Federal Aviation Administration

Operation and Certification of Small Unmanned Aircraft Systems; Proposed Rule

80 Fed. Reg. 9544 (Feb. 23, 2015)

Docket no. FAA-2015-0150-017

Comment by Modovolate Aviation, LLC

§ 1 Introduction

Modovolate Aviation, LLC ("Movo Aviation") submits this Comment on the FAA's notice of proposed rulemaking, Operation and Certification of Small Unmanned Aircraft Systems; Proposed Rule, 80 Fed. Reg. 9544 (Feb. 23, 2015), docket no. FAA-2015-0150-017 (the "NPRM"). This comment is an amendment to Movo Aviation's petition for rulemaking, docket no. FAA-2014-0473-0001, filed on July 10, 2014 ("the Petition"). The Petition made the following points:

1) The most urgent aviation problem is presented by small rotary-wing microdrones. These are the vehicles being purchased online from a wide variety of vendors by individuals lacking any connection with the safety-oriented and FAA-rule compliance culture of the aviation community.
2) Enforcement of traditional FAA rules against these individuals is infeasible.
3) The FAA should regulate microdrones as consumer products.

The Petition proposed specific performance standards for sUAS, generally identical to operating limitations proposed in the NPRM.

It urged prompt regulatory actions to slow the proliferation of thousands of sUAS flown without restriction, resulting in increasing hazards to national airspace.

At the time the Petition was submitted, Movo Aviation had no way of knowing the content of the NPRM. The NPRM and the Petition are generally consistent, however, except that the Petition recommended that performance standards be preconditions to sale and distribution of sUAS. This is not necessary under the NPRM's approach, because it mitigates risk by limiting weight and imposing operator certification requirements and operational limitations. To the extent that this Comment is inconsistent with the Petition, the Comment prevails and should be understood to have superseded the Petition.

The NPRM does an excellent job of applying risk-based regulation to the actual risks associated with the operations of small Unmanned Aircraft Systems ("sUAS"). It represents a far better approach than that adopted in more than 25 section 333 exemptions granted since 10 October 2014.

§ 2 Information about the commenter

Modovolate Aviation, LLC, (the "LLC" or "Movo Aviation") is an Illinois limited liability company organized for the purpose of conducting microdrone research, experimentation, demonstration, and education.

Movo Aviation was formed and is jointly owned by Henry H. Perritt, Jr. and Eliot O. Sprague.

Henry H. Perritt, Jr., the Chief Executive Officer of the LLC, is a law professor and former dean at Chicago-Kent College of Law, the law school of Illinois Institute of Technology. As a member of the bar, he currently represents commercial entities that have applied for section 333 exemptions.

Holding a bachelor of science degree in aeronautics and astronautics from MIT, a master of science degree in management from MIT's Sloan School, and a juris doctor degree from Georgetown University Law Center, Mr. Perritt has written dozens of law review articles and several books on how the law should adapt to technological innovation. He also is an expert on the federal regulatory process, having written many articles on the subject, having served as an official in the federal wage and price control program, as a member of the White House Staff, and as Deputy Under Secretary of Labor. As a consultant to the Administrative Conference of the United States, he wrote reports on, among other things, the utility of negotiated rulemaking, in which affected interests and regulatory agencies collaborate in developing the content of new rules, and on the process for adjudicating civil penalties under the Federal Aviation Act. He is a private helicopter and airplane pilot.

Eliot O. Sprague is the Chief Operating Officer of the LLC. He is a full-time news helicopter pilot, helicopter flight instructor, director for a Chicago-area on-demand commercial helicopter operator, and a member of the board of directors of Midwest Helicopter Association. A graduate of Hillsboro Aero Academy, he is intimately familiar with commercial aviation and familiar with the threats that unregulated microdrone flight present to the safety of himself, his coworkers, his passengers, and to persons and property on the ground. He holds commercial helicopter and SEL/MEL airplane, instrument helicopter, commercial flight instructor-rotary wing, and commercial flight instructor – instrument-rotary wing ratings.

Through the LLC, Messrs. Perritt and Sprague have flown a variety of microdrones. They have co-authored a number of articles over the past several months on microdrone technologies and their application as microdrones are integrated into the National Airspace System. Movo Aviation has consulted with commercial entities wishing to use sUAS in support of their commercial activities.

§ 3 General comments

§ 3.1 Need for pragmatism to promote compliance

The essential hallmark of success of the sUAS rules will be a pragmatic one: whether the content of the regulations are such that they accommodate mission requirements and characteristics of actual vehicles in the marketplace so that compliance is high. The FAA must avoid erecting regulatory barriers that tempt purchasers of sUAS to avoid conforming with the regulatory requirements. The greatest threat to aviation safety is the proliferation of lawless sUAS flight.

As the FAA knows from long experience in developing requirements for manned aircraft, some additional safety margin is always attainable by imposing additional requirements. But at some point, the marginal improvement in safety is unsupportable by the additional cost. This long-standing cost-benefit analysis must be at the forefront of sUAS regulation – as the FAA recognizes in its explicit commitment to a risk-based approach.

§ 3.2 Vehicle certification

Not requiring traditional airworthiness or type certification of sUAS vehicles is the correct approach. The characteristics of these vehicles, the operator certification required by the NPRM, the operating rules imposed by the NPRM, market forces, and emerging insurance requirements adequately assure safe design and manufacture of these vehicles and mitigate safety risks of their flight. To require traditional airworthiness and type certification would impose unwarranted costs on vendors and operators of sUAS, discouraging their commercial use, and thus blunting their contribution to economic growth and American international competitiveness. It also would tempt vendors and purchasers to flout the certification requirements.

Moroever, as the NPRM points out, multi-year delays associated with the traditional process likely would render vehicles subjected to that process obsolete by the time they receive certification. Such a requirement therefore would have the perverse effect of discouraging deployment of new safety technologies.

§ 3.3 Operator certification

Adding a new category of airman, "sUAS operator," and subjecting candidates to an FAA-designed knowledge test is the best approach to assure operator qualification. It strikes a good balance between imposing no operator requirements and requiring a traditional pilot certificate. The knowledge and skills requirement for airplane and helicopter pilots do not correspond to the knowledge and skills needed to fly an sUAS. Many of the requirements for traditional pilot certification are inapplicable to sUAS operation because they focus on reducing risk to persons aboard manned aircraft. Many others are aimed at assuring safety for long-distance flights at altitudes significantly higher than those permitted under the NPRM for sUAS. Conversely, much of the knowledge and many of the skills that sUAS operators must possess to operate safely are not part of the curriculum or the practical test standards for airplane and helicopter pilots. Monitoring battery state, assuring integrity of the wireless control link, and dealing safely with emergencies occasioned by loss of the link are examples.

The NPRM's position that explicit aeronautical experience and skills testing should not be required for operator certification is sound, for the reasons set forth in the NPRM. As the NPRM explains, sUAS are much easier to fly than manned aircraft and can safely be sacrificed in an unrecoverable emergency. Knowledge testing, pre-flight inspection, and the operating rules, including the weight limit, adequately assure safety.

Nevertheless, sUAS operators should be encouraged to participate in some kind of formal training to assure their readiness to take the knowledge test and to assure that they are proficient in operating their sUAS of choice. Virtually all traditional aviation flight training is conducted by private flight schools, tailoring their curricula and procedures to the knowledge and practical test requirements published by the FAA. Participating in these organized training programs builds a culture of safety that is desirable in the emerging UAS community. The 2012 statute recognizes that private associations can complement government regulation by requiring that model aircraft operators operate " in accordance with a community based set of safety guidelines and within the programming of a nationwide community-based organization." 2012 Act, Pub. Law 112–95 § 336(a)(2).

Other areas of human activity that present significant risks similarly rely on private sector training, and also leave testing and certification entirely to the private organizations. This is the case with SCUBA diving, where SCUBA divers can obtain varying levels of certification from the Professional Association of Dive Instructors (“PADI") and competing private associations. Lifeguards typically are certified by the American National Red Cross rather than through government authority. This is an approach that is well-suited to additional training and socialization of sUAS operators.

Movo Aviation recommends that the FAA consider adding a provision to the final rules that would require, in addition to successful completion of the knowledge test, certification by some established association of UAS instructors. As long as a certifying association trains and tests candidate for knowledge and skills corresponding to those listed in the NPRM, certification would meet this requirement.

It would be premature to require preapproval of such programs; it is too early in their development to specify accreditation criteria. Preapproval or accreditation requirements would slow their formation and commencement of their operations, thus delaying implementation of a valuable source of sUAS operator training. Instead, the FAA should monitor experience under this private certification requirement for a period of three years. Then, if an accreditation requirement seems necessary, the FAA can impose it at that time.

§ 3.4 Operating rules

The operating limitations in the proposed section 107.51, are basically sound, except that the visibility requirement of 3 statute miles in subsection (d) and the distance-from-clouds requirement in subsection (d) are inappropriate.

The 500-foot height limit in § 107.51 and the line of sight requirements in the proposed section 107.31 generally reflect a consensus about what constitutes safe operation within the model aircraft and the growing commercial sUAS community. There are, of course, applications for which these limits may be too confining. Those are addressed in section § 4.11 of this Comment. The battery life and control-link range of the most popular sUAS are compatible with these requirements. It is difficult to maintain visual contact with an sUAS flown higher than 500 feet, and what matters for visual contact is the slant distance, not the height or the horizontal distance alone. The range of the typical control link is commensurate with the distance at which the vehicle can be seen clearly.

The right-of-way rules in the proposed section 107.37 are appropriate, as are the pre-flight familiarization and inspection requirements in the proposed section 107.49.

The requirement of 3 statute miles visibility in subsection (d), however, is unnecessary and unduly restrictive. It is unlikely that an sUAS operator could keep the vehicle in sight at a distance of three miles, and thus such a visibility requirement is unnecessary to reinforce the line of sight requirement of section 107.31. If visibility is much lower that the proposed 3 miles, it would restrict the line of sight distance. Any separate visibility requirement is redundant. Likewise, the distance-from-clouds requirement in subsection (d) is unnecessary and inappropriate. An operator cannot maintain visual contact with his sUAS if it is flown in a cloud. On the other hand, he can fly it closer than 500 or 1,000 feet to a well-defined cloud without risk. The risk that a manned aircraft would surprise an sUAS operator by suddenly emerging from a cloud at 500 feet above the ground is infinitesimal, outside an instrument approach corridor, where sUAS flight is prohibited.

The line of sight restriction is sound conceptually. It represents the foundation supporting many of the other choices made in the NPRM. Some aerial photography missions exist, however, where it is extremely difficult to capture the necessary shot without occasionally flying the vehicle behind an obstruction, such as a building, terrain, or foliage. The final rule should make it clear that such momentary interruptions in visual contact do not violate the line of sight requirement. It may be appropriate to offer guidance on what qualifies as "momentary," balancing the risk of the sUAS operator losing situational awareness or control of the aircraft while it is not in sight, against greater mission flexibility. A quantitative limit of, say, 15 seconds maybe appropriate, with a longer limit, say, 60 seconds, allowable when the aircraft is equipped with automatic hover and other autonomous features such as the ability to fly a preprogrammed set of waypoints.

Two problems exist the longer the period that the vehicle is out of the operator's view. One is greater probability that he will lose situational awareness of its position and ultimately lose control of it. The other is that autonomous return to home capability is likely to cause the vehicle to collide with the object it is behind. As collision avoidance technologies become available in this market, the line of sight requirement should be relaxed further for sUAS so equipped.

§ 3.5 Interim exemption and enforcement policy

As a formal matter, the FAA's ban on commercial sUAS flight remains in effect while The NPRM is open for comment. This presents the FAA with an enforcement problem and risks reinforcing a culture of noncompliance in the sUAS community. It is inevitable that individuals and enterprises will continue to buy them and fly them for arguably commercial purposes not withstanding regulatory discouragement. Movo Aviation urges the FAA to align its interim policies with market realities. The agency should begin using the content of the NPRM immediately as criteria for evaluating section 333 petitions. It also should revise its enforcement guidance to make it clear that it will commence enforcement proceedings against those who fly sUAS carelessly and recklessly (as it has done in the NPRM and public statement associated with it), but not against users who fly them carefully within the guidelines of the NPRM, merely because they may have a commercial motivation for their use. Proving a commercial purpose, in any event, is difficult and would consume significant enforcement and adjudication resources.

Any regulation of new technology is necessarily experimental. Allowing immediate operations of the sUAS posing the least risk can produce valuable data to inform the content of the final rules.

§ 3.6 Restraining the rogues

It is very difficult to craft a regulatory regime that will be effective in constraining the behavior of everyone, especially in the absence of an established community with a safety culture. The reality is that micro-sUAS are affordable by almost anyone, and there already is ample evidence of people who buy them and fly them recklessly outside of any community of model aircraft flyers and heedless of any FAA restrictions.

Ultimately, it may be necessary to restrict sales of drones that do not have built-in law-abiding features. For now, the approach suggested by the NPRM is desirable so that experience can be gained with voluntary technological protections introduced by manufacturers and greater compliance with by sUAS operators with the knowledge requirements and operating limitations in the NPRM, as they prepare to get certificated.

§ 4 Comments specifically requested

§ 4.1 Weight segmentation, means of propulsion, and micro-sUAS subcategory

The FAA invites comments, with supporting documentation, on whether the regulation of small UAS should be further subdivided based on the size, weight, and operating environment of the small UAS. The FAA specifically invites comments on the designation of a separate category of "micro sUAS".

A fundamental shortcoming in the NPRM is its failure to address specifically the differences between state-of-the art multi copters, which predominate at the low-end of the 55-pound weight class, and fixed-wing sUAS, which predominate at the high end. The explosion in the availability of sUAS mainly relates to multicopters such as the DJI Phantom, The DJ Inspire, the 3Drobotics IRIS+, and the Cinestar 8HL. These aircraft, electrically powered and equipped with sophisticated navigation and flight control systems, have flight characteristics and operator control issues quite different from those of fixed-wing sUAS, many of which are gasoline- or diesel-engine powered and require more distance to take off and land. The final rule and its justification must take into account these profound differences.

Whether or not a micro-sUAS group is singled out for separate regulatory treatment, microdrones merit separate analysis and discussion in the justification for the final rule. In particular, their unique risks must be assessed and differentiated from those of larger aircraft and those with less automation.

Some degree of segmentation into different weight classes is desirable for two reasons: first, the FAA's conclusion that lightweight sUAS pose minimal risk to other aircraft and to persons and property on the ground is sound, and by establishing a micro sUAS category, the agency can move more quickly to allow commercial flight of these vehicles, which currently dominate the market. Second, heavier vehicles pose significantly greater risk, because of their weight alone, and their likely cost will make it commercially impracticable the fly them within the limitations proposed in the NPRM.

The good analysis in the NPRM about the effect of weight on risk should be refined to deal with the different categories of risk within the entire class of less-than-55-pound sUAS. The analysis also should recognize that larger vehicles in this overall class will have different flight characteristics and different levels of performance, and that their cost will increase as size increases.

Accordingly, the requirements for safe operation logically should be ratcheted up as size increases, generally following the FAA's concept of multiple "groups."[1] Concurrently, the ability of vendors to absorb greater requirements will be greater as price increases.

The FAA should designate at least three subcategories or groups: one for the largest vehicles, say, those above 20 pounds, an intermediate category, with weights between eight pounds and 20 pounds, and a micro-sUAS category as suggested in the NPRM, but with an upper weight limits of 8, instead of 4, pounds. The upper weight limit of 8 pounds for the micro group matches the weight of the bird that must be fired into an engine for an airline transport aircraft as part of it certification testing, under 14 C.F.R. § 33.76(b) (requiring test with "large single bird" aimed at the most critical exposed location on the first stage rotor blades at a bird speed of 200 knots; requiring bird weights of 4-8 pounds, depending on engine inlet throat area). See also FAA Advisory Circular: Bird Ingestion Certification Standards, AC No. 33.76-1A (Aug. 7, 2009). Movo Aviation notes that the popular DJI Inspire weighs 6.5 pounds and that it is marketed for essentially the same applications as the lighter-weight DJI Phantom.

For ease in discussing the three groups, the remainder of this Comment refers to the smallest group as "microdrones," to the intermediate groups as "mididrones" and the largest group as "macrodrones."

The FAA invites commenters to submit data and any other supporting documentation on whether the micro-sUAS classification should be included in the final rule, and what provisions the FAA should adopt for such a classification. The provisions suggested in

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[1] See 80 Fed. Reg. at 9556 (discussing possibility of Groups A-E).

the NPRM for microdrones as a distinct group are appropriate. The general limitations in the NPRM are appropriate for the mididrone group, but more stringent limitations, for equipment, operator qualification, and operating rules are necessary for the macrodrone group.

While it is premature to specify exactly what should be required for largest vehicles, the following requirements are appropriate:

- ADS-B out for vehicles that will fly more than 500 feet AGL
- Practical test and aeronautical experience requirements for beyond- line-of-sight operations
- More onboard automation, with greater functionality

The macrodrone group is more likely to involve fixed-wing designs because of their better longer endurance and larger payloads. Different operating rules and operator requirements are appropriate for fixed-wing, as opposed to rotary wing, configurations.

The FAA's decision to proceed incrementally is sound, and its release of the NPRM for sUAS reflects that approach. Honoring this approach, it should move more quickly to allow commercial sUAS operations where the demand is greatest and the risk the lowest. It should reinforce its incremental approach, however, and move even more quickly with respect to the micro groups, followed soon by regulations for the midi group, then followed by the macro group.

As soon as possible, the FAA should define the micro sUAS category with operator certification rules and operating rules as proposed for that group in the NPRM, including the requirement that the vehicles be constructed from frangible materials.

The microdrone group confronts a problem less likely to exist for the other two groups: promoting a high degree of compliance with FAA requirements. Already, tens of thousands of these vehicles are in use, and evidence abounds that many of them are being flown in violation of the FAA's ban on commercial use without section 333 exemptions or any other form of FAA special approval. The eventual sUAS regulation must try to get this genie back in the bottle, as much as practicable. The greater the burdens of compliance, the more of them that will be flown in violation of the requirements The result is not a simple two-dimensional balance between safety and cost. Risk will be *increased* by unnecessarily demanding regulations, because compliance will be lower. The FAA must try to find the sweet spot in designing its regulations for the micro sUAS subcategory, and the NPRM is a good template in this regard.

Self-certification regarding the requisite knowledge should be allowed. Self-certification of operator qualification will permit flights to begin sooner, while the FAA is constructing the knowledge testing infrastructure for operators of larger vehicles. The rules should require that a candidate certify, not only that he possesses the requisite knowledge, but also that he successfully completed some kind of formal course in the requisite areas of knowledge. A certificate from a flight school or from an organization offering training and testing would suffice to meet this requirement. If the FAA has occasion to launch an investigation of careless and reckless micro sUAS activity, it would have the power to audit satisfaction of this requirement.

The different weight groups present significantly different risks, mainly because of their different weights, but also because their economic attractiveness almost surely will involve more ambitious flight profiles for the larger vehicles. The regulatory regimes for the different groups must be explicitly justified by either weight-based risk or mission-profile-based risk, even though the same requirement might be associated with both.

It is not the right approach simply to ratchet up airframe, operator, and operating rules closer and closer to those for manned aircraft, as the weight of the UAS increases. Instead, any requirement for operator qualification should be related explicitly to more demanding decisions and control inputs that he would be required to make for the larger vehicles and the different types of emergencies he may encounter for different flight profiles.

Airframe requirements should be focused on specific aspects of flight profiles that necessitate greater automation in navigation and onboard control systems and on managing energy dissipation– as in the case of the proposed frangibility requirement.

Operating rules, on the other hand, should resemble those for manned aircraft for UAS operating in airspace where manned aircraft typically operate, as opposed to being limited to areas within a particular radius and height above the operator.

For mididrones, requiring the manufacturer to build in both a return-to-home, and a land-immediately capability is desirable. For macrodrones, however, much greater risk results if the return to home or the land-immediately function causes collision with object. For these vehicles, additional mitigating measures may be appropriate, such as a parachute or some kind of self-destruct mechanism.

The higher payload of macrodrones makes it more likely they will be carrying potentially hazardous payload, such as chemical applications.

§ 4.2 Operations beyond line of sight

The NPRM invites comments on whether there are well-defined circumstances and conditions under which operation beyond the line of sight ("BLOS") would pose little or no additional risk to other users of the NAS, the public, or national security. It invites comments on the technologies and operational capabilities or procedures needed to allow UAS flights beyond visual line of sight, and how such technologies, capabilities and procedures could be accommodated under this rule or in a future rulemaking.

The experience of the armed forces and the intelligence community demonstrates that UAS can be flown well beyond visual line of sight. The sophistication and complexity of systems used in the military and intelligence context to achieve this, however, are unaffordable for civilian use. According to a recent Homeland Security Inspector General's report the total system cost for ten Predator-level UAS for the Customs and Border patrol is $360 million, costing $12,255 per flight hour to operate. Instead of trying to adapt military technology to civilian sUAS, the analysis should begin by appreciating the capacity of specific—affordable-- technologies to mitigate specific risks:

Loss of control of the aircraft. When an sUAS is flown beyond the operator's ability to see it, the probability increases that the operator will lose control of it, because he flies it beyond control link range, or because he becomes disoriented.

The best technologies for reducing the loss of control risk are reliable navigation systems, ones that permit the vehicle to be aware of its position, direction, and orientation of flight by a combination of GPS signal processing and onboard inertial measurement units. These technologies exist, are commercialized, and are standard features of the most popular micro- and midi-sUAS.

Midi- and macrodrones with such systems should be permitted to operate beyond line of sight.

Collision with obstacles. The operator cannot see obstacles with which the sUAS may collide, whether those be other aircraft, people, or objects fixed to the ground.

The best protection against collisions are collision detection and avoidance systems. This has been a major subject of research and development for several decades with respect to manned aircraft, and now is receiving emphasis in the sUAS context. Reliable collision avoidance capability is not yet available in the marketplace, however, certainly not at the level that would detect human beings and trees. When such capability becomes available, the envelope of permissible BLOS operations can be expanded; in the meantime, collision risk must be mitigated by a combination of flight envelope restrictions and limitations based on the terrain the sUAS flies over. The collision risk is far less over large expanses of relatively flat land under the control of the operator or someone in a contractual relationship with the operator. It is much higher over a densely populated area.

§ 4.3 Performance-oriented airworthiness requirements

The FAA seeks comment on whether there are additional requirements that could be specified in ways that are more performance-oriented in order to minimize any disincentives to develop new technologies that achieve the regulatory objectives at lower cost.

The need to avoid traditional airworthiness and type certification is manifest, as the FAA recognizes. Not only would delays in the process render candidate vehicles obsolete by the time they are certificated, the burdens would pose a disincentive to technological innovation that would enhance safety, and would encourage operation of uncertificated vehicles. The question is how to address the technologies that have such significant capability to promote safety without imposing traditional airworthiness certification requirements.

Five models are worth considering and adapting, two from the FAA's experience, and three from other regulatory regimes. Presently, the FAA has a streamlined approval process for equipment installed in experimental, homebuilt, and sailplane aircraft. Its results are apparent in the much lower prices for ADS-B equipment now reaching the market for these categories of aircraft, compared with the much higher prices for ADS-B equipment that has completed the traditional certification process. The characteristics of these equipment approval procedures should be the model for sUAS equipment, rather than the traditional procedures.

Second, the FAA's authority to issue airworthiness directives (“ADs”) arguably is not limited to aircraft with airworthiness and type certification. If the FAA, as this Comment recommends, establishes performance requirements for sUAS automation, leaving it to the manufacturer to work out the details of the specifications, it can subsequently issue airworthiness directives. If problems develop through experience, the FAA can take a data-based approach to its response, issuing ADs that require appropriate modifications to fix the problems actually experienced.

The third example follows the model in the FCC’s "verification" and "declaration of conformity" procedures for standards applicable to unlicensed wireless transmitters under 47 C.F.R. part 15.

The fourth example uses the model adopted by the National Highway Traffic Safety Administration for certain passenger automobile equipment requirements, such as seatbelts. Manufacturers must certify compliance with NHTSA vehicle safety standards prescribed in 49 C.F.R. part 571.

The fifth example uses the model employed by the Consumer Product Safety Commission for certain consumer devices such as walk-behind power lawnmowers in 16 C.F.R. part 1205. The CPSC safety standard specifies performance criteria but leaves it to manufacturers to conduct appropriate tests and certify compliance.

Under this approach, the FAA would prescribe certain performance requirements, as in the following example. Manufactures of vendors would certify compliance with the performance requirements, and part 107 would limit operations to vehicles having that certification.

> *§ 107.xx A midi- or macro-sUAS must be certified by the manufacturer to have the following capabilities:*
>
> *(a) To detect loss of the control link*
>
> *(b) To send telemetry back to the operator on vehicle position, height, direction of flight, speed, and battery state*
>
> *(c) To perform a return-to-home maneuver at the command of the operator or when the vehicle detects a serious malfunction such as loss of control link*

(d) To perform a straight down landing under control upon the command of the operator or detection of a malfunction such as loss of the control link

(e) To fly a preprogrammed flight plan defined by GPS coordinates

(f) To maintain situational awareness in the event of loss of GPS signals

The preflight inspection requirements in the proposed § 107.49 adequately assure operability of installed systems.

§ 4.4 Relaxation of restrictions on sUAS with specific technologies

The FAA invites comments as to whether the final rule should relax operating restrictions on small UAS equipped with technology that addresses the concerns underlying the operating limitations of this proposed rule, for instance through some type of deviation authority (such as a letter of authorization or a waiver).

In general, the FAA should rely on generally applicable rules for the three different weight groups of sUAS; it should avoid the detailed and cumbersome application procedures associated with section 333 exemptions, including the COA applications. If specific classes of sUAS cannot reasonably be accommodated with the final rules growing out of this NPRM, the FAA should make available class exemptions under section 333.

The PTO requirement considered by the FAA and discussed in the NPRM is unduly burdensome, would produce no material safety advantages and the FAA should continue to reject it.

§ 4.5 External load and banner towing

The FAA invites comments, with supporting documentation, on whether external load UAS operations and towing UAS operations should be permitted, whether they would require airworthiness certification, whether they would require higher levels of airman certification, whether they would require additional operational limitations, and on other relevant issues.

The NPRM does not explain sufficiently why external load and banner towing operations should be excluded from the basic approach to sUAS. Moreover, the concept of external load is ambiguous. Surely a camera and camera gimbal designed for a particular model of sUAS should not be considered an external load.

It may be that this exclusion is an artifact of the 2009 ARC recommendations, which were focused on larger, fixed-wing UAS. Or, they may be based on the possibility that external load operations or banner towing would call into question the assumptions on which airworthiness and type certificates are based. In the absence of such certification for sUAS, there is no reason that external load or banners towed by microdrones or mididrones present any risk beyond those associated with the basic vehicle.

Small cameras and gimbals attached to a micro or mididrone and small banners within the payload and thrust capability of these vehicles present de-minimis issues for structural integrity, weight-and-balance and controllability. They are entirely unlike heavy loads attached to a helicopter with a long line or traditional banners towed by a manned airplane.

Specific operating rules for sling loads, however, may be appropriate, especially for the midi- and macro groups.

§ 4.6 Model aircraft interpretation

The FAA invites comment on its model aircraft interpretation. 79 Fed.Reg. 36172, 36175 (June 25, 2014)

Recreational or hobbyist flight of sUAS poses exactly the same risks as commercial flight of the same vehicles. If it's not hazardous when a hobbyist flies at 1,500 feet near clouds, it's not hazardous when a commercial photographer does it with the similar vehicle. If it *is* hazardous what an aerial surveyor or flies with FPV beyond the line of sight, it is hazardous when a hobbyist does the same thing.

Many of the publicized incidents of hazardous operation, such as flight over assemblies or flights near other aircraft, apparently involved hobbyist flight, and not commercial flight. Indeed, the economic incentives to fly safely probably are greater for commercial operations.

Flexibility must exist for *organized* model aircraft activities, however. Model aircraft hobbyists have contributed significantly to technology innovation related to miniaturized electronics and power plants, and the proliferation of inexpensive multirotor aircraft and their use for commercial purposes should not result in a regulatory cloud over the hobbyists. The final regulations should provide for a safe harbor for model aircraft flight out of designated fields, depicted on aeronautical charts, within guidelines published by the major model aircraft associations. If hobbyists want to fly above 500 feet, then specific approval from local ATC should be required, resulting in NOTAMs to alert manned aircraft to the operations. This approach would resemble that for parachute, glider, and ultralight operations.

The NPRM's approach to confine model aircraft to their statutory safe harbor is advisable. It may be that the statutory safe harbor should be amended so that all sUAS are treated the same, based on weight and vehicle characteristics, rather than artificially distinguishing recreational from commercial flight. In the meantime, as long as the statutory immunity remains, the FAA should make it clear that operation above the statutory height limit, or beyond the statutory range limit is not permissible unless the operator meets the same qualifications and requirements imposed on commercial aUAS flight.

For model aircraft operations exceeding the basic limitations, such as the 500-foot height limit, from established model aircraft flight areas, flexibility exists under "mutually agreed-upon operating rules with the airport operator and control tower." FAA, Interpretation of the Special Rule for Model Aircraft Docket No. FAA-2014-0396 at 13 (June 18, 2014); 2012 Act, Pub. L. 112–95 § 336(a)(5) (recommending arrangements for permanent operations within five miles of an airport).

§ 4.7 Frangibility and other energy-dissipating technology

The FAA invites comments on whether it should eliminate frangibility from the micro-sUAS framework.

Frangibility is a subject relevant to every group within the sUAS category, not just to microdrones. As a general matter, sUAS pose less hazard in the event of collisions if they are frangible—designed to break and fragment at relatively low levels of kinetic energy. This reduces the kinetic energy that must be dissipated by deformation of the object collided with. Frangibility increases when materials with a low modulus of toughness are used, and structures make liberal use of fuse bolts, tear-through fasteners, tear-out sections, and built-in breakpoints of structural members.

Frangibility is least necessary for microdrones, which possess the least kinetic energy; it is more appropriate for midi- and macrodrones. Any frangibility requirement must be expressed in terms of performance standards rather than detailed engineering specifications.

§ 4.8 First-person-view

The FAA invites suggestions for ways in which a first-person-view device could be used by the operator without compromising the risk mitigation provided by the proposed visual-line-of-sight requirement. First person view ("FPV") is the popular term used for flying an sUAS wholly or partially by reference to live video acquired by camera on the vehicle and streamed to a monitor on the operator console. As with other technologies associated with sUAS, FPV technology will develop rapidly over the coming months and years.

In conjunction with autonomous performance of certain maneuvers, such as automatic hover and autonomous waypoint navigation according to pre-programmed flight plan, FPV can assure safe control of an sUAS. The problem is that the limited field of view available to the operator restricts situational awareness and adherence to the see-and avoid rule.

It may be appropriate to allow flight via FPV within a defined quantitative range from the operator, as long as automatic waypoint navigation, height limit, and range limits are enabled and operating properly.

FPV technology should not be allowed to substitute for or supplement line of sight unless other navigation and control technologies are available in the vehicle. Movo Aviation's officers, both of them helicopter and airplane pilots, have experimented with controlling microdrones with FPV imagery. The field of view horizontally and vertically is insufficient for the operator to maintain situational awareness and to see other objects, including other aircraft, that might represent collision hazards. While FPV is desirable to support camera or other sensor operation, it is insufficient to fly the aircraft safely.

If the operator is permitted to refer to FPV to fly the aircraft, additional mitigating measures should be required, such as requiring an observer who must keep the sUAS in sight and have real-time communication with the operator, either by voice, or by radio. Alternatively, a vehicle capable of flying a preprogrammed flightplan could be safely flown with FPV technology because the navigational and vehicle control tasks are performed mainly by the onboard computers rather than by the operator, manually.

§ 4.9 Nighttime operations

The NPRM welcomes public comments with suggestions on how to effectively mitigate the risk of operations of small unmanned aircraft during low-light or nighttime operations.

The prohibition against flying after dark should be eliminated, for sUAS that have LED lighting. Visual contact with sUAS now on the market and so equipped is easier to maintain at night than in the daytime. Typically they are equipped with bright, colored LEDs that permit the operator, not only to monitor the location of the vehicle, but also to ascertain its orientation. The final rule should allow night flight by any sUAS so equipped.

§ 4.10 Flight termination systems and other equipage requirements

The FAA invites comments on whether a flight termination system or other technological equipage should be required and how it would be integrated into the aircraft for small UAS that would be subject to this proposed rule.

Equipage requirements are appropriate for the midi- and macrodrone groups, because commercial realization of the potential of vehicles with these classes will require relaxation of line of sight and other limitations imposed on the micro subclass. The challenge is do this without imposing the burden of traditional airworthiness and type certification requirements on sUAS manufacturers.

The FAA's commitment to a risk-based and performance based approach to integrating sUAS into the NAS is fundamental, and its integrity must be preserved. In particular, it is important that the agency avoid anything resembling airworthiness and type certification for manned aircraft. Doing that poses some tricky challenges to the extent the final regulations address technologies for autonomous flight, limiting flight envelopes, collision detection, and failure detection.

One attractive possibility, foreshadowed in § § 4.3 of this Comment, is to adapt the consensus standard approach used in the early days of occupational health and safety regulation and combine it with the performance standards approach used by the Federal Communications Commission for unlicensed wireless devices.

The FAA could encourage sUAS organizations to articulate performance standards for sUAS control technologies, particularly those providing autonomous take off, hover, and landing; autonomous return to home, autonomous flight plan execution; and autonomous emergency landing.

Manufacturers of a particular class of sUAS would certify that they have designed and manufactured their vehicles in accordance with the applicable consensus standards. The operating rules would require operators to confirm that the basic features advertised are present and are operating as advertised, as part of their pre-flight inspection. Manufacturers falsely certifying compliance would be subject to civil penalties and criminal prosecution for mail or wire fraud.

Vehicles in the macro group (20-55 pounds) should be required to have ADS-B out. An ADS-B in requirement would provide the greatest protection if it is coupled with collision avoidance algorithms that would cause the sUAS to yield the right of way to manned aircraft. On the other hand, ADS-B in equipped midi- and macrodrones and manned aircraft potentially interacting with them would benefit even without such coupling. The purpose of the ADS-B in requirement is not to alert the sUAS operator to a manned aircraft already within his line of sight, where he certainly would be aware of it. Rather, the purpose is to alert him to manned aircraft in the general vicinity so that he can take precautionary action to avoid them once they are within his line of sight.

§ 4.11 Horizontal boundary

The FAA invites comments on whether the horizontal boundary of the contained area of operation should be defined through a numerical limit. If the boundary is defined through a numerical limit, what should that limit be?

The premise of safe operation depends upon the operator’s maintaining visual line of sight. The distance depends upon vehicle size, color, and lighting, the operator’s visual acuity, and meteorological conditions. Setting a quantitative horizontal limit would be essentially arbitrary, and in a great many cases be beyond line of sight and range of the control link, simply because the quantitative limit would represent a median or mean.

§ 4.12 Operation from moving vehicles

The NPRM invites comments, with supporting documentation, on whether small UAS operations should be permitted from moving land-based or vehicles, and invites comment on a regulatory framework for such operations. The FAA specifically invites comments as to whether distinctions could be drawn between different types of land-based and water based vehicles or operating environments such that certain operations from moving land-based vehicles could be conducted safely.

The NPRM does not explain persuasively why operating an sUAS from a moving vehicle is riskier than operating it from a stationary position, assuming the operator maintains line of sight and complies with height, speed, and weight restrictions. Indeed operation from a moving vehicle can be safer than operation from a stationary position, because the operator can maintain a position closer to the sUAS rather than flying it to the limits of his vision and then flying back.

Many useful applications of sUAS technology can be more effective if the sUAS operator is in a moving vehicle: boat photography, photography of races, and movie shooting. Also, when the object to be photographed or inspected extends for many miles, such as a power line, pipeline, line of railroad, or a highway, allowing operation from a moving vehicle significantly improves the effectiveness of the mission.

The final rule should permit sUAS to be operated from moving vehicles within the constraints applicable to that weight class.

In no event, however, should an sUAS operator be permitted to operate the sUAS and also drive or operate the ground vehicle. A separate driver must be required.

§ 4.13 Speed limit

The FAA invites comments on whether the 100 mph speed limit should be raised or lowered or whether a speed limit is necessary.

Risk-based regulation of sUAS appropriately considers the kinetic energy of such vehicles, because greater kinetic energy produces produce more damage in the event of a collision or crash.

As the NPRM notes, kinetic energy increases linearly with weight. But it increases with the square of the velocity; a vehicle traveling at 100 mph has 4 times the kinetic energy of one traveling 50 mph and 8 times the kinetic energy of one traveling at 25 mph. It is likely that the hundred mile per hour speed limit is an artifact of the 2009 ARC recommendation, which was preoccupied with larger fixed-wing UAS.

Especially if the FAA embraces the idea of segmentation of sUAS by weight, the speed limit should be adjusted accordingly. While macrodrones need to travel at greater speed to accomplish their missions efficiently, most microdrones employing multirotor technology, do not. A speed limit of 30 or 40 mph would be more appropriate for them, which would have the desirable effect of limiting their kinetic energy and reducing risk.

If higher speeds are necessary for macrodrones, the more than proportional increase in kinetic energy should be taken into account.

§ 4.14 Requirements for Class B, C, D, and E airspace

The FAA seeks comments related to part 91 compliance issues small UAS operators may encounter.

The exclusion of sUAS from class B, C, and D airspace and from the vicinity of airports in class E airspace is sound. The final rule should provide more detail, however, on how ATC clearances can be requested and the criteria under which they can be granted or refused. Class B, C, and D airspace share the characteristic that no one may operate an aircraft within such airspace without being in communication with ATC and, in the case of class B airspace, without a clearance from ATC. Because of the communications requirement, air traffic controllers are aware of all aircraft operating within the airspace for which they are responsible. The NPRM's requirement for sUAS ensures that the controllers also are aware of sUAS in the same airspace-- a sensible and safety-promoting arrangement. The relevant parts of controlled airspace for sUAS are the parts that extend all the way to the surface. Some parts of these classes of airspace extend all the way to the surface, and some have floors, meaning that the controlled airspace begins at a certain altitude above ground level. The portion that runs upwards from the surface typically extends horizontally for five nautical miles, in the case of class C airspace, and four nautical miles, in the case of class D airspace. The horizontal extent of class B airspace is tailored to specific high-density airports. In the case of O'Hare, the inner ring, running upward from the surface, extends from five to six nautical miles from the airport.

The risk of collisions between sUAS and manned aircraft is not the same in all parts of controlled airspace. If an airplane or helicopter is transitioning through class D airspace at 2,500 feet AGL, no collision risk is posed by a sUAS flying below 500 feet. The risk increases in approach and departure paths for the airport for which the controlled airspace is established.

Clearances for sUAS should, in every case, be divided between those areas of the approach and departure paths in active use that are below 500 feet, or whatever the maximum height is for the particular sUAS operation.

Not all parts of approach or departure paths for a controlled airport involve low altitudes. The standard final approach angle of 3° for both instrument and visual approaches does not bring an aircraft flying the approach below 500 feet until the last 9540 feet or about 2 miles. For example, the ILS or LOC RWY 9L approach at O'Hare Airport begins at an altitude of 9,000 feet, about 8,300 above ground level, and does not allow approaching aircraft to descend below 1,000 feet above ground level until 3.3 miles from the runway threshold. They also must remain within a narrow horizontal angle of the runway heading while they are on the approach.

A departing Cessna climbing at 500 feet per minute would be above 500 feet within 6600 feet from the takeoff point, or about a mile from the end of the runway.

In VFR traffic patterns at airports, airplanes fly at a standard height of 1000 feet AGL until they begin their base legs, and in a well-flown pattern would not be below 500 feet until they turn onto the final approach. Helicopters typically fly traffic patterns of 500 feet AGL, although their traffic patterns are more flexible, because their obligation is to avoid the flow of fixed wing aircraft.

These realities do not affect the appropriateness of requiring sUAS to receive clearances from ATC to operate in controlled airspace, but they should affect the criteria for granting or denying permission for sUAS operations. First of all, the authority to grant or deny permission should be vested in the tower manager for a particular airport, delegable to the local controller responsible for the segment where the sUAS seeks to fly.

Second, the final rule should make it clear that controllers should not refuse permission for sUAS operations not proximate to approach or departure paths or traffic patterns, and conversely that they should refuse for missions proximate to such areas.

The question remains: through what channels may sUAS operators request ATC clearance? The most important thing is to avoid imposing elaborate advance notice requirements. An sUAS operator should be able to request clearance by making a telephone call, sending an email , or writing a letter. Ad-hoc radio requests are undesirable, because there is no assurance that sUAS operators will have the requisite radio proficiency and, operating from the ground, they may not be able to establish robust communication. Once their operations are approved, however, they should be required to monitor an assigned frequency so that the tower can alter the clearance.

The basic approaches for parachute and ultralight aircraft operations in 14 C.F.R. parts 105 and 103, respectively, provide templates, although the rules for advance notice and permission for sUAS operations must be flexible enough to accommodate news photography for breaking news—just as they are now for news helicopter operations in Class B, C, and D airspace.

Evidence of requests and approvals and denials is desirable. Obviously, a letter request and the resulting action provides such evidence. But an advance request by letter is not necessary for that reason; FAA procedures cause ATC radio communications and telephone calls to be recorded, and emails to be archived.

§ 4.15 Flight proficiency and aeronautical experience requirements

The NPRM invites comments on whether applicants for operator certification should be required to demonstrate flight proficiency and/or aeronautical experience. If so, what flight proficiency and/or aeronautical experience requirements should the FAA impose?

Separate aeronautical experience and skills testing requirements are unnecessary to assure safety of micro- and mididrone operations, and would impose significant burdens and costs without producing significant benefits. As the NPRM notes, sUAS are much easier to fly then manned aircraft. The typical experience of a purchaser involves getting the vehicle out of the box, reviewing a modest amount of documentation on operating features, and soon thereafter launching a test flight. Within an hour, a typical purchaser is able to keep the vehicle under control and send it where he wants it to go. Mastery is even easier for those products that have built-in autonomous features such as automatic hover, automatic range limits, and automatic return to home. Requiring an operator to demonstrate this level of capability would involve very little instruction. It would require the erection of a training and testing infrastructure far beyond its worth. As this Comment argues, it would be better to omit any such requirement and encourage the development of a private, voluntary-association-based, infrastructure to build a culture of safety and a sense of community.

As to macrodrone group, however, proficiency and aeronautical experience requirements may be appropriate, if the operating rules permit these vehicles to be flown beyond line of sight.

Of particular concern is that a single operator performing an aerial photography or other aerial imagery mission must divide his attention between flying the aircraft and maintaining separation from other aircraft and from obstacles and monitoring what the camera or other sensors is capturing. Any proficiency test should require the operator to fly while capturing acceptable imagery. Performance standards should require that he do both tasks while remaining below any height limits, staying within any horizontal limits and taking appropriate action to avoid obstacles and other aircraft.

§ 4.16 Required training courses

The FAA invites comments as to whether other requirements, such as passage of an FAA-approved training course, should be imposed either instead of or in addition to the proposed knowledge test.

The knowledge test requirement is a paradigmatic performance oriented approach to training. Just as the FAA does not presently prescribe the type of training to be undertaken for preparation for the knowledge tests required of pilots, it should not prescribe training for sUAS operators. It should, however, provide incentives for operator candidates to complete training programs offered by commercial flight schools or voluntary associations, much as it does for ATP candidates graduating from university-based training programs.

§ 4.17 Aeronautical knowledge components

The FAA invites comments on the proposed areas of knowledge to be tested on the initial knowledge test. The FAA also invites comments as to whether the initial knowledge test should test any other areas of knowledge. If so, what additional areas of knowledge should be tested?

The areas of knowledge prescribed in the proposed 107.73 are appropriate. In addition, operator candidates should be tested on:

- Basic RF communication technologies, including propagation, multiplexing, spread-spectrum modulation, and multipath interference
- Flight control automation in multicopters

- Basic navigation instrumentation, including GPS receivers and processors, flux gate magnetometers, accelerometers, and inertial measurement units, and the types of altimeters commonly used in sUAS

§ 4.18 Online test taking

The FAA invites comments on whether the small UAS aeronautical knowledge test should have an option for online test-taking and, if so, what safeguards should be implemented to protect the integrity of the small UAS knowledge test, assure the FAA of the identity of the test taker, and protect the test-taker's PII that would be provided online.

It is not clear how online testing would avoid impermissible reference to materials during the test. Unless open-book testing is permitted, online testing should not be permitted. Security measures similar to those for IACRA are sufficient to assure test and candidate security.

§ 4.19 Recurrent knowledge test

FAA invites comments on the proposed requirement for a recurrent knowledge test.

The recurrent testing requirement is desirable. Presently, sUAS technology is changing much more rapidly than technologies for manned aircraft, especially relating to control systems. It is important that sUAS operators understand current technology, and a recurrent test is a good way to ensure this.

§ 4.20 Expiration of certificate

The FAA invites comments as to whether this certificate should expire after a certain period of time. If so, when should the certificate expire?

sUAS operator licenses should not expire. Like pilot certificates, they should presumptively be effective for life, with recurrent testing assuring currency of knowledge.

§ 4.21 Medical certificate requirement

The FAA invites comment as to whether an FAA medical certificate should be required. The FAA also invites comments as to the costs and benefits of requiring an airman medical certificate for an operator or visual observer.

A medical certificate should not be required. Considerable evidence supports the proposal, under consideration by the FAA, that the current third-class medical certificate requirement for private pilots should be scrapped. The agency should not take a step backwards with sUAS operators. Moreover, as the NPRM exhaustively explains, the risks of the microdrone category are much less than for manned aircraft, even if an sUAS operator becomes incapacitated, The unlikelihood of this event, combined with the limited weight, limited endurance, and limited range of the small vehicles would produce only a small risk, incommensurate with the burden of requiring medical certification.

§ 4.22 Reducing delay of TSA screening

The FAA invites comments with suggestions for how this period could be reduced. The FAA also notes that the TSA will continue to examine certificate holders after FAA issuance of a certificate.

If the delays associated with TSA screening cannot be reduced to hours or days instead of weeks or months, the final regulations should provide for provisional issuance of sUAS operator certificates contingent upon successful TSA screening. If TSA screening subsequently turns up adverse information, the provisional certification can be revoked. Any operator who poses a national security threat will not likely be deterred by *any* requirement to wait for TSA screening he obtains operator certification.

§ 4.23 Knowledge-test-center identity verification

The FAA invites comments on whether knowledge testing centers should be allowed to accept airman applications.

There is no reason that test centers should not be allowed to confirm identity. Test centers already have been accredited, by the FAA, and this accreditation assures their integrity.

§ 4.24 Additional vehicle registration requirements

The FAA invites comments as to whether small unmanned aircraft owners should be required to provide additional information during the registration process.

Registration requirements proposed in the NPRM are appropriate. No further data should be required to register an sUAS. In no event should special mission-specific applications such as COAs be required for operations within the parameters set by the general rules. The current COA a requirement for section 333 exemptions is cumbersome, and imposes a burden inconsistent with the effective use of sUAS.

Non-standard designs should be certified by the designer and builder as meeting the performance-oriented criteria such as those suggested in § § 4.3 of this Comment.

§ 4.25 Display of registration number

The FAA invites comments on whether a small unmanned aircraft should be required to display its registration number in accordance with Subpart C of part 45. If compliance with Subpart C should not be required, what standard should the FAA impose for how a small unmanned aircraft displays its registration number in order to fulfill its safety oversight obligation regarding small unmanned aircraft operations?

The NPRM's requirement to display an sUAS registration number is appropriate. The registration number should be displayed in whatever size is feasible.

§ 4.26 Fireproofing identification plate

The FAA invites comment on whether fireproof plating of identification plates should be required.

Fireplating should not be required.

§ 4.27 Accident reporting

The FAA invites comment on whether accident reporting should be required. The FAA also invites suggestions for alternative methods of ensuring compliance with the regulations governing small UAS operations. The FAA specifically invites comments as to whether small UAS accidents that result in minimal amounts of property damage should be exempted from the reporting requirement. If so, what is the threshold of property damage that should trigger the accident reporting requirement?

Some kind of accident reporting should be required. The existing criteria in proposed § 107.9 are an appropriate starting point. Neither the sUAS operator nor regulators should be burdened with reports of relatively trivial incidents, say collision of a micro-sUAS with a tree that breaks a rotor blade. On the other hand, incidents or accidents involving complete loss of control, failure of automated safety systems such as airspace exclusion or return to home, and injuries involving hospitalization should be reportable.

"Any injury to any person" is too broad, however. It would include an sUAS operator who gets nicked on through his pants leg by a rotor blade while preflighting his vehicle. A threshold reporting requirement should prescribe any injury requiring hospitalization or other treatment by a provider of medical care.

Likewise, the criterion of "Damage to any property is too broad." It would include severance of a few leaves and small branched of a tree after an sUAS collides with it. A threshold of $1,000 damage should be prescribed.

§ 4.28 Threat to national security

The Secretary proposes to find that these small UAS operations would not pose a threat to national security. The NPRM invites comments on this proposed finding.

Wider use of sUAS is largely irrelevant to the threat of terrorist attacks. Terrorists can use almost any implement as a weapon: Boeing 757s and 767s in the case of the September 11 attacks, pressure cookers as in the case of the Boston Marathon attacks, fertilizer, as in the Oklahoma City attacks. Attempting to mitigate the terrorist threat by restricting the use of every implement that might be used would shut down the economy.

The reality is that sUAS are not particularly attractive as terrorist weapons, compared with manned aircraft or ground-based devices. Their payload is limited. Their range is limited, and their control links tie them to the individuals flying them. Putting counterterrorism efforts into securing large assemblies against backpacks that might contain explosives is a far more cost-effective way to reduce the threat that by guessing how an attacker might jury rig a DJI Phantom to carry a harmful device or substance.

§ 4.29 No need for airworthiness certification

The Secretary finds, pursuant to section 333(b)(2) of Public Law 112–95, that airworthiness certification would be unnecessary for small UAS subject to the proposed rules. The NPRM invites comments on this finding.

The NPRM itself and §§ § 3.2, § 4.3, and § 4.4 of this Comment explain why this finding is appropriate.

§ 4.30 Test site program

The NPRM requests comment on the test-site program. Every indication is that the test sites are underutilized and not living up to their potential. Part of the reason for this is the lack of a clear agenda for test site activities. The FAA has been reluctant to seem to direct R&D activity, but it need not be altogether silent. The agency should be more explicit about the areas of research, demonstration, and testing that would be most helpful in filling the data void, much referred to in the NPRM.

In particular, more data would be desirable on energy dissipation in collisions between sUAS and manned aircraft. Because helicopters are more likely than fixed-wing aircraft to be operating at altitudes where they may come in contact with sUAS, the emphasis should be on sUAS /helicopter collisions. Different masses and shapes and materials representing sUAS should be projected at various velocities and into accurate mockups of helicopter bubbles, main rotors, and tail rotors. The working hypothesis would be that sUAS, such as those weighing less than 8 pounds – the limit suggested in this Comment for a micro-sUAS group--would do acceptable levels of damage, while heavier ones, such those approaching the upper limit of 55 pounds would do unacceptable damage.

In particular, the collision energy dissipation tests should collect data on the effect of sUAS being made of frangible material. The effect of different types of frangible material should be tested. The tests also determine whether certain types of material would shatter before the object penetrates a Plexiglas helicopter bubble. They also should explore the effect of battery mass and the effect of having multiple smaller batteries rather than one large battery.

These energy dissipation tests should not be required of sUAS manufacturers or vendors; instead, the FAA should arrange to have such tests made at the six test centers, through NASA or through the FAA's centers of excellence, with resulting data made available publicly

§ 4.31 Quantifying benefits

The FAA estimates that the proposed rule could not only enable numerous new industries, but also provide safety benefits and create a safe operating environment. The FAA has not quantified the specific benefits due to a lack of data. The FAA invites commenters to provide data that could be used to quantify benefits of this proposed rule.

The challenge of improving the cost-benefit analysis is that many of the benefits of any new technology are hard to identify and even more difficult to quantify. Costs are easier. The Regulatory Evaluation by the Office of Aviation Policy and Plans accompanying the NPRM does a good, but limited, job of quantifying both costs and benefits of using sUAS instead of manned helicopters for moviemaking and of using sUAS instead of ground crews for tower inspection. These two examples represent a desirable model.

Broadening the benefit/cost analysis must accommodate two facts: first, sUAS will complement helicopters, not replace them; and second, many of the missions performed by sUAS involve aerial activities not performed at all today.

Wedding photography is a prosaic example. Few formal weddings occur without a professional photographer present. Only the most elaborate ones involve helicopter or airplane photography. With the wide availability of sUAS to take aerial video, a new photographic viewpoint will become routine. How can be benefit of this be quantified?

Or, consider construction site monitoring. While aerial surveys of some large projects are common, more routine projects involve surveyors and engineers working on the ground to monitor elevations of cuts and fills, lines of right-of-way, and the like. Now sUAS can supplement the activities of ground crews. How can be benefit of this be quantified?

As a final example, consider electronic news gathering by sUAS. sUAS are unlikely to replace ENG helicopters for the TV stations that use them. The smaller aircraft cannot complete with helicopter speed, range, and flexibility, and the much heavier packages of gimbaled cameras and directional microwave antennas well within their payload capabilities. So sUAS are more likely to be deployed as adjuncts to ground field teams, allowing them to add an aerial perspective to the video they can capture from the ground. How are the benefits of this new capability to be quantified?

The best way to quantify benefits is to use the value the market sets for them. The problem is: the market for sUAS flights does not yet extend beyond those under the limited number of section 333 exemptions. A rough proxy is the value – the price – the market sets for comparable light helicopter support. For many activities, consumers will not pay that price for helicopter support: the supply-and-demand equilibrium represents a level of service quantity less than would be demanded at a lower price. The price elasticity of demand for aerial imagery is unknown, however.

As a rough approximation, one can assume a price half that for helicopter support, assume a unitary elasticity, and further assume that the part of the market that can be served by helicopters will continue to be served by them. Helicopters have features that sUAS do not, and purchasers will continue to pay a higher price for them.

If the market for sUAS services is competitive, price will approach marginal cost, although suppliers will try to cover fully allocated total cost. Without data about the price structure for sUAS services, assuming a figure for marginal or total cost would involve much guesswork. Operating costs, including fuel and maintenance costs will be much less. Crew costs likely will be equivalent or only somewhat less. The same infrastructure for marketing, office administration, finance, and operations management likely will be the same. Halving the price of the lowest-cost helicopter support is a reasonable starting point.

Then, there is the matter of estimating the level of supply and demand at this price. Unitary elasticity means that the total quantity demanded will twice that of the total quantity of helicopter services now demanded at twice the price. One can begin with the total number of weddings performed in the United States, and the total number of ENG vans that are used by television stations. Alternatively, one could take census reports on total revenue of the wedding-supported industry and the greenfield construction industry.

From such data and assumptions benefits can be projected and then refined as actual data become available.

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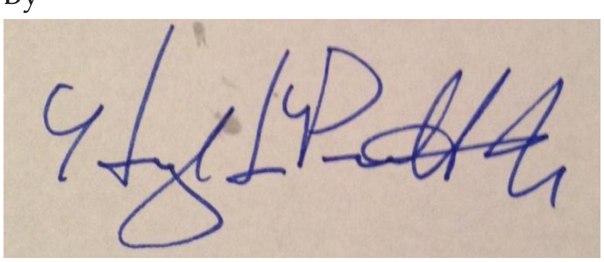

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