costs for time process a certification of physical capability form over the five year analysis interval.

TABLE 13
Small UAS Operators and Applicants Physical Capability Certification Costs
(Thousands of Current Dollars)

Year	Number of sUAS Applicants	Applicant Time (Hours)	Hourly Wage (Personal Time)	Total Costs (000)	7 % Present Value (000)
1	3,236	0.1	$25.09	$8.1	$7.6
2	2,589	0.1	$25.39	$6.6	$5.7
3	2,071	0.1	$25.70	$5.3	$4.3
4	0	0.1	$26.01	$0.0	$0.0
5	0	0.1	$26.32	$0.0	$0.0
Total				**$20.0**	**$17.7**

* Details may not add to row or column totals due to rounding.

V.F.4. Knowledge Test Time

The time it takes a small UAS operator or applicant to take the initial or recurrent aeronautical knowledge test proposed in § 107.73 is a compliance cost of the proposed rule. Currently, FAA initial and recurrent knowledge tests are taken online and each screen represents one question and multiple choice answers. Assuming that the initial and recurrent exams are the typical 60 questions, each screen equals one page, and there would also be some introduction, instruction, and closing screen to the tests to read. The FAA estimates that it would take up to three hours for an applicant to take the knowledge test.

In order to estimate the knowledge test time costs for this section, we multiply the number of small UAS operators and applicants who would take both the initial and recurrent knowledge test from Table 3 by the time it takes for an applicant to take the knowledge test and then by the hourly value for personal time from the "Assumptions and Data" section. We then multiply the knowledge test time costs by 10 percent to account for the applicant failure rate. Table 14 shows the estimate costs over the five year analysis interval.

Table 14
Small UAS Operators and Applicants Knowledge Testing Time Cost
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Applicant Time (hours)	Hourly Wage (Personal Time)	Application Failure Rate	Total Costs (000)	7 % Present Value (000)
1	3,236	3	$25.09	1.1	$267.9	$250.4
2	2,589	3	$25.39	1.1	$216.9	$189.5
3	5,307	3	$25.70	1.1	$450.0	$367.4
4	2,397	3	$26.01	1.1	$205.7	$156.9
5	1,917	3	$26.32	1.1	$166.5	$118.7
Total					**$1,307.1**	**$1,082.9**

* Details may not add to row or column totals due to rounding.

V.F.5. Small UAS Registration Form

Section 107.89 also proposed that all small unmanned aircraft must be registered. The FAA estimates that this provision would take 0.5 hours for the owner to complete the required form.

In the "Small UAS Registration Fee" section we estimated the number of initial and recurrent small UAS registrations and show the results in Table 7. In Table 15 below, we estimate the total costs to complete the required form based on our estimate of the number of initial and recurrent small UAS registrations shown in Table 7.

We multiply the number of annual number of initial and recurrent small UAS registrations from the "Small UAS Registration Fee" section by the time it would take to complete each registration form and then by the hourly value for personal time from the "Assumptions and Data" section.

Table 15 shows the estimated registration form cost, in thousands of dollars, over the five year analysis period.[53]

TABLE 15
Small UAS Registration Form Costs
(Thousands of Current Dollars)

Year	Number of Initial and Recurrent Small UAS Registrations	Applicant Time (hours)	Hourly Wage (Personal Time)	Total Costs (000)	7 % Present Value (000)
1	3,236	0.5	$25.09	$40.6	$37.9
2	3,236	0.5	$25.39	$41.1	$35.9
3	3,236	0.5	$25.70	$41.6	$33.9
4	3,976	0.5	$26.01	$51.7	$39.4
5	3,458	0.5	$26.32	$45.5	$32.4
Total				**$220.5**	**$179.7**

* Details may not add to row or column totals due to rounding.

V.F.6. Change of Name or Address Form

The FAA recognizes that individuals who hold airman certificates may change their name or address. Proposed § 107.77 would require the holder of a small UAS operator certificate to change the name or address on a certificate by submitting appropriate paperwork to the FAA.

Not every small UAS operator would have a name or address change. Although the FAA does not have data on small UAS operators that would change their name or address we do have data on sport pilots. The FAA calculated that about 15 percent of sport pilots have changed their name or address in 2012 and for this analysis we use 15 percent to estimate the small UAS operators who would change their name and address.

[53] The FAA notes that our small UAS forecast may be understated if operators choose to own extra FAA-registered aircraft in case one is disabled or companies choose have an inventory of small UAS to lease to FAA-approved operators. If this is the case, then the FAA assumes an additional 20 percent increase in our small UAS forecast and as a sensitivity analysis, the costs in Table 14 would increase by 20 percent. We request comments, with supporting documentation, from owners who would register more than one small UAS and lease them out.

The FAA estimates that this provision would take 0.25 hours to complete for about 15 percent of the small UAS operators. The FAA estimates that it would cost each applicant $6.17 ($24.68 * 0.25) to complete the form. We multiply 15 percent by the number of applicants from Table 3 in the "Number of small UAS Operators" section and then by the time it would take to complete the change of name or address form and then by the hourly value for personal time from the "Assumptions and Data" section. Table 16 shows the estimated cost for the time to fill out the forms to either change a name or address over the five year analysis period.

Table 16
Small UAS Operators and Applicants Change Name or Address Costs
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Percent Who Change Name or Address	sUAS Operators Who Change Name or Address	Applicant Time (hours)	Hourly Wage (Personal Time)	Total Costs (000)	7 % Present Value (000)
1	3,236	0.15	485	0.25	$25.09	$3.0	$2.8
2	2,589	0.15	388	0.25	$25.39	$2.5	$2.2
3	5,307	0.15	796	0.25	$25.70	$5.1	$4.2
4	2,397	0.15	360	0.25	$26.01	$2.3	$1.8
5	1,917	0.15	288	0.25	$26.32	$1.9	$1.4
Total						**$14.9**	**$12.3**

* Details may not add to row or column totals due to rounding.

V.F.7. Accident Reporting Form

Section 107.9 requires that an operator report any operation of the small UAS that involves any injury to a person or damage to any property, other than the small UAS. The FAA estimates that there is one page of paperwork associated with reporting an accident and it would take an applicant 0.25 hours to complete. In the absence of data relating to UAS accident rates, the FAA assumes that small UAS would have the same accident rate as general aviation pilots;

therefore, we calculated the probability of an accident by dividing the accident rate for general aviation pilots by the total number of hours and estimated that an accident would occur .001% of the time. The expected total time to report accidents is 0.0000025 hours (.00001 X .25 hours) which the FAA expects to be minimal. The FAA requests comments, with supporting documentation, on the accident rate for small UAS and the probability of a small UAS accident resulting in an injury or damage to property other than the unmanned aircraft. The FAA also seeks comments on the preamble discussion of the threshold of property damage that should trigger the accident reporting requirement.

V.F.8. Maintenance and Inspection

Sections 107.19 and 107.21 require that the small UAS operators are responsible for identifying specific actions that must be taken to ensure that the small UAS will continue to operate safely. These specific actions may include periodic systems maintenance and inspection checks to avoid operational failures. The manufacturers of small UAS supplies user manuals, either in hard copy or on the internet, that include actions the operator must take to ensure that the small UAS will operate safely.

It is the responsibility of the operator to consult the manufacture's user manual to maintain the small UAS in a condition safe for operation and inspect the small UAS prior to flight. Preflight inspection, battery condition, and maintenance are all addressed in the owner's manuals that come with the small UAS. This proposal would require the operator to conduct a preflight inspection of the area of operation and the aircraft. It is anticipated that the nature and scope of each small UAS operation will vary greatly. Accordingly, the time it will take to perform the required preflight inspection will also vary. For example, the required preflight action for a simple small UAS operation conducted in a remote location using a simple-design small UAS that does not involve the use of support personnel may take only five minutes. Conversely, a small UAS operation in a populated area using additional support personnel and using a small UAS of a more complex design could take significantly longer. Failure to perform maintenance and inspections could result in the small UAS being destroyed, therefore causing the owner to lose their investment and their business revenue-generating opportunity. Without more context on small UAS applications, a quantitative estimate would be highly speculative. As a result, the FAA is not providing a quantified cost estimate associated with preflight inspections. We do anticipate that the cost for each specific preflight action would mostly be recovered by the operator as a cost of doing business for that flight. However, it would nonetheless be a social cost of the proposed rule. The FAA requests comments, with supporting documentation, as to the amount of time a preflight inspection would take.

V.F.9. FAA Knowledge Test Report

After a small UAS operator or applicant passes an initial or recurrent aeronautical knowledge test, the knowledge testing center (KTC) would issue an airman knowledge test report indicating whether the applicant passed the test. The information in the knowledge test report includes the name of the person who administered the test, the test approval number, the graduation number assigned to the certificate of qualification, a statement indicating whether the test was an initial or a recurrent test, and the name of the person who passed the test.

The FAA estimates that this provision would take 0.5 hours to complete this requirement. We multiply the number of small UAS operators and applicants who would take both the initial and recurrent knowledge test from Table 3 by the time it would take to issue an airman knowledge test report and then by the hourly value of a KTC support person from the "Assumption and Data" section. Table 17 shows the estimated paperwork costs to process a knowledge test certification over the five year analysis interval.

Table 17
Knowledge Test Center Report Costs
(Thousands of Current Dollars)

Year	Total who Incur Costs From Table 3	Applicant Time (hours)	KTC Support Hourly Wage	Total Costs (000)	7 % Present Value (000)
1	3,236	0.5	$20.06	$32.5	$30.3
2	2,589	0.5	$20.06	$26.0	$22.7
3	5,307	0.5	$20.06	$53.2	$43.5
4	2,397	0.5	$20.06	$24.0	$18.3
5	1,917	0.5	$20.06	$19.2	$13.7
Total				**$154.9**	**$128.5**

* Details may not add to row or column totals due to rounding.

V.F.10. FAA Enforcement Costs

The FAA does not anticipate that the proposed rule would increase its legal costs of enforcement. This is because, in the absence of this rulemaking, there already exist statutory and regulatory requirements that govern the operation of a UAS. [54] The FAA currently spends its enforcement resources ensuring compliance with these existing requirements.

If finalized, the proposed rule would create a set of legal standards more specifically applicable to the operation of a small UAS. Such legal standards would increase compliance by the regulated entities; thus, reducing the need for enforcement action. In addition, these legal standards would reduce the uncertainty associated with small UAS operation, which may in turn

[54] See, e.g., Law Enforcement Guidance for Suspected Unauthorized UAS Operations, available at http://www.faa.gov/uas/regulations_policies/media/FAA_UAS-PO_LEA_Guidance.pdf (discussing existing legal requirements that apply to UAS operations).

reduce the likelihood of enforcement litigation. This is because litigation is more likely when the parties disagree as to which legal standards are applicable to an operation and how those standards apply to the operation.

V.G Individual small UAS Operator/Owner Out-Of-Pocket Costs

With respect to the potential operator costs, we assume that each operator would be a new entrant into the commercial market and that each operator would have one small UAS. Table 18 shows the proposed rule's estimated out-of-pocket startup and recurrent direct compliance costs for a new small UAS operator or owner.

TABLE 18
Small UAS Operator Out-Of-Pocket Costs
(Current Dollars)

	Cost	
Type of Cost	**Initial**	**Recurrent**
Applicant/small UAS operator		
Travel Expense	$9	$9
Knowledge Test Fees	$150	$150
Positive Identification of the Applicant Fee	$50	-
Total applicant/small UAS operator	**$209**	**$159**
Owner		
Small UAS Registration Fee	$5	$5
Total Owner	**$5**	**$5**
Total	**$214**	**$164**

* Details may not add to row or column totals due to rounding.

The FAA notes that at some point in the future the costs estimated in the "Government Costs" section may be passed directly to the operator.

V.H Summary of Total Costs

The proposed rules major costs are the knowledge test requirements for the airman certification of small UAS operators, the positive identification of their identity, and the travel costs. The Transportation Security Administration (TSA) would incur costs vetting applicants for national security. The FAA incurs costs to issue operator certificates with a small UAS rating. Additional costs would also accrue from time it takes to complete the paperwork due to accident reporting, airman and aircraft certification, airman name or address changes, and the registration of a small UAS.

In Table 19, we summarize the total estimated compliance costs by category.

TABLE 19
Total and Present Value Cost Summary by Provision

Type of Cost	Total Costs (000)	7 % P.V. (000)
Applicant/small UAS operator		
Travel Expense	$151.7	$125.9
Knowledge Test Fees	$2,548.6	$2,114.2
Positive Identification of the Applicant Fee	$434.3	$383.7
Owner		
Small UAS Registration Fee	$85.7	$70.0
Time Resource Opportunity Costs		
Applicants Travel Time	$296.1	$245.3
Knowledge Test Application	$108.9	$90.2
Physical Capability Certification	$20.0	$17.7
Knowledge Test Time	$1,307.1	$1,082.9
Small UAS Registration Form	$220.5	$179.7
Change of Name or Address Form	$14.9	$12.3
Knowledge Test Report	$154.9	$128.5
Pre-flight Inspection	Not quantified	
Accident Reporting	Minimal Costs	
Government Costs		
TSA Security Vetting	$1,026.5	$906.9
FAA - sUAS Operating Certificate	$39.6	$35.0
FAA - Registration	$394.3	$321.8
Total Costs	**$6,803.1**	**$5,714.0**

* Details may not add to row or column totals due to rounding.

The FAA requests comments, with supporting documentation, on the cost estimates and forecasts presented in this chapter.[55]

V.I Cost Estimate for Special Rule for Model Aircraft

The proposed rule would also codify the special rule for model aircraft that Congress created in Public Law 112-95, § 336. Section 336 of Public Law 112-95 defines a model aircraft as an "unmanned aircraft that is – (1) capable of sustained flight in the atmosphere; (2) flown

[55] See Appendix 4 for a sensitivity analysis on the Time Resource Opportunity Costs.

within visual line of sight of the person operating the aircraft; and (3) flown for hobby or recreational purposes." Section 336 limits the FAA's rulemaking authority over model aircraft that meet all of the following criteria:

- The aircraft is flown strictly for hobby or recreational use;
- The aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;
- The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;
- The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft; and
- When flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation.

However, while § 336 limits the FAA's rulemaking authority over model aircraft that meet the above criteria, it does not limit the FAA's authority to pursue enforcement action against those model aircraft operators that "endanger the safety of the national airspace system." The proposed rule would codify this enforcement authority in part 101. Because the model-aircraft component of the proposed rule would simply codify enforcement authority that the FAA already possesses, it will not result in any costs or benefits.

The FAA requests comments, with supporting documentation, on this conclusion.

VI. BENEFIT – COST CONCLUSION

The benefit of this proposed rule is that it would enable new business and other non-recreational small UAS opportunities to occur in a safe operating environment.

The estimated out-of-pocket cost for a small UAS operator to be FAA-certified is less than $300. As this proposal enables new businesses, the private sector expected benefits would exceed private sector expected costs. As profitable opportunities increase, so will the social benefits. In addition, if the use of a small UAS saves one human life, that alone would result in benefits outweighing the costs of this proposed rule. Accordingly the FAA has determined that the proposed rule would be cost beneficial.

In order to evaluate the net benefits of a rule, we must generally evaluate the costs and benefits associated with each provision. We must also look at the collective costs and benefits of related provisions. In the context of this rule, this analysis involves weighing the potential safety benefits of each individual provision, as well as related provisions, against the possibility that the provision, or related provisions, may preclude certain potential, valuable applications of UAS. Because the UAS industry is in its infancy, we lack data on both the safety effects of provisions and the likely effects on development of UAS applications. The FAA invites information and data from commenters on these issues to assist us to engage in a quantitative analysis of the likely net benefits of the proposed rule. Finally, we anticipate that as small UAS operations increase over time and we gain experience in integrating them into the National Air Space (NAS), the requirements proposed in this rule would be re-evaluated and correspondingly adjusted.

Appendix 1

Aerial Aviation Photography Accidents 2005-2009

Count	Date	NTSB #	Fatalities	Serious	Minor	Hull
1	10/14/2009	ANC10FA004	1	1	0	
2	3/20/2009	WPR09LA160	0	0	0	Substantial Damage
3	1/25/2009	ERA09FA141	1	1	0	
4	3/13/2008	NYC08FA133	4	0	0	
5	3/4/2008	ANC08LA040	0	0	2	
6	10/6/2007	NYC08LA005	1	1	0	
7	9/11/2007	MIA07FA147	2	1	0	
8	7/22/2007	SEA07LA209	0	1	1	
9	10/18/2006	LAX07FA012	5	0	0	
10	10/11/2006	MIA07CA004	0	0	0	Destroyed
11	8/10/2006	LAX06LA257	1	1	0	
12	4/20/2006	NYC06FA100	2	0	0	
13	3/15/2006	DEN06CA048	0	0	0	
14	2/26/2006	LAX06FA124	2	0	0	
15	6/26/2005	DEN05CA094	0	0	0	
16	3/15/2005	ANC05CA049	0	0	0	
17	2/12/2005	LAX05CA102	0	0	0	

Appendix 2 – Value of Statistical Life (VSL)

Estimated Value of Preventing Fatalities and Injuries

(2013 $)

Analysis Year	Calendar Year	Growth Factor	VSL	Serious	Minor
0	2013	1.0000	$9,200,000	$1,281,900	$27,600
1	2014	1.0118	$9,308,560	$1,297,026	$27,926
2	2015	1.0237	$9,418,401	$1,312,331	$28,255
3	2016	1.0358	$9,529,538	$1,327,817	$28,589
4	2017	1.0480	$9,641,987	$1,343,485	$28,926
5	2018	1.0604	$9,755,762	$1,359,338	$29,267
6	2019	1.0729	$9,870,880	$1,375,378	$29,613
7	2020	1.0856	$9,987,357	$1,391,608	$29,962
8	2021	1.0984	$10,105,207	$1,408,029	$30,316
9	2022	1.1114	$10,224,449	$1,424,644	$30,673
10	2023	1.1245	$10,345,097	$1,441,454	$31,035

Source: "Revised Departmental Guidance 2014: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses"

Appendix 3 – 2013 Airmen Knowledge Tests - Weighted Average Calculation

Category	Volume	Pass Rate	Average	Weighted
Air Transport Pilot Airplane (14 CFR part 121)	8,019	95.1%	86.0	7,622.1
Air Transport Pilot Airplane (14 CFR part 135)	516	89.3%	80.6	461.0
Aircraft Dispatcher	1,286	72.7%	75.6	935.1
Airline Transport Pilot Airplane (14 CFR part 135) (Added Rating)	16	68.8%	76.4	11.0
Airline Transport Pilot Airplane Canadian Conversion	86	96.5%	86.5	83.0
Airline Transport Pilot Helicopter (14 CFR part 135)	717	97.5%	88.4	699.0
Airline Transport Pilot Helicopter (14 CFR part 135) (Added Rating)	47	78.7%	79.7	37.0
Aviation Maintenance Technician Airframe	8,744	86.6%	80.3	7,567.9
Aviation Maintenance Technician General	9,373	90.5%	82.1	8,484.4
Aviation Maintenance Technician Powerplant	8,878	80.5%	77.6	7,146.8
Commercial Pilot Airplane	8,421	96.3%	87.0	8,108.6
Commercial Pilot Airplane Canadian Conversion	78	88.5%	83.4	69.0
Commercial Pilot Airship	0	0.0%	0.0	0.0
Commercial Pilot Balloon – Gas	0	0.0%	0.0	0.0
Commercial Pilot Balloon - Hot Air	67	97.0%	87.8	65.0
Commercial Pilot Glider	42	100.0%	91.3	42.0
Commercial Pilot Gyroplane	1	100.0%	92.0	1.0
Commercial Pilot Helicopter	980	96.8%	88.0	949.0
Flight Engineer Reciprocating Engine (Added Rating)	1	100.0%	80.0	1.0
Flight Engineer Reciprocating Engine (Basic)	8	100.0%	87.3	8.0
Flight Engineer Turbojet (Added Rating)	0	0.0%	0.0	0.0
Flight Engineer Turbojet (Basic)	48	100.0%	94.5	48.0
Flight Engineer Turboprop (Added Rating)	2	100.0%	80.0	2.0
Flight Engineer Turboprop (Basic)	10	100.0%	86.1	10.0
Flight Instructor Airplane	3,474	89.7%	83.4	3,115.8
Flight Instructor Airplane (Added Rating)	60	91.7%	84.5	55.0
Flight Instructor Glider	28	100.0%	90.1	28.0
Flight Instructor Glider (Added Rating)	44	84.1%	85.2	37.0
Flight Instructor Gyroplane	2	100.0%	89.5	2.0
Flight Instructor Gyroplane (Added Rating)	1	100.0%	88.0	1.0
Flight Instructor Helicopter	598	96.2%	85.5	575.0
Flight Instructor Helicopter (Added Rating)	56	92.9%	88.5	52.0
Flight Instructor Instrument Airplane	2,719	96.8%	88.2	2,630.9
Flight Instructor Instrument Airplane (Added Rating)	68	97.1%	84.4	66.0
Flight Instructor Instrument Helicopter	521	96.4%	85.5	502.0
Flight Instructor Instrument Helicopter (Added Rating)	45	95.6%	86.8	43.0
Flight Instructor Sport Airplane	33	93.9%	85.5	31.0
Flight Instructor Sport Glider	0	0.0%	0.0	0.0

Flight Instructor Sport Gyroplane	0	0.0%	0.0	0.0	
Flight Instructor Sport Powered Parachute	7	100.0%	87.1	7.0	
Flight Instructor Sport Weight-Shift-Control	6	83.3%	81.2	5.0	
Flight Navigator	2	100.0%	85.0	2.0	
Fundamentals of Instructing	4,570	91.9%	84.8	4,198.9	
Ground Instructor (Advanced)	953	97.1%	87.5	925.0	
Ground Instructor (Basic)	50	80.0%	77.2	40.0	
Ground Instructor Instrument	789	97.2%	87.6	767.0	
Inspection Authorization	964	85.5%	82.2	824.0	
Instrument Rating Airplane	12,861	85.1%	80.1	10,948.6	
Instrument Rating Airplane Canadian Conversion	47	93.6%	85.3	44.0	
Instrument Rating Foreign Pilot	213	86.4%	81.7	184.0	
Instrument Rating Helicopter	933	91.4%	82.6	853.0	
Military Competency Airplane	1,379	99.5%	94.6	1,372.0	
Military Competency Helicopter	1,621	99.3%	91.1	1,610.0	
Military Competency Instructor	1,450	99.0%	93.1	1,435.1	
Parachute Rigger	199	86.9%	80.3	173.0	
Parachute Rigger Military Competence	65	98.5%	89.7	64.0	
Private Pilot Airplane	24,902	90.9%	83.8	22,635.9	
Private Pilot Airplane Canadian Conversion	31	100.0%	87.8	31.0	
Private Pilot Airplane/Recreational Pilot - Transition	11	90.9%	82.5	10.0	
Private Pilot Airship	1	0.0%	62.0	0.0	
Private Pilot Balloon – Gas	0	0.0%	0.0	0.0	
Private Pilot Balloon - Hot Air	109	90.8%	82.3	99.0	
Private Pilot Glider	225	92.4%	86.5	208.0	
Private Pilot Gyroplane	2	100.0%	92.5	2.0	
Private Pilot Helicopter	1,537	95.5%	85.7	1,467.1	
Private Pilot Helicopter/Recreational Pilot - Transition	4	75.0%	73.3	3.0	
Private Pilot Powered Parachute	3	66.7%	80.3	2.0	
Private Pilot Weight-Shift-Control	2	100.0%	89.5	2.0	
Recreational Pilot Airplane	64	92.2%	83.0	59.0	
Recreational Pilot Helicopter	2	100.0%	82.0	2.0	
Sport Pilot Airplane	616	95.9%	85.8	591.0	
Sport Pilot Glider	2	100.0%	79.0	2.0	
Sport Pilot Gyroplane	8	100.0%	90.4	8.0	
Sport Pilot Lighter-Than-Air (Balloon)	0	0.0%	0.0	0.0	
Sport Pilot Powered Parachute	53	96.2%	83.9	51.0	
Sport Pilot Weight Shift Control	49	100.0%	89.4	49.0	
Weighted Average Calculation	**108,719**			**98,164.1**	**90%**

Appendix 4 – Sensitivity analysis on the Time Resource Opportunity Costs

The FAA performed a sensitivity analysis on the Time Resource Opportunity costs incurred by small UAS operators and applicants that is shown in Table 19. Instead of using the DOT guidance for the small UAS operator or applicant's personal or business hourly wage rates from the "Assumption and Data" section, the sensitivity analysis used the personal wage rate for local travel from the Department guidance. [56]

The sensitivity analysis was applied to the small UAS operator or applicants travel time, knowledge test application time, physical capability certification time, knowledge test time, small UAS registration form time, and the change of name or address form time. The estimated cost calculations are the same as described in their perspective sections above, with the exception of using the local travel time – personal hourly wage rate.

The following table shows the results of these calculations.

[56] Source: Revised Departmental Guidance on The Valuation of Travel time in Economic Analysis (published June 9, 2014 (Table 4, Local Travel - Personal). Per this guidance future Travel Time Saving estimates are also augmented by 1.2 percent per year to reflect projected annual growth of real median household income. Year 1 (2012$) travel time savings estimates are calculated as $\$12.30*1.012^2= \$12.60$; Year 2 as $\$12.30*1.012^3=\$12.75$; Year 3 as $\$12.30*1.012^4=\$12.90$; Year 4 as $\$12.30*1.012^5=\$13.06$; and Year 5 as $\$12.30*1.012^6=\$13.21$.

Sensitivity Analysis on Travel Time using $12.30 - Personal category from DOT Table 4 guidance

Type of Cost	Total Costs (000)	7 % P.V. (000)
Applicant/small UAS operator		
Travel Expense (mileage)	$151.7	$125.9
Knowledge Test Fees	$2,548.6	$2,114.2
Positive Identification of the Applicant Fee	$434.3	$383.7
Owner		
Small UAS Registration Fee	$85.7	$70.0
Time Resource Opportunity Costs		
Applicants Travel Time	$151.1	$125.2
Knowledge Test Application	$54.7	$45.3
Physical Capability Certification	$10.0	$8.9
Knowledge Test Time	$656.2	$543.7
Small UAS Registration Form	$110.7	$90.2
Change of Name or Address Form	$7.5	$6.2
Knowledge Test Report	$154.9	$128.5
Pre-flight Inspection	Not quantified	
Accident Reporting	Minimal costs	
Government Costs		
TSA Security Vetting	$1,026.5	$906.9
FAA - sUAS Operating Certificate	$39.6	$35.0
FAA - Registration	$394.3	$321.8
Total Costs	**$5,825.8**	**$4,905.3**

Using the local travel time – personal hourly wage rate, the total costs would be 14.4 percent (1.0 – (5,825.8 / $6,803.1)) less than using the hourly wage rates for small UAS operators and applicants from the "Assumption and Data" section.

Appendix 5 – Alternatives the FAA Considered

This section discusses the alternatives the FAA considered during the course of this rulemaking. This proposed rule would treat the entire spectrum of operations that would be subject to this rule in a similar manner by imposing the least stringent possible regulatory burdens that would ensure an acceptable level of safety of the NAS because small UAS operations pose the least amount of risk.

Alternative 1.

The FAA considered allowing small unmanned aircraft to conduct external-load operations and to tow other aircraft or objects. However, these operations involve a greater level of public risk due to the dynamic nature of external-load configurations and inherent risks associated with the flight characteristics of a load that is carried, or extends, outside the aircraft fuselage and may be jettisonable. These types of operations may also involve evaluation of the aircraft frame for safety performance impacts, which may require airworthiness certification. This type of an evaluation would be beyond the scope of the flexibility provided for in section 333.

As a result of the FAA's decision to limit this rulemaking to lower-risk small UAS operations, this proposed rule would not apply to small unmanned aircraft conducting external-load operations or to small unmanned aircraft towing another aircraft or object.

Alternative 2.

The FAA also considered whether to further subdivide small UAS into different categories of unmanned aircraft that would be regulated differently based on their weight, operational characteristics, and operating environment. After extensive deliberation, the FAA ultimately determined that such a regulatory framework was too complex and burdensome for both the public and the FAA. The FAA then examined the entire small UAS category of aircraft (unmanned aircraft weighing less than 55 pounds) and determined that appropriate operational risk mitigations could be developed to allow the entire category of small UAS to avoid airworthiness certification.

Furthermore, the FAA decided to also substantially simplify the operational limitations and airman (operator) certification requirements in a manner that would equally accommodate all types of small UAS business users with the least amount of complexity and regulatory burden. The FAA believes that treating small UAS as a single category without airworthiness certification would accommodate a large majority of small UAS businesses and other non-recreational users of UAS. The operational limits in this proposed rule would mitigate risk associated with small UAS operations in a way that would provide an equivalent level of safety to the NAS with the least amount of burden to business and other non-recreational users of UAS of even the smallest UAS.

Alternative 3.

The FAA is also considering further segmenting the small UAS that would be subject to this proposed rule and creating a set of regulatory provisions that would be applicable specifically to a “micro UAS” subcategory of small UAS operations. This classification would be based on the UAS ARC's recommendations, as well as approaches adopted in other countries that have a separate set of regulations for micro UAS.

The micro UAS provisions that the FAA is considering would apply to operations that fit the following parameters:

- The unmanned aircraft used in the operation would weigh no more than 4.4 pounds (2 kilograms);
- The unmanned aircraft would be made out of frangible materials that break, distort, or yield on impact so as to present a minimal hazard to any person or object that the unmanned aircraft collides with;
- During the course of the operation, the unmanned aircraft would not exceed an airspeed of 30 knots;
- During the course of the operation, the unmanned aircraft would not travel higher than 400 feet AGL;
- The unmanned aircraft would be flown within visual line of sight; first-person view would not be used during the operation; and the aircraft would not travel farther than 1,500 feet away from the operator;
- The operator would maintain manual control of the flight path of the unmanned aircraft at all times, and the operator would not use automation to control the flight path of the unmanned aircraft;
- The operation would be limited entirely to Class G airspace; and
- The unmanned aircraft would maintain a distance of at least 5 nautical miles from any airport.

The operational parameters discussed above may provide significant additional safety mitigations. Specifically, a very light (micro) UAS operating at lower altitudes and at lower speeds, that is made up of materials that break or yield easily upon impact, may pose a much lower risk to persons, property, and other NAS users than a UAS that does not operate within these parameters, Additionally, limiting the micro UAS operation entirely to Class G airspace, far away from an airport, and in close proximity to the operator (as well as limiting the unmanned aircraft's flight path to the operator's constant manual control) would significantly reduce the risk of collision with another aircraft. Accordingly, because the specific parameters of a micro UAS operation that the FAA is considering would provide additional safety mitigation for those operations, this classification would allow micro UAS to operate directly over people not involved in the operation.

Under the micro UAS classification, the operator of a micro UAS would also be able to operate using a UAS airman certificate with a different rating (an unmanned aircraft operator certificate with a micro UAS rating) than the airman certificate that would be created by proposed part 107. No knowledge test would be required in order to obtain an unmanned aircraft operator certificate with a micro UAS rating; instead, the applicant would simply submit a signed statement to the FAA stating that he or she has familiarized him or herself with all of the areas of knowledge that are tested on the initial aeronautical knowledge test that is proposed under part 107.

The FAA invites commenters to submit data and any other supporting documentation on the issue of whether the micro UAS classification is a viable course of action that should be included in the final rule. FAA also invites comments as to whether the ability to operate an unmanned aircraft over a person and the ability to obtain an airman certificate without a knowledge test provide sufficient operational flexibility to actually incentivize someone to operate under the micro UAS framework. Finally, the FAA invites comments, with supporting documentation, showing the costs and benefits of a micro UAS classification in the final rule. The FAA notes, however, that due to statutory constraints, the FAA cannot eliminate the requirement to hold an airman certificate and register the unmanned aircraft even if it were to adopt a micro UAS classification in the final rule.

During the course of this rulemaking, the FAA also received a petition for rulemaking from UAS America Fund LLC. This petition presented the FAA with an alternative approach to regulating micro UAS, complete with a set of regulatory provisions that would be specific to micro UAS operations along with an economic analysis of the costs and benefits. The FAA has not substantiated the costs and benefits in the petition for rulemaking.

Because the FAA was already in the process of rulemaking at the time this petition was filed, pursuant to 14 CFR 11.73(c), the FAA will not treat this petition as a separate action, but rather, will consider it as comment on this rulemaking. Any comments received in response to the proposals in the petition will be considered as part of the final rule.

Alternative 4.

The FAA considered proposing that a UAS operator be permitted to exercise his or her see-and-avoid responsibilities through technological means, such as onboard cameras. At this time, technology that could provide an acceptable substitute for direct human vision in UAS operations has not been miniaturized to the extent that would allow it to be used in small UAS operations. Because there is no acceptable technological substitute for direct human vision in small UAS operations at this time, the FAA proposes to require, in §§ 107.31 and 107.37(a)(1), that the operator (and visual observer, if used) must be capable of maintaining a visual line of sight of the small unmanned aircraft throughout that aircraft's entire flight with human vision that is unaided by any device other than spectacles or contact lenses. If a visual observer is not used, the operator must exercise this capability and maintain watch over the small unmanned aircraft during flight. Therefore, at this time, the FAA has decided against the alternative that a UAS operator be permitted to exercise his or her see-and-avoid responsibilities through technological means.

Alternative 5.

The FAA considered proposing to allow small UAS operations outside the hours of official sunrise and sunset, recognizing that this would integrate a greater quantity of small UAS operations into the NAS. The FAA notes that most small unmanned aircraft flights under this proposed rule would take place at low altitudes, and flying at night would limit the small UAS operator's ability to see people on the ground and take precautions to ensure that the small unmanned aircraft does not pose a hazard to those people. Moreover, allowing small UAS operations outside of daylight hours would require equipage and certification requirements that are contrary to the FAA's goal of a minimally burdensome rule for small unmanned aircraft. Therefore, at this time, the FAA has decided against this alternative.

Alternative 6.

The FAA also considered whether the vertical boundary should be set at a higher level than 500 feet AGL. However, because most manned-aircraft operations can transit the airspace above the 500-foot level, UAS operations at that altitude would likely require greater levels of operator training, aircraft equipage, and some type of aircraft certification in order to avoid endangering other users of the NAS. Since these provisions would be contrary to the goal of this rulemaking, which is to regulate the lowest-risk small UAS operations while imposing a minimal regulatory burden on those operations, this proposed rule would not allow small UAS to travel higher than 500 feet.

Alternative 7.

In addressing the issue of airworthiness for small UAS, the FAA considered several approaches, including requiring small UAS operators to comply with the existing inspection and maintenance requirements of this chapter. The FAA also considered requiring a separate permit to operate (PTO) in addition to aircraft registration and airman certification. A PTO would have required an applicant to adhere to requirements for airworthiness certification.

After further consideration, the FAA decided that neither of these approaches is proportionate to the risk posed by small UAS. The FAA notes that due to their light weight, small unmanned aircraft generally pose a significantly lower risk to people and property on the ground than manned aircraft. This relatively low risk is mitigated even further by the see-and-avoid and loss-of-positive-control provisions of this proposed rule, which are discussed above. Accordingly, based on existing information, the FAA believes that requiring small UAS operators to conduct inspection and maintenance of the small UAS pursuant to the existing regulations of part 43, or to obtain a PTO, would not result in significant safety benefits. As a result, this proposed rule would not require small UAS compliance with part 43 or the application for or issuance of a PTO.

Alternative 8.

The FAA considered proposing to require an individual to obtain a commercial pilot certificate with a UAS type endorsement before operating a small UAS. Issuance of such a certificate would require that the applicant obtain a Class II airman medical certificate, pass an aeronautical knowledge test, and demonstrate flight proficiency and aeronautical experience with a certificated flight instructor. However, given the lower level of public risk posed by small UAS operations, the FAA decided that imposing such requirements would be unduly burdensome to small UAS operators. Moreover, as explained in further detail in preamble, the FAA believes that the training, testing, proficiency and experience requirements for obtaining a commercial pilot license have limited relevance to the nature of small UAS operations.

Alternative 9.

The FAA also considered whether to offer an option for the knowledge test to be administered online. However, in examining this approach the FAA ultimately determined that there would be significant risk in the integrity of a knowledge test becoming compromised if that test was to be administered outside of a controlled environment. This could be accomplished through someone copying and circulating the test questions, using unauthorized materials to take the test, or even taking the test for another person. Using the identity of another person to take the knowledge test may also allow an applicant to manipulate the security vetting procedures that take place once the applicant's identity is verified.

In addition, the FAA determined that it would be more difficult to safeguard the personally identifiable information (PII) of a test-taker that is collected online rather than in-person at a knowledge testing center. Accordingly, the FAA has decided against proceeding with an online test-taking option.