UNMANNED AIRCRAFT SYSTEMS

BEYOND VISUAL LINE OF SIGHT

AVIATION RULEMAKING COMMITTEE

MARCH 10, 2022

FINAL REPORT

I. Background

It is widely understood that the safety and efficiency benefits of commercial Uncrewed Aircraft Systems (UAS) are significant. For example, commercial UA operations provide countless public benefits and essential services to the American public, including delivering critical supplies, life-saving medicines, and commercial products. UA are also helping to improve safety and efficiency by inspecting critical infrastructure at scale, enhancing access to essential goods and services, connecting communities, and supporting first responders.

Notwithstanding these benefits for the American public, current Federal Aviation Administration (FAA) regulations do not enable the domestic UA beyond visual line-of-sight (BVLOS) industry to scale and achieve meaningful results from those benefits. The current rules also do not reflect the competencies needed to safely operate highly automated UAS, which hinders the ability to expand UAS BVLOS operations to achieve the maximum societal and economic benefits for the American public. Safely realizing these benefits at scale should be the goal of any rulemaking initiatives for routine BVLOS integration. The industry is ready and willing to provide resources, technology, and expertise to scale BVLOS; and many companies, communities, and industrial sectors have invested substantial resources in developing UAS technologies to realize these benefits. It is important that a new regulatory framework be established to capitalize on UAS, enhance safety, and promote sustainable transportation solutions—all while ensuring America's continued leadership in aviation innovation.

In June 2016, the FAA issued Part 107 of Title 14 of the Code of Federal Regulations (14 CFR Part 107), the final rule for "Operation and Certification of Small Unmanned Aircraft Systems.",[1] Part 107 set forth requirements for routine operation of small uncrewed aircraft (UA) in the National Airspace System (NAS), but did not include requirements for UAS design, manufacturing, or production. Instead, it limited small UA operations to certain areas (e.g., at or below 400 feet in Class G airspace) and conditions (e.g., operations within visual line-of-sight (VLOS)), with the intent to prevent UA from interfering with other aircraft in flight or posing an undue hazard to people or property on the ground. This rule was a critical step toward normalizing low-risk VLOS small UAS operations in the United States.

Uncrewed aircraft flying beyond an operator's visual line-of-sight present unique challenges to the FAA's existing regulatory framework. Most aviation regulations that would apply to UA operations (besides Part 107) assume an aircraft with an onboard pilot who is responsible for avoiding other aircraft. Not only do UA lack an onboard pilot, but even a remote pilot pushes the boundaries of the traditional

[1] 81 FR 42063 - Operation and Certification of Small Unmanned Aircraft Systems - Content Details - 2016-15079 (govinfo.gov). https://www.govinfo.gov/app/details/FR-2016-06-28/2016-15079

regulatory role of a pilot. However, the UA's capability to fly without the pilot onboard, and indeed beyond the pilot's visual line-of-sight, is what offers the most economic and societal benefits. Today, companies, communities, and industrial sectors are eager to realize these benefits and have invested substantial resources developing UAS technologies. The FAA's existing regulatory framework must change to better support the long-term viability and sustainability of this evolving aviation sector. However, these are challenges the entire UA community must confront together, because they have implications not only for safety, but also security and society at large. The FAA recognizes the significant safety, economic, and environmental value associated with UAS BVLOS operations. Over the past five years, the FAA has engaged in multiple pilot programs and partnership arrangements – including the UAS Integration Pilot Program (IPP), Partnership for Safety Plans (PSPs), and currently BEYOND – to further both the Agency's and the stakeholder community's collective understanding of the minimum performance criteria for safe UAS BVLOS operations. The UAS BVLOS ARC considered the various lessons and insights gained from these and other activities to inform the Aviation Rulemaking Committee on performance-based criteria to enable safe, scalable, economically viable, and environmentally advantageous UAS BVLOS operations in the NAS.

II. Executive Summary

The UAS-BVLOS ARC membership represented diverse interests and viewpoints. The ARC worked in two phases, divided into various groups and subgroups, and collaborated on developing the best recommendations with as much consensus as possible. Although there was not a unanimity of views, the ARC was able to reach general agreement on many recommendations to the FAA. Dissenting opinions are referenced throughout the material, and nonconcurrences are included in the Appendix.

To capture the scope of the ARC's work, including the diversity of opinions among its members, highlights of major aspects of the ARC recommendations are below. Supporting text for all ARC recommendations can be found in the body of the report.

In terms of key recommendations, the ARC recommends that the FAA set an acceptable level of risk (ALR) for UAS that is consistent across all types of operations being performed. The ARC envisions that this approach will allow the FAA to adopt a common and consistent set of regulations and guidance, giving operators the flexibility to meet the ALR through qualitative or quantitative methods, or a hybrid approach.

Next, the ARC recommends a series of modifications to the right of way rules in Low Altitude Shielded Areas (within 100' of a structure or critical infrastructure as defined in 42 U.S.C. § 5195c)[2] and in Low Altitude Non-Shielded Areas (below 400') to accommodate UA operations. Specifically, the ARC recommends several amendments to 91.113 to:

allow automatic means for see-and-avoid responsibility;

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[2] The National Infrastructure Protection Plan (NIPP)—NIPP 2013: *Partnering for Critical Infrastructure Security and Resilience*—outlines how government and private sector participants in the critical infrastructure community work together to manage risks and achieve security and resilience outcomes. *See also* Presidential Policy Directive 21 (PPD-21): *Presidential Policy Directive -- Critical Infrastructure Security and Resilience | whitehouse.gov (archives.gov),* which advances a national policy to strengthen and maintain secure, functioning, and resilient critical infrastructure.

give UA right of way in Shielded Areas;
give UA right of way over crewed aircraft that are ***not*** equipped with ADS-B or TABS in Non-Shielded Low Altitude Areas; and
give crewed aircraft that are equipped with ADS-B or TABS (and broadcasting their position) right of way in Non-Shielded Low Altitude Areas.

Third, the ARC recommends an approach to operator qualification that would extend Part 107, Remote Pilot Certificate with Small UAS Rating, to cover topics associated with Extended Visual Line of Sight (EVLOS) and shielded UAS operations. The recommendation creates a new Remote Pilot certificate rating to cover BVLOS operations beyond the scope of the extended Part 107 rating. The examination for both ratings would consist of a knowledge test on relevant areas, while practical training and qualifications would be tied to new Remote Air Carrier and Remote Operating certificates, which would be required for most commercial 1-to-many operations. The qualifications would be based on specific UA systems, Use Cases, and operational restrictions.

Fourth, the ARC recommends that the FAA establish a new BVLOS Rule which includes a process for qualification of UA and UAS, applicable to aircraft up to 800,000 ft-lb of kinetic energy (in accordance with the Operation Risk Matrix).

Finally, the ARC recommends that the FAA adopt a non-mandatory regulatory scheme for third party services to be used in support of UAS BVLOS operations. In addition to its recommendations, the ARC identified certain issues relevant to UAS BVLOS operations that are beyond this ARC's scope, but which are identified in this report as considerations for future ARCs to address. Similarly, the ARC also identified several issues that are beyond the FAA's scope of authority. However, these recommendations are in the interest of providing a full framework of actions and policies to promote safe and widespread adoption of UAS BVLOS activities.

III. Chairs' Comments

The use of UAS continues to grow and evolve globally. The technology has proven to provide many societal and economic benefits and can be used as a critical tool to support numerous use cases and public safety efforts. These include, but are not limited to, inspections of critical infrastructure, options for industrial applications, and operations involving the delivery of medical supplies and packages to consumers. Additionally, UAS technology has proven to be a key component in supporting numerous public safety efforts including aiding with disaster recovery, wildfire response, and search and rescue missions. The co-chairs of the UAS-BVLOS ARC were proud to lead conversations around the technical and regulatory challenges toward safely integrating UAS into the NAS.

Prior initiatives to integrate UAS include: the Small Unmanned Aircraft Systems (sUAS) ARC (2008), the UAS Registration Task Force (2015), the Micro UAS ARC (2016), the UAS in Controlled Airspace ARC (2017), the UAS Remote Tracking and ID ARC (2017), and numerous advisory recommendations produced by the FAA/DOT Drone Advisory Committee (recently renamed the Advanced Aviation Advisory Committee) and the Drone Safety Team. The work and expertise devoted to these efforts has resulted in a regulatory structure that facilitates very basic visual line of sight (VLOS) operations by rule.

When the FAA issued the Part 107 rule in 2016 for "Operation and Certification of Small Unmanned Aircraft Systems," it was an important first step in normalizing UA operations by rule and facilitating UA operations that were previously only achieved via waivers and exemptions. Encouragingly, the public/private partnerships that ensued in the wake of the Part 107 Rule brought together state, local, and tribal governments with private sector entities "*to test and evaluate the integration of civil and public drone operations*." [3] Together, these participants demonstrated the potential social, economic, and environmental values associated with UA operations, which included BVLOS operations conducted under waiver. These events were an important validation of the overall safety of UAS BVLOS operations. In fact, out of the many flights conducted under Part 107, Part 91, and Part 135 to date, there have been zero fatalities and only one serious injury attributable to these operations.

It has become evident that the current aviation regulatory framework is not capable of accommodating UA operations at the existing levels, and certainly not at the levels anticipated as the industry grows. Consequently, regulatory changes are necessary to support industry growth. Now is the time to take progressive and deliberate steps towards creating scalable UAS BVLOS rules and pathways to support complex operations. The industry can capitalize on the knowledge gained from previously granted waivers and exemptions, and the demonstrated safety record, to fully realize the societal and economic benefits the technology presents.

Considering the expansive opportunities UAS enable, the ARC was comprised of a diverse community of experts to ensure recommendations were considered from a variety of stakeholders. This includes academia and standards bodies; critical infrastructure owners and operators; infrastructure security; privacy groups; state, local, tribal, territorial interests – including environment and equity considerations; technology and network infrastructure interests; traditional aviation associations; and UAS associations. All members were invited to join Subgroups focused on various issue areas, leading to thousands of hours of meetings and draft review and comment for the collective group. Overall, the ARC supported 10 Plenary sessions and at least 7[4] commenting opportunities. The ARC timeframe was extended an additional 3 months to properly consider and respond to representative viewpoints.

While the COVID-19 pandemic made in-person meetings for the full ARC impossible, the leadership team took numerous steps to ensure a transparent process in which members had ample opportunities to weigh in on issues and play an essential role in shaping the recommendations, while working in a virtual environment. The ARC kicked off on June 24, 2021, and presented the schedule and tasks to accomplish in a 6-month period. This included full plenaries throughout the process to provide updates and allow all members to discuss and comment on the ARC's work at different stages of its development and refinement. In addition, leaders for each Working Group conducted hundreds of hours of meetings at the working group level, as well as follow-up discussions with individual members regarding specific issues when warranted.

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[3] For example, the UAS Integration Pilot Program (now BEYOND focused on BVLOS) has created a meaningful dialogue on the balance between local and national interests related to UAS integration, and provided actionable information to the USDOT on expanded and universal integration of UAS into the National Airspace System. [UAS Integration Pilot Program (faa.gov)](https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/).
https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/

[4] This includes two Phase 1 drafts published for comment, and five Phase 2 drafts published for comment through Dec 17, 2021. This does not include the numerous partial drafts created by the three Phase 1 working groups and five Phase 2 working groups that provided the content for the seven major drafts published for ARC-wide comment.

The ARC recognized that the large number of stakeholders[5] and variety of perspectives made consensus on the recommendations an ambitious goal, particularly within the timeframe granted in the Charter. However, the ARC remained committed to the mission of the Charter and worked tirelessly to create recommendations that were robustly debated and meticulously researched. While we were unable to achieve unanimity on every recommendation, we are confident that the recommendations, including those regarding right of way and acceptable level of risk, are supported by a majority of the ARC's voting members and based on respected data and research. We consider that the final recommendations strike the right balance of capitalizing on past successes and progressing the industry toward a safe and sustainable future.

Beyond the technical mitigations and operating recommendations, this report focused on being responsive to the needs of our communities as a key focus of our efforts. In addition to providing specific regulatory recommendations to the FAA, this ARC report portrays a UA industry that:

- benefits underserved areas and opens doors to aviation that were previously closed (such as for people with disabilities);
- introduces a clean energy transportation solution to fight climate change and enhance environmental justice;
- seeks to provide significant economic, environmental, and equity benefits to the public, but finds itself held back due to bureaucratic hurdles; and
- struggles to fit into a regulatory framework that never contemplated UA.

The regulatory recommendations we present here provide the greatest opportunity to safely realize the manifest benefits of UAS BVLOS operations. We urge all readers to read the Phase 1[6] report as well in order to understand the background history and broader context of the recommendations.

The ARC acknowledges the view (expressed by some ARC members) that the proposed new rules are overly broad and disruptive. Indeed, this criticism can be (and has been) lodged against almost every rulemaking initiative because new rules are precedent setting by nature. Many traditional aviation rulemaking efforts were also met with skepticism and criticism, especially when those efforts were aimed at modernization and automation of the aircraft flight deck and air traffic control system. While we anticipate similar criticism here, we remain confident that it will be tempered by an objective review of the incremental approach, based on numerous aviation studies, and validated by a stellar safety record.

The ARC recommendations are progressive, but they are limited to UA with a mass and speed which result in UA kinetic energy of no more than 800,000 ft.-lbs., representative of a Light Sport Aircraft. Moreover, the UA are operated at very low altitudes and in volumes of airspace that do not have significant numbers of general aviation operations. These are reasonable and logical recommendations that advance the UAS industry and ensure that the United States remains a global leader in the UAS arena. Moreover, the ARC considers it truly transformative to have the opportunity to introduce aviation to those who would not otherwise be able to participate, and to do so in a way that is environmentally advantageous. In this light, the question we should be asking ourselves today is not, "is

[5] Over 90 ARC participants, comprised of voting members, alternates, observers, and governmental partners.
[6] Appendix H. Phase 1 Report.

this the right time for BVLOS," but rather "is time, technology and public benefit passing us by because we have not facilitated safe and secure BVLOS operations?"

IV. ARC Charter Summary

The charter established the Unmanned Aircraft Systems Beyond Visual Line-of-Sight Operations Aviation Rulemaking Committee, which is sponsored by the Associate Administrator for Aviation Safety. The charter outlines the ARC's organization, responsibilities, and tasks.

A. ARC Objectives

The UAS BVLOS ARC's purpose is to make recommendations to the FAA for performance-based regulatory requirements to normalize safe, scalable, economically viable, and environmentally advantageous UAS BVLOS operations that are not under positive air traffic control (ATC). The ARC's recommendations should support the following concepts of operation: long-line linear infrastructure inspections, industrial aerial data gathering, small package delivery, and precision agriculture operations, including crop spraying. The ARC was not tasked with addressing aircraft or operations carrying passengers or crew, nor did it address the integration of operations for which Air Traffic Services (ATS) are provided.

B. ARC Tasks

Identify safety and environmental considerations for UAS BVLOS operations, accounting for the security needs of the United States government. The ARC should consider economic, environmental, public health, and safety benefits of enabling UAS BVLOS operations within the scope of the ARC's objectives. At a minimum, the ARC must consider:

- Safety objectives of the UA operation and the risk it presents to other aircraft and people and property on the ground.
- Concepts of UAS BVLOS operations and their potential environmental impacts across environmental resource areas (e.g., noise, emissions, endangered species, visual).
- Approaches to evaluating community response to UA noise, and identification of concepts of operations that may have limited or no community noise exposure.
- Whether and how UAS BVLOS operations can enhance environmental justice.
- Solutions that address security concerns related to BVLOS operations.
- Societal benefits for UAS BVLOS operations.

Recommend and provide rationale for requirements to enable UAS BVLOS operations, including:

- Defining the expected future market participants and their responsibilities in these operations.
- Considering the breadth of aircraft operations in low-altitude airspace, outside of areas designated for positive air traffic control (operations with and without persons on board).
- Enabling routine operations of aircraft where no pilot is on-board with a visual reference, outside of Visual Flight Rules or Instrument Flight Rules.
- Recommending performance-based regulations that enable and reward continued improvements in technology.
- Describing a regulatory framework for the FAA to oversee the integration of UA and the operation of the

integrated UAS, including initial qualification and continued operational safety.

- Addressing the use of highly automated UAS, for which the individual operating the UA defines the mission and initiates the operation, but has no access to flight controls.
- Identifying the level of FAA involvement in certification and oversight that is appropriate to address safety and environmental concerns.
- Determining whether and how to amend the current regulatory framework to include new BVLOS regulations.
- Identifying potential incremental benefits, savings, and costs of recommendations where possible, including quantitative data and estimates, qualitative benefit-cost description, and compliance trade-offs.

The ARC took a holistic approach in making its recommendations. It considered the safety of UA operations, as well as the safety benefits that would be derived in crewed aircraft operations. The recommendations are supported by empirical studies and data from trusted sources, such as the National Transportation Safety Board (NTSB) and the International Civil Aviation Organization (ICAO). These recommendations and their rationale are more fully discussed in Section V.A. Safety below.
The ARC members considered it essential to understand both the promise and potential problems associated with UAS BVLOS operations. This was necessary to develop recommendations that were in the public interest, but also addressed matters of public concern. To that end, the first Phase of the ARC focused on understanding the landscape and developing a pathway forward. They began their efforts with the following questions:

What are the UAS BVLOS use cases?
What are the environmental impacts and potential environmental justice benefits of BVLOS operations? What risks are created to other aircraft, people and property on the ground by these operations?
How can we identify security risks that may be introduced by the operations? How can we address these safety, environmental, and security risks to realize the economic and societal benefits, without compromising public safety and national security?
How is the market organized and funded, and what does that mean for the economic viability of the industry?
How significant are the societal benefits of these operations for both industry and the public, and what is the opportunity cost of delaying these benefits?
What does industry need to do to scale UAS BVLOS operations, and how is scalability affected by current approaches to regulation?
How should the FAA define priorities for the rule, including justifying its need for a risk-based, performance-based, flexible rule that generally enables a wide variety of beneficial BVLOS use cases?
What are the significant issues presented by the current regulatory framework that must be resolved to enable these operations?

In tackling these questions, the BVLOS ARC chose to conduct its work in two phases. Three workgroups were established during Phase 1 of the ARC to examine these issues:

1. Working Group 1.1 Community Interest: Safety, Environment, and Security
2. Working Group 1.2 Market Drivers
3. Working Group 1.3 Regulatory Challenges

Notably, a supportive regulatory environment for BVLOS will require more than just one rule and more than just one regulatory partner. Indeed, the Phase 1 Team identified that other federal entities such as national security agencies, the Federal Communications Commission (FCC), and the National Telecommunications and Information Administration (NTIA), also have a substantial role to play in optimizing BVLOS in addition to FAA. In some cases, legislation might be necessary.

Workgroup 1.1 divided into three Subgroups:

Subgroup 1.1.1 Safety was tasked to report to the broader ARC on the safety objectives of BVLOS operations, specifically from the public's point of view. This Subgroup considered societal acceptance of risk and reward and made recommendations on how to measure them. Many of the recommendations were consolidated for Phase 2 consideration and addressed under the categories of Acceptable Level of Risk, Strategic and Technical Risk Mitigation, and Automated Flight Rules.

Subgroup 1.1.2 Environment and Community identified environmental considerations necessary to enable UAS BVLOS operations. This subgroup recommended that Phase II consider the best options to maximize and distribute the benefits of UAS BVLOS operation across communities, while minimizing the environmental impacts that would constrain the scaled and responsible growth of UAS BVLOS operations.

Subgroup 1.1.3 Security Considerations focused on how to identify and address BVLOS security risks such that the benefits of BVLOS operations could be realized without compromising public safety and national security. The Subgroup considered what sort of regulations, processes, and technologies could be employed by private and public entities to protect the NAS and associated infrastructure, as well as reduce the risk of malicious actors with respect to BVLOS operations. Most of the issues identified by this Subgroup in Phase 1 were considered in Phase 2 by the Operator Qualifications Team. The team focused specifically on the concept of remote pilot licensing under a new Part 108[7] Certificate. Consideration was also given to the balance of security with privacy, specifically with respect to Third-Party Services. An early and enduring recommendation was that Third-Party Services should not be required until higher levels of operational complexity are reached in the BVLOS domain.

Working Group 1.2 divided into three Subgroups:

Subgroup 1.2.1 Market Organization was tasked to report on how the UAS industry is organized and funded as a basis for a future UAS BVLOS rulemaking. The Subgroup tackled questions regarding sources of funding, market participants and organization, and expectations for commercial sustainability.

[7] The ARC is aware that the rule will be numbered in accordance with FAA policy and the rulemaking process. The ARC report uses the terms 'new rule', 'new rule part', and 'Part 108' interchangeably.

Additional areas included how participants relate and work together, the range of BVLOS use cases, and industry diversity.

Subgroup 1.2.2 Societal Benefits was tasked with identifying and documenting the societal benefits of UAS BVLOS operations. Societal benefits include both the benefits to those stakeholders with a direct and immediate economic interest as well as the broader benefits to the public. To advance with a BVLOS rulemaking effort, the Subgroup understood that the FAA must be able to demonstrate to the interagency community, as well as to the public, that the benefits of updated regulation exceed the costs, and that there is a net positive benefit to society. To lay the proper foundation, the Society Benefits Subgroup worked to identify, quantify, and rationalize compelling and defensible examples of benefits for society associated with UAS BVLOS operations.

Subgroup 1.2.3 Industry Needs focused on identifying and rationalizing what the industry needs to scale UAS BVLOS operations, such that the industry ultimately will be able to provide the societal benefits identified by the Societal Benefits Subgroup. This Subgroup recognized that some needs would require regulatory reform, while other industry needs such as physical infrastructure could be provided by industry. Phase 2 captured many of these ideas through their work on the Automation Matrix and Third-Party Services. Other related recommendations can be found in the "Industry Needs" section of this report.

Working Group 1.3 was intended to provide scope and focus to the Working Groups in Phase 2. To that end, the group developed a series of "Problem Statements" to be addressed by Phase 2. The identification of issues greatly assisted the Phase 2 team with refining the scope of work. The Phase 2 responses to these issues are captured in the individual Phase 2 Working Group reports[8] and reflected in the overall ARC recommendations.

V. Guiding Principles

Safety and societal benefits were the guiding principles of the ARC's work. The need to develop safe, pragmatic, and standardized approaches for BVLOS is critical to support the benefits and future of UAS operations and technology. The ARC sought to keep these two considerations front of mind as it worked to develop a framework for integrating UAS BVLOS operations into the NAS and fully realizing all that this technology has to offer.

A. Safety

The Safety Subgroup was tasked to report to the broader ARC on the safety objectives of BVLOS operations, particularly from the public's point of view. The Safety framework for BVLOS would be predicated on the actual, perceived, and measurable risk. Therefore, it was essential to assess societal acceptance of risk and reward, and how it should be measured, to establish an acceptable level of risk that would drive the ARC's work and its recommendations. Traditional frameworks for evaluating aviation risk contemplate the presence of individuals onboard an aircraft. However, UA do not have pilots or passengers onboard, so the risk to human life stems from the UA potentially colliding with a traditional aircraft or a collision with an individual on the ground. Given the differences between

8 Annex.

traditional aviation and UA, Working Group 1.1 believed the ARC and the FAA ought to consider the following factors to determine an ALR for UAS BVLOS operations:

- **Public Perception:** The public's belief or opinion about the benefits and risks of UAS BVLOS operations. Fear of new technology is not unique to UA, and public perception typically evolves as people are educated about a new technology's benefits. UA stakeholders should work together to educate the public about the many UA benefits. It should also be noted that there is a level of excitement from the general public about UA and the benefits BVLOS operations could bring to their communities as evidenced by the number of applicants nationally that have expressed an interest in participating in the UAS Integration Pilot Program (IPP).
- **Aviation and Non-Aviation Risk Analogues**: The relevance of data and research released by FAA, National Highway Traffic Safety Administration (NHTSA), National Transportation Safety Board (NTSB), Department of Transportation (DOT),[9] Occupational Safety and Health Administration (OSHA), and other agencies that could help inform overall levels of safety associated with UAS BVLOS operations, including impacts to safety which extend beyond the NAS. For example, acceptable levels of risk for ground vehicles, autopilots, general aviation, and commercial space transportation.
- **Public Benefits of UA Operations**: The economic, public health, environmental and societal benefits of BVLOS operations, which must be weighed against any real or perceived increases in risk to the NAS.
- **Risk Transference**: Where BVLOS operations replace higher risk operations, as well as where risk can be transferred to industry through accountability, liability, and insurance requirements.

B. Social Benefits

Traditional approaches to safety assessment, which assume that there are people onboard, are not appropriate for UA, and there are currently no established UA safety targets. A UA accident in an unpopulated area is assumed to provide minimal risk to persons or structures on the ground. Similar considerations could be given to UA that collide with property, especially the property of the operator. In such an instance there is little to no risk of injury to persons on the ground. For these reasons, the FAA's focus must be on protecting individuals on the ground and preventing collisions with crewed aircraft, not on preventing a UA crash. Consideration should be given to risk to first responders in the aftermath of a UA crash and the mitigations that UA can provide.

Current FAA policies were designed for crewed aircraft and did not contemplate the UA marketplace or UA operations on a large scale. Given the novelty of the policy and regulatory issues raised by UA operations, FAA staff often need to elevate risk issues and decisions on a case-by-case basis, which has resulted in delayed and inconsistent outcomes. This impacts the FAA's efficiency and limits its ability to provide timely responses to regulatory applications. Moreover, as noted by the U.S. Government Accountability Office, the FAA lacks transparency and collaboration with industry[10] and the public about

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[9]U.S. Department of Transportation, Bureau of Transportation Statistics. https://data.bts.gov/browse?q=fatalities&sortBy=relevance

[10] *See* General Accounting Office, *UNMANNED AIRCRAFT SYSTEMS - FAA Could Strengthen Its Implementation of a Drone Traffic Management System by Improving Communication and Measuring Performance*, https://www.gao.gov/assets/gao-21-165.pdf, (Jan. 2021).

the level of safety that the public expects. As a result, industry remains unsure about the safety standard it needs to meet, which stifles investment and innovation.

The following are the Safety Subgroup's key findings and principles:

- **Regulators Should Consider Safety Benefits Holistically**: Establishing a baseline level of acceptable risk must account for safety benefits broadly and across transportation modes, recognizing that some UAS BVLOS operations will increase safety both inside and outside the aviation system. Acceptable levels of safety for UAS BVLOS operations must reflect this notion.

- **There Is a Data Gap.** Existing data associated with crewed aircraft operations are not appropriate when applied to UAS BVLOS operations because of the fundamental risk differences that exist between crewed aircraft and UA.

- **Regulators Should Focus on Risk Profile, Not Use Cases.** Use Cases in and of themselves are a poor proxy for determining the risk profile of BVLOS operations. It is essential that regulators focus on component characteristics, including combinations of characteristics that influence overall levels of ground and air risks associated with BVLOS operations.

- **The Public's Risk Tolerance Is Evolving.** As UA operations increase, technology continues to improve and society realizes the benefits of the technology, the public's tolerance for safety will also evolve.

- **Regulatory Processes Must Be Streamlined, Transparent, and Consistent.** The current FAA approaches for granting certifications, approvals, and exemptions do not meet the needs of industry and the market cycle. A uniform method of analysis will create predictability for stakeholders, allowing industry to fully realize the benefits of BVLOS operations while maintaining an acceptable level of risk for society.

- **UAS BVLOS Integration into the NAS May Mean Changing the "Rules of the Sky."** With the integration into the NAS of UAS BVLOS operations, ranging from piloted to highly automated, the FAA may need to reconsider the operational hierarchy in the NAS of all stakeholders to ensure the safe, efficient, and fair use of the airspace by all users.

The DOT and FAA have previously recognized the significant value associated with UAS operations. However, many important UAS applications require BVLOS operations. Over the past several years, the FAA has engaged in multiple pilot programs and partnership arrangements – including the Pathfinder Program, UAS IPP, Partnership for Safety Plans (PSPs), and currently BEYOND – to further both the agency's and stakeholder community's collective understanding of the benefits of such operations.

As stated above, the FAA must demonstrate the value of BVLOS operations to the public and to the interagency community. To lay the proper foundation, the Phase 1 teams worked to identify, quantify, and rationalize compelling safety benefits.

The first step was the development of categories that could be used to accurately and efficiently describe various types of societal benefits that may be achieved through UAS BVLOS operations. The categories were comprehensive and reflected the current state of broader values recognized and accepted by society. They mirror the "Four Pillars" that are priorities for the current administration: *economy*, *safety*, *environment,* and *equity*. A set of use case examples were created and then used to validate the adequacy of this initial set of categories. After further analysis, the categories were expanded to include *health* and *security* benefits. It should be emphasized that while the use cases and operations have a clear and compelling societal benefit for one of the main categories, almost all UAS BVLOS operations have the potential for crosscutting societal benefits that would align with and across multiple categories. For example, a UAS BVLOS operation might simultaneously provide *economic*, *safety* and *equity* benefits.

The *economic benefits* category describes BVLOS missions and use cases that provide an economic benefit such as cost savings and expanded market opportunities. This category breaks down further into *private* and *public* economic benefits. A company using UAS BVLOS to reduce costs might be described as receiving a "private economic benefit"; whereas UAS BVLOS operations that add convenience, lower costs, or provide more access to products for consumers would be described as a "public economic benefit". Ultimately, it was recognized that virtually all economic benefits examples could be classified as "public economic benefits", since society at large ultimately benefits.

The *safety* category captures the benefits of BVLOS operations that result in improved safety either for an individual, group, or community. For example, using UAS BVLOS operations for infrastructure inspection tasks that previously would have required a human worker to operate in a dangerous or risky environment demonstrates a case of safety benefits for an individual worker. *Public safety* is another important category of safety benefits and refers to the use of UAS BVLOS operations by law enforcement to provide situational awareness in emergencies.

The *security* benefits category captures benefits of BVLOS operations such as monitoring the perimeter of a large critical infrastructure facility.

The *environmental* benefits category describes those BVLOS use cases where some type of benefit to the environment could be identified and quantified. For example, UAS BVLOS operations can perform helpful weather measurements or combat climate change. UAS operations themselves are also greener and cleaner than traditional fossil-fuel modes of transportation.

The *health benefits* category grew out of the realization that UAS BVLOS operations could potentially lead to opportunities to improve both individual and community health. The humanitarian work underway in Africa and elsewhere is an example of BVLOS missions that can improve health and health outcomes. For example, this category could involve UAS BVLOS delivery of vaccines or important medications.

Finally, the *equity* benefits category describes those operations that provide benefits or opportunities for traditionally disadvantaged communities. UAS BVLOS operations can be a potential "equalizer" of access to opportunities for previously disadvantaged areas, regions, and communities – including but not limited to the disability community.

All of these societal benefits are discussed in depth in the Phase 1 report. From the ARC's perspective, one top line message clearly shines through: The societal benefits of UAS BVLOS operations are significant, and in some cases *very* significant. The ARC recommendation to FAA and DOT is intended to achieve a wide range of both public and private benefits for consumers, businesses, and governments. (See ARC Recommendation below at GP 2.1).

VI. ARC Activities and Outputs

The UAS BVLOS ARC has taken a comprehensive approach to developing the recommendations. Phase 1 of the ARC focused on developing initial findings and guidelines for UAS BVLOS operations, while Phase 2 focused on establishing a risk framework that builds on the Phase 1 inputs and makes recommendations to enable BVLOS operations by rule. Under the proposed regulatory structure, BVLOS operators would be able to operate to the rule without the need for exemptions and waivers. The framework should also facilitate an interim operating pathway, allowing BVLOS operations to occur pending the rulemaking implementation.

The Phase 2 Working Groups met for several months to identify and assess the risks for their specific Focus Areas. They were guided by the following tenets in making their recommendations:

Air & Ground Risk – The ARC should develop a Risk Framework to oversee the operation and integration of UA in the NAS. UA operations enabled under a newly proposed BVLOS rule must meet an acceptable level of risk. Qualitative and quantitative approaches to assess air and ground risks should be implemented via the new regulations to enhance compliance and reduce risks to an acceptable level. Mitigations may be assessed using qualitative or quantitative methodologies (or a hybrid approach), depending on the operating environment and levels of operational risk. Industry consensus standards should be used as a Means of Compliance, which would be subject to FAA acceptance.

Aircraft and Systems – Qualification of UA should follow a risk continuum, aligned with the Risk Framework, with the goal of meeting the acceptable level of risk. Where safety can be achieved outside of the traditional airworthiness certification processes, qualification should be implemented through a framework based on FAA acceptance of a statement or declaration of compliance to an FAA-accepted means of compliance. Where additional oversight is appropriate, a similar compliance framework can be implemented through a new category of special airworthiness certificate.

Operator Qualifications – A certified Operator or a properly trained and certified remote pilot qualified for BVLOS flight operations should have responsibility for assessing the operational environment, interpreting rule language, understanding technologies critical to BVLOS, selecting a UAS appropriate for the operation, and determining if the system is in a condition for safe operation.

Automated Flight Rules – Automated Flight Rules (AFR) ensure that UAS operators understand the risks to other users operating in the same airspace. There is a need to develop training proportional to the risks of the operation and levels of autonomy of the aircraft to ensure operators understand aviation weather, changing environmental conditions, and the safety implications associated with allowing an operation to commence or continue after an adverse event or change in environmental conditions.

Third Party Services – Use of a Third-Party UAS Service Provider (3PSP) is voluntary and should not be required by the regulations. There is no intent to require FAA approval of a third-party service as a condition of use by a UAS operator. However, if an operator elects to use a third-party service as a primary or secondary mitigation tool, the service must meet the requirements of an FAA approval or qualification. Different levels of performance may be provided by 3PSPs. A Service Level Agreement will be used to establish the details of the service provided to each operator. Third-Party Services that are included in the FAA approval of Associated Elements can be approved as a part of the operational approval. The FAA may also accept a service that has been pre-approved through the proposed new regulations for 3PSP approvals. Different levels of performance may be provided by 3PSPs.

A. Risk Management

One of the key principles from Phase 1 was a strong desire for a safety continuum that held all operations to a uniform standard for safe performance. The Phase 1 team also suggested that strategic and technical mitigations should play an important role in assigning risk values and defining operational criteria. The Phase 2 efforts toward meeting these objectives resulted in the development of a regulatory framework supported by an Operation Risk Matrix and an Automation Matrix. The Operation Risk Matrix defines risk levels based on a number of factors, including strategic and technical mitigation and kinetic energy of the UAS. The Automation Risk Matrix describes the acceptable ranges of autonomous UAS operations and prescribes the operator qualifications necessary to conduct these operations. The ARC has also developed a certification pathway for UAS and supporting Third-Party Services.

Risk reduction for any activity is dependent on the mitigations applied. For UAS BVLOS operations, the mitigations depend primarily on controlling access to and behavior within a specified operating environment. By regulating access, the number of persons exposed to risk is greatly reduced. By regulating behavior, specifically through operational and technical mitigations, risk is further reduced in a manner that is appropriate for the operating environment.

The ARC's risk hierarchy was designed to support a "fly to rule" framework that, in its simplest form, permits BVLOS operations when a Remote Pilot in Command can adhere to prescribed mitigations during all phases of flight. When adherence to the prescribed mitigations cannot be achieved or maintained, the operation would not be allowed *under the rules*, but may still be conducted via an alternative means of compliance. Consistent with that approach, the ARC developed the **Operation Risk Matrix**, which reflects some basic assumptions about operations at this altitude and the roles and responsibilities of traditional aircraft and UA. The ARC considered the nature in which low altitude airspace could be used for the betterment of society. The NAS is a public resource and there are numerous public benefits associated with opening it up to uncrewed aviation participants, including those that may not be able to become (or remain) traditional aircraft pilots due to physical, financial, or other barriers to entry. Redefining how aircraft operate in this volume of airspace will ensure safe and scalable operations for all operators. This will also reduce GA and ground fatalities by enabling lower risk UA BVLOS to conduct certain types of higher risk crewed aircraft operations that result in a number of deaths every year (e.g., agricultural spraying and helicopter inspections of power lines).

OPERATION RISK MATRIX – OPERATION LEVELS AND MITIGATIONS

AGL	BVLOS Ops Levels	Acceptable Level of Risk (ALR)	Strategic Ground Risk Mitigations	Strategic Air Risk Mitigations	Technical Ground Risk Mitigations	Technical Air Risk Mitigations	Right of Way		Third Party Services
<500 ft AGL+	**Level 1** **Air/Ground Risk Strategically Mitigated**	One acceptable level of risk the public expects of UAS met by qualitative/ quantitative or combined approach	Transient operation over human beings	Shielded Operations (as defined)	**<u><800,000 ft-lbs.</u> Minimum BVLOS Capabilities** UAS must have minimum BVLOS capabilities as defined in the new rule RPIC/operator determines compliance	N/A (shielded)	Amend 91.113 to say: "Within 100 feet of a structure, UAS has the Right of Way."	A/C ***<u>not equipped</u>*** with ADS-B out or TABS- Accept Risk, Gives way below 500 feet	Service Providers and Advisory Services
	Level 2a **Only Air Risk Strategically Mitigated**		N/A	Shielded Operations (as defined)	**<u><25,000 ft-lbs</u>.** FAA-accepted Declaration of Compliance by the manufacturer to an FAA accepted Means of Compliance based on industry consensus standards* **<u>25,000-800,000 ft-lbs.</u> SAC-UAS** DAR issues Certificate of Airworthiness + FAA-accepted Declaration of Compliance by the manufacturer to an FAA-accepted Means of Compliance based on industry consensus standards*	N/A (shielded)			Service Providers, Advisory Services, and Information Sharing/ Network Services when needed for safety
	Level 2b **Only Ground Risk Strategically Mitigated**		Transient operation over human beings	NOTAM	**<u><800,000 ft-lbs.</u> Minimum BVLOS Capabilities** UAS must have minimum BVLOS capabilities as defined in the new rule RPIC/operator determines compliance	**<u><800,000 ft-lbs.</u>** **Minimum BVLOS Capabilities** Collision Avoidance Capability that meets FAA-accepted means of compliance based on industry consensus standards* appropriate for relative risk of operating environment Conspicuity Capability that meets FAA-accepted means of compliance based			Service Providers, Advisory Services, and Information Sharing/ Network Services when needed for safety

						on industry consensus standards*			
	Level 3 **Neither Air nor Ground Risk Strategically Mitigated**		N/A	NOTAM	<u>**<25,000 ft-lbs.**</u> FAA accepted Declaration of Compliance by the manufacturer to an FAA accepted Means of Compliance based on industry consensus standards* <u>**25,000-800,000 ft-lbs.**</u> **SAC-UAS** DAR issues Certificate of Airworthiness + FAA-accepted Declaration of Compliance by the manufacturer to an FAA accepted Means of Compliance based on industry consensus standards*	<u>**<800,000 ft-lbs.**</u> **Minimum BVLOS Capabilities** Collision Avoidance Capability that meets FAA-accepted means of compliance based on industry consensus standards* appropriate for relative risk of operating environment Conspicuity Capability that meets FAA-accepted means of compliance based on industry consensus standards*			Service Providers, Advisory Services, and Information Sharing/ Network Services when needed for safety

* The FAA may permit submission of alternative MOCs by applicants, when compliance to a specific standard is not requested for interoperability issues.

1. Acceptable Level of Risk

Over the past half-century of aviation, safety objectives have been derived by examining historically accepted rates informed by decades of supporting data and public acceptance. These quantitative objectives are extraordinarily useful to the aviation industry, as they allow the FAA and industry to create and accept qualitative system/subsystem level requirements and standards that meet or exceed these acceptability objectives. Defined acceptable safety objectives have also enabled aircraft manufacturers and operators to show thorough analysis and testing for other acceptable means of compliance. For these reasons, the ARC feels it is paramount that the FAA establish an acceptable level of risk for UAS operations so that there is clear guidance for industry and regulators on what is acceptable, including helping to enable the development of industry standards.

While there was agreement in the ARC that determining an acceptable level of risk (ALR) was the best approach, there was some disagreement about how an ALR should be implemented. While the majority of the ARC desired a single value for all operations, some members suggested that the level should vary based on the type of operation. After substantial discussion, the consensus of the ARC is that a single set of ALR is appropriate to support all types of BVLOS operations. The set of ALR values should be consistent across all BVLOS operation levels. This approach is expected to ease implementation, increase understanding, and streamline compliance methods while promoting interoperability between differing UAS use cases. The expectation is that operators will be able to demonstrate they meet the ALR using qualitative methods, quantitative methods, or a combination of both. This is similar to existing Safety Management System constructs where a value is assigned and both qualitative and quantitative approaches are accepted to show compliance.

When selecting ALR values, the ARC proposes that the FAA base the quantified UA ALR values upon historical publicly accepted values for the risk associated with performing similar tasks using more traditional means. This is sometimes referred to as *risk transference*. The basis for risk transference is that the public understands that the tasks being performed incur a certain amount of risk, which they accept in return for the value of that task. It is thus reasonable to infer that if the method of performing that task changes, the risks associated with that method should be as low or lower than what the public currently accepts. In the case of UAS, this assumption is expected to be conservative, as the UAS operation is expected to bring additional societal and economic benefits that would increase the public's acceptance of UAS performing those operations. Over time, as UAS operations become more common and more data is collected, the acceptable levels of risk can be adjusted, as is done in traditional aviation.

Risk Assessment Methodology

When considering risk in aviation, there are three types of parties that may be involved:

People on-board the aircraft (1^{st} party risk);

People on-board another aircraft (2^{nd} party risk);

People on the ground who are not participating in aviation (3^{rd} party risk).

In traditional aviation, the predominant risk is to 1^{st} party participants–those on-board the aircraft, as they are directly affected by aircraft damage, failure, or pilot error. 2^{nd} party risk is incurred by those onboard another aircraft that the first aircraft may collide or otherwise interfere with, causing injury or death to that aircraft's occupants. The risk that an aircraft will cause injury or death to non-participating persons on the ground constitutes the 3rd party risk.

For UA, there are no people on board (and thus no 1st party risk). As there are different types and levels of risk for 2nd and 3rd parties (for example, people who choose to board an aircraft are by definition "participants in aviation activities" and therefore accept the risks associated with that aviation operation), these risk types should be distinctly addressed. The ARC therefore recommends that the FAA create two ALR values: one for air risk and one for ground risk. Both ALR should be based upon the corresponding risk rates for general aviation aircraft, as UA operations are most analogous to general aviation operations (UA do not carry passengers or substantial amounts of cargo) and pose a similar collision hazard.[11]

To determine an acceptable air risk value for UA operations, there is a direct comparison available between crewed aviation aircraft and UA: the fatality rates associated with a midair collision (MAC). By flying in the NAS today, general aviation pilots already accept the current risk posed by other general aviation aircraft. Matching UA rates (i.e., Acceptable Level of Risk) with the GA fatality rates currently experienced in the NAS provides a common risk benchmark accepted by both the aviation community and the public. It is important to note that strategic and/or technical mitigations may be used as part of a multi-layered approach to separation assurance. Performance requirements for technical mitigation, such as DAA, should be based upon present means (i.e., see and avoid) for meeting the operational rule. Thus, the technical mitigation performance requirement is only a singular component of ALR determination, and the two should not be conflated.

The ground risk ALR value should similarly be based primarily upon the currently accepted general aviation risk rate to 3rd party, non-participating people on the ground[12]. Similar to the air risk component, the current general aviation aircraft ground fatality rate can be easily calculated and has been historically accepted by the public and the aviation community for many years.

With the above in mind, the ARC recommends that the ALR for UA operations be aligned with the currently accepted general aviation (GA) fatality <u>rates</u> (e.g., per 100,000 flight hours) for both 2nd party MAC and 3rd party ground fatalities. This approach provides a clear, appropriate, and defensible quantified ALR that:

Is simple to calculate;

Enables rapid adoption and implementation;

Is fully supported by the substantial history of general aviation operations as a benchmark for risk rates that are acceptable to both the public and to the aviation community;

Ensures that the total acceptable risk rates for UA operations do not normally exceed historically accepted rates for general aviation fatalities.

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[11] While posing a collision hazard similar to crewed aircraft, using historical examples, it is expected that the consequence of a UA collision with a crewed aircraft will most likely be less severe.

[12] The ARC assumes that participants in the UA operation such as crewmembers, observers and customers are presumably aware of and accept the potential additional risk and have the ability to mitigate those risks in ways not expected of by the public (such as shelter, PPE and/or training).

The ARC notes that historically accepted fatality rates for both airborne MAC fatalities and 3rd-party ground fatalities can be calculated using accepted traditional aircraft expected reliability data and data available from the NTSB.

Furthermore, the ARC proposes that the FAA review existing societally accepted risks to inform and support the selection of the ground risk component of the ALR. For example, current ground vehicle fatality rates are an indicator of a risk that society accepts on a large scale. Many Americans participate in ground vehicle transportation activities on a daily basis and, for a certain societal benefit, have accepted the risk. Additionally, UAS operation may replace other modes of transportation (e.g., motor vehicles) for many use cases. Currently, the public understands that existing modes of transportation incur a certain amount of risk, which they accept in return for the value of that task. It is thus reasonable to infer that if the method of performing that task changes, the risks associated with that method should be as low or lower than what the public currently accepts. Leveraging this information may provide a confirmation value for the ground risk component of the ALR by ensuring that it aligns or favorably compares with the risks associated with other modes of transportation. Current fatality rates for other forms of transportation are publicly available via safety databases maintained by the NHTSA.

The ARC further recommends that the selection of risk mitigation methods (strategic, technical, or a combination of both) used to meet the ALR should be left to the UAS operator, provided that they can sufficiently demonstrate conformity to the acceptable level of risk.

Other Considerations

During discussion of the most appropriate risk approaches, the ARC considered additional risk and risk determination factors, including flight over people, UAS flight characteristics, property/infrastructure damage, and risk determination methodologies. Consideration of these factors determined and influenced several ARC recommendations.

In consideration of flight over people, the ARC considered a variety of approaches and factors in order to enable flight over people. Discussions were held regarding the number of people exposed to a UAS operation, relative-time exposure, and methodologies to determine exposure in BVLOS operations, etc. One method to determine number of people exposed to a UAS operation may be population densities. The ARC noted that population density values may not correlate to an accurately assessed risk level. A static population density may not account for dynamic circumstances in which the exposed number of people varies from a documented or published population density. Differentiating population categories, such as “densely populated” or “sparsely populated” are not defined in existing regulations, and may not account for dynamic circumstances. Furthermore, published total population may not be a meaningful factor to consider when a town of 50,000 in comparison to a city of millions may have the same population density in particular neighborhoods or areas. Additionally, the population density values do not consider the percentage of time in which people may be sheltered (indoors or in a vehicle), in which adequate protection from UAS activity may be provided, factors which may lead to more accurately assessed risk levels. The ARC noted that previous studies reported, on average, people only spend about 7% of the day outside.[13] This study illustrated the extent to which the number of

[13] *See:* https://pubmed.ncbi.nlm.nih.gov/11477521/ Klepeis NE, Nelson WC, Ott WR, Robinson JP, Tsang AM, Switzer P, Behar JV, Hern SC, Engelmann WH. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. J Expo Anal Environ Epidemiol. 2001 May-Jun;11(3):231-52. doi:

people exposed to a UAS operation may vary from a published population density. These considerations challenge the use of population density as a valuable method for determining risk. The ARC noted that the relative time-based exposure of UAS flights is an important factor in determining actual ground risk exposure and probability. Therefore, the ARC recommends the characteristics of the flight be paramount to determine actual ground risk exposure and probability. While the ARC strongly supports a single set of ALR values for UA operations, we recommend the FAA consider differentiating between flights that transit populated areas for only a small percentage of the overall flight time (e.g., the minimal ground risk and exposure of a BVLOS flight quickly crossing a road in a rural area) versus the exposure of a flight with characteristics of sustained flight over people (e.g., a UAS covering a parade). This differentiation allows flights that only briefly transit populated areas to be appropriately and accurately risk-assessed as comparable to flights over less-populated or non-populated areas, particularly when the shelter factor is considered. As UAS BVLOS operations increase, the FAA may need to consider additional wide scale characteristics, which account for repeated, high-frequency, or multiple UAS activities over an area.

Additionally, the ARC considered what factors should be included in risk determination. Discussion and comments throughout the ARC recommended the consideration of property and infrastructure damage. Historically, traditional aviation risk is measured in harm to people. Damage to property and infrastructure is a consideration in the risk of an operation, but presents challenges in how the risk can be measured in a function of severity and likelihood. Collision with property and infrastructure that results in 3rd party fatalities should be measured and considered in the determination of an ALR.

The ARC considered in detail the advantages of employing both qualitative and quantitative methodologies. The ARC notes that it could be challenging, and not necessarily risk appropriate, for all operators to demonstrate compliance with a quantified ALR for lower risk, or 'Level 1' operations, as described in the proposed Operation Risk Matrix (below). Therefore, the ARC recommends that the FAA accept qualitative, quantitative, or a combination of both methods to achieve an acceptable level of risk because certain elements will be more practical to demonstrate and verify from a quantitative standpoint, while others from a qualitative standpoint. It is expected though that qualitative requirements and standards would be based on industry best practices, lessons learned, and existing standards; as is currently done in traditional aviation.

2. Strategic & Technical Risk Mitigation

The Operation Risk Matrix depicts Risk Levels based on the strategic air and ground mitigations applied to the operation. The ***Risk Levels*** are - 1, 2A/2B and 3, with 3 being the highest level of risk. Strategic mitigations reduce risk prior to flight, while technical mitigations reduce risk inflight. The majority of the ARC decided that the Risk Level should be based on strategic mitigations, or how much risk is removed from the operation before it commences.

The ARC acknowledges that in some cases, a mitigation can be both strategic and technical in nature. For example, UTM Strategic Deconfliction is a strategic air risk mitigation (i.e., avoid UA-UA collision) that can also be used as a technical ground risk mitigation (e.g., reroute an airborne UA away from a

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10.1038/sj.jea.7500165. PMID: 11477521. "NHAPS respondents reported spending an average of 87% of their time in enclosed buildings and about 6% of their time in enclosed vehicles."

high-risk area). While the ARC recognizes that both strategic and technical elements may be present in a given mitigation tool, strategic mitigation was considered the most suitable factor to categorize risk because it reflects the actions taken by the operator to *proactively* reduce it – i.e., reduce the risk before the flight. Thus, the ARC considers strategic mitigation to be paramount in avoiding risk even when there are also technical mitigations available. As such, the degree to which risk can be reduced prior to launch was the determining risk factor in the Operation Risk Matrix.

It follows then that operations with the highest risk rating are those where neither air nor ground risk are strategically mitigated, or only one is partially mitigated. These operations, depicted in Level 3 on the Operation Risk Matrix, require technical ground and air risk mitigations, including a qualified UA and collision avoidance and conspicuity capabilities that meet the performance requirements of FAA-accepted industry standards. The mitigations must be appropriate for the relative risk of the operating environment, and may include the use of Third-Party Services.

For Level 2A, the air risk has been strategically mitigated to an acceptable level. This may include information sharing and network services, such as strategic deconfliction as described above. Technical ground risk mitigations are required, including a qualified UA and collision avoidance and conspicuity capabilities that meet the performance requirements of FAA-accepted industry standards.

In Level 2B, ground risk has been strategically mitigated to an acceptable level, but Technical air risk mitigations are required. When only ground risk is strategically mitigated, a collision avoidance capability and conspicuity is required for technical air risk mitigation.

At Level 1, air and ground risk are strategically mitigated to an acceptable level. Here, the only technical mitigation is that the UAS have the minimum BVLOS capabilities. The recommended minimum UAS BVLOS capabilities for all aircraft involved in the flight operation are:

- Maintain awareness of the location of the UA;
- Adhere to all limitations applicable to the operation including, but not limited to:
  - Operating rules, and
  - UAS performance and environmental limitations.
- Navigate with accuracy appropriate for the operation and operating environment.
- Provide command and control appropriate for the operation and level of automation.
- Manage contingencies that can reasonably be expected to occur during the operation, including but not limited to:
  - Loss or degradation of aircraft functions, third party services, or external systems needed for safe operation.
  - Low fuel/power state.
  - Changing weather and environmental conditions.
  - Avoid collisions between UA during one-to-many operations within a single operating area.
  - Protect against common security threats.

3. Risk Mitigation Using Third-Party Services

Third-party services are a range of services that:

1. directly support the flight of the aircraft. This includes ground based DAA systems, or command and control links for technical mitigation during the flight; or
2. provide strategic safety benefits, such as deconfliction of flight plans; or
3. are efficiency improvement or indirect support services that do not have a direct impact on safety but do have a supporting function to ensure safe operations.

The ARC has developed a categorization scheme for the services that includes two major qualifiers: Impact on Safety and Impact on Control.

Impact on Safety

- Safety-Enhancing: a service, or article provided as a service, whose failure condition is minor.[14]
- Safety-Integral: a service, or article provided as a service, whose operation is required by the MOC used to approve the UA and/or by the remote operating certificate.[15]

Impact on Control

- Advisory: Advice and information provided as a service to assist pilots (onboard or remote) in the safe conduct of flight and aircraft movement.
- Compulsory: Operational control provided as a service to exercise authority over initiating, conducting, or terminating a flight. When using a compulsory service, no pilot in command may deviate from that service unless an amended clearance is obtained from ATC, an emergency exists, or the deviation is in response to a traffic alert and collision avoidance system resolution advisory.

There are three resultant categories, from the perspective of the Operator Applicant:

- 3PSP used as primary mitigation (technical or strategic); Safety-Integral, Service supporting a Compulsory function
- 3PSP used as secondary/alternate mitigation (technical or strategic); Safety-Enhancing Service supporting a Compulsory function and/or Safety-Integral Advisory Services
- 3PSP not used as primary or secondary/alternate mitigation; Safety-Enhancing Advisory Services

The ARC considered a recommendation to make third-party services mandatory. Some members felt that certain services should be required for all UAS operations, while others believed a recommendation of that nature was premature. The ARC ultimately decided against recommending mandatory third-party services, but did acknowledge that additional services (third party or otherwise) could be required when warranted by the actual airspace conditions. To that end, the ARC recommends that the FAA and NASA conduct a study to determine what level of aircraft operations in a defined volume of airspace

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[14] Derived from FAA Policy Statement: Approval of Non-Required Safety Enhancing Equipment (NORSEE), Policy No: PS-AIR-21.8-1602, Initiated By: A.V. AIR-100, 3/31/16.
https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgPolicy.nsf/0/1790b02f1833357486257f9200592110/$FILE/PS-AIR-21.8-1602.pdf

[15] *See* 14 CFR Part 91.213.

would trigger the need for mandatory participation in federated or third-party services. (See ARC Recommendation TP 2.2). The ARC further recommends that a formal certification process, with direct FAA approval, be required for third-party services that are the primary method of risk mitigation, and have a direct safety or control impact on a flight (or on many flights). (See Third-Party Services Recommendations at Section X.E. below).

B. Operating Rules

The ARC is recommending several changes to Part 91 to facilitate UAS BVLOS operations as well as low altitude, shielded, and non-shielded operations for all aircraft. The ARC seeks a regulatory regime where UAS never present an appreciable risk to GA aircraft or to 2nd or 3rd parties. The ARC's recommendations for the UA industry will make them a more safety conscious and diverse participant, while the recommendations for crewed aircraft operators will not require significant changes in operational procedures because they are confined to airspace where very few GA operations occur. The ARC is hopeful that impacted stakeholders are motivated to engage in an appropriate give and take that allows the tremendous safety and economic benefits of UAS BVLOS operations to be realized.

The proposed amendments will ensure that contemporary technologies are incorporated into the regulations. The ARC's recommendations are designed to incentivize the use of 'detect and avoid' (DAA) technology to improve safety for all users in the NAS and to resolve longstanding issues around safety critical requirements, such as separation minimums.

1. Detect and Avoid & Well Clear

Under FAR § 91.113, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. UAS without pilots on board must provide an equivalent to the 'see and avoid' requirement. This is usually accomplished by using an individual RPIC, visual observers on the ground, or visual observers in chase planes who are in constant contact with the remote pilot. These restrictions greatly limit the viability of UA operations and significantly increase their costs.

The 'see and avoid' requirement is also problematic vis-à-vis GA-UA operations. In the NPRM for Small Unmanned Aircraft Systems, the FAA stated:

> The operation of UAS presents challenges to the application of the traditional right-of-way rules. The smaller visual profile of the small unmanned aircraft makes it difficult for manned pilots to see and, therefore, avoid the unmanned aircraft. This risk is further compounded by the difference in speed between manned aircraft and the often slower small unmanned aircraft.

Consequently, the FAA implemented § 107.37(a)(2), requiring UAS operators to always initiate an avoidance maneuver to avoid collision with any other user of the NAS.[16] The FAA acknowledged, however, that technological solutions might one day exist that would solve the 'see and avoid' problem for UAS, but they were not yet sufficiently developed. Several years later, the technology has evolved as the FAA anticipated, allowing more effective sensing methodologies to be used safely. Amending the rules to allow greater use of this technology helps bridge the gap to the long-term goal of developing

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[16] Operation and Certification of Small Unmanned Aircraft Systems, Feb. 22, 2015, https://www.regulations.gov/document/FAA-2015-0150-0017.

the policy, guidance, and operational procedures necessary to enable crewed and uncrewed aircraft to fly together.[17]

The proposed amendments are based on studies that demonstrate the difficulty of see and avoid in operational environments. The first study examined 40 years of data and estimated that the probability of an aircraft encounter where there is a loss of well clear in Class E airspace is 1.94×10^{-6}. The study calculated this number using the NTSB midair collisions between January 1977 and December 2016. During this period, there were 4 collisions between IFR aircraft and VFR aircraft[18] in Class E airspace below 10,000 feet. The number of flight hours during this period was approximately 9.88E08.[19] This produces a collision rate of 4.05×10^{-9} per flight-hour. The study used an estimate that aircraft that is in a loss of well clear trajectory will be on a collision trajectory approximately 1-in-145 (0.0069) encounters[20]. The effectiveness of see and avoid has been estimated at 0.6975, averaging alerted and un-alerted encounters.[21] Only about 70% of aircraft within the pilot's field of view would be detected by a GA pilot prior to a loss of separation. Using the number of aircraft in the field of view does not account for the fact that no aircraft has a constant 360° field of view for the pilot, so there will be even fewer detections of the total population of potential intruders.

Likelihood of see and avoid:

a. ~70% of intruders visibly detected (Andrews, LL Study)
b. ~25% of airspace visible from generic cockpit (Assumes a fixed wing cockpit where the pilot cannot see behind or below due to the aircraft structure blocking the view which yields 90° vertical and 180° horizontal field of view)
c. ~17.5% (70% x 25%) of intruders detected and avoided (Current level of collision risk accepted by GA)

In addition, combining the historical collision rate with the geometric consideration and the effectiveness of see and avoid, the Andrews study estimated that an IFR and a VFR[22] aircraft are in a loss of well clear encounter approximately 2 times in every million hours of flight (4.05E- 09/(0.0069*0.3025) = 1.94E- 06). This shows that for high operational density Class E airspace, 'see and avoid' is not the main mitigating factor in collision avoidance. For lower operational density airspace, such as below 500' AGL, there are certainly fewer aircraft to 'see', but the pilot's ability to do so is compromised by the necessary

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[17] Unmanned Aircraft Systems Aviation Rulemaking Committee, Jun 17, 2011, https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/uasarc-6172011.pdf .

[18] NTSB data for mid-air collisions for VFR operations for calendar years 1990-2018 indicate there were approximately 11.6 mid-air collisions per year. Analyzing the FAA General Aviation and Air Taxi Activity and Avionics Surveys (GAATAA Surveys) provides the number of flight hours from 1999-2018. The GAATAA Surveys showed 1999 as a peak year for crewed VFR flight with 25 million hours and indicated a 20% decline by 2018. Extrapolating the NTSB Data and the peak VFR hours from this 28-year period resulted in the statistical risk of a mid-air collision every 1.08 million flight hours. This figure represents the risk of mid-air collision involved in VFR operations with human crews, who can mitigate some collisions that would have otherwise occurred.

[19] Bureau of Transportation Statistics.

[20] *Modeling of Air-to-Air Visual Acquisition*, J. W. Andrews, MIT Lincoln Laboratory Journal, Volume 2, Number 3 (1989). https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.186.2376&rep=rep1&type=pdf.

[21] Andrews, MIT Lincoln Laboratory.

[22] The ARC acknowledges that the study focused only on IFR-VFR encounters. However, the ARC is unaware of any studies that focused on VFR-VFR encounters and considers this study's information to provide valuable metrics for the purpose of this discussion.

focus on avoiding terrain and other obstacles. Consequently, it is when see and avoid is most needed that a pilot is least able to accomplish it effectively, further reducing its mitigation value.

In another study conducted by Embry-Riddle,[23] the authors found that:

Participants detected the sUAS during 12 out of 40 possible events, resulting in an overall detection rate of 30.0%. Moving sUAS were detected during 9 out of 18 possible events, resulting in a detection rate of 50.0%. Static sUAS were detected during only 3 out of 22 possible events, yielding a detection rate of 13.6%.

Although the numbers vary, the results from both studies demonstrate that visual detection of UAS is difficult and steps should be taken to manage UA visibility in order to fully integrate UA into the NAS. The ARC considers that its recommendations strike an appropriate balance between UA and GA operators that promotes shared responsibility in this shielded airspace, and facilitates a performance-based approach to collision avoidance based on the mission, environment, and aircraft involved. The ARC also notes that its recommendations are consistent with those made by the authors of the Embry-Riddle study who stated that:

> "Participants generally indicated that spotting the sUAS was much more difficult than originally anticipated. Despite favorable visual conditions, participants were still challenged to successfully spot airborne sUAS. While participants indicated that moving and high-contrast sUAS targets were easier to detect, efforts should be made to employ scanning strategies to spot static and low-contrast targets, as well. **This suggests a possible need for emphasis in scanning training to adequately prepare pilots to employ proper techniques to maximize visual detection. This could also include an effort to make manned pilots more aware of the need for vigilant scanning to detect unmanned aircraft when flying at low altitude or in areas of known sUAS operations.** (emphasis added).
>
> Small UAS operators should be cognizant of the challenges associated [with] pilot detection of their platforms. **Steps should be taken by the sUAS Remote Pilot to maximize the conspicuity of their platforms, such as using high-contrast UAS colors, performing regular maneuvers, or other strategies to make their operation as visible as possible."** (emphasis added).

As more fully discussed below, the ARC's proposals include educating and training crewed aircraft pilots to associate obstacles and structures along their flight path with uncrewed flight operations, thereby increasing situational awareness during both preflight planning and actual operations. Uncrewed aircraft operating within the agreed boundaries of a structure or obstacle would be considered part of the structure/obstacle, providing a UAS operational volume that is largely free of crewed aircraft.

The incorporation of other sensing methods in the regulatory framework will improve safety, and the collision avoidance risk for both UA and GA could be reduced by encouraging the use of ADS-B out or Traffic Awareness Beacon Systems (TABS)[24], especially during very low altitude operations. The safety

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[23] Cleared to Land: Pilot Visual Detection of Small Unmanned Aircraft During Final Approach, Ryan Wallace, Samuel M. Vance, *International Journal of Aviation, Aeronautics, and Aerospace* (2019), https://commons.erau.edu/ijaaa/vol6/iss5/12/.
[24] Use of TABS equipment that conforms to FAA TSO C-199, for aircraft that are not currently required to have ADS-B under 14 CFR § 91.225.

benefits of this recommendation are significant for all aircraft operations. Accordingly, the ARC recommends that FAR § 91.113(b) be amended as follows:

General. When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules, visual flight rules, or *automated flight rules,* vigilance shall be maintained by each person operating an aircraft so as to *detect* and avoid other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under, or ahead of it unless *able to maintain adequate separation.*

The ARC recommends adding the word 'detect' in lieu of the word 'see'. This change allows the use of other sensing methods beyond human visual capabilities, and creates more options for industry. This is also consistent with a recommendation from the 2013 UAS ARC that a new subsection (1) be added to 91.113(b) clarifying that, for UA, the use of the word 'detect' should apply.[25]

The ARC also recommends removing the phrase 'well clear' and replacing it with 'adequate separation'. This change creates solution space for the regulator and industry by allowing different levels of separation to apply in different situations, and better align with 'performance based' approaches. For the airspace below 500', the existing well clear definitions are not safe or feasible so avoiding the use of that term in the regulatory structure is recommended. Implementation of this change requires a different approach to determining collision risk that is not dependent on a volume of airspace, but rather on an acceptable level of collision risk appropriate for the airspace. Enabling operations that do not require a non-cooperative sensor will accelerate the approval of UA that will replace higher risk operations and activities, increasing aviation and societal safety with no appreciable increase in risk to other crewed operations.

2. Collision Avoidance, Conspicuity and Maneuverability

All operators bear responsibility for collision avoidance, but under Part 107, UA are *always* required to yield right of way to other aircraft. As stated above, this rule was adopted primarily due to the FAA's concerns about conspicuity and maneuverability. The ARC is proposing to move away from conspicuity and maneuverability as the *only* factors to consider for right of way, and instead, establish a risk-based approach that increases conspicuity requirements while also:

- mandating DAA equipage for UA conducting BVLOS operations; and
- establishing an operational hierarchy that mitigates crewed aircraft maneuverability concerns.

As more fully explained below, these proposed solutions will support UAS integration and increase safety for all aircraft operators.

The ARC is recommending conspicuity requirements for UAS to mitigate visibility risks. The requirements could include strobe or other lighting features, or a paint scheme that increases visibility. The FAA should consider establishing a Means of Compliance through a standards development organization (SDO) for conspicuity requirements.

[25] See footnote 17 above.

The ARC is sensitive to the argument that no amount of conspicuity will ever make a UAS as visible as a crewed aircraft. However, even if that was possible, there are still limitations to 'see and avoid' that justify a recommendation for other types of mitigations being accepted in the rules. As discussed above, the ability of crewed aircraft pilots to 'see' and avoid *any* aircraft by visual observation alone is very limited. Therefore, other safety solutions should be implemented to reduce the likelihood of UA-GA encounters. To that end, in addition to the conspicuity requirements, the ARC is also recommending a change to the right of way rules to give UA right of way over *unequipped* crewed aircraft in operating environments with minimal GA activity.

Given the Charter's restriction to UAS BVLOS operations outside of ATC, there is no viable way to achieve the ARC's objectives (and the corresponding benefits of scaled UAS BVLOS operations) without addressing right-of-way rules and allowing UA to have right of way in some limited circumstances. The current status quo, where the UA assumes 100% of the collision avoidance responsibility, is not reflective of contemporary technologies and is unsustainable in the UAS BVLOS environment. Some ARC members strongly disagree with an adjustment to the right of way rules, but the majority determined that the shift is necessary to fulfill the ARC's mission and bring these benefits to the American people.

The recommendations present a significant paradigm shift because in some cases, crewed aircraft would yield right of way to UA. However, the recommendations provide the greatest overall safety benefit for the expected mix of crewed and uncrewed aircraft in the NAS because:

- The unmitigated risk of mid-air encounter between UA and unequipped GA aircraft in the below 500' AGL operating environment is low;
- The risk of a collision fatality between a GA and UA aircraft is very low when compared to the risk of controlled flight into terrain or obstacles involving low altitude operations with human crews (e.g., crop application, power line patrol, etc.);
- The short-term minimal risk of a UA-GA collision in Low Altitude and Shielded airspace is far outweighed by the long-term reduction of the high risk of fatal accidents involving crewed aircraft conducting low altitude missions; and
- The proposed rules are limited to UA with a mass and speed which result in UA kinetic energy of no more than 800,000 ft.-lbs. to limit the consequences of ground collisions.

C. Right-of-Way Rules for Low Altitude Operations

The ARC recommends changes to the Right of Way rules between UA and GA aircraft for Shielded Operations and Non-Shielded Low Altitude Operations. The ARC does not intend to negate UA's collision avoidance responsibilities and recognizes that right of way and collision avoidance are related but not the same regulatory requirement. However, there currently exists an operational hierarchy for right of way and the ARC is recommending that the UA's position in that hierarchy shift in operating environments where there is little GA traffic.

1. Low Altitude Operations

The ARC selected the altitude limits for the application of the proposed Right-of-Way rules to most closely align with widely understood controlling altitudes for both traditional and uncrewed aviation. The ARC clarifies that this recommendation is primarily for Class G airspace and recommends that the FAA create a method to authorize coordination with ATC for operations in controlled airspace (e.g., Low

Altitude Authorization and Notification Capability (LAANC), Letter of Authorization (LOA), or other approval).

a. 500' AGL is the minimum safe altitude for aircraft operating away from airports and over other than congested areas as defined in 14 CFR §91.119(c), and well below the minimum safe altitude for aircraft operating away from airports and over congested areas as defined in §91.119(b). Exceptions to this rule are limited to specific types of aircraft operations as defined in §91.119(d) (for helicopters and weight shift control aircraft); and in §137.49 and §137.51 (for agricultural aircraft during actual dispensing operations). This **substantially limits the number of aircraft that are authorized to operate** in the limited altitude strata from the surface to 500' AGL, and therefore would **substantially limit the number of aircraft that might be affected by the rule change**– particularly as many of these aircraft are already equipped with ADS-B out or TABS capability.
b. 400' AGL is the current altitude limit for UA operating under Part 107. It is widely understood and accepted by the aviation community, and has proven to support the vast majority of sUAS Use Cases.

The difference between the altitude cap for UA (at 400' AGL) and the altitude floor for traditional aircraft (at 500' AGL) affected by the rule change provides an altitude "buffer" of up to 100' AGL that provides:

a. Traditional unequipped aircraft descending into this stratum the opportunity to scan the area for potential traffic conflicts **before** the UA is co-altitude;
b. UA equipped with ADS-B in collision avoidance the opportunity to detect descending converging traditional aircraft **before** the aircraft is co-altitude;
c. Sufficient safeguard for altitude accuracy errors (with up to 75' allowable under §91.411 and as specified in Appendix E of Part 43).

2. Non-Shielded Low Altitude UAS BVLOS – *ADSB Equipped* Crewed Aircraft Have Right of Way

The ARC is recommending that § 91.113 be amended to give crewed aircraft equipped with ADS-B or TABS right of way over UAS conducting BVLOS. This proposes a requirement for the UAS conducting BVLOS to have an FAA approved or accepted DAA system that can detect ADS-B or TABS equipped aircraft **or** an FAA approved or accepted system that can detect all aircraft using another means (e.g., radar, acoustic or electrical optical).

The proposed regulatory text is as follows:

§ 91.113(h)

<u>Uncrewed Aircraft Conducting BVLOS Operations Below 500 ft AGL.</u>

(1) Uncrewed Aircraft with a maximum kinetic energy of no more than 800,000 ft.-lbs. must yield right of way to all aircraft that are equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.

(2) The UAS must:

a. be equipped with an FAA approved or accepted detect and avoid system that can detect ADS-B or TABS equipped aircraft or can detect all aircraft using another means as specified in 14 CFR 108.XX
b. Be approved in accordance with 14 CFR Part 108.XX.

(3) The UAS operator must:

a. Notify other aircraft of their operation through use of a NOTAM or other means accepted by the FAA.
b. For operations in controlled airspace, obtain prior authorization from the airspace controlling facility
c. For operations in uncontrolled airspace, coordinate with the airport operator for operations within 3 nautical miles for public airports
d. For operations in uncontrolled airspace, coordinate with the heliport operator for operations within ½ nautical mile of the published heliport.

3. Non-Shielded Low Altitude UA BVLOS – UA Have Right of Way

The ARC proposes to amend 91.113 to require crewed aircraft that are **not** equipped with ADS-B or TABS operating below 500 feet and away from structures to yield right of way to UA conducting Low Altitude BVLOS Operations away from Airports/Heliports. The UA would be required to detect and avoid ***only*** those crewed aircraft that are broadcasting ADS-B out or TABS. Unequipped crewed aircraft would be required to yield the right of way to UA traffic.

To clarify, the ARC is not recommending a mandated equipage requirement for crewed aircraft. Rather, it is recommending that equipped aircraft have right of way over non-equipped aircraft, regardless of which aircraft is crewed. Nearly half of the existing GA fleet is already ADSB equipped (107,000 equipped of 220,000 active aircraft).[26] It is expected that equipage rates will increase if the proposed regulations are adopted. The ARC encourages the FAA to consider restarting the ADS-B subsidy program to support crewed aircraft operators that were not previously impacted by the ADS-B equipage mandate. Increasing equipage rates among a greater number of crewed aircraft would yield a safety benefit for all users of the NAS, regardless of any UA interactions. Requiring UAS BVLOS operators to be able to detect ADS-B or TABS equipped aircraft or all aircraft using another means also improves safety, especially for operations where crewed and uncrewed aircraft may both be present (e.g., UAS and helicopter providing coverage of the same event).

4. Shielded Operations – UA Have Right of Way

Shielded Area is defined as a volume of airspace that includes 100’ above the vertical extent of an obstacle or critical infrastructure and is within 100 feet of the lateral extent of the same obstacle or critical infrastructure as defined in 42 U.S.C. § 5195c. A Shielded Operation is an operation within a Shielded Area.

The ARC is recommending that § 91.113 (d) be amended to give UA right of way over all aircraft for Shielded Operations. The proposed regulatory text is as follows:

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[26] FAA reported ADS-B Equipage Levels as of 11/2021, https://www.faa.gov/nextgen/equipadsb/installation/current_equipage_levels/.

§ 1.1 General Definitions

Shielded Area is a volume of airspace that includes 100’ above the vertical extent of an obstacle or critical infrastructure and is within 100 feet of the lateral extent of the same obstacle or critical infrastructure as defined in 42 U.S.C. § 5195c. A Shielded Operation is a UAS BVLOS operation within a Shielded Area.

§ 91.113 (d)(4)

Uncrewed Aircraft conducting BVLOS Shielded Operations have right of way over all other aircraft.

The ARC intends to maximize the utility of the existing “bubble” of airspace near structures and other obstacles that crewed aircraft are already in the habit of avoiding. The ARC considers the likelihood of UA-GA encounters to be minimal in shielded airspace because crewed aircraft typically do not conduct operations near obstacles, and the existing regulations prohibit a significant portion of helicopters and non-agricultural GA aircraft from operating at low altitudes except for takeoff or landing.[27] With perhaps the exception of a helicopter landing or taking off from a building, no crewed aircraft should be within 100 feet of a structure for the vast majority of low altitude operations. The limited crewed operations in this volume of airspace provides a strategic mitigation that allows UA operators to obtain the full benefits of shielded operations, and increase safety without any additional cost or technology. The intent is to capitalize on structures that pilots are already trained to avoid under existing VFR operating rules.

For the recommendations that give UA right of way, the ARC clarifies that it does not intend to change the responsibility for a UA to *avoid* any aircraft that it has detected that has the potential to create a collision hazard. The ARC has added language to proposed §108.37 clarifying this continuing responsibility. The ARC further clarifies that its recommendation is to grant UA right of way within 100 feet of structures. This includes natural or man-made objects, such as trees, buildings, towers, or power lines, as well as operations associated with critical infrastructure as defined in 42 U.S.C. § 5195c. Inclusion of critical infrastructure is consistent with the special treatment defined in the FAA Reauthorization of 2016 in section SEC. 2210. “Operations Associated with Critical Infrastructure.” (Public Law 114–190—July 15, 2016).

The recommendation is based on a study of shielded operations that was conducted to determine the collision risk over transmission lines located in Class G airspace.[28] The actual recorded aircraft tracks calculated an unmitigated collision risk of 2.2 in 100 million hours of operation in shielded Class G airspace, outside 3 NM of public airports. This number is assuming a once-a-year traverse of the transmission line by the UA against an average traffic count from the actual recorded data. The tracks were collected from a length of transmission line located inside a Mode C veil, and within FAA radar coverage to the ground so that all aircraft were accounted for in the recorded data. The altitude over the ground was calculated using actual pressure altitude data corrected using the recorded barometric pressure. Conservative assumptions were made to determine the possibility of an aircraft being close enough to the transmission lines to result in a loss of well clear (within 250 feet vertical and 2000’ feet

[27] 14 CFR §91.119 Minimum Safe Altitude.
[28] *See* UAS XCEL ENERGY BVLOS PROJECT AIRSPACE ANALYSIS CAT062 Track Counts and P(LWC), Tony Boci, Systems Engineering Scientist, Surveillance & Automation Solution, July 17, 2020 at Appendix D.

horizontal), and the 1-in-145 ratio mentioned previously was used to extrapolate from loss of well clear to midair collision. Because of the need to know the exact height and location of the infrastructure, only inspections coordinated with the owners of the infrastructure could qualify for these types of shielded operations. These types of operations will be authorized by the new proposed rule. (See Flight Rules Recommendations). For BVLOS operations authorized under the proposed amendments to existing Part 107, coordination with the obstacle owner would not be required (e.g., FPV inspections with a VO for airspace awareness).

5. Airport & Heliport Requirements for Low Altitude UAS BVLOS Operations

The ARC proposes that:

- UAS BVLOS operations **near** published airports are in conformance with LAANC facility maps. For public airports without a LAANC grid, UAS BVLOS operators must maintain a 3 NM distance unless a closer operating distance is coordinated in advance with the airport manager.
- UAS BVLOS operations may not be conducted within ½ NM of a published heliport without prior coordination with the airport or heliport manager/operator.
- Coordination with airport or heliport operators may occur via NOTAM, chart markings, or other FAA published materials.
- UAS BVLOS operators must notify other aircraft of their operation through use of a NOTAM or other means accepted by the FAA. Presently, UA awareness is via NOTAMs and could be further facilitated by upcoming UTM or Network Remote ID implementations.
- UAS BVLOS operations **away** from public airports or published heliports are required to detect and avoid ***only*** those crewed aircraft that are broadcasting ADS-B out or TABS. The GA traffic that routinely operates below 500’ and away from airports/ heliports and their traffic patterns comprise a small fraction of the GA population. The unmitigated risk of encounter between UA and unequipped GA aircraft in the below 500’ operating environment is very low.

6. Regulatory Structure & Other Regulatory Amendments

There are several other regulatory amendments required to support the proposed Operating and Right of Way Rules, including:

- Creating a new part (c) in § 91.103 to expand upon current guidance and ensure compliance with preflight actions unique to uncrewed aircraft conducting BVLOS operations in the NAS. (Recommendation FR 2.6).

- Amending § 91.119 to allow UAS to legally operate below the current minimum safe altitudes. (Recommendation FR 2.7).

- Amending § 107.31 to expand visual line of sight aircraft operations to include Extended Visual Line of Sight. (Recommendation FR 2.8).

- Amending § 107.33 – to allow a visual observer to assist and support BVLOS operations. (Recommendation FR 2.9).

In addition to these proposed amendments, the ARC also recommends the following example structure for the new BVLOS rule:

Subpart A – General

Subpart B – General Operating and Flight Rules for UAS Beyond Visual Line-of-Sight Operations

Subpart C – Certification: Remote Pilots

Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS

Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators

Subpart F – Operating Requirements: Remote Air Carriers and Remote Commercial Operators

Subpart G – Agricultural Remote Aircraft Operations

VII. Qualification Standards

The ARC considered the question of type certification for all UA in BVLOS operations. Specifically, whether a Part 21 approval process was necessary for safety or whether qualification of aircraft and systems could be achieved through a different process or framework. The timelines for certification projects and typical UAS product lifecycles were considered alongside the safety benefit of certification processes and oversight. While there were differing viewpoints among the ARC members, the overall recommendation is that type certification should not be required for all UA operating under the limitations of this proposed BVLOS rule which is applicable to lower relative risk environments and only a portion of the NAS. However, there is no intention to compromise safety. The ARC recommendations are based on the premise that while all UAS require appropriate engineering level standards, not all aircraft and systems qualification processes require the same level of FAA oversight to ensure safety. This concept is central to the risk-based, performance-based approach.

While most are familiar with smaller UAS which have been enabled under P107, the ARC discussed beneficial use cases that greatly benefit from larger aircraft. These use cases are typically not conducted over non-participants. Examples include long range railroad and pipeline patrol in rural areas, agricultural spraying close the ground directly over farm fields, forestry, and potentially firefighting. When considering how to establish the boundary where design and production approval or airworthiness certification would be appropriate, both the size of the UA, aircraft configuration, and the operating environment were considered. (e.g., It may not make sense to operation a large fixed-wing UA entirely below 400 ft AGL, but it may make sense, and even be advantageous, to operate a large UA rotorcraft.) This led to a discussion of the Special Airworthiness Certificate for Light Sport Aircraft as an example framework that could be applicable to larger UAS.

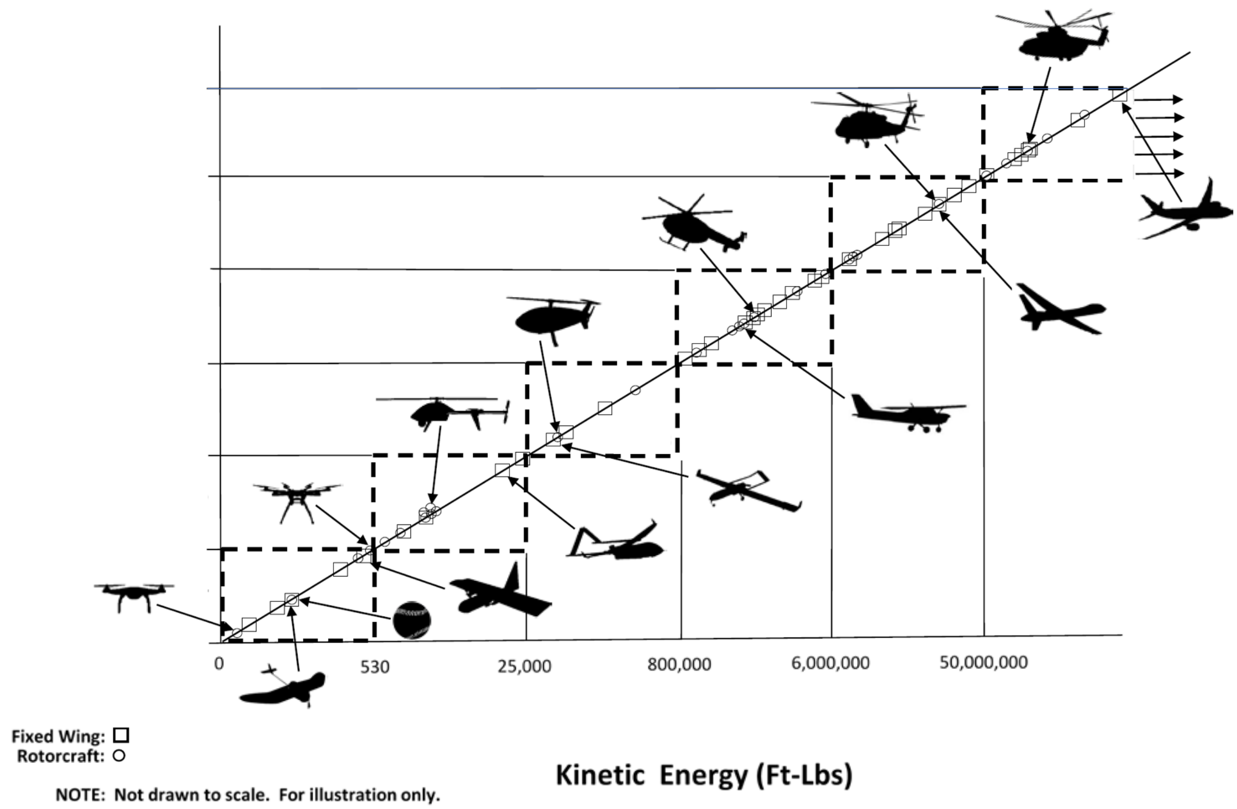
Rather than draw boundaries based on max takeoff weight, kinetic energy was determined to be a useful metric because it reflects the risk continuum. Generally, the severity of outcomes for smaller UA operating with lower kinetic energy is lower than that of larger UA operating with higher kinetic energy. The use of kinetic energy encourages manufacturers to balance design features and operating limitations to reduce transferred energy, particularly at the boundaries. This is a safety enhancement.

A. Kinetic Energy

Kinetic energy is directly proportional to the mass of the object and to the square of its velocity: **K.E. = 1/2 m** $\mathbf{v^2}$

Kinetic energy of the UA is determined using the maximum takeoff weight and a velocity that considers failure modes. Depending on the UA configuration, the design cruise speed, autorotation speed, or terminal velocity may be appropriate. Guidance in the form of an advisory circular or industry standard practice should be developed to provide methods of calculation and methods for reducing energy transfer through design features (frangibility) or technical means (parachute).

The figure below illustrates the range of kinetic energy values of familiar aircraft and rotorcraft, both traditional and uncrewed.



Familiar traditional general aviation aircraft such as the Cessna 172 and 182 exceed 800,000 ft-lbs. Light sport aircraft, such as a Piper Cub, which can carry two people onboard can also have 800,000 ft-lbs. of kinetic energy. Examples of UA that exceed 25,000 ft-lbs., but are less than 800,000 ft-lbs. include the aircraft safely flown since 2016 as part of the FAA Pathfinder Program for BVLOS and others.[29]

B. Qualification of Aircraft and Systems

Based on this, there was agreement to **not limit** the BVLOS rule to small UAS (weighing less than 55 lbs. or ~<25,000 ft-lb KE). Instead, the maximum was set at no more than 800,000 ft-lbs. of kinetic energy, which is analogous to a lower performance light sport aircraft based on weight and max level flight speed.

For operations with a **Small UAS (<25,000 ft-lbs.)** in environments where the ground risk has not been strategically mitigated to an acceptable level (i.e., when ground risk is high), the manufacturer's DOC to an FAA accepted MOC is accepted by the FAA and subject to rescission under certain circumstances.

[29] L3Harris FVR-90, SwisDrone, and DoD Group 3.

Compliance may be audited, but no FAA or FAA designee approval or oversight is required in the first instance.

Light UAS (25,000 ft lbs. up to 800,000 ft lbs. of kinetic energy) a SAC is required. A manufacturer may obtain type certification, but it is not required by the rule. The ARC emphasizes that the SAC for Light UAS is not a SAC within the existing categories of SACs such as Experimental or Restricted Category. Rather, it is a new category of SAC specifically for Light UAS, and a new Part 21 regulation (e.g., 21.175b) will be required. This is similar to FAR Part 21.190, which is a standalone regulation for Light Sport Aircraft (LSA). The Light UAS SAC is issued following FAA acceptance of the manufacturer's Declaration of Compliance (DOC) to an FAA accepted Means of Compliance (MOC). The MOC may be based on industry consensus standards and a final inspection of the aircraft and any AE interfaces with the aircraft by the FAA or a Designated Airworthiness Representative (DAR). The MOC includes requirements for a quality program, but importantly - a production certificate is not required as it does not provide safety benefits proportional to the effort and expense needed to achieve one.

Within both frameworks, industry may develop standards and propose means of compliance that are applicable to a subset of aircraft and systems. Industry has the opportunity to craft technical requirements and specific standards that are aligned with the risk-based approach, but are not necessarily applicable to all aircraft or are technologically or architecturally agnostic. For example, the means of compliance for UA with less than 500 ft-lbs. of kinetic energy could be different from those with 25,000 ft-lbs. of kinetic energy. Standards for rotorcraft may differ from those for fixed-wing aircraft. Performance requirements for a radar-based system may be different from those using other sensors. The FAA may permit submission of alternative MOCs by applicants when compliance to a specific standard is not requested for interoperability issues.

The specific requirements for UA based on weight and size are depicted in the Technical Ground Risk Mitigation section of the Operation Risk Matrix above at section VI.A.

VIII. Automation Risk Matrix Overview

The ARC developed Automated Flight Rules (AFR) for UAS BVLOS operations. The **Automation Risk Matrix** classifies risk levels based on the degree of human interface in automated flight operations, and the strategic and technical air and ground risk mitigations applied to UAS operations. The ARC identified four levels.

AFR Level 1 represents a manual system. Direct monitoring and human interface are necessary and intended for the vast majority of the flight. The aircraft may have some automated features (e.g., auto hover, “return to home”), but the human remote pilot has direct control over the aircraft’s flight control surfaces and is actively controlling the aircraft state during all phases of flight. This level is similar to “human-in-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 2 represents a system with increased automation. Human remote pilots are responsible for the flight of assigned aircraft, and are expected to directly monitor and maintain situational awareness for the flight(s) under their control. During AFR Level 2 operations, human intervention is possible but not required for certain aspects of the operation, such as to abort a mission or trigger a non-normal response. The Remote Pilot is directing the aircraft through a software interface, and does not directly manipulate flight control surfaces. The pilot may also program or direct routes, altitudes, and contingency procedures through the software interface. This level is similar to “human-on-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 3 represents extensive automation, similar to the capabilities of existing on-demand delivery operations. While AFR Level 3 operations may not *require* human intervention to operate successfully, they may *accommodate* human supervision and intervention. For the human RFOS or Remote Pilot, such accommodation may include monitoring operations in an area or sector, coordinating and executing exception management functions, and the pausing or halting of operations in response to changing conditions. When AFR Level 3 operations are used to support substantially scaled 1-to-many operations, the ARC expects that such operations will be conducted by the holder of an Air Carrier certificate or a Commercial Operating Certificate. This level is similar to “human-over-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 4 represents a state of ultimate automation. AFR Level 4 flight (and in some cases, ground) operations are handled completely by the automation, with no provision for human intervention during both nominal and off-nominal operations. AFR Level 4 operations are assumed to be at very high volumes/scale to the extent that no human pilot could maintain situational awareness necessary to effectively and safely intervene. The ARC has stipulated AFR Level 4 as a future state, and has not assigned attributes to this state. This level is similar to “human-out-of-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

The ARC identified a broad spectrum of training necessary to accommodate different automation levels and operations. The potential operations range from fully manual where the pilot manipulates the flight control surfaces of the UA (AFR Level 1); to semi-automated where the pilot indirectly controls the UA through flight control software (AFR Level 2); and ultimately through highly or completely automated operations where a human pilot may not directly control any portion of the flight (AFR Levels 3 and 4). These automation levels are defined in the AFR Table below.

A. AUTOMATION / AUTOMATED FLIGHT RULES RISK MATRIX

Autonomous Level	Flight Controls	Human Roles and Qualifications	N:1 Operations	Equipage Req'ts
AFR 4 – Autonomous: Human out-of-the-loop	No possibility for human intervention during the flight			
AFR 3 – Fully/ Highly Automated: Human over-the-loop No requirement for human intervention during the flight	**Highly Automated:** System performs route selection, initiates/terminates flights, commands movement, and handles contingency situations. There is no tactical interaction by a pilot during a flight, but ***there may be a human monitoring operations in an area or sector.***	**Remote Air Carrier, Remote Operating or Agricultural Operating Certificate** **Designated Remote Flight Operations Supervisor** Hold Remote Pilot certificate w/BVLOS rating May supervise RPICs and/or non-certificated flight support positions Complete Operator or OEM-specified BVLOS course of instruction (company/system specific) Tailored FAA UAS Medical **AND/OR** **Remote Pilot certificate w/BVLOS rating** Complete OEM-specified BVLOS course of instruction (system-specific)	**RFOS: Authorized; no pre-set limits. Determined by demonstrated capability** **BVLOS RPIC Only: Authorized, limited**	**TBD**
AFR 2 – Increased Automation: Human on-the-loop Person intervenes to abort a mission	**Automatic Flight Controls:** The Remote Pilot is directing the aircraft through a software interface ("mouse clicks") and does not directly manipulate the aircraft's movement through manual control	**Remote Air Carrier, Remote Operating or Agricultural Operating Certificate** (unless the type of operation is explicitly excluded by rule) **Designated Remote Flight Operations Supervisor (RFOS)**	**RFOS: Authorized; no pre-set limits. Determined by demonstrated capability**	**TBD**

or trigger some non-normal response	inputs. The Remote Pilot is responsible to monitor assigned aircraft and intervene when necessary.	**AND/OR** **Remote Pilot certificate w/BVLOS rating**: Complete OEM-specified BVLOS course of instruction (system-specific)	**BVLOS RPIC Only: Authorized, limited**	
AFR 1 – Manual: Human-in-the-loop Person is in control of the drone throughout its flight	**Manual:** Pilot exercises direct, real-time control over a single aircraft's movement primarily by manual inputs ("thumbs on sticks") and is in the control loop during all phases of flight. Some automation features may be used (i.e., auto hover, RTB, lost link).	**Remote Pilot Certificate w/Small UAS rating** Expanded knowledge test to include EVLOS/Shielded operations **OR** **Remote Pilot Certificate w/BVLOS Rating**	**Not allowed**	**TBD**

B. Uncrewed Aircraft Operator Qualifications

With differing levels of human interaction and control, new constructs are needed to define, train, and certify human pilots to operate such systems. As the scale of BVLOS operations increases, particularly in highly automated 1-to-many environments, new constructs are also needed to support how the operations are managed. Finally, as these operations are normalized, UAS-specific types of operating certificates are needed to enable large scale BVLOS operations without the excessive complexity and burden of modifying 14 CFR Parts 119, 121, 135, and their associated references.

After extensive review and coordination, the ARC ultimately settled on the following foundational changes to the rules governing UAS operations:

- Define the types of UA automation used in BVLOS operations;
- Expand the privileges of the 14 CFR Part 107 Remote Pilot certificate with a Small UAS rating to include limited BVLOS operations (such as EVLOS and "shielded" operations) without the need for a waiver;
- Create a new BVLOS rating for the Remote Pilot certificate that requires additional knowledge specific to conducting BVLOS and 1:many operations, particularly at scale;
- Create two new types of Operating Certificates: a Remote Air Carrier Certificate and a Remote Operating Certificate to authorize and set requirements for certain types of operations;
- Create a new designated position for holders of a Remote Air Carrier or Remote Operating Certificate that exercises operational control, is directly responsible for, and is the final authority as to the conduct of multiple simultaneous UAS flights in an assigned area; and
- Tailor medical qualifications to remove barriers for UAS pilots and crew who are fully able to perform UAS operations.

The ARCs recommendations are designed to align with the foundational underpinnings of existing flight rules, while substantially streamlining and tailoring the requirements and privileges that are specific to UAS.

IX. Public Interest Considerations

A. Market Drivers & Market Organization

Current regulatory frameworks are pegged to crewed aviation, but the UAS industry performs differently from aviation in several important ways. The UA industry is diverse and funded by a range of investors, with expectations of commercial viability. It is difficult, and in some cases, impossible to demonstrate commercial viability in BVLOS applications given existing regulatory approaches. This ARC is an important step toward removing the barriers to safe, scalable, and commercially viable BVLOS operations.

While there has been much in the literature chronicling how UA differ from crewed aircraft, less time has been spent describing how the industries themselves differ. Both understandings are critical, as regulatory frameworks tend to mirror and anticipate the industries they are regulating. As the UAS industry has grown and evolved, a few distinct themes have emerged that illustrate different capabilities, missions, and needs of the UA industry. First, the UA industry is funded and organized differently from the conventional aviation marketplace. Private venture capital is a major source of funding for larger companies, supplemented by a range of other funding sources, while many smaller companies are self-funded. The UA marketplace is also organized differently than the traditional aviation marketplace. For example, traditional regulatory requirements focus on the role of personnel (e.g., flight crew or ATC). However, many UA are highly automated, reducing and modifying the role of humans to gain efficiency. In addition, different participants may be highly integrated, designing, manufacturing, and operating UA in-house; while other participants may be highly specialized, providing a narrow set of technologies or capabilities to other operators, including both UAS and UTM capabilities. These variations are not reflected in the traditional approach to regulation.

A second theme relates to commercial forces: To succeed, the UA market is expected to demonstrate viability. After years of investment, financial supporters expect the industry to achieve a minimum level of commercial sustainability. This depends on UAS BVLOS operations at scale across a range of populated and unpopulated environments, and in shared airspace.

A third theme involves the safety characteristics of UAS, which are different than crewed aircraft. Many UAS apply mitigations that:

1. ensure a high level of reliability (e.g., through distributed electric propulsion);
2. lower the risk of personnel failure (e.g., through automation);
3. lower the collision risk (e.g., by carrying goods instead of people or by inspecting infrastructure at low altitudes); and
4. lower the risk of injury or damage in the unlikely event of a collision (e.g., by reducing impact characteristics through size, weight, and contingency mitigations).

Many of these mitigations are not available to traditional crewed aviation and are not recognized or credited within the existing regulatory system. With all this in mind, it is clear that current aviation regulations are ill-equipped to regulate the UAS industry. By comparison, performance-based approaches to regulation will foster a diverse, competitive, and scalable UAS industry that supports a range of participants, from small to large, integrated to specialized, and established companies to new entrants. The ARC urges the FAA to develop a risk-based, performance-based, and adaptable approach to regulation that accounts for the current and future diversity of airspace users. The ARC attempts to provide such an approach in this report and its recommendations (e.g., see ARC Recommendation AG 2.2).

As the FAA considers how to implement the recommendations in light of how the UAS market is organized, the agency should consider eliminating separate airworthiness, operational, airspace, and personnel approval processes. A better approach would be a streamlined, scalable, and holistic application process that accounts for the specific characteristics of different operations, and provides flexibility for different operators to seek any subset of approvals at one time.

The ARC also urges the FAA to future-proof its regulations and consider more than just the design of the marketplace today, but also how the technology is evolving. For example, the market is trending toward increasing levels of automation. The FAA should seek to enable high-value, lower risk automated operations immediately while working toward a comprehensive regulatory solution for highly automated operations that may present higher levels of risk.

Regulatory transparency, consistency and certainty are also important to provide the marketplace with stability. The FAA should seek to improve consistency and predictability in approvals. For example, this ARC will recommend that after establishing a robust acceptable level of risk, the FAA should identify feasible, realistic, and non-exhaustive means of compliance. The ARC also recommends that the FAA conduct all aspects of the approval process in parallel rather than sequentially so that the industry can reasonably plan for market entry without undue or unpredictable delays. The FAA should commit to and communicate clear definitions of requirements and reasonable timelines for processing approvals. The FAA should also scale-up resources as necessary to account for the expected growth in applications. As noted in ARC Recommendation AG 2.8, the FAA should also make allowances for expedited approval of low-risk R&D activities that may need to be approved on rapid timelines to meet institutional or financial deadlines.

For these reasons, the FAA should consider implementing clear acceptable means of compliance, as well as Standard Scenarios (STS) or Pre-Defined Risk Assessments (PDRAs), which industry can reference for guidance in its applications. It is important to understand that STS or PDRAs could be implemented well in advance of a BVLOS rule. As such, STS and PDRA could be a way of enabling safe, high-value, and lower risk BVLOS operations now while the FAA develops and releases for public comment a rule on BVLOS.

B. Environmental Considerations

The ARC was tasked with identifying environmental considerations necessary to enable UAS BVLOS operations. Understanding such environmental considerations will help maximize and distribute the benefits of UAS BVLOS operation across communities, while minimizing the environmental impacts that would constrain the scaled and responsible growth of UAS BVLOS operations. The ARC's work was guided by FAA's responsibilities under the National Environmental Policy Act (NEPA), which requires federal agencies to consider the potential environmental impact of their proposed actions in decision-making and disclose significant impacts to the public, including, but not limited to, air quality and climate, noise, environmental justice and more.

The Phase 1 Environmental Subgroup found that:

- UAS have a different environmental footprint than crewed aircraft.
- Traditional environmental review processes may not apply to UAS.
- A flexible, science-based environmental approach is key to the FAA's success.
- The public's perception of environmental impacts will evolve.
- The transition from VLOS to BVLOS itself may not drive significant environmental impact.
- The traditional aviation environmental regulatory process does not meet industry's needs.
- BVLOS operations may enable more environmentally friendly operations.
- Focusing on "use cases" is beneficial but may be insufficient.
- There are data limitations due to limited scope of current operations.
- UAS BVLOS operations have the potential to enhance environmental justice.
- Operators should consider possible impacts to environmental justice in their communities.

Use cases that have a lower environmental impact may be those, for example, which take place infrequently and over unpopulated or sparsely populated areas. Use cases that have a higher potential environmental impact are those which occur on a regular basis, at higher volumes, and in proximity to large numbers of people. It is important for both industry and the FAA to develop a comprehensive list of characteristics associated with low, medium, and high environmental impacts to begin any analysis.

The ARC further noted that while increased scale of BVLOS operations would likely have a meaningful impact on noise and community response, the transition from VLOS to BVLOS operation itself is unlikely to have an environmental impact. The environmental impact of any given UAS operation is independent of whether the UA is operated VLOS or BVLOS. For example, there almost certainly will be VLOS operations with more significant and direct environmental impacts than BVLOS operations, and any impact is likely to be greatest in areas of increased use

Working from this foundation, the ARC makes several recommendations relating to the FAA's environmental approval processes. Under NEPA and its implementing regulations, FAA, like all federal agencies, is required to consider the environmental impact of its actions, including for a rulemaking to establish a new BVLOS Rule and for certain individual agency approvals. In addition to environmental benefits and potential impacts (discussed in greater detail below), the ARC charter asks the ARC to "[i]dentify the level of FAA involvement in certification and oversight that is appropriate to address. . . [the] environment."

In response to this charge, the ARC has considered the FAA's environmental review at two junctions: (1) when the FAA promulgates the BVLOS rulemaking, and (2) when the FAA considers individual BVLOS approvals. After summarizing the environmental benefits of UAS BVLOS operations and providing additional background on NEPA and the current environmental review process, we examine each of these aspects of environmental review in turn.

At the outset, we note that in this report, the ARC discusses noise as a potential environmental impact within the context of NEPA review; however, UA noise certification is a distinct issue and is discussed elsewhere in this report in connection with UA certification.

The ARC recognizes that environmental review is a critical piece of the regulatory framework that will ultimately enable commercial UAS to operate at scale. Based on reasonably foreseeable industry conditions and FAA precedent, the ARC expects that environmental review of the BVLOS Rule should result in a finding of no significant environmental impacts from the BVLOS rule enabling broader use of efficient UAS. As part of this review, the ARC expects that the FAA would account for the environmental benefits that could be realized by enabling BVLOS operations at scale. The ARC urges the FAA to streamline the environmental review process and avoid delaying further the realization of such environmental benefits. For example, it would be unsustainable both environmentally and economically for every advanced UAS operation (and every modification of an advanced UAS operation) to be gated by a separate and individual environmental review that is not applicable in the same way to operations by car, truck, and the other fossil fuel powered alternatives that UAS may replace. The FAA must alter its process to move from individual assessments and instead address operating types and characteristics to enable a healthy UAS industry at scale. Operations at scale implies that bounds and upper limits should be assessed rather than individual characteristics and sites.

Accordingly, as will be detailed further in the recommendation section, the ARC recommends:

- In accordance with FAA precedent and agency policy, environmental review of the BVLOS Rule be initiated early in the rulemaking process and completed in a timely fashion;
- FAA take an efficient and effective approach to environmental review of BVLOS operations, including programmatic review, and avoid to the maximum extent possible the need for individual reviews;
- FAA work with industry to develop data and information that may be used by FAA to establish a categorical exclusion for individual BVLOS approvals;
- FAA identify environmental review efficiencies for BVLOS operational approvals in the near term to assist with FAA's data collection to inform future FAA efforts (e.g., rulemaking);
- FAA identify pathways to allow for interim BVLOS approvals with no significant environmental impact not requiring environmental review processes, allowing for such data-gathering; andFAA be properly resourced to complete timely environmental review.

1. Environmental Benefits of Uncrewed Aircraft

As described in depth by Phase 1, UA can provide extensive benefits and essential services to the American public in an environmentally friendly way.[30] Commercial UA represent a sustainable transportation, inspection, and monitoring solution that can be used for, among other things:

- Delivering critical supplies, life-saving medical equipment, and medicines;
- Assisting with fire, accident, public safety and natural disaster response; and
- Inspecting and monitoring railroad tracks, bridges, power lines, energy facilities, and other critical infrastructure.
- Supporting critical environmental initiatives such as wildfire recovery, wildlife conservation, and tracking climate change.

As a result, a wide variety of industries are counting on UAS to help decarbonize their operations, particularly those that currently rely on larger, louder gas-powered vehicles. Existing commercial UAS deployments have already demonstrated a net positive impact on the environment—including reductions in overall noise levels and CO_2 greenhouse gas emissions. Two studies in November 2021[31] found that UAS-based delivery reduced delivery carbon emissions and energy usage by 96-98% compared to cars, a significantly larger reduction than switching to EVs. Similarly, a September 2020

[30] *See e.g.,* Virginia Tech Office of Economic Development, "Measuring the Effects of Drone Delivery in the United States," (September 2020), https://vtechworks.lib.vt.edu/bitstream/handle/10919/100104/Effects%20of%20Drone%20Delivery%20US_September%202020.pdf?sequence=1&isAllowed=y.

[31] Rodrigues et al, *Drone flight data reveal energy and greenhouse gas emissions savings for small package delivery* (Cornell Univ. arXiv.org, Nov. 2021).

economic report[32] published by the Virginia Tech Office of Economic Development found that enabling UAS delivery in a single metropolitan area could avoid up to 294 million miles per year in road use and up to 580 car crashes per year, equivalent to taking 25,000 cars off the road or planting 46,000 acres per year of new forest, reducing carbon emissions by up to 113,900 tons per year.

UA play an increasingly important role in reducing the 70% of global greenhouse gas emissions associated with infrastructure construction and sustainment.[33] For example, enabling UA to inspect bridges is the carbon equivalent to taking thousands of vehicles off the road compared to traditional methods of inspection.[34] Finally, use of UA significantly reduces noise impacts on communities by replacing noisier alternatives. Today, "there is almost no part of the United States in which transportation noise is not noticeable."[35] For example, when it comes to road noise, trucks and motorcycles are permitted to generate up to 80dBA 50 feet away,[36] while, as the DOT's Bureau of Transportation Statistics note", "[n]oise from automobiles ... is not regulated."[37] Indeed, measurements of street noise levels show that the "most important" contributor to vehicle noise level in inner city traffic is delivery trucks.[38] By contrast, surveys of communities with active UAS operations not only show extremely strong community sentiment for UAS, but the vast majority of residents never even mention noise as a negative factor.[39]

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[32] Virginia Tech Office of Economic Development, "Measuring the Effects of Drone Delivery in the United States," (September 2020), https://vtechworks.lib.vt.edu/bitstream/handle/10919/100104/Effects%20of%20Drone%20Delivery%20US_September%202020.pdf?sequence=1&isAllowed=y.

[33] World Bank, "Low-Carbon Infrastructure, Private Participation in Infrastructure (PPI) 2002 to H1 2017" (2018) ("Approximately 70 percent of global greenhouse-gas emissions emanate from infrastructure construction and operations such as power plants, buildings and transportation systems.").

[34] Groves, Brendan, "How Drones Can Unlock Greener Infrastructure Inspection," *World Economic Forum* (Aug. 10, 2021), https://www.weforum.org/agenda/2021/08/how-drones-unlock-greener-infrastructure-inspection/.

[35] U.S. Department of Transportation Bureau of Transportation Statistics, Chapter 7 Transportation Energy Use and Environmental Impacts, https://www.bts.gov/archive/publications/transportation_statistics_annual_report/2016/chapter_7.

[36] 40 CFR § 205.52 (trucks); 40 CFR § 205.152 (motorcycles). Helicopters produce similar noise: close to 90dB on a 500' overflight. Hearing Health & Technology Matters, "Helicopter Noise", https://hearinghealthmatters.org/lawandhearing/2011/helicopter-noise/.

[37] U.S. Department of Transportation Federal Highway Administration, "Public Roads - July/August 2003", https://highways.dot.gov/public-roads/julyaugust-2003/living-noise.

[38] Björkman, M. and R. Lynn Rylander. "MAXIMUM NOISE LEVELS IN CITY TRAFFIC." Journal of Sound and Vibration 205 (1997): 513-516, https://www.semanticscholar.org/paper/MAXIMUM-NOISE-LEVELS-IN-CITY-TRAFFIC-Bj%C3%B6rkman-Rylander/bbcc1e8b6e6db33c0ec4c9e3029947767b67ecc1.

[39] Vinsel, Lee, Eleanor Nelsen, and Adeline Guthrie. "When the Drone Is in Your Backyard." Issues in Science and Technology 37, no. 3 (Spring 2021): 29–31, https://issues.org/when-the-drone-is-in-your-backyard-nelsen-guthrie-vinsel/.

2. NEPA Background

Under NEPA, federal agencies are required to prepare an assessment of the environmental impacts of an action significantly affecting the environment. These statements are referred to as an Environmental Assessment (EA) or an Environmental Impact Statement (EIS), depending on the level of review. The purpose of an EA is to determine whether a proposed action has the potential to significantly affect the human environment and is used by the FAA to determine whether to prepare an EIS or a Finding of No Significant Impact (FONSI).[40] Certain FAA actions, however, may qualify for a categorical exclusion—a lower level of environmental review as compared to an EA or EIS. Categorical exclusions are actions identified in an agency's NEPA implementing procedures that do not normally have a significant impact on the environment, and therefore do not require either an EA or an EIS.[41] In analyzing the applicability of a categorical exclusion, an agency (here, the FAA) also must determine whether extraordinary circumstances are present that would warrant the preparation of an EA or EIS. Prior FAA UAS rulemakings, including Part 107, Remote ID, and Operations over People, qualified for a categorical exclusion and did not involve extraordinary circumstances.

Current Status: FAA Environmental Review Processes

The substantial environmental benefits of UAS cannot be brought to the United States without the BVLOS Rule. Thus, it would be paradoxical for NEPA to delay those benefits from being realized in the United States as a result of an unduly lengthy environmental review process. While the ARC recognizes NEPA is a procedural law, excessive delay in completing the NEPA process produces the substantive result of restraining this industry from achieving scalable viability in the U.S. by introducing further uncertainty and delay.

The ARC is concerned that recent FAA environmental review processes for UAS operations could continue to delay safe and environmentally friendly commercial and other UAS operations that the BVLOS Rule is intended to enable. While the ARC is aware that the FAA has attempted to complete its environmental reviews within the broader safety analysis timeline, the ARC does not consider that to be the proper benchmark for timely review given the FAA's record of extensive delay on UAS safety analyses. The ARC seeks improvement on both scores, and to the extent the FAA is keying one timeline to the other, the FAA must streamline both processes.

As Phase 1 documented, UAS have much lower environmental footprints than crewed aircraft. Accordingly, we present here ARC recommendations that, if adopted, would ensure that the FAA conducts an appropriate NEPA analysis of the BVLOS Rule and, as appropriate, pursues efforts to establish categorical exclusions for any FAA authorizations of individual BVLOS operations not covered by the environmental review conducted for the BVLOS Rule. The ARC further recommends that the FAA

[40] *See* FAA Order 1050.1F, paragraph 3-1.2, (July 16, 2015).

[41] *See* 40 C.F.R. § 1508.4.

ensure efficient and effective processing of applications until a categorical exclusion is established.[42] These recommendations adhere to the purpose and requirements of NEPA while avoiding unnecessary delay in approving environmentally friendly UAS operations for the benefit of the American public. We attempt to strike an appropriate balance where efficient and effective environmental review avoids the risk that the BVLOS Rule and its implementation could be significantly delayed due to NEPA review, with the end result being that the status quo fossil fuel technologies (which are largely exempt from NEPA review requirements) prevail.

Application of NEPA to BVLOS Rulemaking

Under the FAA's policy for implementing NEPA, if the action underlying the FAA rulemaking does not cause a significant impact on the human environment following consideration of extraordinary circumstances, then it is categorically excluded from further NEPA review under paragraph 5-6.6f of FAA Order 1050.1F.[43] For example, in 2020, the FAA determined that the Small UAS Operations Over People (OOP) Rule qualified for a categorical exclusion.[44] The FAA similarly determined that the Part 107 regulations qualified for a categorical exclusion based upon FAA forecasts, noise data available at the time, and "the best available information regarding the intensity of use, location, and the characteristics of UAS covered by the rule (less than 55 pounds and primarily electric/battery powered)…[the rule] would not produce significant environmental impacts and involves no extraordinary circumstances."[45] However, an FAA rule does not qualify for a categorical exclusion if "extraordinary circumstances" exist, which, among other things, could include the potential for a significant impact on "noise levels of noise sensitive areas," "impacts on the quality of the human environment that are likely to be highly controversial on environmental grounds," and other exceptional impacts or scenarios.[46]

The ARC recognizes that the industry has not been static since the OOP and Part 107 Rules were promulgated. However, key aspects of those analyses remain applicable to contemporary NEPA analyses, including the physical limitations imposed by separation rules, while UAS themselves have

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[42] As noted at the outset, these recommendations focus on environmental evaluations conducted by the FAA under NEPA and its implementing regulations. UA noise certification is a distinct issue which is discussed in the certification section of the report.

[43] *See* FAA Order 1050.1F, paragraph 5-6.6f (noting that "Regulations, standards, and exemptions (excluding those that if implemented may cause a significant impact on the human environment)" are subject to categorical exclusion).

[44] *Operations of Small Unmanned Aircraft Systems over People*, 86 Fed. Reg. 4314 (1/15/2021), 86 Fed. Reg. 13630 (3/10/2021) (hereafter, "OOP Rule"), https://www.govinfo.gov/app/details/FR-2021-01-15/2020-28947. *See also* FAA, *Supporting Document for OOP Rule CATEX*, FAA-2018-1087-0971, (Dec. 17, 2020), https://www.regulations.gov/document/FAA-2018-1087-0971.

[45] FAA, "Final Signed AVS UAS Categorical Exclusion," FAA-2015-0150-4718 at 2 (Mar. 9, 2015).

[46] *See* FAA Order 1050.1F, paragraph 5-2.

increasingly become quieter.[47] As such, the ARC is of the view that application of FAA precedent would result in a finding that the BVLOS rulemaking would not result in significant impacts to the environment.

The ARC recommends that the FAA consider its precedent and apply similar analysis to evaluate the applicable categories of potential impacts of the BVLOS rule that FAA used when carrying out its environmental reviews of Part 107 and the OOP Rule. Furthermore, the FAA should scope the environmental review in a manner that can be appropriately leveraged in the future for any individual approval enabled by the BVLOS rule.

Importance to BVLOS Rulemaking Efforts

The ARC recognizes that the manner in which the FAA approaches NEPA review for this rule is critical for the rulemaking's success. If the FAA does not streamline its environmental review process, this could add years of uncertainty to the BVLOS Rule timeline. Alternatively, the ARC is concerned that FAA may severely limit the scope of what operations the BVLOS Rule authorizes to simplify environmental review. This also would be problematic. Finally, if environmental review of the BVLOS rule is not programmatic in nature (such that it enables future tiering), the FAA could decide that individual approvals for operators, which qualify as "federal actions," trigger separate NEPA review, in essence "pushing down" the NEPA review step and related burden to individual operations and approvals. The resulting procedural requirements under each of these three scenarios would impede the industry from scaling, notwithstanding the benefit of the BVLOS Rule.

Accordingly, the ARC aims to achieve at least the following three objectives:

- Provide facts and information relevant to the FAA's environmental analysis of the BVLOS Rule.
- Encourage the FAA to account for the positive environmental benefits of the operations enabled by the BVLOS Rule when approaching its environmental review.
- Recommend streamlined and efficient individual approval processes that would enable expanded BVLOS operations in the near term.

3. ARC Supports a Finding of No Significant Impacts (FONSI) for UAS BVLOS Rule

In undertaking its environmental review of the BVLOS Rule, the FAA must determine whether the rule has the potential for significant environmental impacts, as defined by prior FAA precedent. A Finding of No Significant Impacts (FONSI) is appropriate where the FAA determines that the proposed action's environmental impacts, with no additional mitigation, would not be significant.[48] In evaluating the potential to cause significant impacts, the FAA will assess potential impacts on historic and cultural resources, biological resources such as wildlife (and particularly endangered species), noise levels in noise sensitive areas, air quality, visual impacts/light emissions, and properties protected by Section 4(f)

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[47] *See*, e.g., environmental reviews conducted by FAA in 2021, https://www.faa.gov/uas/advanced_operations/nepa_and_drones/.

[48] FAA Order 1050.1F, Paragraph 6-1. A FONSI may be prepared if the FAA determines that mitigation will reduce impacts below significant levels. *Id.* at 6-2.2. This is known as a "mitigated FONSI."

of the Department of Transportation Act.[49] Based on FAA precedent, the ARC believes that most of these categories will not be relevant to the environmental review of the BVLOS Rule.[50] For example:

Historic and Cultural Resources. The nature of UAS BVLOS operations' effects on historic/cultural properties are limited to non-physical, reversible impacts (i.e., the introduction of audible or visual elements) that are not likely to result in an alteration to the setting of the historic property that qualifies it for inclusion in or eligibility for the National Register[51]

Wildlife/Endangered Species. BVLOS operations are likely to be useful in the research and monitoring of various species and the BVLOS Rule would not affect "existing prohibitions on the harassment, harming, or killing of birds, mammals, ocean dwelling animals protected by other laws."[52]

Air Quality. UAS BVLOS operations are currently almost exclusively by battery-powered electric motors[53] and do not produce the pollutants covered by the National Ambient Air Quality Standards (NAAQS). Accordingly, potential emissions will not cause air quality impacts or any exceedance of the NAAQS. As with the OOP Rule and Part 107 operations, "the replacement of fossil-fuel-powered aircraft with electrically powered…UAS could result in a positive impact on air quality."[54]

Section 4(f) Properties. Even if there are potential noise and/or visual and light emissions impacts from BVLOS operations, they are not significant impacts (that would give rise to "extraordinary circumstances") because they will not result in actual physical use of a Section 4(f) property or "constructive use" such that the impacts are so severe the protected activities, features or attributes of the property are substantially impaired.

Based on FAA precedent established in its environmental review of Part 107 and the OOP Rule, the ARC anticipates that the FAA's evaluation will primarily focus on noise, or, more specifically, (1) the scale of additional operations enabled by the BVLOS Rule, and (2) whether such scale will have a significant effect on noise levels in noise sensitive areas. If the FAA determines – as precedent indicates – that there will not be any significant environmental impacts, including noise, then a FONSI is warranted and

[49] Resources that are protected by Section 4(f) are publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance; and publicly or privately owned land from an historic site of national, state, or local significance. Section 4(f) of the Department of Transportation Act of 1966 was repealed in 1983 when it was codified without substantive change at 49 U.S.C. 303. Because DOT continues to refer to the provision as Section 4(f), the ARC uses the same terminology in this report.

[50] Similar to the categorical exclusion analysis in the OOP Rule, we anticipate the FAA will conclude that the other environmental impact categories enumerated in FAA Order 1050.1F are not present because the BVLOS Rule will not involve: coastal resources; farmlands; land acquisition; physical changes to the environment resulting from ground disturbance or construction activities; changes in patterns of population movement or growth, increases in public service demands, or business and economic activity; or generation, disturbance, transportation, or treatment of hazardous materials.

[51] *Id.* at p. 6.

[52] *Id.* at p. 7-8.

[53] The vast majority of projected UA are also expected to be battery powered.
[54] *Id.* at p. 9

legally defensible. Although there are specific facts and limiting assumptions within the Part 107 and OOP Rule NEPA reviews, the ARC urges the FAA to ensure its environmental analysis of the BVLOS rule is consistent with its own relevant precedent.

In its policies and procedures implementing NEPA, the FAA specified DNL 65 dB as the "significance threshold for the noise effects of its actions. The FAA has further defined a "significant impact" due to noise as any location exposed to noise greater than DNL 65 dB and experiencing a 1.5 dB or greater increase in noise due to an action.[55] In its most recent relevant rulemaking, the OOP Rule, the FAA found that the rule would <u>not</u> trigger any extraordinary circumstances, including significant noise effects, which would have otherwise excluded the use of a categorical exclusion.[56] With respect to noise, the FAA concluded that operations under the OOP Rule would not be conducted at a sufficient scale to have the potential for significant environmental effects (emphases added):

> For en route operations, the analysis in the noise report shows that for the small UAS with the loudest measured noise level . . . it would take at least 3,686 operations over a 24-hour period to exceed a DNL 65 dB level. The maximum possible activity analysis for either configuration of small UAS demonstrates that the maximum number of operations that could occur, while maintaining separation criteria recommended by FAA, is 2,126 operations over a 24-hour period. This means that the maximum possible activity level is more than 1,500 operations below the activity level that would exceed DNL 65 dB over a 24-hour period. Accordingly, for en route operations with fixed or rotary wing small UAS operating in compliance with part 107 and the amendments to part 107, the activity levels will not exceed a DNL 65 dB in any single location, and there is no potential for significant noise impact.
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> For hover operations, which FAA assessed in the noise analysis report as a representative of delivery operations, the Gryphon Dynamics GD28X (rotary wing) had the loudest measured noise level assessed in the IPP CNO Noise Measurement Report. FAA determined that it would take an average of at least 77 operations a day over an entire year to exceed DNL 65 dB at a point. Over the course of a year, this would be at least 28,105 operations at a particular point. FAA does not believe that this number of annual hover operations would be met under the parameters in part 107 and the amendments to part 107, particularly with the weight limitations for small UAS and the requirement to maintain line of sight with the small UAS. The types of operations that would normally consist of longer hover times, such as infrastructure inspections, would occur infrequently at a particular location and generally not over noise sensitive areas.

Similarly, the FAA's Part 107 rulemaking found that over 25,000 flights a day would be required to preclude application of a categorical exclusion (emphasis added):[57]

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[55] FAA Order 1050.1F, Exhibit 4-1 "Significance Determination for FAA Actions."[56] *See* OOP Rule and *Supporting Document for OOP Rule CATEX*, Docket FAA-2018-1087.

[56] *See* OOP Rule and *Supporting Document for OOP Rule CATEX*, Docket FAA-2018-1087.

[57] FAA, *Operation and Certification of Small Unmanned Aircraft Systems*, 81 FR 42063, codified at 14 CFR Part 107.

> FAA land use compatibility guidelines establish DNL 65 dB as compatible with residential, public, commercial, manufacturing and production, and recreational land uses. To illustrate how the noise of an individual small UAS might relate to the land use planning guidelines, FAA used data from the noisier of the two small UAS airworthiness and noise certification projects. Calculations showed that it would take over 6,000 flights of the heavier of the two certificated UAS over one 24-hour period at an altitude of 200 feet to produce a noise level of DNL 65 dB, and at 400 feet altitude over the measurement point, there would need to be 25,000 flights in one 24-hour period to produce this level of noise. The FAA does not anticipate this level of small UAS operations at any location in the United States, nor would the airspace over a particular location support such levels of activity.

Importantly, these limits were for the loudest UAS known to the FAA at the time. For modern, quieter UAS,[58] or indeed any operator not operating those particular UAS, it would require an even greater scale of operations in order to exceed DNL 65 dB.

The same analysis applies to the BVLOS rule. The FAA's use of a categorical exclusion in the OOP Rule and its examination of the significance thresholds for noise establishes relevant precedent for evaluating noise that should be applied to the environmental analysis for the BVLOS Rule. In addition, the FAA's language in the OOP Rule related to scale (i.e., number of operations) and the visual line of sight requirement also is relevant to the FAA's analysis here. While the BVLOS rule will enable commercial UAS operations to scale in a limited way, other factors (separation requirements, pilot-vehicle ratios, technology limitations and more) will prevent the type of scaled levels of activity in any location that would trigger concern from an environmental perspective. With respect to other potential environmental impacts that the FAA will evaluate, the FAA's analysis for prior UAS rules will continue to be applicable to, and instructive for, the BVLOS Rule.

4. Environmental Justice

The Environmental Subgroup assessed the extent to which BVLOS operations could affect environmental justice both positively and negatively. In addition to responding to challenge questions suggested by the FAA, the Subgroup considered elements that could be built into BVLOS operational plans to address potential adverse environmental justice impacts, assessed what parties might take these actions, and evaluated the extent to which the FAA would need to monitor these efforts.

The FAA has adopted the following definition of environmental justice:

> *The fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental effects*

[58] See, e.g., environmental reviews conducted by FAA in 2021, https://www.faa.gov/uas/advanced_operations/nepa_and_drones/.

resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and tribal programs and policies.[59]

Environmental justice will be enhanced, especially for low-income communities and tribal lands, by enabling BVLOS operations in the air transportation community. UA are more cost effective to operate than larger, conventional crewed aircraft, and would bring benefits that other types of aircraft cannot, at speeds that cannot be matched by ground vehicles. UA have the potential to be involved in a range of beneficial activities, such as small package delivery of medical equipment, tests, and pharmaceutical products, public safety activities and emergency response, and infrastructure inspections. By providing lower cost ways for Americans to access the NAS, UA enable individuals and companies of a wider income strata to avail themselves of this natural resource, thereby lowering barriers to entry. At the highest level, the costs associated with training and becoming a certificated Remote Pilot are far less than becoming a Part 61 certificated Pilot, providing individuals a more affordable pathway to aviation. This has a further positive impact on STEM, employment, and technology transfer. Lower cost of entry into the UA business is also another positive advantage. Outside of the aviation community, the services and goods that could be delivered by UAS BVLOS operations can be provided to communities that were previously inaccessible by other means due to technical or affordability issues.

The Environmental Subgroup also acknowledges that UAS BVLOS operations may adversely affect environmental justice, and such impacts would be highly mission-specific, defined by the location of operation, volume, time of day, aircraft type, and mission type, among other factors. The Environmental Subgroup considers that many adverse environmental justice impacts could be avoided entirely or substantially mitigated through effective operational planning and community outreach.

Ultimately, the extent to which UAS BVLOS operations will enhance environmental justice depends on an array of factors—including the types of missions BVLOS rules will enable, the locations and populations over which these missions will fly, the communities within which large-scaled operations (where relevant) are deployed, and steps BVLOS operators take to limit disproportionate adverse environmental impacts to low-income or minority populations.[60] It is also worth noting that members representing environmental justice communities were invited and participated as members in this ARC to facilitate the inclusion of their perspectives in the recommended rules.

5. Noise Considerations

Current approaches to evaluating community response to noise remain relatively limited and have yet to explore differences between various types of UAS operation. For now, the Subgroup identified two potential approaches to evaluating community response to UAS noise. The first attempts to identify the differences arising from small UAS as compared to other forms of transportation such as road noise or

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[59] Chapter 10, p, 1. *Environmental Desk Reference for Airport Actions,* FAA Office of Airports, October 2007. See also Executive Order 12898 and DOT Order 5610.2. https://www.faa.gov/airports/environmental/environmental_desk_ref/media/desk-ref-chap10.pdf

[60] The Desk Reference describes how EJ is considered by the FAA in environmental reviews: *Environmental justice analysis considers the potential of Federal actions to cause disproportionate and adverse effects on low-income or minority populations. Environmental justice ensures no low-income or minority population bears a disproportionate burden of effects resulting from Federal actions. Id* at p.1.

crewed aircraft. A second approach leverages survey and research data on community response to existing operations.

As part of the analysis into the environmental impact of UA for BVLOS use, the ARC should consider all the available data or studies that could inform the FAA's position on community response to UA sounds, including:

1. As appropriate, analogous noise data from non-aviation and crewed aircraft;
2. Existing UAS noise data from IPP and international operations; and
3. Research on the impact of UAS sound emissions on humans.

Additional research is needed to more definitively establish community response and annoyance both to noise and overflight during scaled BVLOS operations similar to research that the FAA has undertaken to assess noise annoyance for crewed aircraft. The FAA should also consider whether BVLOS operations normally do not individually or cumulatively have a significant impact on the environment, and if so, the extent to which some FAA actions to enable UAS BVLOS operations may qualify for a categorical exclusion from environmental review under NEPA.

C. Privacy & Security Considerations

The Security Subgroup focused on how to identify and address BVLOS security risks such that the benefits of BVLOS operations could be realized without compromising public safety and national security. The Subgroup considered what sort of regulations, processes, and technologies could be employed by private and public entities to protect the NAS and associated infrastructure, as well as reduce the risk of malicious actors in BVLOS operations.

The Security Subgroup highlighted the following Key Findings and Principles**:**

- **Differing and evolving security concerns.** BVLOS security regulations should not be static or uniform, but rather must reflect the varying degrees of security risk that different types of operations, operators, or other elements create.

- **Benefit/risk tradeoff.** Security requirements should reflect the risk and benefits of BVLOS operations.

- **Regulations should enable near-term operations.** BVLOS regulations should provide an immediate path forward for BVLOS operations.

- **Technology-neutral**. BVLOS regulations must be technology neutral, performance-based, and, when possible, leverage internationally recognized standards. These technologies must be able to be broadly adopted and non-proprietary (must not mandate one specific technology).

- **Federal Certification**. Federal regulators should have sole authority to certify and vet UAS BVLOS operators.

Per the ARC charter, consideration was limited to BVLOS operations, and five issue areas were used to frame the discussion: (1) Security Framework; (2) Operator Authorization; (3) Privacy; (4) Cybersecurity;

and (5) Physical Security. The Security Subgroup felt that the important security concerns could be organized in these five categories. No other security concerns or principles were raised by members, the FAA, or security agencies that were not addressed by the five categories below.

1. Privacy & Transparency

The Security Subgroup agreed that having transparency in UAS BVLOS operations may mitigate security risks, but further agreed that transparency comes at a cost to privacy of BVLOS operators and customers and that consideration must be given for how much transparency is needed to mitigate security risks and address privacy concerns. The Security Subgroup identified three categories of individuals/entities whose privacy may be implicated by security concerns:

- UAS BVLOS operators and remote pilots,
- UAS BVLOS customers, and
- the general public.

Concluding that the ability to identify which UA belongs to which operator, and which type of operation(s) that UA has been cleared to conduct, is likely sufficient information to enable the FAA and law enforcement to identify security concerns.

Transparency is a fundamental element of acceptance of UAS operations by the public. The use of new technologies will bring many benefits to communities and will also require operators to recognize potential privacy implications of these technologies. Privacy impact assessments are a routine requirement for many government information collection processes and should be conducted for government collection of domestic data related to UAS operations. Determining which agencies or entities are responsible for addressing public concerns will be critical in managing privacy issues.

Likewise, it is essential that operators understand the impact of their operations on privacy and have appropriate policies in place. In light of the fact that the BVLOS rule is designed to enable more widespread operations that may have varying impacts on privacy, it is recommended that the federal government consider appropriate mechanisms to promote and protect privacy, such as operator training, voluntary best practices, or seeking public input on the privacy implications of UAS operations. There is also general consensus that further consideration should be given to statutory privacy protections.

2. Physical Security

While physical security risks exist with VLOS operations, the introduction of BVLOS has the potential to increase these risks. Federal security agencies have expressed concerns that BVLOS offers new tools for would-be terrorists or other malicious actors. However, there was not consensus among members of the Security Subgroup that physical security is differently relevant to BVLOS operations than general VLOS operations.

3. Cybersecurity

The ARC recognizes there are inherent cybersecurity risks associated with UA, but notes that these risks are not unique to BVLOS or even to UA. Any connected product is vulnerable. To address cybersecurity concerns across the industry, the ARC recommends that FAA establish a cybersecurity working group composed of members of the UAS and aviation industry, communications industry, academics, expert agencies, and other cybersecurity experts. Where possible, the working group should leverage existing technical, certification, and onboarding standards that have been developed through industry-driven standards bodies. The working group should also capitalize on public private partnerships, such as the NIST cybersecurity framework and RTCA's body of work on aircraft related cybersecurity issues. The Joint Authorities for Rulemaking on Unmanned Systems (JARUS) has also published cyber guidance to accompany the Specific Operations Risk Assessment. All these efforts have resulted in flexible, non-binding best practices that enable industry to adopt the framework best suited to their particular products and services, while not being constrained by strict regulations that lack flexibility and do not allow for adaptation as technology changes. Standards that can be adopted globally with wide industry acceptance are ideal, with specific emphasis on the following issues:

- potential threats, vulnerabilities, and consequences;
- unique vulnerabilities with BVLOS operations assuming a nominal level of security controls and a Security Risk Management Plan (SRMP);
- critical controls and gaps in the available industry standards; and
- industry standards and best practices pertaining to data protection.

4. Operator Authentication

Uncertainty about the persons and entities conducting BVLOS operations may raise security concerns that are unique to certain BVLOS operations. The Security Subgroup considered whether the BVLOS regulations should include a path for certification as a "Trusted Operator," which would be administered by the federal government and allow certified operators streamlined access to BVLOS operations. The ARC report ultimately recommends enhanced vetting for flights near sensitive areas in Recommendation OQ 2.19. The Subgroup was also mindful, however, that there would also need to be a process for authorizing BVLOS operations outside of Trusted Operator certification, including the parameters of the authorization. As with other security-related considerations, the extent of the authorization should be commensurate with the risks posed by the operation. In either case, the Security Group encouraged the use of existing methods for operator authentication, where available.

5. HAZMAT

The Security Subgroup also considered the regulations and processes required to transport hazardous materials (HAZMAT) and other items with restrictive designations, such as weapons. The ARC was advised to consider whether these regulations were appropriate for BVLOS operations given the small size of UA, and the fact that UA do not carry passengers. The emphasis was on assessing whether the existing regulations are overly broad relative to the security benefits gained, serving only to create entry barriers for small operators. The ARC's recommendations on this issue are below at AG 2.5 and OQ 2.20.

D. Industry Needs

As the ARC researched the marketplace, it immediately became clear that a supportive regulatory environment for BVLOS depends on more than just a single rule. The private sector is ready and willing to provide much of what the industry needs to scale UAS BVLOS operations, including infrastructure and UTM, but for certain capabilities it will be necessary for the public sector, including the federal government, to take steps to enable and support private sector initiatives.

The ARC studied five core needs in particular: physical and technological infrastructure, uncrewed traffic management, cybersecurity, training and workforce development, and laws/rules/policy issues outside of the immediate UAS BVLOS rulemaking. Some of these needs must be accommodated via regulation, while others require industry or other stakeholder action, including consideration of when UTM may be required to support future complex, scaled operations. Much more can be found on each of these topics within the Phase 1 report.

In considering industry needs, the ARC documented laws, rules, and/or policy issues outside the domain of the instant FAA BVLOS rulemaking effort which, without clarification, could inhibit or delay the scaling of the UAS BVLOS industry. The ARC developed the following list of issues, all of which necessitate congressional, federal executive branch, international, state, local, and/or tribal government attention.

1. Legislation

The ARC encourages the FAA to immediately assess whether it has the necessary statutory authority to implement this ARC's recommendations in advance of the rulemaking process as it may be necessary for Congress to revise the law in the next FAA Reauthorization legislation, which is due for revisions in 2023, or in different legislation.

2. Economic Authority

Laws defining aviation citizenship were defined for a different industry and different era. Due to how aviation citizenship laws are currently drafted, certain BVLOS operators (air carriers) will require "economic" authority (or registration) from the DOT to operate. This includes the requirement that the operator be a "citizen of the United States" as defined in 49 USC 40102. Foreign civil aircraft operators conducting operations other than air carrier operations in the U.S. will also need DOT authorization. One or both could have implications for a variety of UAS BVLOS Use Cases. The application of the aviation citizenship laws to the UAS industry often leads to absurd results where American companies are not able to prove citizenship. If not addressed, a UAS operator subject to these requirements may not be able to legally operate. The "citizen of the United States" requirement for UAS operators therefore has many implications for UAS operator ownership and can significantly restrict ownership and investment. Further, citizenship requirements imposed for economic or competitive reasons are an unjustifiable barrier to entry for global operators and providers. These entities can help to stimulate competition and innovation in the U.S. market. U.S. companies are permitted to operate in a range of jurisdictions abroad, and the same privileges should be extended to global companies in the U.S. The ARC therefore recommends that Congress and the Department of Transportation consider economic authority issues and how they impact this emerging industry in a new era.

3. Spectrum-Related Issues

Given UAS reliance on RF communications, the FCC has played and will continue to play an important role in enabling growth of the UAS industry. Reliable and continuous access to spectrum is essential to the continued growth of the UAS industry. There is no one-size-fits-all approach to spectrum suitable for UAS, so it is critical that the FCC and NTIA enable all available communications technology for the industry. This includes consideration of regulatory restrictions on using certain spectrum bands for airborne operations, such as the restrictions set forth in 47 CFR 22.925, as well as the "mobile except aeronautical mobile" designation set forth in the FCC's Table of Allocations (47 CFR 2.106) that applies to many spectrum bands. BVLOS operations will require that spectrum bands with appropriate characteristics are sufficiently available to meet the needs of numerous users operating in a variety of operating environments. Without appropriate access to adequate spectrum, it will be difficult to scale UAS BVLOS operations.[61] The ARC recommends that FCC and NTIA enable all available communications technology for the industry in a

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[61] *CDA Letter to FCC — Commercial Drone Alliance*, https://www.commercialdronealliance.org/letters-comments/cda-letter-to-fcc-2021, June 7, 2021.

timely way.[62] The allocation of spectrum for UAS operations should not negatively impact crewed aviation operations.

4. Ambiguity Around Intergovernmental Jurisdictional Roles

The legal authorities of the FAA intersect with tribal, state, and local governments. Advancing UAS BVLOS operations would be expedited by operators/UTMs having access to all appropriate regulations related to a flight plan through a collaborative standard data exchange like FAA's Low Altitude Authorization and Notification Capability. This would allow the FAA to advance a clearinghouse of available information from certified tribal, state, and local government entities. The ARC supports an open dialogue with all interested stakeholders. Further, the ARC recommends the FAA explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.

5. Counter-UAS Issues

While the use of UAS for good must be enabled, there must also be a means to detect and mitigate unauthorized, criminal, or rogue UA that may cause harm. In 2016, federal national security agencies prevented expanded UAS operations from moving forward through the interagency process until UAS security was properly regulated. This is because under Title 18 of the United States Code, the deployment of many forms of counter-UAS technology is illegal. The Preventing Emerging Threats Act of 2018 was therefore passed by Congress to authorize relevant national security agencies to deploy counter-UAS technology to mitigate UAS threats to select U.S. facilities or assets.[63] The Preventing Emerging Threats Act is scheduled to expire in October 2022. To scale BVLOS operations in the U.S., federal national security agencies must continue to have the legal authority to protect against potential public safety and homeland security threats posed by rogue UA. If Congress does not take action to renew the Preventing Emerging Threats Act, industry worries that security concerns will continue to handicap further integration of UAS into the NAS, including the ability to scale BVLOS operations. The ARC recommends that the legislative and executive branches work together to consider counter-UAS issues and renew the Preventing Emerging Threats Act.

6. International Harmonization

Integrating scalable BVLOS operations into the NAS will require new and novel ways of approaching regulatory approvals on issues relating to airworthiness, operator certification, licensing of remote pilots and operational requirements. Standards and regulations relating to BVLOS operations that are harmonized around the world, such as Specific Operational Risk Assessment (SORA), may streamline compliance for UAS operators and manufacturers and help drive further innovation in the development of UAS technology and their commercial applications. If the FAA, EASA and other civil aviation authorities around the world adopt different standards or approaches relating to UAS airworthiness, operator/pilot certification and/or operational requirements for BVLOS operations, UAS operators and manufacturers will face barriers to operating abroad and marketing products in foreign markets. A lack of uniformity will create uncertainty and impede the development of new and innovative UAS technologies and commercial use-cases. The ARC encourages the FAA to coordinate with other civil aviation authorities on processes related to design and operational approval. Amongst other benefits, international harmonization enables commerce, including by facilitating easier import and export of hardware, and enables regulators to draw

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[62] FCC should work together with industry to move on rulemakings that will enable access to RF communications, such as AIA's petition for rulemaking on C2 Link.

[63] Preventing Emerging Threats Act of 2018; 6 U.S.C. § 124n - Protection of certain facilities and assets from unmanned aircraft.

on a shared pool of expertise and experience in safe, secure, and responsible UAS integration. The ARC considers partnership between the FAA and other international civil aviation authorities will greatly streamline regulatory processes.

7. Executive Branch Leadership on UAS Issues

The countless public benefits of commercial UAS operations are in jeopardy of not being realized on a broad scale, as is America's leadership in aviation and innovation if the U.S. does not move forward quickly with the safe and secure integration of UAS into the NAS. High-level executive branch leadership is necessary for UAS integration to move forward in a timely way. The White House must exercise leadership on the issues and challenges facing UAS integration, including expanded UAS operations and UTM. These topics require input from and coordination among various federal agencies, including national security and law enforcement agencies. The White House is best positioned to convene key federal decision makers and drive a constructive conversation with industry stakeholders, tribal, state, and local regulators, the security industry, and other relevant stakeholders.[64] The ARC urges the White House and Department of Transportation to play a leadership role in UAS BVLOS integration.

8. FAA Extension Act – Section 2209

Section 2209 of the 2016 FAA Extension Act mandated that the FAA implement a process by which critical infrastructure facilities and other "fixed sites" may limit UAS use over private property. The national security agencies, as well as all security stakeholders, are following this rulemaking closely. The ARC supports the spirit of Section 2209 and views the upcoming rulemaking as a critical aspect of UAS integration. The ARC also believes that it is important to enable authorized commercial operators to fly over these fixed sites in certain situations. In recommendation OQ 2.19, the ARC recommends that approval for operations deemed to be a higher security risk, or access to airspace surrounding sensitive or critical infrastructure, be controlled to allow only appropriately vetted UAS operators that are approved by the relevant authority.

9. Network Remote ID Implementation

While network remote ID is not a condition precedent for UTM operations, the FAA should explore additional identification solutions to supplement broadcast remote ID for UAS BVLOS operations. As noted in the Final Rule for Remote Identification, the FAA should strive to ensure that they, along with DHS and DOJ are "prepared to solve safety and security issues related to those concepts based on more mature understandings."[65] The ARC urges the national security agencies to engage in an open dialogue with industry stakeholders and civil society stakeholders to find solutions that enhance remote identification, specifically remote ID solutions that enable remote ID data to be accessed via a network,[66] while maintaining appropriate privacy safeguards for UAS operators and customers.

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[64] https://www.commercialdronealliance.org/letters-comments/cda-wh-summit-request.

[65] 86 FR 4390 - *Remote Identification of Unmanned Aircraft,* https://www.govinfo.gov/app/details/FR-2021-01-15/2020-28948.

[66] Network as used in this sentence includes, but is not limited to, the internet. For example, there may be private networks, secure networks, peer-to-peer networks, or other interconnections that may not necessarily be considered the internet.

10. Public Perception

All stakeholders can agree that public perception and acceptance – in terms of how the public responds to UAS in their communities – is of utmost importance to the long-term success of the industry.[67] This includes perceptions of privacy, noise, and other relevant factors. The industry recognizes this, and has worked with other stakeholders to develop Voluntary Privacy Best Practices on UAS use.[68] The industry has worked with all stakeholders on community outreach through the IPP and other similar programs. The ARC urges industry to continue to work with all governments – including federal, tribal, state, and local – as well as directly with communities to address this ongoing challenge.

11. Research & Development

UAS Research and Development (R&D) activities help support the safe and efficient integration of UAS into the NAS. R&D operations are key to unlocking new transportation solutions and innovative UAS Use Cases that will bring safety, economic, environmental, health, security, and equity benefits to the American people. This will also support American competitiveness in the global aviation market. The ARC considers a risk-based approach to authorizing R&D operations to be most suitable because many R&D missions are extremely low risk and conducted in controlled environments. The process for approving R&D operations should also be efficient and timely, allowing UAS companies to test and develop products and demonstrate incremental progress to investors. This is especially critical for UAS companies because they have a different funding model than that of traditional crewed aviation. After years of investment, financial supporters expect the industry to achieve a minimum level of commercial sustainability, bolstered by R&D activities that demonstrate the safety of UA operations, as well as provide the FAA with information in critical areas such as Human Factors, Detect and Avoid systems, and Certification. The FAA should streamline and expedite low risk R&D activities to leverage beneficial industry R&D outcomes. This will greatly aid in the efforts to safely integrate UAS into the NAS. The ARC has recommended expedited approvals for low-risk R&D initiatives in ARC Recommendation AG 2.8.

X. ARC Recommendations[69] Intent, Rationale and Approach

This report provides detailed information on each recommendation, including the ARC's intent, supporting rationale, research, examples, and suggested regulatory approach. As the FAA has ultimate responsibility for developing the regulatory approach while following the public rulemaking process, the report does not provide a full draft regulatory text implementing the ARC's recommendations. However, the ARC does offer potential draft regulatory text in those cases where it was developed as part of the process of refining specific recommendations.

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[67] *Perspectives-on-drone-delivery.pdf,* https://maap.ictas.vt.edu/content/dam/maap_ictas_vt_edu/Perspectives-on-drone-delivery.pdf.

[68] *Voluntary Best Practices for UAS Privacy Transparency and Accountability,* https://www.ntia.doc.gov/files/ntia/publications/voluntary_best_practices_for_uas_privacy_transparency_and_accountability_0.pdf.

[69] A full list of all ARC recommendations is found at Appendix B.

A. Air & Ground Risk Recommendations

The Air & Ground Risk section contains recommendations for ALR, HAZMAT carriage, and operations over people. It also includes recommendations regarding reporting and data collection, as well as research and development initiatives.

AG 2.1 – Acceptable Level of Risk

AG 2.1	The acceptable level of risk (ALR) for UAS should be consistent across all types of operations being performed, and no more restrictive than the accepted fatality rates of general aviation.

INTENT: The expectation is that operators will be able to meet the UAS ALR through qualitative or quantitative methods, or a hybrid approach. This is similar to existing Safety Management System constructs where a value is assigned and both qualitative and quantitative approaches can be used to demonstrate compliance.

RATIONALE: As mentioned earlier in this report, establishing an ALR for UAS operations that enables the public and economic benefits of UAS to be realized at scale is clearly in the public interest. Such an ALR should be based upon established and documented risk acceptance thresholds for both the aviation community and the general public. Using the fatality rate of crewed General Aviation aircraft as the basis for the ALR not only is the most applicable comparison from an aircraft and operations perspective (lighter structure, limited in ability to carry humans and cargo, frequently operates at lower altitudes and outside of controlled airspace), but follows the precedent established by other light aircraft such as LSA and powered gliders. However, as there are no possible first-party fatalities in UA operations due to the fact there are no pilots onboard the UA, only second and third-party fatalities should be considered.

A consistent set of values for ALR is important to facilitate practical implementation. This will allow industry to create clear and usable standards and the FAA to adopt a common and consistent set of regulations and guidance. Having multiple values for different types of operations will dramatically increase the complexity of the regulatory framework and compliance.

The Uniform Safety Continuum defines ALR by aviation sector. The Safety Continuum organizes sectors on a scale, based on the public's tolerance for risk. The lowest tolerance for risks is associated with commercial transportation, which is "held to the highest degree of safety in the public interest." The tolerance for risk informs safety performance targets, decisions on accepting risk in SMS, and the level of FAA involvement and oversight that may be necessary. By using the ALR associated with general aviation, UAS operations are conservatively being held to a higher standard than the Continuum proposes.

[*Source: FAA*]

Chart 1 – Uniform Safety Continuum

While UAS technology has moved forward quickly, policy and regulatory guidance has lagged. Unlike traditional aviation operations, the FAA has not developed guidance concerning an ALR for UAS. Therefore, decisions relating to approving waivers and exemptions lack consistent and industry-appropriate underlying guidelines like those that the FAA routinely applies to commercial and general aviation. Without this guidance, the FAA often applies experience from traditional aircraft where it may not be appropriate.

Furthermore, given the novelty of the policy and regulatory issues raised by UAS operations, FAA staff may need to elevate risk issues/decisions on a case-by-case basis which impacts the FAA's efficiency and limits their ability to provide timely responses to regulatory applications.

The FAA has established aviation safety targets informed by decades of experience in traditional aviation and public feedback, but there are currently no established safety targets for UA. To determine the acceptable level of risk for BVLOS UA operations, the ARC believes the following mitigation and risk tradeoff factors should be considered:

Public Perception - the public's belief or opinion on the benefits and risks of BVLOS operations

Aviation and Non-Aviation Risk Analogues – the relevance of data and research released by the FAA, NHTSA, NTSB, DOT, and OSHA

UAS Operations Benefits – the economic, public health, environmental and societal benefits of BVLOS operations must be weighed against any risk

Risk Transference – the risk of completing the task in the traditional way as well as where risk can be transferred to industry in accountability, liability, and insurance requirements.

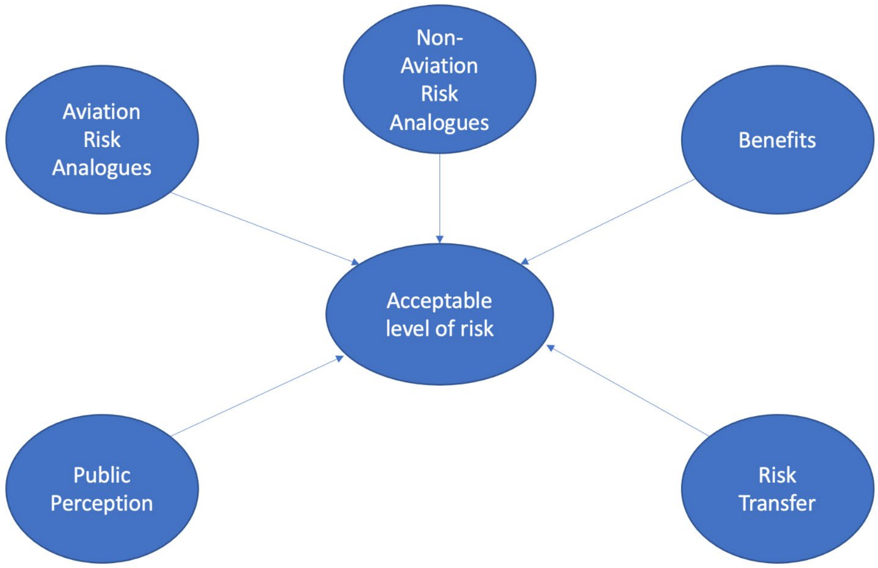

Figure 1 - Inputs into developing the acceptable level of risk.

The ARC recommends a single set of ALR values for UA operations. The ground risk ALR value should be no more restrictive than the 3rd party ground fatality rate of general aviation; and the air risk ALR value should be no more restrictive than the 2nd party MAC fatality rate of general aviation.

APPROACH: The ARC proposes the rule language laid out in the Regulatory Text section of this report, which reflects a holistic view of the safety considerations of the aircraft, the operator, and the airspace. This regulation is intended to ensure that there is an understanding by the operator that they have responsibility for the operation when deciding to conduct BVLOS operations.

AG 2.2 – Risk Based UA Characteristics & Operating Environment

AG 2.2	The rules should be predicated on the risks of operation based on UA capability, size, weight, performance, and characteristics of the operating environment as opposed to the purpose of the operation.

INTENT: To base the FAA's framework for managing air and ground risk on the characteristics of the operating environment rather than distinguishing between operations for different purposes, establishing a scheme that can greatly reduce the number of persons exposed to risk by broadly regulating how operations are conducted as opposed to why operations are conducted. The ARC's intent is to establish one ground and one air Acceptable Level of Risk, regardless of whether the operation is conducted at Level, 1, 2, or 3.

RATIONALE: The risk level will fluctuate based on the mitigation applied to the operation, but the safety threshold for the operation remains constant regardless of type of operation. Prioritizing how an operation is conducted allows a performance-based approach that ensures that the best mitigation is applied based on UA capability, size, weight, performance, and characteristics of the operating environment.

Shifting the emphasis from why to how operations are conducted has several regulatory, cost, and public interest benefits. First, a uniform ALR can be applied to all UAS operations, allowing greater flexibility in the methods an operator chooses to meet it. Second, safety requirements can be adapted to a range of operations, allowing lower-risk operations to be conducted with less FAA oversight and preserving FAA resources for higher-risk operations. Third, a performance-based approach better accommodates new or emerging technology. This is a major benefit from a cost and public interest perspective as it removes many of the barriers to entry in the UAS domain that would otherwise exist with an onerous or complex regulatory regime.

APPROACH: The ARC proposes to establish a range of risk levels based on strategic and technical mitigations. The risk levels are based on the strategic air and ground mitigations applied to the operation. Strategic mitigations reduce risk prior to flight, while technical mitigations reduce risk in-flight. The ARC decided that the risk level should be based on strategic mitigations, i.e., how much risk is removed from the operation before it commences. Once the risk level is determined, the regulatory framework should then provide for the reduction of that risk to acceptable levels through the application of technical mitigations.

Level 3 operations require technical ground and air risk mitigations, including a qualified UA and collision avoidance and conspicuity capabilities that meet the performance requirements of FAA-accepted industry standards. The mitigations must be appropriate for the relative risk of the operating environment, and may include the use of Third-Party Services.

For Level 2A, the air risk has been strategically mitigated to an acceptable level. This may include information sharing and network services, such as strategic deconfliction as described above. Technical ground risk mitigations are required, including a qualified UA and collision avoidance and conspicuity capabilities that meet the performance requirements of FAA-accepted industry standards.

In Level 2B, ground risk has been strategically mitigated to an acceptable level, but Technical air risk mitigations are required. When only ground risk is strategically mitigated, a collision avoidance capability and conspicuity is required for technical air risk mitigation.

At Level 1, air and ground risk are strategically mitigated to an acceptable level. Here, the only technical mitigation is that the UAS have the minimum BVLOS capabilities.

AG 2.3 – Fly to Rule Without Waivers

AG 2.3	BVLOS operations to the greatest extent possible should be allowed to occur through compliance with the regulation alone without the need for a waiver or exemption.

INTENT: As much as possible, the rule should allow BVLOS operations to occur solely through compliance with requirements outlined in the rule itself, rather than requiring those conducting operations to navigate the process of obtaining waivers or exemptions.

RATIONALE: BVLOS operations are presently only achieved by waiver and exemptions and should be authorized by rule. The rule should allow enough flexibility to authorize operations of a higher risk and complexity without an overly burdensome process.

APPROACH: The ARC proposes that the rule establish several different risk levels (1, 2A/2B, and 3) and clearly lay out the types of mitigations that apply to operations at each level in order to achieve the acceptable level of risk. The risk levels and associated mitigations are designed so that the measures needed to properly carry out a wide range of BVLOS operations can be found in the rule itself, with waivers and exemptions only used as needed to incorporate flexibility in authorizing higher-risk and more complex operations.

AG 2.4 – Voluntary Reporting with the UAS ASRS

AG 2.4	The FAA should encourage voluntary reporting in accordance with the UAS Aviation Safety Reporting System (ASRS).

INTENT: To collect data to provide a quantitative framework for qualitative and comparative analysis. Reporting via existing processes, such as the ASRS, already protects against punitive purposes.

RATIONALE: There is value in collecting data for comparative analysis. Care should be taken to avoid being overly prescriptive or requiring proprietary information. The framework should create a system for voluntary reporting as opposed to mandating reporting. As the existing ASRS system provides a solid framework for this type of voluntary data collection, it is appropriate to extend it to uncrewed aviation activities. The ARC also notes that data on UAS activities can easily be integrated into the existing GA and Part 135 Activity Survey, or a similar survey can be easily deployed. (See recommendation AG 2.9 below).

APPROACH: The ARC proposes the establishment of a voluntary system for reporting in accordance with the ASRS and guidance on what types of information should be reported (e.g., flight hours and basic safety metrics).

AG 2.5 – HAZMAT Carriage

AG 2.5	The rule should enable carriage of hazardous materials beyond the specified quantities (per OQ 2.19). Carriage of hazardous materials beyond the specified quantities of OQ 2.19 shall have appropriate mitigations, as established via a performance-based industry consensus standard that is proportionate to the risk of the operation.

INTENT: The ARC recommends developing HAZMAT rules that reflect the specific characteristics of BVLOS operations. The rule shall allow carriage of specified quantities of hazardous materials for delivery by holders of a Remote Air Carrier or Remote Operating Certificate. (Reference OQ 2.19) The ARC recommends developing rules that allow carriage of hazardous materials beyond the specified quantities of OQ 2.19 to include additional overall risk mitigation factors, such as sufficient protections to guard against relevant risks.

RATIONALE: Although UA HAZMAT operations are currently allowed (e.g., will carry program), the existing rule framework was designed for aircraft that transport humans onboard and that carry higher quantities of HAZMAT than could be carried by a UA. The rules need to be adjusted to reflect the differing risk factors involved in UAS operations and should include a risk assessment and mitigations for persons on the ground, such as first responders, employees handling HAZMAT, and containment capability.

The FAA has already determined that the carriage risk for specified quantities of certain hazardous materials is acceptable in routine aviation operations, there is sufficient rationale and precedent for extending similar exceptions to carriage of the same quantities of those materials by UA by certificated operators. (Reference 49 CFR § 175.10, and OQ 2.19) Uncrewed aircraft are likely to carry a range of commonly shipped items which contain HAZMAT. Additionally, UA may be equipped with sufficient protections to guard against risks of HAZMAT carriage. A rule that accurately addresses the nature of the risks involved will guard against these risks without introducing unnecessary restrictions. Assessments on the types of cargo carried and mitigations should be conducted reflecting the unique characteristics of UAS operations.

APPROACH: The ARC proposes that the FAA allows carriage of hazardous materials of specified quantities per OQ 2.19. The ARC proposes the carriage of hazardous materials beyond the specified quantities (per OQ 2.19) tie permissible carriage to an industry-consensus standard, establishing a provision in Part 108 laying out accepted MOC based on this standard, proportionate to the risk of the operation.

The standard must address the carriage of common shipped items such as small consumer electronic goods and individually consumable items, not otherwise permissible by rule. It should take a risk-based approach that establishes clear categories of acceptable/unacceptable cargo that can be shipped. In addition, the standard should consider cargo accessibility requirements, means to notify first responders and Aircraft Rescue and Fire Fighting (ARFF) personnel of HAZMAT onboard an incident aircraft, Emergency Response Guidance to the pilot in the event of an inflight spill, and whether a means to detect an inflight HAZMAT release is needed.

AG 2.6 – Operations Over People

AG 2.6	The rule should allow UAS to conduct transient flight over people. The rule should allow sustained flight over non-participants with strategic and/or technical mitigations applied.

INTENT: To allow *transient* flight over people and *sustained* flight over non-participants in circumstances that reflect mitigated risks, such as when people are sheltered, using PPE, or aware of the risks from the flight. The selection of risk mitigation methods (strategic, technical or a combination of both) used to meet the ALR should be left to the UAS operator based on the environment and system performance.

RATIONALE: The ARC considered operations over people within the scope of this rulemaking, and believed it important to state that the UAS industry will not succeed without the ability to fly BVLOS over people and moving vehicles. The ARC assessed risk-based and performance-based approaches that could broadly enable BVLOS operations over people.

“Densely populated” and “sparsely populated” are not defined in current regulations. The ARC considers the concept of “sustained flight over people” to better capture the risks associated with operations where population density poses risk. There should be an acknowledgement that mitigating factors could include:

- participants that are aware of the risk (e.g., movie sets);
- participants that are sheltered or have PPE; or
- flight over non-participants when strategic and/or technical mitigations are applied.

In all cases, selection of mitigating factors used to meet the ALR should be left to the UAS operator, as long as they can sufficiently demonstrate conformity to the acceptable level of risk.

The ARC further noted that the relevant time-based exposure of UAS flights is an important factor in determining actual ground risk exposure and probability. Densely populated areas are not a meaningful factor to consider, as towns with 50,000 residents and cities with millions may have roughly the same population density. The ARC view is that the relevant time-based exposure is what contributes the most exposure to ground risk. While the ARC strongly supports a single set of ALR values for UA operations, the ARC recommends differentiating between flights that transit populated areas for only a short duration of time (e.g., the minimal ground risk and exposure of a BVLOS flight quickly crossing a road in a rural area) versus the exposure of a flight with characteristics of sustained flight over people (e.g., a UAS covering a parade). This differentiation allows flights that only briefly transit populated areas to be appropriately and accurately risk-assessed as comparable to flights over less-populated or non-populated areas.

APPROACH: The ARC proposes that the rule permit sustained flight over people only when the ALR is met. The UAS operator shall determine the appropriate strategic and/or technical mitigations, as long as they can sufficiently demonstrate conformity to the acceptable level of risk. Mitigations may include, but not be limited to;

- Use of systems to reduce the impact area or consequences of a UA collision (e.g., parachutes, foam and/or frangible aircraft, etc.)
- The people involved are participants who are aware of the risks from sustained flight operations.
- Adequate shelter is available and properly in use.
- Adequate personal protective equipment is available and properly in use.
- Appropriate aircraft and system qualifications are met.

In addition, the ARC recommends the FAA evaluate methodology and industry consensus standards for assessing the safety of UAS impacts to better reflect the results of the UAS Center of Excellence study." The FAA's Operations Over People (OOP) rule finalized earlier this year codified an OOP approach that does not recognize the full range of available mitigations for safety to nonparticipants on the ground. The OOP rule incentivizes the marketplace to operate very small UAS, which can meet the kinetic energy impact injury thresholds but does not account for heavier UAS that have highly effective mitigations for safe BVLOS operations. The ARC, therefore, sees tension between its BVLOS recommendations and the OOP rule. The ARC urges the FAA to adopt a risk-based, performance-based approach that broadly enables a safe and reasonable path forward for BVLOS operations over people and moving vehicles. Operations over people should be allowed when the risk level is appropriate. As UAS BVLOS operations increase, the FAA may need to consider additional wide scale characteristics, which account for repeated, high-frequency, or multiple UAS activities over an area.

AG 2.7 – Minimum Capabilities List

AG 2.7	The rule should be based on a minimum capability needed to safely perform the operation, not a minimum equipment list.

INTENT: The rule should focus on identifying a minimum capability needed to safely perform UAS BVLOS operations rather than on establishing equipage requirements which may be prohibitive for some UAS.

RATIONALE: Excessive equipage requirements could be costly and incur additional weight penalties onboard an aircraft. This can be operationally prohibitive for many of the small UAS currently in operation. Nonetheless, the BVLOS regulation presents an opportunity to accelerate UAS equipage requirements. However, the rule should not limit equipage requirements to just UAS. Equipping more aircraft should result in a lower risk of collision. "Layering" mitigations could be one way to achieve safety objectives (e.g., if an aircraft is operating in a location with a known traffic density, other defined mitigations equal an acceptable level of risk). The layered mitigations should meet an acceptable level of risk for the operation.

APPROACH: The ARC proposes that the rule lay out a minimum capability needed to safely perform UAS BVLOS operations, allowing operators flexibility in choosing equipage that will allow them to achieve this capability level. The ARC further proposes that the rule explore "layering" mitigations and that output should meet a certain acceptable level of risk.

AG 2.8 – Support Innovation and Emerging Technology through R&D

AG 2.8	The FAA should develop pathways to support innovation and accommodate emerging technology. The FAA should give consideration to approvals for low-risk Research and Development initiatives.

INTENT: To leverage R&D activities and provide the FAA with critical information in areas such as Detect and Avoid, UAS Communications, Human Factors, System Safety, and Certification, all of which will aid in the FAA's efforts to safely integrate UAS into the NAS.

RATIONALE: When 14 CFR Part 107 was enacted, the FAA acknowledged "that new technologies could come into existence after this rule is issued that could alleviate some of the risk concerns underlying the provisions of this rulemaking." As UAS technology constantly evolves, the ARC also considers it prudent to establish pathways to support innovation to be able to accommodate emerging technologies that enable safer or more efficient operations.

Current approval processes for R&D operations do not enable broad testing in the U.S. in a timely way. The FAA should implement policies and procedures that encourage companies to innovate and ensure that that innovation occurs in the U.S. UAS R&D activities help support the safe and efficient integration of UAS into the NAS. R&D operations are key to unlocking new transportation solutions and innovative UAS use-cases that will bring safety, economic, environmental, health, security and equity benefits to the American people and support American competitiveness in the global aviation marketplace. The ARC considers a risk-based approach to authorizing R&D operations to be most suitable because many R&D missions are extremely low risk, and conducted in controlled environments. The process for approving R&D operations should also be efficient and timely, allowing UAS companies to test and develop products and demonstrate incremental progress to investors. This is especially critical for UAS companies because they have a different funding model than that of traditional crewed aviation.

APPROACH: The FAA has existing tools that it can use to streamline and expedite approvals for low-risk R&D activities, such as:

- Prioritizing and streamlining the workflow for issuing experimental certificates.

- Empowering FAA UAS Test Sites to conduct R&D activities without the need to obtain individual approvals on a case-by-case basis.

- Leveraging statutory authority for authorizing R&D activities as public aircraft operations (PAO) to the greatest extent possible. The FAA has flexibility to interpret the PAO statute more broadly and it should do so.

- Immediately leverage the authority in 49 USC 44803(c) to issue broad waivers to FAA UAS Test Sites in a streamlined way.

- Utilize DARs wherever possible to improve the timeliness for issuing airworthiness approvals necessary to enable R&D activities.

- Leverage the more than 1.2 million Recreational Operators in the USA to speed time to market, create USA-based UAS manufacturing and nurture UAS software innovation with lower costs, and leverage STEM programs to identify and cultivate aviation enthusiasm to help youth in the USA join the aviation work force.

- Allow provisions of this rule to be waivable to accommodate emerging technology, and that the FAA follow established practice when evaluating waivers or exemptions to the BVLOS rule and ensure that waiver processes are streamlined and timely.

Wherever possible, the FAA should identify ways to consolidate different FAA approvals that may be required to conduct R&D activities. For example, under the current regulatory framework, an operator seeking to conduct R&D using an aircraft with an experimental SAC may need to file a separate petition for exemption from various FARs to obtain relief necessary to actually operate the UAS issued a SAC-E. As recommended by Phase 1, the FAA should consolidate and streamline approval processes, including for R&D.

Lastly, the ARC recommends that the FAA follow established practice when evaluating waivers or exemptions to the BVLOS rule and ensure that waiver processes are streamlined and timely. Applying SMS principles and processes as required by FAA Order 8040.4[] and in alignment with traditional aviation practices and establishing streamlined and timely waiver processes will help ensure an efficient and user-friendly waiver system. The ARC proposes that the rule specify that the FAA apply SMS principles and processes and take steps, such as establishing deadlines to ensure that the waiver process is streamlined and timely.

AG 2.9 – Incorporate UA into Existing Surveys or Develop a UA Survey for Safety Data

AG 2.9	The FAA should incorporate uncrewed aviation into existing surveys or deploy a survey similar to the General Aviation and Part 135 Activity Survey.

INTENT: To allow the FAA to capture safety information and develop a set of safety metrics, the ARC intends to ensure that data collected via the existing processes reflects uncrewed aviation activities.

RATIONALE: The ARC considers it valuable to collect data to provide a quantitative framework for qualitative and comparative analysis. However, under the current survey structure, UA are not allowed to participate. UA and UAS activities can easily be integrated into the GA and Part 135 Activity Survey, and reporting should be safety-focused without being too burdensome or overly broad. The ARC acknowledges that UA operators may submit safety reports through the ASRS system (as noted above in recommendation AG 2.4); but considers it imperative that UAS operations be captured in the GA and Part 135 Activity where UA will have a greater presence as they become more fully integrated into the NAS. The ARC recommends that UAS data reported via the GA and Part 135 Activities Survey support the determination of an ALR associated with BVLOS operations. Data reported should include the nature of the flight (BVLOS or VLOS), and may also include information such as operating flight rules (e.g., Part 107, Part 108, or Part 91).

APPROACH: The ARC proposes that the FAA incorporate data gathered from uncrewed aviation activities into the General Aviation and Part 135 Activity Surveys or deploy a similar survey. Uncrewed aviation activities may include UA flown for recreational purposes, as well as non-hobby or commercial purposes. The information would be provided on a voluntary basis, and the FAA should encourage UA participation in such processes.

B. Flight Rules Recommendations

The Flight Rules section contains recommendations on amending right of way rules in Shielded Areas and Non-Shielded Low Altitude Areas and allowing UA operations below the Minimum Safe Altitude (MSA) restrictions. It also includes recommendations on revising existing right of way rules to allow a range of sensing methodologies and clarify adequate separation; incorporating Extended Visual Line of Sight rules and BVLOS operations assisted by an observer into the existing Visual Line of Sight operations rule; and providing operator training to increase situational awareness.

FR 2.1 – Detect and Avoid & Well Clear

FR 2.1	The FAA should amend Part 91.113 (b) to allow a range of sensing methodologies and clarify adequate separation.

INTENT: To change ‘see and avoid’ to ‘detect and avoid’ to allow all aircraft to utilize technical or non-technical means to detect other aircraft. Replace ‘see and avoid’ with ‘detect and avoid’ and remove the phrase ‘well clear’ and replace it with ‘adequate separation’.

RATIONALE: Allowing a broader range of sensing capabilities improves safety by providing more options to ensure adequate separation. This recommendation is consistent with a recommendation from the 2013 UAS ARC. Specifically, that a new subsection (1) be added to 91.113(b) clarifying that, for UA, the use of the word 'detect' should apply.

The word 'see' has been problematic when used in the context of UA. Other technical means are available to satisfy the same core intent, which is to identify other aircraft and avoid collisions. Removing the word 'see' expands the rule to permit the use of technology and provide remote pilots the ability to view a real-time image from the UA. This improves situational awareness, adds an additional mitigation of safety hazards and risk, and allows the use of sensing methodologies beyond human visual capabilities.

It has already been discussed that traffic separation below 500' AGL among the UAS community shall be provided by the community itself, i.e., no ATC services provided. The ARC also notes that promotion of the use of simple detection methods, such as ADS-B in (added to UAS), could encourage the use of ADS-B out or TABS by crewed aircraft operators.

Currently, there are no FAA recognized standards for the acceptability of detect and avoid systems suitable for the types of aircraft used in low altitude operating environments. There are technologies that could provide some level of protection from collisions, but there is not an FAA accepted standard to evaluate their performance. Standards have been accepted for large powerful radar-based systems intended for operations by large UA in Class E airspace. However, the well clear definition used for those systems would be overly conservative for the low altitude environment, and the exact definition of well clear for this airspace has not been studied or established in a standard. This change creates solution space for the regulator and industry by allowing different levels of separation to apply in different situations, and better align with 'performance based' approaches. For the airspace below 500', the existing well clear definitions are not safe or feasible so avoiding the use of that term in the regulatory structure is recommended. Implementation of this change requires a different approach to determining collision risk that is not dependent on a volume of airspace but rather on an acceptable level of collision risk appropriate for the airspace. Enabling operations that do not require a non-cooperative sensor will accelerate the approval of UA that will replace higher risk operations and activities, increasing aviation and societal safety with no appreciable increase in risk to other crewed operations. With the appropriate policy framework in place, the FAA could begin authorizing UA operations using the exemption or waiver process in the interim while BVLOS regulations are promulgated.

APPROACH: – Proposed regulatory text for FAR 91.113(b).

General. When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules, visual flight rules, ***<u>or automated flight rules,</u>*** vigilance shall be maintained by each person operating an aircraft so as to ***<u>detect and avoid</u>*** other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under or ahead of it unless able to maintain ***<u>adequate separation.</u>***

FR 2.2 – Non-Shielded Low Altitude UAS BVLOS – ADSB Equipped Crewed Aircraft Have Right of Way

FR 2.2	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400' AGL) yield right of way to crewed aircraft equipped with ADS-B or TABS and broadcasting their position.

INTENT: To give crewed aircraft equipped and broadcasting with ADS-B or TABS right of way over UA in low altitude Non-Shielded Areas.

RATIONALE: Crewed aircraft equipped with ADS-B or TABS would have right of way over UAS conducting BVLOS. The UAS must have an FAA approved or accepted DAA system that can detect ADS-B or TABS equipped aircraft **or** an FAA approved or accepted system that can detect all aircraft using another means (e.g., radar, acoustic or electrical optical).

APPROACH: Create a new part (h) in FAR 91.113. The proposed regulatory text is as follows:

§ 91.113(h)

(h) Uncrewed Aircraft Conducting BVLOS Operations Below 500 ft AGL.

1. Uncrewed Aircraft Conducting BVLOS Operations Below 500 ft AGL must yield right of way to all aircraft that are equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.

2. The UA must:
   a. be equipped with an FAA approved or accepted detect and avoid system that can detect ADS-B or TABS equipped aircraft or can detect all aircraft using another means
   b. Notify other aircraft of their operation through use of a NOTAM or other means accepted by the FAA.
   c. Be approved in accordance with 14 CFR Part 108.XX.

3. The UA operator must:
   a. For operations in controlled airspace, obtain prior authorization from the airspace controlling facility.
   b. For operations in uncontrolled airspace, coordinate with the airport operator for operations within 3 nautical miles for public airports.
   c. For operations in uncontrolled airspace, coordinate with the heliport operator for operations within ½ nautical mile of the published heliport.

FR 2.3 – Non-Shielded Low Altitude UAS BVLOS – UA Have Right of Way

FR 2.3	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400' AGL) have right of way over crewed aircraft that are not equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.

INTENT: To give UA right of way over crewed aircraft that are not equipped with an ADS-B or TABS in low altitude Non-Shielded Areas.

RATIONALE: The GA traffic that routinely operates below 500' and away from airports/ heliports and their traffic patterns comprise a small fraction of the GA population. The unmitigated risk of encounter between UA and unequipped GA aircraft in the below 500' operating environment is very low. The ARC is not recommending a mandated equipage requirement for crewed aircraft. Rather, it is recommending that equipped aircraft have right of way over non-equipped aircraft, regardless of which aircraft is crewed. Nearly half of the existing GA fleet is already ADSB equipped (107,000 equipped of 220,000 active aircraft).[70] If these recommendations increase equipage rates even further, it will yield a safety benefit for all users of the NAS, regardless of any UA interactions. The ARC encourages the FAA to consider restarting the ADS-B subsidy program to support crewed aircraft operators that were not previously impacted by the ADS-B equipage mandate.

Requiring UAS BVLOS operators to be able to detect ADS-B or TABS equipped aircraft or all aircraft using another means (e.g., radar, acoustic or electrical optical) also improves safety, especially for operations where crewed and uncrewed aircraft are likely to both be present (e.g., UAS and helicopter providing coverage of the same event).

APPROACH: UAS BVLOS operations **away** from public airports or published heliports would be required to detect and avoid ***only*** those crewed aircraft that are broadcasting ADS-B out or TABS. UAS BVLOS operations **near** published airports must conform to LAANC facility maps. For public airports without a LAANC grid, UAS BVLOS operators must maintain a 3 NM distance unless a closer operating distance is coordinated in advance with the airport operator. UAS BVLOS operations may not be conducted within ½ nautical mile of a public airport or published heliport without prior coordination with the airport or heliport manager. UAS BVLOS operators must notify other aircraft of their operation through use of a NOTAM or other means accepted by the FAA. Presently UA awareness is via NOTAMs, VFR chart markings and could be further facilitated by upcoming UTM or Network Remote ID implementations or by further notation in FAA published materials.

FR 2.4 – UA Has Right of Way for Shielded Operations

FR 2.4	The FAA should amend FAR Rule Part 91.113(d) to give UA Right of Way for Shielded Operations

INTENT: To maximize the use of shielded areas for UA operations and reduce GA accidents and fatalities that occur when crewed aircraft conduct missions in shielded areas.

[70] FAA reported ADS-B Equipage Levels as of 11/2021, https://www.faa.gov/nextgen/equipadsb/installation/current_equipage_levels/.

RATIONALE: Shielded Area is defined as a volume of airspace that includes 100' above the vertical extent of an obstacle or critical infrastructure and is within 100 feet of the lateral extent of the same obstacle or critical infrastructure as defined in 42 U.S.C. § 5195c (Critical Infrastructures Protection Act of 2001).

It is agreed that within this volume, there are typically no fixed-wing general aviation, rotorcraft, ultralight, hang glider or other crewed aircraft operations due to the safety hazard presented by the obstacle itself. Operations within 100 feet of a structure present a considerable hazard to crewed aircraft and occupants. As a result, the likelihood of UA-GA encounters is insignificant in Shielded Areas because crewed aircraft typically do not conduct operations near obstacles, unless the obstacle is the focus of the operation.

Uncrewed aircraft, operating within the agreed boundaries of an obstacle, should be considered part of the obstacle. This provides a UAS operational volume that is largely free of crewed aircraft, providing a strategic mitigation that allows UA operators to obtain the full benefits of shielded operations and increase safety without any additional cost or technology. This promotes shared responsibility in this shielded airspace and facilitates a performance-based approach to collision avoidance based on the mission, environment and aircraft involved. Moreover, this facilitates the transition of certain inherently high-risk, very low-level operations to BVLOS UA operations, potentially saving the many lives lost each year by crewed aircraft conducting higher risk operations.

APPROACH: Create a new part (4) in FAR 91.113(d).

§91.113(d)(4)

(4) Uncrewed Aircraft conducting BVLOS Shielded Operations have right of way over all other aircraft.

This provision applies under the following conditions:

- UA operating in this airspace must be approved according to the new aircraft approval rules proposed by the BVLOS ARC.
- The UAS Operator or Remote Pilot must provide a means to ensure the UA remains within the Shielded Area.
- Operations near airports must conform to LAANC requirements or maintain 3 NM distance from public airports without a LAANC grid unless access is coordinated in advance with the airport operator.
- No shielded operations within ½ NM from a published heliport without coordination in advance with the heliport operator.

FR 2.5 – Increase UA Awareness Among Crewed Aircraft Pilots

FR 2.5	Pilots should be educated to associate obstacles and structures along their flight path with uncrewed flight operations to increase situational awareness during both preflight planning and actual operations.

INTENT: To leverage existing training practices for low altitude flight operations to reduce the risk of collision between UA and GA and safely integrate UA in low altitude operations.

RATIONALE: The ARC intends to maximize the utility of the airspace near structures and other obstacles that crewed aircraft are already in the habit of avoiding. GA pilots are currently trained to avoid cardinal altitudes to reduce the risk of collision with other aircraft. GA operations around uncontrolled airports are also conducted to reduce the risk of loss of separation. With both existing and proposed training, crewed aircraft pilots will associate obstacles and structures along their flight path with uncrewed flight operations, thereby increasing situational awareness during both preflight planning and actual operations. The intent is to capitalize on structures that pilots are already trained to avoid under existing VFR operating rules.

APPROACH: Pilot training programs should include an awareness of UAS operations, with an emphasis on training GA pilots to associate obstacles and structures along their flight path with uncrewed flight operations to reduce collision risk. The existing training, procedural, and operating norms applied to VFR operations should include consideration of UA operations at low altitudes. The training should also include human factors considerations for UAS operations. The ARC notes that the FAA is currently researching human factors issues for both crewed and uncrewed pilots and encourages its continued work. The four key research categories are function allocation, control station requirements, pilot training and certification requirements, and visual observer requirements.[71] The research will support the development of standards, regulations, and guidance for civil UAS, which should be used for future pilot training programs.

[71]Unmanned Aircraft Systems Human Factors Considerations, https://www.faa.gov/uas/research_development/information_papers/#hf.

FR 2.6 – Amend Pre-Flight Action to Include UA Pilots

FR 2.6	The FAA should revise §91.103 to include a new part (c) to accommodate UA operations.

INTENT: To amend existing regulations to create references to Automated Flight Rules (AFR) as required.

RATIONALE: For a BVLOS UA flight under AFR, the remote pilot in command will take appropriate steps to confirm conditions for safe operation and safe launch and landing areas by consulting relevant information, which may include weather station information, systems and sensors on-aircraft and other flight support systems. FAR § 91.103 Preflight action was written before UA operations in the NAS were anticipated. In some respects, the rule is intentionally vague to allow pilots flexibility in gathering information to ensure conduct of a safe flight. BVLOS operations are unique to UA; therefore, ground based pilots require sensors, or cameras, and other sophisticated equipment installed on the aircraft to ensure flight safety.

APPROACH: – Addition of a new part (c) expands upon current guidance to ensure compliance with preflight actions unique to UA conducting BVLOS operations in the NAS.

Proposed regulatory text creates a new part (c) in FAR 91.103.

§91.103(c)

For a BVLOS UA flight under AFR and a flight not in the vicinity of an airport, the remote pilot in command will take appropriate steps to confirm conditions for safe operation and safe launch and landing areas by consulting relevant information, which may include weather station information, systems and sensors on-aircraft and other flight support systems.

Addition of a new part (c) expands upon current guidance to ensure compliance with preflight actions unique to UA conducting BVLOS operations in the NAS.

FR 2.7 – Amendments to Minimum Safe Altitudes to Facilitate Low Altitude Operations

FR 2.7	The FAA should amend § 91.119 to allow UA operations below the Minimum Safe Altitude restrictions

INTENT: To allow operations below current minimum safe altitudes to accommodate Shielded and Non-Shielded Low Altitude UAS Operations.

RATIONALE: This recommendation is supported by comparing the operational similarities between helicopters and vertical lift UAS. The FAA rationale supporting helicopter operations below the minimums established for fixed wing aircraft is that "they have unique operating characteristics, the most important of which is their ability to execute pinpoint emergency landings during power-out emergencies. Vertical lift UAS possess the same *unique operating characteristics* as larger crewed helicopters/rotorcraft. In fact, UAS have additional equipment and operating system capabilities not found on helicopters/rotorcraft, such as geo-fencing, lost link with return home feature (or other predetermined location), and emergency shutoff/power reduction features that allow the UA to quickly land. Some UAS also include a parachute recovery system to minimize damage to the UAS or injury to people. This amendment would allow lower risk UA BVLOS to conduct certain types of higher risk crewed aircraft operations (e.g., agricultural spraying and helicopter inspections of power lines) and reduce the number of deaths that occur in these operations every year. Allowing UA operations below minimum safe altitudes is also consistent with §91.119(d), §107.51(b), and §137.49 when the operations are conducted without creating a hazard to persons or property on the surface.

APPROACH: – Proposed regulatory text for FAR §91.119

§91.119 (d) Helicopters, powered parachutes weight-shift-control, and uncrewed aircraft. If the operation is conducted without hazard to persons or property on the surface -

(3) A UA may be operated at less than the minimums prescribed in paragraph (b) or (c) of this section, provided those operations are done in accordance with 14 CFR 108.XX.

FR 2.8 – Extended Visual Line of Sight

FR 2.8	The FAA should amend FAR Rule Part 107.31 to include Extended Visual Line of Sight

INTENT: To expand § 107.31 Visual line of sight aircraft operation to include Extended Visual Line of Sight and allow operations where a RPIC does not see the UAS, but a trained crewmember has situational awareness of the airspace around the UAS.

RATIONALE: A Trained Visual Observer(s) would communicate critical flight information, to assist the RPIC to maintain adequate separation. Critical flight information includes, but is not limited to, crewed and uncrewed aircraft, structures, terrain, people, and changes in weather. While these are technically intermittent BVLOS operations, a crewmember has situational awareness of airborne and ground hazards that provide an increased level of safety. This would also enable operations where a UAS flies on the other side of a building or trees for more than momentary amounts of time. Another example is the situational awareness that a crewmember has of the airspace and the ground during a mapping mission over a farm. Revising §107.31 would allow a RPIC to legally fly such a mission even if they lose sight of the UAS. At the discretion of the regulator, additional mitigations may include weather limitations such as a ceiling of 1,000 feet AGL and 3 statute miles visibility.

APPROACH: – Proposed regulatory text for FAR 107.31

§ 107.31 Visual line of sight aircraft operation

(a) With vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one or more are used), or the person manipulating the flight controls of the small uncrewed aircraft system must be able to see the uncrewed aircraft throughout the entire flight in order to:

(1) Know the uncrewed aircraft's location;
(2) Determine the uncrewed aircraft's attitude, altitude, and direction of flight;
(3) Monitor the airspace for other air traffic or hazards; and
(4) Determine that the uncrewed aircraft does not endanger the life or property of another.

(b) Throughout the entire flight of the small uncrewed aircraft, the ability described in paragraph (a) of this section must be exercised by either:

(1) The remote pilot in command and the person manipulating the flight controls of the small uncrewed aircraft system; or
(2) A visual observer.

(c) The remote pilot in command, the person manipulating the flight controls, and the visual observer (if one is used), are relieved from the requirement of seeing the uncrewed aircraft throughout the entire flight if they are able to:

(1) Know the uncrewed aircraft's location;

(2) Determine the uncrewed aircraft's attitude, altitude, and direction of flight;
(3) Observe the airspace for other air traffic or hazards; and
(4) Determine that the uncrewed aircraft does not endanger the life or property of another.

(d) To be relieved of the requirement to see the uncrewed aircraft under paragraph (c) of this section, the uncrewed aircraft must not be flown more than three statute miles away from the remote pilot in command, the visual observer (if one is used), or the person manipulating the controls, and the remote pilot in command, the visual observer (if one is used), and the person manipulating the controls must:
(1) Receive training on and be permitted to operate an aviation radio; and
(2) Monitor aviation frequencies for nearby air traffic.

FR 2.9 – Visual Observer to Support BVLOS

FR 2.9	The FAA should amend FAR Rule Part 107.33 to allow a visual observer to assist and support BVLOS operations

INTENT: To allow a visual observer to assist and support BVLOS operations and describe visual observer roles and responsibilities

RATIONALE: See Recommendation FR 2.8 above.

APPROACH: – Proposed regulatory text for § 107.33 Visual observer.

§ 107.33 Visual observer.

If a visual observer is used during the aircraft operation, all of the following requirements must be met:

(a) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer must maintain effective communication with each other at all times.

(b) The remote pilot in command must ensure that the visual observer is able to see the uncrewed aircraft in the manner specified in § 107.31.

(c) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer must coordinate to do the following:

(1) Scan the airspace where the small uncrewed aircraft is operating for any potential collision hazard; and

(2) Maintain awareness of the position of the small uncrewed aircraft through direct visual observation.

(d) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer are relieved from subsections (b) and (c) if the flight is conducted in compliance with 107.31(c) and (d).

C. Aircraft and Systems Recommendations

The Aircraft and Systems section contains recommendations for the establishment of a new BVLOS rule for qualification of UA and Associated Elements. The section further contains recommendations addressing UA and Associated Elements maintenance, repair, and modification and for new Special Airworthiness and Repairperson certificates, as well as on the qualification process for UA systems and declarations of compliance. It further includes recommendations on applying the Operations Matrix framework to exemptions.

AS 2.1 – Process for Qualification of UA and UAS

AS 2.1	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of uncrewed aircraft and systems. The rule should be applicable to uncrewed aircraft up to 800,000 ft-lb of kinetic energy in accordance with the Operating Environment Relative Risk Matrix.

INTENT: To establish a new alternative regulatory pathway for qualification of uncrewed aircraft and systems to enable commercial BVLOS operations offering clear public benefit in operating environments where the oversight of the type and production certification process will not provide additional significant safety benefit.

RATIONALE: Currently, one of the only regulatory pathways to UAS commercial operations beyond visual line of sight is through type and production certification under Part 21.17b. Type and Production Certification are lengthy and involved processes which are appropriate for aircraft operating throughout the entire NAS and over densely populated areas, carrying passengers, and volumes of cargo. However, the safety benefits of these existing processes are not proportional to the risk posed to the public by UA which do not carry passengers and will be limited under these proposed rules to relatively low risk environments and the portion of the NAS below 400ft AGL.

There is precedent for the concept of risk-proportional processes for qualification of traditional aircraft. Restricted Category, Experimental Category, and Light-Sport Category Special Airworthiness Certification each offer pathways with less FAA oversight than that afforded through full type and production certification. The public accepts that these traditional aircraft are qualified to operate with limitations. For example, a Light-Sport Category (LSA) aircraft is an aircraft weighing up to 1,320 lbs. carrying no more than 2 persons and the maximum level flight airspeed is limited to 120 kts. Under 14 CFR 21.190, LSA are qualified under a declaration of compliance framework with issuance of certificate of airworthiness for each individual aircraft. This is not approval of the design as in type certification and compliance to a quality program is in lieu of production certification. The kinetic energy of these person carrying traditional aircraft, which have greater access to the NAS than proposed for UA by this ARC, is approximately 800,000 ft-lbs.

UA

Based on the rationale in Section VII and above, the qualification process of the UA is based on kinetic energy and the relative risk of the operating environment. It should be made clear that the framework speaks to risk proportional requirements and oversight. Detailed design standards for these aircraft and engineering level requirements for systems must be developed and the robustness level of mitigations should be traceable to the overall acceptable level of risk.

Associated Elements (AE) of the UAS

AE are defined through interface and performance specifications necessary to perform the intended function. It is envisioned that initial qualification for use with a UA is accomplished as part of a lightweight flight test program. Operators will be provided with the means to ensure interface and functional specifications continue to meet the performance specification while in service. For AE required for safe operation that are provided directly by a manufacturer rather than by a third-party, the interface and performance specification is validated during qualification of the UA.

Technical Requirements and Performance

It should be made clear that under the proposed certification framework, the robustness level of mitigations and engineering-level requirements must be developed by Industry and detailed in consensus standards, which must be found acceptable by the FAA before being available for use as means of compliance.

A list of UAS BVLOS minimum capabilities was developed. This is not a specific list of technologies requiring a specific automation level. These capabilities should form the baseline performance-based requirements for minimum design, safety, and performance criteria in the means of compliance for the BVLOS rule. MOCs should enable automation in a wide range of systems and operational contexts.

APPROACH:

To support the ARC recommendations contained in this section, Subpart D of the new rule should address the following as shown in the Table AS1 below:

Minimum Capabilities for UA operating with less than 800,000 ft-lbs. of kinetic energy in Level 1 (Air and Ground Risk is Strategically Mitigated) and Level 2B (Ground Risk is Strategically Mitigated) Operating Environments are:

1. Maintain awareness of the location of the UA
2. Adhere to all limitations applicable to the operation including but not limited to:
    a. Operating rules, and
    b. UAS performance and environmental limitations.
3. Navigate with accuracy appropriate for the operation and operating environment.
4. Provide command and control appropriate for the operation and level of automation.
5. Manage contingencies that can reasonably be expected to occur during the operation, including but not limited to:
    a. Loss or degradation of aircraft functions, third party services, or external systems needed for safe operation.
    b. Low fuel/power state.
    c. Changing weather and environmental conditions.

d. Avoid collisions between UA during one-to-many operations within a single operating area
e. Protect against common security threats

Compliance with the rule is by inspection of the system and its operating instructions by the RPIC. Per Subpart C, to obtain a BVLOS rating, an RPIC must be trained on and demonstrate technical knowledge of the minimum capabilities, how to determine contingencies that can reasonably be expected to occur during the operation, and how to assess compliance by inspection. Further guidance on rule interpretation should be offered through an Advisory Circular.

Qualification for UA operating with less than 25,000 ft-lbs. of kinetic energy in Level 2A (Only Air Risk is Strategically Mitigated) and Level 3 (Neither Air nor Ground Risk Strategically Mitigated) Operating Environments is based on an FAA accepted declaration of compliance by the manufacturer to an FAA accepted means of compliance which may be based on industry consensus standards. This declaration of compliance framework is similar to that for Category 2 and 3 Operations over people under Part 107 Subpart D.

UA Means of Compliance by test, analysis, or inspection should address at least these elements:

- Minimum design, safety, and performance criteria including - minimum BVLOS performance capabilities, and interfaces and minimum performance specification of associated elements.
- Quality assurance - inspection procedures, parts, materials and assemblies, and manufacturing controls that will assure aircraft conform to design criteria.
- Acceptance tests and procedures- assuring completed aircraft meet reported criteria. This may include verification of **limits** such as: design weights, center of gravity, performance specifications, controllability and maneuverability, stability, minimum flight speed, human-machine interaction, propulsion system limits and operating characteristics, systems functions, flight control system, and interfaces with associated elements.
- A baseline plan for continued airworthiness systems, including methods for monitoring and maintaining continued operational safety, and processes for identifying, reporting, and remedying safety-of-flight issues.
- Required information to be provided with Maintenance Manuals, Operating Handbooks, etc.
- Minimum documented process for software development.
- Existing industry consensus standards could be used and revised as necessary, and new standards and practices developed to directly address the required elements. **The FAA may wish to permit submission of MOCs by other than standards development organizations (SDO).**

Special Airworthiness Certification for Light UAS under a new rule in 14 CFR 21 (recommendation AS 2.7, Table AS1 below). For UA operating with greater than or equal to 25,000 ft-lbs. but less than 800,000 ft-lbs. of kinetic energy in Level 2A (Only Air Risk is Strategically Mitigated) and Level 3 (Neither Air nor Ground Risk Strategically Mitigated) Operating Environments, UA qualification is a Special Airworthiness Certification. This is still based on an FAA accepted manufacturer's declaration of compliance to an FAA accepted means of compliance based on industry consensus standards. It includes issuance of a Certificate of Airworthiness for each UA by the FAA or by a Designee

Authorized Representative of the Administrator (i.e., Designees – DAR), as defined in Part 183. This framework is similar to LSA under Part 21.190.

UA Means of Compliance by test, analysis, or inspection should address at least these elements:

- Minimum design, safety, and performance criteria including - minimum BVLOS performance capabilities, and interfaces and minimum performance specification of associated elements.
- Quality assurance - inspection procedures, parts, materials and assemblies, and manufacturing controls that will assure aircraft conform to design criteria.
- Acceptance tests and procedures- assuring completed aircraft meet reported criteria. This may include verification of **limits** such as: design weights, center of gravity, performance specifications, controllability and maneuverability, stability, minimum flight speed, human-machine interaction, propulsion system limits and operating characteristics, systems functions, flight control system, and interfaces with associated elements.
- A baseline plan for continued airworthiness systems, including methods for monitoring and maintaining continued operational safety, and processes for identifying, reporting, and remedying safety-of-flight issues.
- Required information to be provided with Maintenance Manuals, Operating Handbooks, etc.
- Minimum documented process for software development.
- Existing Industry consensus standards could be used and revised as necessary, and new standards and practices developed to directly address the required elements. **The FAA may wish to permit submission of MOCs by other than SDOs.**

Table AS1

Operating Environment Relative Risk Level	**Level 1** Air/Ground Risk Strategically Mitigated	**Level 2A** Only Air Risk Strategically Mitigated	**Level 2B** Only Ground Risk Strategically Mitigated	**Level 3** Neither Air nor Ground Risk Strategically Mitigated
Aircraft Kinetic Energy less than 25,000 ft-lbs.				
Qualification	**New BVLOS Rule:** UAS must have the minimum capabilities defined by the rule. Compliance by inspection of the vehicle and its operating instructions	**New BVLOS Rule:** UA must have an accepted declaration of compliance to an FAA accepted means of compliance for its risk class and proportional to its operating risk level. The FAA-accepted MOC may be supported by industry consensus standard(s) when available. The FAA may permit submission of alternative MOCs by applicants, when compliance to a specific standard is not requested for interoperability issues	UAS must have a Collision Avoidance Capability which meets Performance Requirements appropriate for relative risk of the operating environment based on industry consensus standards	UAS must meet the requirements of Level 2A and Level 2B
Aircraft Kinetic Energy greater than or equal to 25,000 and less than 800,000 ft-lbs.				
Qualification	**New BVLOS Rule:** UAS must have the minimum capabilities defined by the rule. Compliance by inspection of the vehicle and its operating instructions	**New Part 21 Rule:** UA must have a Certificate of Airworthiness – SAC or TC	UAS must have a Collision Avoidance Capability which meets Performance Requirements appropriate for relative risk of the operating environment based on industry consensus standards	UAS must meet the requirements of Level 2A and Level 2B

AS 2.2 – UA Maintenance, Repair, and Modification

AS 2.2	The new BVLOS rule should address Maintenance, Repair, and Modifications of UA.

INTENT: To ensure the continued safe operation of UA and serviceability of Associated Elements (AE) is the function of maintenance, repair, and modifications performed throughout the service life of the UAS. The responsibilities between OEM/integrator and operators should be clear and enable safety and efficiency. The requirements should be aligned with the Operating Risk Level and maintenance system complexity - that is, the complexity required to maintain the system, rather than the inherent complexity of the system itself. For example, a UA component may involve an array of sensors that use advanced algorithms in performing a particular function, however, the maintenance may involve simple remove/install/test actions that do not require any detailed knowledge of the inner workings nor any specialized skills. The level of qualification and training for maintenance, repair, and modification of UA and AE should be appropriate to the level of knowledge and skill required for safety.

RATIONALE: Maintenance on aircraft involves several distinct work streams that come together to enable operators to determine if the aircraft is in a condition for safe operation. Risk is mitigated when the UAS configuration matches the original requirements (or as revised) and when required actions (inspections, replacements, and repairs) have been accomplished.

Critical Parts

A critical part is a part, the failure of which could result in a loss of flight or unrecoverable loss of UAS control. If the UA or AE contains critical parts, a critical parts list must be established and the manufacturer must develop and define mandatory maintenance instructions or life limits, or a combination of both, to prevent failures of critical parts. Instructions should be inclusive of actions taken based on health monitoring and fault detection, which may be used to trigger parts replacement based on performance as opposed to replacement at specific intervals. Each of these mandatory actions must be included in documentation similar to Instructions for Continued Airworthiness (ICA). It is noted that a tradeoff exists between the reliability of a part and its replacement interval. Either or both in combination can be used to achieve the same overall reliability of the system.

Material / Parts / Specialized Tooling

In all cases, it must be possible for operators to determine what materials and replacement parts are acceptable for use on UA and AE. Having materials that perform their function and are aligned with the MOC is a critical link in ongoing safe operations. Approved parts (PMA, Part 21, Subpart K) should not be required for UA qualified under the proposed rule (type and product certification processes are not addressed here).

Not all parts are individually critical, but the OEM/integrator must establish either specific parts or specifications and interfaces so operators can use appropriate materials. An OEM/integrators and

Operators can then use whatever original, spare, or replacement parts meet these requirements and interface specifications.

Specialized tooling (including test, calibration, and fixtures) that is unique to the OEM must be provided with documentation to ensure proper use and accomplishment of associated tasks.

Preventative Maintenance

Owner operators should be authorized to perform simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations. Methods, techniques, and practices used are normally set forth in the manufacturer’s maintenance instructions; however, some may be found in ACs published by the FAA.

Tools, equipment, and test apparatus necessary to ensure the work is completed should be in accordance with accepted industry practices. This means that the person performing the preventive maintenance must use proper tools and test apparatus, appropriately calibrated, if applicable. Normally these are listed as part of any FAA-approved manufacturer’s maintenance instructions.

A prescriptive list of authorized preventative maintenance actions is NOT recommended.

Training

Given the relative risk of proposed operations and the low complexity of maintenance actions for Small UA, it is recommended here that manufacturer's instructions must be followed, with an additional training course if one is advised by the manufacturer.

However, the FAA may consider establishing a Small UAS Repairperson certification or qualification under the new BVLOS rule. Persons trained and qualified as Small UAS Repairpersons would perform maintenance and repair actions on aircraft operating in Level 2A and 3 of the Operating Risk Matrix. It is envisioned that this qualification and training would be flexible, performance-based, and tailored to small UAS.

A separate recommendation on establishing qualification and training requirements for Repairmen of Light UAS under Part 65 is discussed in AS 2.8.

Record Keeping

Keeping sufficient evidence that required actions have been accomplished and that the configuration of the UAS meets the MOC is required. Absent records, the audit and accountability for actions is not possible. The record keeping requirements for UAS should be designed to focus on only those records required to establish compliance.

Work / Task Instruction (ICA)

The specific actions and the interval (time, cycles, calendar) should be defined by the OEM at the outset of the UAS model’s entry into service. As operators gain experience, they will provide feedback and may also make local improvements to ensure the continued safe operation of the fleet.

Modification / Repair

During the service life of a UAS, circumstances may require the modification or repair of the system. Determining the magnitude of the change (Major/Minor under Part 43 Appendix A) must include the ability for operators to generate their own repairs/modifications absent OEM support. This can come about due to OEMs going out of business, or specific operating events/needs.

An OEM/integrator may make modifications and alterations not permitted under the OEMs maintenance instructions, but may need to make a new declaration of compliance (DOC) if these are "Major" or require validation of compliance with a MOC.

APPROACH:

The proposed approach is to address each of these workstreams in a manner that scales with the risk and complexity. Maintenance activities that are extremely simple in nature (e.g., replace a modular battery that requires no tools) remain maintenance actions. However, the rules for UA should accept unique means to comply with the task and record keeping requirements. For example, if the system can automatically record which batteries are installed and log that data for future use, an operator should be allowed to use that as part of their records without having it meet prescriptive format/content/structure requirements.

To support the ARC recommendations contained in this section, Subpart D of the new rule should address the following as shown in the Table AS2 below.

To illustrate how these requirements might be implemented in different operating risk/complexity scenarios, the following examples are provided.

Small UAS operating in higher risk environment

- Material = OEM provided list of parts & tools. Operators may use any material they deem appropriate.
- Preventative Maintenance = By owner operator, in accordance with manufacturer's maintenance instructions.
- Training = course designed by the manufacturer or manufacturer approved third party
- Record keeping = simple log per manufacturers maintenance instructions with signature requirements
- ICA = OEM provided procedures. Operators may refine on their own with no additional approvals.
- Mod/Repair = OEM may perform mod/repairs, document in records. Operators may establish their own mod/repair and confirm continued airworthiness via their own DOC (including document of test/inspection/changes to ICA).
- Oversight = For holders of a Remote Aircraft Air Carrier Certificate or Remote Aircraft Operating Certificate, the maintenance program (including procedures, manuals, training and qualification standards) is evaluated by the FAA as part of the certification process and are subject to review and inspection for the duration of the certificate.

Light UAS operating in higher risk environment

- Material = OEM provided list of parts (IPC) and tools. Specifications for AE and COTS are provided to enable operators to source independent of the OEM.
- Preventative Maintenance = By owner operator, in accordance with manufacturer's maintenance instructions.

- Preventative Maintenance = By owner operator, in accordance with manufacturer's maintenance instructions.
- Training = FAA Repairman cert - UAS-specific.
- Record keeping = record keeping ensures time tracking, repairs, inspections, and other actions are documented with reference to ICA. Signatures are required.
- ICA = OEM provides revision service to ICA (including Service Bulletin and SL type documents as needed). Operators incorporate the ICA into their program as needed for the specific system/operation.
- Mod/Repair = OEM approved repairs/mods and the operator may seek their own approval through DER or internal operator program process.
- Oversight = For holders of a Remote Aircraft Air Carrier Certificate or Remote Aircraft Operating Certificate, the maintenance program (including procedures, manuals, training and qualification standards) is evaluated by the FAA as part of the certification process and are subject to review and inspection for the duration of the certificate.

As an *example* of how industry standards can be used to address these topics for UA, below are FAA-accepted standards for LSA Aircraft:

- Quality Assurance F2972-15
- Maintenance and Inspection Procedures F2483-18$^{\varepsilon 1}$
- Identification and Recording of Major Repairs and Major Alterations F2483-18$^{\varepsilon 1}$
- Continued Airworthiness F3198-18

Table AS2

Operating Environment <u>Relative</u> Risk Level	**Level 1** Air/Ground Risk Strategically Mitigated	**Level 2A** Only Air Risk Strategically Mitigated	**Level 2B** Only Ground Risk Strategically Mitigated	**Level 3** Neither Air nor Ground Risk Strategically Mitigated
Aircraft Kinetic Energy less than 25,000 ft-lbs.				
Aircraft Maintenance, Alteration, and Repair	UAS must have maintenance instructions supplied by the manufacturer Compliance is by owner or operator per manufacturer maintenance instructions	UA must have maintenance instructions supplied by the manufacturer. The maintenance instructions must be developed in accordance with an industry standard when available. The FAA may permit submission of alternative MOCs by applicants when compliance to a specific standard is not requested for interoperability issues. Preventative Maintenance = Qual/Training = Owner or operator may maintain per manufacturer maintenance instructions after passing maintenance course designed by the manufacturer and provided by the manufacturer or manufacturer approved third party Material = OEM provided list of parts & tools. Owner or operator may use any material they deem appropriate. Record keeping = simple log (refers to manufacturers maintenance instructions)	UAS requirements same as Level 1 Collision avoidance capability must have maintenance instructions supplied by the manufacturer. Record keeping and mod/repair as in Level 2A	UAS must meet the requirements of Level 2A Collision avoidance capability must have maintenance instructions supplied by the manufacturer. Record keeping and mod/repair as in Level 2A

		with signature requirements (person who performed the action). ICA = OEM provided procedures. Operators may refine on their own with no additional approvals. Mod/Repair = OEM may perform mod/repairs, document in records. Operators may establish their own mod/repair and confirm compliance with MoC via their own DOC (including document of test/inspection/changes to ICA). Oversight = For holders of a Remote Aircraft Air Carrier Certificate or Remote Aircraft Operating Certificate, the maintenance program (including procedures, manuals, training and qualification standards) is evaluated by the FAA as part of the certification process and are subject to review and inspection for the duration of the certificate.		

Aircraft Kinetic Energy greater than or equal to 25,000 and less than 800,000 ft-lbs.				
Aircraft Maintenance, Alteration, and Repair	UAS must have maintenance instructions supplied by the manufacturer Compliance is by owner or operator per manufacturer maintenance instructions	UA must have manufacturer supplied Maintenance Manual, ICAs, and Safety Directives per an FAA-accepted standard/MoC. The FAA may permit submission of alternative MOCs by applicants when compliance to a specific standard is not requested for interoperability issues. Owner or operator maintenance permitted Qual/Training = Maintenance, Inspection and Repair by Certified UAS Repairman (new under Part 65) Material = OEM provided list of parts (IPC) and tools. Specifications for AE and COTS are provided to enable operators to source independent of the OEM. Record keeping = record keeping ensures time tracking, repairs, inspections, and other actions are documented with reference to ICA. Signatures are required. ICA = OEM provides revision service to ICA (including Service Bulletin and SL type documents as needed). Operators incorporate the ICA into their program as	UAS requirements same as Level 1 Collision avoidance capability must have maintenance instructions supplied by the manufacturer. Record keeping and mod/repair as in Level 2A	UAS must meet the requirements of Level 2A Collision avoidance capability must have maintenance instructions supplied by the manufacturer. Record keeping and mod/repair as in Level 2A

		needed for the specific system/operation. Mod/Repair = OEM approved repairs/mods and the operator may seek their own approval through DER or internal operator program process. Oversight = For holders of a Remote Aircraft Air Carrier Certificate or Remote Aircraft Operating Certificate, the maintenance program (including procedures, manuals, training and qualification standards) is evaluated by the FAA as part of the certification process and are subject to review and inspection for the duration of the certificate.		

AS 2.3 – UA and AE Software Qualification

AS 2.3	The new BVLOS rule should address software qualification for UA and AE.

INTENT: To establish software qualification requirement for UA and AE appropriate for the level of risk.

RATIONALE: Existing software design assurance standards may not be appropriate for all UAS in all operating environments. The group discussed a minimum requirement to reduce the risk that software errors lead to hazards for operations in lower relative risk environments.

<u>Software Configuration Management</u>
To enable rapid innovation, improvement, and supportability, configuration management should consist of functional and performance requirements, interfaces, and versions (software/firmware).

<u>Major and Minor Changes to Software</u>
With a focus on continuous improvement, software and firmware updates, both critical and non-critical, are more frequent. In the context of UAS, a major change has an impact on safety, including an impact on the minimum BVLOS capabilities. Software changes should be evaluated in the same manner.
It is recommended that all changes be 'certifiable' through a declaration to a Means of Compliance by default, but that major changes undergo a more formal review process, which includes testing.

<u>Autonomy</u>
The group discussed whether there is a higher level of risk associated with higher automation level and one to many operations of UA. The group believes that 1:N or M:N does not pose higher risk so long as software is properly developed and tested.
Recommendations related to verification and validation of autonomy and/or non-deterministic algorithms are beyond the scope of this ARC and outside of the expertise of this working group. However, the group believes that such processes should also be applied proportional to the risk of the operating environment. It should be acceptable to implement and validate fault detection logic that leads to simple, deterministic contingency behaviors.

APPROACH:
The new rule should include minimum requirement that OEM or System Integrators developing software for UA (meaning onboard systems), or safety critical AE must have a documented process. This process does not extend to commercial parts having software or firmware such as modems and electronic speed controllers. Software versions may be part of an interface specification for AE.
A minimum documented process for software development should include the following:

1. System-level requirements-based testing with artifacts that provide evidence the software implementation satisfies the system requirements.
2. At a minimum, the following items under configuration control and change control:
    a. Requirements (which may be functional requirements)
    b. System and software test environment descriptions
    c. Test procedures, and results with requirements traceability to test cases and procedures
    d. Source code and development environment/tools
    e. Build and load procedures for replication of the executable object code

3. A problem reporting system that documents non-compliances with system level requirements or anomalous software behavior and ensures that problem reports that affect intended function are addressed, or if deferred, justified.

This process is similar to that required under the current D&R MOC for type certification under 21.17b. Qualification of Software is outlined in Table AS3.

Table AS3

Operating Environment Relative Risk Level	**Level 1** Air/Ground Risk Strategically Mitigated	**Level 2A** Only Air Risk Strategically Mitigated	**Level 2B** Only Ground Risk Strategically Mitigated	**Level 3** Neither Air nor Ground Risk Strategically Mitigated
Aircraft Kinetic Energy less than 25,000 ft-lbs.				
Software Qualification / Approval (Autonomy is implemented through software)	Software must perform as intended and be suitable for the intended operation* RPIC must comply with manufacturer operating instructions	Manufacturer must have a documented process** to demonstrate that the software has correctly implemented system requirements. RPIC must comply with manufacturer operating instructions	Same as Level 2A	Same as Level 2A
Aircraft Kinetic Energy greater than or equal to 25,000 and less than 800,000 ft-lbs.				
Software Qualification / Approval (Autonomy is implemented through software)	Software must perform as intended and be suitable for the intended operation* RPIC must comply with manufacturer operating instructions	Manufacturer must have a documented process** to demonstrate that the software has correctly implemented system requirements. RPIC/operator must comply with manufacturer operating instructions	Same as Level 2A	Same as Level 2A

Associated Elements				
Software Qualification / Approval (Autonomy is implemented through software)	Software must perform as intended and be suitable for the intended operation* RPIC must comply with manufacturer operating instructions	Manufacturer must have a documented process** to demonstrate that the software has correctly implemented system requirements. RPIC/Operator must comply with manufacturer operating instructions	Same as Level 2A	Same as Level 2A

* This is not intended to invoke 14 CFR 23.2500

** Similar to Appendix A of "Durability & Reliability-based Type Certification process for low-risk smaller Unmanned Aircraft systems Means of Compliance"

AS 2.4 – Noise Certification Requirements

AS 2.4	The new rules should include UA noise certification requirements appropriate to the operating environment. Compliance should be demonstrated through a simple testing methodology.

INTENT: To address noise certification requirements for UA.

RATIONALE: The group discussed noise certification for UA. This is a separate consideration from evaluation under NEPA. The group is aware of the noise energy (dB) limitations under other CAAs, and the requirements proposed under an NPRM[72] by a current applicant in the UAS TC process (14 CFR 21.17b). While the scaling method proposed in the recent NPRM results in a reasonable threshold for most environments, the working group believes the noise energy level requirements/thresholds should consider both the ambient noise in the operating environment and the noise exposure to humans. For example, for operations over an industrial facility or a sparsely populated area, there are few unprotected non-participants who will be exposed to the sound produced by the UA. Here, a higher threshold is acceptable.

There was strong agreement within the group that testing methodology for noise certification should be appropriate for UA, especially for smaller UA. There is little value in using the existing methodologies applicable to traditional aircraft as these require specialized testing equipment and compliance through an expansive test matrix with test conditions that are not applicable to all UA.

APPROACH:

To support the ARC recommendations contained in this section, noise certification should be addressed as shown in the Table AS4 below:

Table AS4

Operating Environment <u>Relative</u> Risk Level	**Level 1** Air/Ground Risk Strategically Mitigated	**Level 2A** Only Air Risk Strategically Mitigated	**Level 2B** Only Ground Risk Strategically Mitigated	**Level 3** Neither Air nor Ground Ri Strategically Mitigated
Aircraft Kinetic Energy less than 25,000 ft-lbs.				
Noise	Should be scaled/proportional to environment – i.e., dB levels + simple testing methodology			
Aircraft Kinetic Energy greater than or equal to 25,000 and less than 800,000 ft-lbs.				
Noise	Should be scaled/proportional to environment – i.e., dB levels + simple testing methodology			

[72] *See* Federal Aviation Administration [Docket No.: FAA–2021–0710; Notice No. 21–01] Noise Certification Standards: Matternet Model M2 Aircraft, Federal Register / Vol. 86, No. 164 / Friday, August 27, 2021 / Notices. 2021-17769.pdf (govinfo.gov).

AS 2.5 – Qualification of the Associated Elements for UAS

AS 2.5	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of the associated elements of an uncrewed aircraft system.

INTENT: To establish a process for qualification of the associated elements of an uncrewed aircraft system.

RATIONALE: Associated elements are not aircraft, and they should not be subject to the same requirements as aircraft, rather they should be subject to requirements as appropriate for safety.

APPROACH:

To support the ARC recommendations contained in this section, Subpart D of the new rule should address the following as shown in the Table AS5 below.

If AE contains critical parts, a critical parts list must be established and the manufacturer must develop and define mandatory maintenance instructions or life limits, or a combination of both, to prevent failures of critical parts. Instructions should be inclusive of actions taken based on health monitoring and fault detection, which may be used to trigger parts replacement based on performance as opposed to replacement at specific intervals. Each of these mandatory actions must be included in documentation similar to Instructions for Continued Airworthiness (ICA). It is noted that a tradeoff exists between the reliability of a part and its replacement interval. Either or both in combination can be used to achieve the same overall reliability of the system.

If a 3PSP is used as an AE, the approval of that 3PSP would be proposed by the UAS manufacturer instead of that specified in Table AS5.

Table AS5

Operating Environment <u>Relative</u> Risk Level	**Level 1** Air/Ground Risk Strategically Mitigated	**Level 2A** Only Air Risk Strategically Mitigated	**Level 2B** Only Ground Risk Strategically Mitigated	**Level 3** Neither Air nor Ground Risk Strategically Mitigated
Aircraft Kinetic Energy less than 25,000 ft-lbs.				
AE Qualification	AE must be designed and produced such that the UAS has the minimum capabilities defined by the rule Compliance by inspection of the vehicle and its operating instructions			
AE Maintenance, Alteration, and Repair	AE must have maintenance instructions supplied by the manufacturer Compliance is by owner/UAS operator per manufacturer maintenance instructions			
Aircraft Kinetic Energy greater than or equal to 25,000 and less than 800,000 ft-lbs.				
AE Qualification	AE must be designed and produced such that the UAS has the minimum capabilities defined by the rule Compliance by inspection of the vehicle and its operating instructions			
AE Maintenance, Alteration, and Repair	AE must have maintenance instructions supplied by the manufacturer Compliance is by owner/UAS operator per manufacturer maintenance instructions			

AS 2.6 – Declarations of Compliance

AS 2.6	The new rule should define who must make a declaration of compliance.

INTENT: To ensure the rule accommodates market organization.

RATIONALE: Today, many operators also act as 'systems integrators', adding stand-alone or GCS integrated ground-based air traffic situation awareness, secondary data links, new payloads, or custom ground support equipment.

For qualification of aircraft and systems, the rule should account for manufacturers of UA and of UAS, manufacturers of AE, and providers of third-party services. Also envisioned are other parties who may integrate UA and AE to form UAS.

APPROACH: Table AS6 below outlines the various parties who may submit a declaration of compliance for a UA.

Table AS6

Critical Entities / Roles	**UA**	**AE**	**May Integrate 3PSP Functions into UA/UAS?**
UA Manufacturer builds only UA	DoC Accepted or C of A		Yes
AE Manufacturer builds only AE		DoC Accepted for AE with safety-integral function.	Yes
UAS Integrator integrates an UA and AE together to form a UAS may be called a UAS manufacturer	Must make new DoC if making Major change to UA. May be negotiated and developed with UA Manufacturer.	Must make new DoC when making Major change to AE with safety-integral function. UTM is considered AE.	Yes

***Critical for safety or 3PSP where a DOC/MOC is applicable – C2, Surveillance, etc.**

AS 2.7 – Special Airworthiness Certificate for UAS Under Part 21

AS 2.7	Establish a new Special Airworthiness Certification for the UAS category under Part 21.

INTENT: To create a regulatory framework for UA that is similar to that of Light-Sport Category aircraft using an FAA accepted declaration of compliance to an FAA-accepted means of compliance, which includes industry standards.

RATIONALE: Airworthiness certification should not be required for smaller UA operating in very low risk environments. For commercial BVLOS operations in higher relative-risk operating environments with UA 25,000-800,000 ft-lbs., Special Airworthiness Certification (SAC) should be required under Part 21 instead of a Type Certificate.

APPROACH:

To support the ARC recommendations contained in this section, the FAA should:

- Establish UAS as a new Category of aircraft with a range of Classes, such as airplane, rotorcraft, or glider. Rotorcraft should be included.
- Operating rules should connect to both the new BVLOS rule and to Part 91 (and to all other applicable rules) and should permit use for compensation or hire
- Develop requirements for Means of Compliance. These should be similar to those for LSA.
- Develop a process for accepting Means of Compliance. This should be similar to that for LSA.
- A catalog of standards and approaches, including industry consensus standards, should be developed and used to address the many differences in UAS across the range of issues.
- The FAA should establish a process for accepting and/or approving the associated elements that interface with a UA for operations requiring a SAC.
- Consider defining the applicability of this SAC to Special Purposes defined in the operating rule, for example those listed in 14 CFR 21.25 - including a provision to expand the list of purposes (e.g., small package delivery). This is a mechanism which could be used to connect the new rules to the ARC charter. It does not imply a recommendation that the operating limitations of Restricted Category aircraft be applied to UAS under a new SAC rule.

AS 2.8 – UAS Repairperson Certification

AS 2.8	The FAA should establish a Repairperson Certification for the UAS Category to perform inspection, maintenance, and repair of UAS holding SAC under this proposed rule.

INTENT: To ensure repairpersons are adequately trained and define the scope of their privileges.

RATIONALE: UAS have architectures, systems, and performance and operating characteristics unique from those of traditional aircraft. Persons performing maintenance actions should possess the appropriate knowledge, skills, and abilities to accomplish the task in a safe and efficient manner. Maintenance training requirements should be aligned with the operating risk and system complexity of the environment and system.

APPROACH: These requirements should be inspired by 14 CFR 65.107 - the Light-Sport Category, where certification for Repairmen is provided outside of a Part 145 or Part 121/135 CAMP. The FAA may develop an entirely new course for UAS, it could consider adding UAS specific training to the existing LSA course, or consider offering a supplement to the LSA repairperson certification that would allow LSA qualified repairpersons to become qualified to work on UAS.

AS 2.9 – Production Certificate Not Required if Declaring to an LSA Standard

AS 2.9	Recommend exemption from Production Certification requirements IF TC applicants declare compliance to the LSA standard for a quality system.

INTENT: Production Certification should be tailored to various levels of complexity and applicants.

RATIONALE: Production certification, at its most basic level, is intended to ensure the repeatable production of aircraft to an established standard design. The methods, controls, oversights, and system elements of a Production Certificate can be tailored to various levels of complexity and applicants. However, there are some fundamental limitations in how regulations treat such systems, and there is no built-in recognition of alternatives that are inherent in the scaled production methods that are most commonly used in UA and electronics industries.

The rapid development cycles and relatively short life cycles of modern UA are only a fraction of the service life of most traditional aircraft, many of which have service lives that are measured in decades. Often these changes result in improvements in reliability and safety for the aircraft. If the airworthiness approval for these aircraft is based on exemptions, the resultant need for frequent review and processing of exceptions to a UA Production Certificate can quickly become more costly than the product itself, while effectively reducing fleet safety by delaying safety and reliability improvements.

The production of UA at scale inherently requires repeatable production processes as thousands of aircraft can be produced within a few weeks. However, the tools commonly used to ensure conformity and repeatability in traditional aviation production certification can lead to non-conformance, as they tend to interrupt production line flow (e.g., in-process inspections.) Additionally, the FAA's burden to ensure oversight of a system that *automatically rejects* non-conformances for efficiency becomes less beneficial particularly for low risk and low-cost UA.

Considering the above, the ARC recommends an approach where the FAA does not rely on a framework of production certification, but instead specifies the necessary elements of an applicant quality system similar to the process used for Light Sport Aircraft. Under this construct, the FAA may *choose* to review and accept certain applicant's quality systems, but applicants would not be required to gain acceptance or approval of the UA system or changes to the UA system.

As changes in suppliers, processes, methods, or even recovery from component obsolescence may require agile company shifts, a reduction in controls and placing responsibility for those controls on the company can both promote and foster improvements in overall safety. As this recommendation is implemented, the ARC encourages the FAA to continue to outline elements, attention areas, and other areas of interest based on their experience, while emphasizing the importance of repeatable processes and continued operational safety.

APPROACH: Specifically, the FAA should approve a standard process for exemptions to the production approval regulations using the existing Light Sport approval process as an acceptable equivalent level of safety.

AS 2.10 – Compliance Audits by Third Party Test Organizations

AS 2.10	The FAA should consider allowing third party test organizations to audit compliance.

INTENT: To develop a method of ensuring conformity and assessing compliance to standards. Audits should be commensurate with risk and not unduly burdensome.

RATIONALE: There are several models for this market surveillance around the world. The "CE Mark" means that a product has been assessed by the manufacturer and meets health and safety requirements. For non-hazardous products, testing and conformity assessment may be done by the manufacturer themselves. This would be similar to the declaration (rule enforcement) proposed for the Low level of "Oversight Authority". UAS in the "Open" category are foreseen to be sold in the EU using various markings defined by EASA in addition to the CE Mark. Compliance will be to a standard being written by one of the three European Standardisation Organisations (ESOs)[73].

The EC uses other market surveillance techniques such as the use of Notified Bodies (NB). A notified body is an organization designated by an EU country to assess the conformity of products before being placed on the market when a third party is required – similar to the Delegated (DER/DAR/Third-Party) proposed for High "Oversight Authority". This would be done for more "hazardous products" prior to

[73] The European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC), and the European Telecommunications Standards Institute (ETSI).

them getting the CE mark. NBs are also allowed to audit the manufacturer's DOC which would be similar to the Declaration + Audit (if requested) and could be used for the Medium level of “Oversight Authority”.

The equivalent to an NB in the US would be a “Certification Body (CB)”. ANAB accredits CBs for ISO/IEC 17065 (Conformity Assessment - Requirements for Bodies Certifying Products, Processes and Services). ANAB accredits labs using ISO/IEC 17025 (General Requirements for The Competence of Testing and Calibration Laboratories) and auditors using ISO/IEC 17020 (Conformity Assessment - Requirements for the Operation of Various Types of Bodies Performing Inspection). A Means of Compliance to a rule, e.g., Operations Over People (OOP), can be crafted into a Certification Scheme (under 17067) owned and managed by a CB (accredited to 17065) using labs accredited to 17025. For example, one aspect of the OOP MOC is the kinetic energy/injury requirements which could be verified by an accredited lab and the results used by a CB (along with other MOCs such as the Remote ID requirements for OOP) to declare compliance. We can see a Certification Body performing a similar role for assessing compliance with some of the Means of Compliance.

The European Community has made legal provision for bodies called Qualified Entities (QE) to assist European Union Aviation Safety Agency (EASA). Regulation (EC) No 216/2008 of the European Parliament and of the Council (the “Basic Regulation” for EASA) defines a qualified entity as follows: ‘qualified entity’ shall mean a body which may be allocated a specific certification task by, and under the control and the responsibility of, the Agency or a national aviation authority.

Article 69 of the New EASA Basic Regulation (NBR) gives to the Aviation Authorities of the European Union (EU) Member States (MS) and to EASA, the possibility to accredit Qualified Entities (QEs) and, where this is the case, also to grant them the privilege to issue, renew, amend, limit, suspend or revoke certificates, or to receive declarations (emphasis added). This is a very powerful model and allows for a lot more than the DER/DAR/ODA does in the US.

EASA also grants Design Organizational Approval which is similar to ODA in that a DOA holder can perform design activities within the scope of approval, have compliance documents accepted without further verification, and perform these activities independently from EASA.

Lastly, EASA AMC1 ARO.GEN.305(b);(c);(d);(d1) Oversight program, related to EU Regulation 2012/965 on aircraft operations (including UA in the certified category), which links industry approvals with authority oversight, includes the following:

This requires the third-party to use a Certification Scheme, e.g., ISO 17067, and to be accredited to declare compliance with that scheme, e.g., ISO 17065.

APPROACH: At the highest risk levels, Industry would be well served by the use of an accredited third-party to assess compliance with a recognized certification scheme composed of industry consensus standards. Third parties could also be authorized to conduct audits of the manufacturers’ compliance to the approved MOC.

D. Operator Qualifications Recommendations

The Operator Qualifications section contains recommendations for UAS BVLOS Pilot and Operator certification requirements and operating rules. It also includes recommendations on enabling limited BVLOS operations under the existing Part 107 Remote Pilot framework, as well as on tailored medical qualifications, applicability to public agency operations, and enhanced vetting in certain circumstances.

OQ 2.1 – Create New Rule Part for UAS BVLOS Pilots & Operators

OQ 2.1	The FAA should create a new 14 CFR Part that governs UAS BVLOS Pilot and Operator certification requirements and operating rules.

INTENT: To create a new rule Part that governs UAS BVLOS Pilot and Operator certification requirements and operating rules.

RATIONALE: The ARC's recommendations for a new part are rooted in the following concepts:

<u>Clarity</u>: New rules can be written without the need for clarification on applicability or exclusion to UAS, using plain language that captures intent without having to analogize different conditions for UAS vs. traditional aircraft.

<u>Ease of Implementation</u>: During Phase 1, the Operational Qualification Working Group conducted a detailed review of 14 CFR Parts 61, 91, 107, 119, 121 and 135 to ensure we were capturing the broad scope and intent of current aviation regulations. During that review, Part 91 alone contained over 3,200 line items, with most of the other Parts having substantial volume as well. The number of regulatory changes required to 1) create new UAS rules; 2) modify existing rules to accommodate UAS; or 3) mark existing rules as applicable or non-applicable to UAS is staggering and would incur substantial costs in time and effort. The better approach is to mirror the FAA's process in creating Part 107, which follows precedent, reduces costs, and ultimately results in a clearer and more concise rule set.

<u>Ease of Execution</u>: UAS are by far the most accessible form of aviation today. With over 865,000 UA registered and over 248,971 UAS Remote Pilots certified as of September 2021, the number of new entrants to UAS operations greatly exceeds traditional aviation. Forcing these new entrants to navigate a byzantine web of regulatory material that contain substantial portions of non-applicable conditions, creates a substantial barrier to entry and disincentivizes adoption of this uniquely accessible technology. Having the majority of UAS guidance in a single rule Part supports better training, speeds qualification, and eases the burden of compliance.

APPROACH: The proposed new 14 CFR Part should encompass all facets of UAS BVLOS operations that are not currently contained in 14 CFR Part 107. Subparts should be created for flight rules, Remote Pilot certification, Operator certification, aircraft qualification and operating requirements. An example structure might contain:

Subpart A – General

Subpart B – General Operating and Flight Rules for UAS Beyond Visual Line-of-Sight Operations

Subpart C – Certification: Remote Pilots

Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS

Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators

Subpart F – Operating Requirements: Remote Air Carriers and Remote Commercial Operators
Subpart G – Agricultural Remote Aircraft Operations

To support the ARC recommendations contained in this section. Subpart C of the new 14 CFR Part will establish a new Remote Pilot certificate and associated knowledge requirements for BVLOS flight. Subpart E of the new 14 CFR Part will:

1. Establish two new Operating Certificates: the Remote Air Carrier certificate and the Remote Operating certificate;
2. Establish the requirements and privileges associated with each type of certificate; and
3. Establish a new Designated Position of Remote Flight Operations Supervisor under the Remote Air Carrier certificate and the Remote Operating certificate

Subpart F of the new 14 CFR Part will establish the operating requirements for certificated remote operators, and Subpart G will create a new Agricultural Remote Aircraft Operations Certificate.

As a part of rule implementation, exception clauses citing the new Part should be added to the "applicability" sections of 14 CFR Parts 61, 107, 119 and 137. Parts 135 and 141 should not be affected, as Part 119 should point to Subpart E of the new Part, which in turn points to Subpart F. Subpart F replaces Parts 135 and 141 respectively.

OQ 2.2 – Training and Qualification Based on Levels of Automation

OQ 2.2	The FAA adopt the categories defined in the Automation Matrix for BVLOS training and qualification requirements.

INTENT: The FAA adopt the four levels of automation (defined in the Automation Matrix) as a framework for BVLOS training and qualification requirements, allowing tailored training programs that focus on functions that the pilot has the ability to control or affect through the system.

RATIONALE: As discussed above, as UAS control automation becomes more robust, the number and types of control tasks that require human in- or on-the-loop tends to decrease. Consequently, the level and depth of training required to safely operate such systems correspondingly decreases. As human-performed tasks and responsibilities are simplified or eliminated, training programs must be tailored to focus on those functions that the responsible person pilot has the ability to control or affect through the system.

To aid in determining the appropriate levels of training, the Working Groups created a set of automation categories that are designed to capture and reflect the existing and expected levels of UAS automation. These categories were merged and aligned across the ARC to create the automation definitions shown in the Automation Matrix. The ARC proposes that these category definitions provide sufficient detail to accurately structure current training requirements while remaining broad enough to accommodate future system designs and implementations.

As depicted in the Automation Matrix, each of the listed automation levels are associated with certain assumptions and conditions:

AFR Level 1 represents a manual system. Direct monitoring and human interface are necessary and intended for the vast majority of the flight. The aircraft may have some automated features (e.g., auto hover, “return to home”), but the human remote pilot has direct control over the aircraft’s flight control surfaces and is actively controlling the aircraft state during all phases of flight. This level is similar to “human-in-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 2 represents a system with increased automation. Human remote pilots are responsible for the flight of assigned aircraft, and are expected to directly monitor and maintain situational awareness for the flight(s) under their control. During AFR Level 2 operations, human intervention is possible but not required for certain aspects of the operation, such as to abort a mission or trigger a non-normal response. The Remote Pilot is directing the aircraft through a software interface, and does not directly manipulate flight control surfaces. The pilot may also program or direct routes, altitudes, and contingency procedures through the software interface. This level is similar to “human-on-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 3 represents extensive automation, similar to the capabilities of existing on-demand delivery operations. While AFR Level 3 operations may not *require* human intervention to operate successfully, they may *accommodate* human supervision and intervention. For the human RFOS or Remote Pilot, such accommodation may include monitoring operations in an area or sector, coordinating and executing exception management functions, and the pausing or halting of operations in response to changing conditions. When AFR Level 3 operations are used to support substantially scaled 1-to-many operations, the ARC expects that such operations will be conducted by the holder of an Air Carrier certificate or a Commercial Operating Certificate. This level is similar to “human-over-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

AFR Level 4 represents a state of ultimate automation. AFR Level 4 flight (and in some cases, ground) operations are handled completely by the automation, with no provision for human intervention during both nominal and off-nominal operations. AFR Level 4 operations are assumed to be at very high volumes/scale to the extent that no human pilot could maintain situational awareness necessary to effectively and safely intervene. The ARC has stipulated AFR Level 4 as a future state, and has not assigned attributes to this state. This level is similar to “human-out-of-the-loop” operations as referenced in RTCA SC-203 or ASTM AC377.

For operations conducted under a Remote Air Carrier Certificate or a Remote Operating Certificate, there is an assumption that the rulemaking process will include a UAS-specific process for certifying both types of operators, similar to Parts 119 and 135 but without the baggage of manned-specific requirements. These certificate holders are expected to:

1. Assume operational control and ultimate responsibility for any portion of the operation that is controlled by automation;
2. Designate legally responsible positions similar to Part 135 designees (such as Chief Pilot, Director of Maintenance, and Director of Operations).
3. Additionally, holders of a Remote Air Carrier Certificate or Remote Operating Certificate may designate a new legally responsible position that oversees and is responsible for a broad number of

simultaneous UAS operations. This position (referred to by the ARC as a Remote Flight Operations Supervisor, or RFOS) would hold key operational and safety-related functions for a broad geographic area conducting multiple simultaneous UAS operations, including the ability to pause/halt or modify operations at scale (completely or partially) in response to relevant events.

4. Develop and certify training programs that provide sufficient qualification and proficiency to safely operate the system. This training can and should be tailored to the system being used, and qualifications are not transferable to other types of UAS or other commercial operators' UA operations.

APPROACH: The ARC recommends aligning qualification and certification requirements to the categories described in the Automation Matrix (AFR Levels 1 through 4). For AFR Level 1, limited BVLOS operations may be conducted under a Remote Pilot certificate with Small UAS rating. For AFR Levels 2 through 4, BVLOS operations may be conducted under a Remote Pilot certificate with BVLOS rating.

OQ 2.3 – Enable Limited BVLOS for Part 107 Remote Pilots with Small UAS Rating

OQ 2.3	The FAA modify 14 CFR Part 107 to enable limited BVLOS operations under the existing Remote Pilot with Small UAS Rating certificate.

INTENT: The FAA modify 14 CFR Part 107 to enable limited BVLOS operations for holders of a Part 107 Remote Pilot certificate with Small UAS Rating.

RATIONALE: During its review, the ARC considered that there are operational constructs that require very limited BVLOS functionality in order to be successful. Examples of such operations include those extending visual observers or modifying visual observer requirements (a.k.a. EVLOS) and those conducted in close proximity to a structure (a.k.a. "shielded" operations). Similar operations are being conducted today under specific FAA waivers to 14 CFR Part 107, such as operations where controls are present that mitigate, to an acceptable level of risk, the hazards normally attributed to BVLOS operations. Examples of such controls include:

- Supplementing the operation with additional Visual Observers (Vos);
- Rules, tools and techniques for the RPIC to see the airspace and any conflicting airborne traffic while flying the UAS (or 1:many operation) farther than the human eye can see or orient the UAS;
- Flying the UAS (or 1:many operation) behind an object where conflicting airborne traffic would not be present, as determined by the RPIC as a pre-flight action;
- Examples include flying within a stadium with the RPIC located outside in the parking lot when it has been determined no parachute activities or other airborne traffic would reasonably be expected; or, flying for sustained periods behind a large tree or building where the majority of airspace can be visually observed by the RPIC and where other airborne traffic would not reasonably be expected.
- Other circumstances found acceptable by the FAA Administrator.

The conditions and limitations for approval of such waivers has begun to normalize, and the risk associated with such operations has proven to be acceptable. These factors strongly support the authorization of these types of operations by rule instead of waiver.

In addition to the operations which the FAA currently authorizes through waiver, the ARC recommends that the FAA authorize shielded operations within a specified proximity of a structure. Shielded operations, as defined within the Flight Rules section of this report, are UAS operations associated with a structure (such as inspection) and that are conducted within 100 feet of that structure, in which the UAS is assumed to have the right-of-way as a consequence of proximity to the structure. Shielded operations are justified by an extremely low level of risk to non-participating persons or property.

As shielded operations do not require key components of BVLOS operations (e.g., means to avoid obstacles and other aircraft) and are primarily conducted in relatively close proximity to the remote pilot, the ARC recommends that such operations be authorized under the 14 CFR Part 107 Remote Pilot certificate with Small UAS Rating.

OQ 2.4 – Expand Knowledge Test for Remote Pilot Certificate with Small UAS Rating

OQ 2.4	The FAA expand the knowledge test for the 14 CFR Part 107 Remote Pilot Certificate with Small UAS Rating to cover topics associated with EVLOS and shielded UAS operations

INTENT: As limited BVLOS capabilities are enabled under the Part 107 Remote Pilot Certificate with Small UAS Rating, the associated knowledge test should be expanded to cover additional topics associated with limited BVLOS operations.

RATIONALE: As operations under waiver or exception to Part 107 have proven to be conducted safely, the FAA has continued to expand the scope of operations allowable under the Remote Pilot Certificate with Small UAS Rating. Examples of previous expansions include night operations and operations over people. In each case, the FAA has updated the knowledge test associated with the Remote Pilot Certificate with Small UAS Rating to include applicable rules and best practices to conduct such operations.

As limited BVLOS operations are enabled under this rule, the ARC recommends that the FAA continue this practice, updating the knowledge areas of the 14 CFR Part 107 written examination and any associated FAA-sourced training materials to include limited BVLOS operations.

APPROACH: 14 CFR §107.73 lists the knowledge areas currently required for the Remote Pilot certificate. These are:

- Applicable regulations relating to small uncrewed aircraft system rating privileges, limitations, and flight operation;
- Airspace classification, operating requirements, and flight restrictions affecting small uncrewed aircraft operation;

- Aviation weather sources and effects of weather on small uncrewed aircraft performance;
- Small uncrewed aircraft loading;
- Emergency procedures;
- Crew resource management;
- Radio communication procedures;
- Determining the performance of the small uncrewed aircraft;
- Physiological effects of drugs and alcohol;
- Aeronautical decision-making and judgment;
- Airport operations;
- Maintenance and preflight inspection procedures; and
- Operation at night.

To support limited BVLOS operations, the ARC recommends that the following additional knowledge areas be included in the Part 107 Remote Pilot examination:

- Review of 14 CFR §91.119 to understand the privileges and restrictions of crewed aircraft operations below 500' AGL;
- The conditions and limitations of limited UAS BVLOS operations under the new rule;
- Altitudes and distances from structure minima for shielded operations;
- Strategic and technical risk mitigations for limited BVLOS operations;
- Crew coordination techniques for multiple visual observer operations;
- Communications procedures and techniques for multiple visual observer operations;
- Communications and monitoring requirements for limited BVLOS operations;
- C2 considerations for operations near a structure;
- Navigation requirements for limited BVLOS operations;
- Tools and techniques to improve situational awareness in a limited BVLOS environment.

OQ 2.5 – Establish New BVLOS Rating for Remote Pilot Certificate

OQ 2.5	The FAA establish a new BVLOS rating for the Remote Pilot certificate under the new 14 CFR Part.

INTENT: To create a new level of pilot certification that sets knowledge and examination requirements for conducting UAS BVLOS operations beyond the scope of Part 107 limited BVLOS.

RATIONALE: To enable other-than-limited BVLOS operations under the new rule Part, there is a need to certify UAS pilots in the appropriate knowledge areas that reflect very different use cases, capabilities, and operational concepts than the Limited BVLOS operations enabled by the ARC's recommended changes to 14 CFR Part 107. Some examples of such capabilities:

- The capability to travel beyond the range of visual observers for all or substantial portions of the flight;

- The capability to navigate by primary means of geo-referenced maps, terrain and obstruction information;
- The capability to manage remote contingencies and, when necessary, land the aircraft at locations that are not associated with the remote pilot or other crew.

Per the automation matrix contained in Attachment A of this report, BVLOS operations other than those authorized under 14 CFR Part 107 also require the use of Automated Flight Rules (AFR) Level 2, 3 or 4 UAS, and provide limited to no opportunity for the remote pilot to directly manipulate the flight control surfaces of the UA.

These fundamental differences in remote pilot knowledge areas, aircraft capabilities and operational constructs are distinctly different from 14 CFR Part 107 limited BVLOS operations. The knowledge and examination areas required for certification should therefore be identified, codified, and enabled under a distinct type of rating.

APPROACH: The BVLOS rating for Remote Pilots should be established and associated certification requirements set forth within the appropriate Subpart of the new 14 CFR Part.

OQ 2.6 – Incorporate Existing Knowledge Areas into Part 107 Remote Pilot Exam

OQ 2.6	The FAA's required UAS pilot knowledge areas and skills for the BVLOS rating should include the knowledge areas required by the FAA for the 14 CFR Part 107 Remote Pilot certificate.

INTENT: After an extensive review and comparison, the ARC recommends that the existing knowledge areas required by the FAA in the 14 CFR Part 107 Remote Pilot examination be incorporated into the requirements for the BVLOS Rating.

RATIONALE: After extensive review of 14 CFR parts 61, 91, 107, 119, 121, and 135, the Working Group compiled a list of core UAS pilot functions and requisite knowledge areas applicable to UAS operations. By establishing that required UAS pilot knowledge areas and skills must include the ARC-identified Core UAS Pilot Knowledge Areas, the FAA can ensure that BVLOS-rated UAS pilots have a baseline familiarity with the key concepts behind UAS operations *and can apply this knowledge to BVLOS-specific situations*. In addition, reinforcement of these core knowledge areas provides a clear and progressive transition path between Part 107 Remote Pilot certificate (with Small UAS Rating) and the BVLOS rating.

APPROACH: The Working Group's independent review identified the following list of core UAS pilot knowledge areas:

Core UAS Pilot Functions/Knowledge Areas (all operations)	
Responsibility & Authority of Pilot, PIC, Person & Operator	Airports Access & Avoidance
Pilot/Crew Qualifications and Experience	Preflight/Flight Planning
Flight Restrictions/Limitations	Aircraft Performance

General Operating/Flight Rules	Aircraft Loading
Airspace Classifications & Characteristics	Crew Resource Management
Aeronautical Decision-Making and Judgment	Equipage
Aviation Weather	Night Operations/Physiology
Contingency Management/Emergency Procedures	Maintenance and Inspection Procedures
Communications	Navigation (GPS)
Airworthiness Assessment & Responsibilities	Effects of Drugs/Alcohol

During our review, the ARC noted that these knowledge areas are largely contained, and align well, with the more generalized topics selected by the FAA in establishing Part 107 knowledge requirements:

14 CFR §107.73 Knowledge Areas

(a) Applicable regulations relating to small uncrewed aircraft system rating privileges, limitations, and flight operation;
(b) Airspace classification, operating requirements, and flight restrictions affecting small uncrewed aircraft operation;
(c) BVLOS Aviation weather sources and effects of weather on small uncrewed aircraft performance;
(d) Small uncrewed aircraft loading;
(e) Emergency procedures;
(f) Crew resource management;
(g) Radio communication procedures;
(h) Determining the performance of the small uncrewed aircraft;
(i) Physiological effects of drugs and alcohol;
(j) Aeronautical decision-making and judgment;
(k) Airport operations;
(l) Maintenance and preflight inspection procedures; and
(m) Operation at night.

Given the established precedent and unquestioned success of Part 107 operations since the enactment of that rule, and the improved transferability of knowledge from the Part 107 Remote Pilot certificate with Small UAS Rating and the BVLOS Rating, the ARC finds that these core Part 107 knowledge areas continue to be applicable to BVLOS operations.

OQ 2.7 – Additional Knowledge and Exam Areas for 1-to-Many Operations.

OQ 2.7	The BVLOS rating process should incorporate additional knowledge and examination areas to support advanced BVLOS and 1-to-many operations.

INTENT: The ARC recommends that the training and qualification areas and thresholds for the BVLOS rating reflect the different use cases, capabilities and operational concepts that are unique to operations enabled under the new rule Part. The ARC further recommends that these qualification areas and thresholds recognize and provide for the need to conduct multiple simultaneous (a.k.a. “1-to-many”) UAS BVLOS operations at higher levels of automation.

RATIONALE: In addition to the core UAS knowledge areas identified in Recommendation OQ 2.6, BVLOS-rated Remote Pilots are expected to be capable of conducting robust and sustained BVLOS operations both individually and at high levels of scale. BVLOS-rated Remote Pilots should thus be familiar with not only the knowledge areas required for BVLOS operations, but the conduct of 1-to-many operations and the system characteristics and regulatory requirements that enable them. The knowledge qualifications for this certificate should therefore encompass these types of BVLOS operations.

The ARC also expects that, as the automation level increases to support scaled operations, the types and level of qualification required will also become more system specific. This is particularly true for operations using very large numbers of function-specific aircraft in a 1-to-many control construct such as package delivery. As the ARC expects large-scale, function-specific operations to be conducted by holders of a Remote Air Carrier certificate or a Remote Operating certificate, pilots operating such system should be required to complete a specific course of training relevant to the system(s) they will operate. This is addressed in ARC recommendation OQ 2.13.

APPROACH: In addition to the knowledge areas required for the 14 CFR Part 107 Remote Pilot Certificate with Small UAS Rating, the knowledge test for the BVLOS rating should include areas related to advanced and 1-to-many BVLOS operations. The ARC recommends that the following areas be included:

BVLOS Operations	**Multi-Aircraft Operations, Management & Deconfliction**
Right-of-Way Rules for BVLOS Operations	Assignment and Transfer of Control
BVLOS Strategic and Technical Risk Mitigation Strategies/Approaches	Multi-Aircraft Exception Management
Safe Separation Minima	Multi-Aircraft Contingency Management & Recovery
Principles of Uncrewed Traffic Management	
C2 System Characteristics & Functionality	
Spectrum Considerations	
Navigation (Geo-Reference/FPV)	

Obstacle and Conflict Detection & Resolution	
Safety Risk Management	

OQ 2.8 – Pathways to Remote Pilot Certificate with BVLOS Rating

OQ 2.8	The FAA should provide both direct and progressive paths to achieving the Remote Pilot Certificate with BVLOS rating.

INTENT: To provide tailored paths to achieving the Remote Pilot with BVLOS rating for both currently certificated Remote Pilots and new applicants.

RATIONALE: As the proposed rule is implemented, substantial numbers of currently certificated Remote Pilots that hold a Small UAS rating will likely choose to add a BVLOS rating to their current certificate.

As commercial UAS BVLOS operations grow and scale, however, there is also expected to be a substantial number of potential pilots who will be hired and specifically trained to operate UAS BVLOS systems. These pilots may never operate VLOS UAS, and thus may not require a Small UAS Rating. A path to direct achievement of a Remote Pilot Certificate with BVLOS rating is thus appropriate for applicants who do not currently hold a Remote Pilot Certificate with Small UAS rating.

APPROACH: For currently certificated Remote Pilots with a Small UAS rating, a specific BVLOS knowledge test can focus on the areas specified in Recommendation OQ 2.7.

For applicants that do not already hold a Remote Pilot certificate with Small UAS rating, the knowledge test should encompass all the knowledge areas specified in Recommendations OQ 2.6 and OQ 2.7, with an emphasis on situations and examples that are applicable to BVLOS operations.

OQ 2.9 – Online Training Option for Remote Pilot Certification

OQ 2.9	Remote Pilots certificated under Part 107 that have completed a BVLOS training program certified by a public aircraft operator entity (as defined in 14 CFR Part 1) should be able to receive their BVLOS rating via online training, similar to the existing Part 107 certification pathway for current Part 61 pilots.

INTENT: To provide an alternative pathway to the BVLOS rating for Part 107 certificated Remote Pilots with a Small UAS rating who have completed a BVLOS training program certified by a public entity.

RATIONALE: Some public entities, such as the US military, currently conduct robust UAS pilot training (including BVLOS operations) that are certified by the public entity and include extensive practical training and evaluation. Graduates of such courses normally go on to serve in positions of UAS operational responsibility. That training is considered sufficient by the public entity and accepted as such by the FAA.

The current Part 107 process provides two paths for award of the certificate: completion of a knowledge test at an FAA-authorized testing facility or completion of online training and a knowledge test online for current holders of a Part 61 certificate. The second path recognizes that Part 61 certificate holders have acquired a certain degree of base knowledge in relevant topic areas and credits them appropriately.

For Part 107 Remote Pilots that are graduates of a public-entity-certified UAS training program that includes BVLOS operations, similar credit is appropriate, particularly given the fact that their training is UAS-specific rather than general aviation topics. The ARC believes that completion of such a program reflects a level of core knowledge that supports the award of the BVLOS rating through FAA online training and examination, instead of requiring the applicant to schedule an examination through an FAA-authorized testing facility.

APPROACH: The ARC recommends that Part 107-certificated Remote Pilots who can provide proof of completion of a public-entity-certified UAS training program that includes a BVLOS component be allowed to achieve the appropriate level of UAS certificate through completion of an online training and knowledge test.

OQ 2.10 –Training, Qualification, Currency, and Operational Control

OQ 2.10	UAS BVLOS guidance and advisory materials should establish a clear and traceable path for operational control and specific training/qualification/currency requirements.

INTENT: The ARC intends to ensure that, for each operational construct within the scope of the BVLOS rule, there is a clear designation of the individual(s) who is/are the final authority and hold ultimate responsibility for the conduct of the UAS flight.

RATIONALE: In 14 CFR Parts 61, 91, and 107, there is a series of regulatory sections that:

1. Designates a legally responsible person (such as the PIC or the RPIC) as having direct responsibility and final authority for the operation of the aircraft (Parts 91.3, 107.19);
2. Establishes the requirement for the legally responsible person (the certificate holder) to be appropriately certificated (Parts 61.3(a)(1)(i) and 107.12(b));
3. Requires that the certificate holder have sufficient knowledge and training in specific functional areas in order to exercise the privileges of the certificate (107.65).
4. Lists the specific areas of knowledge required to meet those requirements (61.105/61.109, 61.125/61.129, 107.73/107.74)

In addition, 14 CFR §119.69 provides for the designation of certain certificate-holding management personnel who may hold responsibility for certain management and oversight functions. In each of these cases, the qualifications and experience requirements for each of these certificate-holding designations is spelled out in the appropriate sections of the FARs (e.g., §119.71).

These provisions provide the regulatory guidance and legal underpinnings to establish operational control, ultimate responsibility and management oversight and training/qualification requirements for aircraft operations conducted under the respective parts.

This framework offers clear traceability, directly spelling out the circumstances in which a specific type of certificate holder has operational control and ultimate responsibility for conducting a particular operational construct, as well as the qualifications that certificate holder must meet to conduct these operations. The ARC recommends that the FAA take the same approach in its guidance and advisory materials for UAS BVLOS operations, clearly delineating who has operational control under given circumstances and what requirements that party must satisfy to obtain a certificate.

APPROACH: The ARC envisions that operational control and associated ultimate responsibility be assigned to either of two separate and appropriately certificated parties who are directly responsible for, and is the final authority as to, the operation of the aircraft(s) under their control:

- The Remote Flight Operations Supervisor (RFOS): For operations conducted by holders of a Remote Air Carrier certificate or Remote Operating certificate, the certificate holder may designate an RFOS to oversee the operation of multiple aircraft. When an RFOS is appropriately designated, that individual is the final authority and holds ultimate responsibility for the conduct of the UAS flights under their supervisory control. See Recommendation OQ 2.15 for additional information regarding the recommended designation and qualification process for an RFOS.

- The Remote Pilot in Command (RPIC): For operations where an RPIC is not under the supervision of an RFOS, the RPIC holds ultimate responsibility for a flight. Conversely, when an RFOS is supervising an RPIC, the RFOS is the ultimate responsibility.

OQ 2.11 – Remote Air Carrier & Remote Commercial Operating Certificate

OQ 2.11	Create two levels of Operating Certificates for commercial UAS operations: a Remote Air Carrier certificate and a Remote Commercial Operating certificate.

INTENT: Establish two levels of Operating Certificates to exercise economic authority for certain flight operations conducted for compensation or hire: a Remote Air Carrier certificate and a Remote Operating certificate.

RATIONALE: As commercial UAS BVLOS operations continue to grow in reach and scale, more and more such operations will be conducted by companies and other organizations that intend to operate regularly in a position of public trust. For commercial air carrier, cargo and other operations, the FAA issues two types of commercial operating certificates: an Air Carrier certificate (for operators engaged in common carriage for compensation or hire) and an Operating certificate (for other types of operations for compensation or hire). The certification requirements for both are contained in 14 CFR Part 119, while the operating requirements for each are contained in 14 CFR Parts 121 and 135, respectively.

While the legal underpinnings for certificated operators remain, the regulations governing those operations were designed to mitigate risks that do not exist in UAS operations. Parts 119, 121 and 135 contemplate passenger and cargo-carrying operations conducted by large to very large aircraft. UAS operations, however, convey orders of magnitude less risk than operations of a relatively large air carrier aircraft with potentially hundreds of passengers aboard. Specifically:

- UAS incur zero 1st party risk as they carry no passengers;
- UAS incur an extremely low 2nd party risk to other air traffic because the risk of collision is extremely low and the potential severity of such a collision is substantially less than in Part 135 or Part 121 operations; and
- UAS weighing from a few pounds to at most a few hundred pounds have a comparatively less 3rd party (ground collision) risk than that of a commuter or large air carrier aircraft filled with passengers and thousands of pounds of fuel.

Modifying existing regulations to respond to the lower UAS risk would be burdensome, complex, and confusing because the certification and operating requirements are vastly different, and need to be appropriately scaled. Training, crew, and currency requirements are also different for UAS operators when compared to traditional certificated commercial aviation operations. The differences in the type and nature of the risk makes Parts 121 and 135 ill-suited for adaptation to UAS. This drives the need for new types of operating certificates that are specifically tailored to commercial UAS BVLOS operations.

APPROACH: As mentioned in the Rationale, there are statutory and other rule requirements that shape the current FAA processes for certificating operators. These include key foundational definitions and discriminators such as “hold out,” “common carriage,” “on demand,” etc. In order to minimize the “ripple effect” of changes required to support new constructs, the ARC has chosen to align the types of operating certificates with the existing aviation structure. Subject to the threshold requirements set in Recommendation OQ 2.12, each certificate covers the following types of operations:

- Remote Air Carrier Certificate: to authorize common carriage of property by UAS. An applicant is engaged in common carriage if the applicant “holds out” to the public (by advertising or other means) to transport persons or property from place to place for compensation or hire.
- Remote Operating Certificate: To authorize commercial operations not involving common carriage such as:
    - Noncommon carriage (operation for compensation or hire that does not involve a holding out to others);
    - Operations in which cargo is transported without compensation or hire;
    - Operations not involving the transportation of cargo; or
    - Private carriage.

The ARC’s recommended structure would align Operator certification requirements under **Subpart E** of the new Part. The ARC has created draft rule text for Subpart E that is included in Section XIII. of this report.

The ARC recommends that limited BVLOS commercial operations conducted under 14 CFR Part 107 be explicitly excluded from the requirement to hold a Remote Air Carrier or Remote Operating certificate (See OQ 2.12 below).

OQ 2.12 –Threshold for Remote Air Carrier or Remote Operating Certificate

OQ 2.12	Set threshold requirements for certain UAS BVLOS operations beyond which a Remote Air Carrier Certificate or Remote Operating Certificate is required.

INTENT: To require that UAS operators who exceed certain threshold requirements hold a Remote Operating Certificate or Remote Air Carrier Certificate, as appropriate, to conduct operations at higher pilot-to-aircraft ratios or above designated takeoff weight.

RATIONALE: The process for obtaining and maintaining a Remote Operating Certificate or a Remote Air Carrier Certificate contains provisions for operating specifications, recordkeeping, crew training/qualification/currency, management and compliance reporting that are more rigorous than what is required for non-certificate holders. The ARC believes that this level of rigor is appropriate for certain complex UAS BVLOS operations (particularly at scale) or for larger UAS BVLOS operations.

In the traditional aviation world, certain operations that are not engaged in air commerce or common carriage must still certificate once certain limits are exceeded. For example, 14 CFR 119.1(a)(2) requires certification "when common carriage is not involved, in operations of U.S.-registered civil airplanes with a seat configuration of 20 or more passengers, or a maximum payload capacity of 6,000 pounds or more." Such requirements recognize that it is appropriate that certain aircraft sizes or scales of operations benefit from the additional rigor that this requirement provides.

During the ARC's review of draft certification requirements of Subpart E, we recognized that certain operations might reach substantial scale without necessarily engaging in air commerce or common carriage. Similar to the Part 119 rule, the sense of the ARC was that appropriate thresholds should be set to ensure that UAS BVLOS operations of a certain size or complexity would benefit from the requirements and rigor of operator certification. The ARC further determined that the ratio of pilot (or RFOS) to aircraft was the most relevant and appropriate metric for operational complexity.

As stated throughout this report, the ARC recognizes that the complexity of 1-to-many operations is highly dependent upon the level of automation supporting those operations. Therefore, separate threshold values were selected for AFR Level 2 and AFR Level 3 operations.

To index on the appropriate threshold value for each level of automation, the ARC leveraged the experience of ARC member organizations currently conducting 1-to-many operations under FAA approval. Two key indexes were identified:

1. A pilot-to-aircraft ratio of 1-to-5, as supported by:
   a) An FAA Safety Risk Management Document (SRMD) dated June 13th, 2019; and
   b) Multiple exemption approvals issued as early as March of 2017 for both ARC member and non-member UAS operations;
2. A pilot to aircraft ratio of 1-to-20, as approved by the FAA in multiple G-1 issue papers for ARC Members.

The ARC also proposed a delineator for medium and higher risk operations with UA that have greater than 25,000 ft-lbs. of kinetic energy.

Given the above information and the specific subject-matter experts of the ARC, the recommendation is for a threshold value of 1:5 for 1-to-many operations at AFR Level 2, and a threshold value of 1:20 for 1-to-many operations at AFR Level 3.

APPROACH: In the "Applicability" section of Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators

- As a remote air carrier or a remote commercial operator, or both, in air commerce, when conducting UAS BVLOS operations:
- For UAS with less than 25,000 ft-lbs. of kinetic energy, including everything that is on board or otherwise attached to the aircraft, operating at the following Automated Flight Rules (AFR) Levels:
    - AFR Level 2 Automation: a pilot to UA ratio greater than 1:5
    - AFR Level 3 Automation: a pilot to UA ratio greater than 1:20
- For medium and higher risk operations with UA that have greater than 25,000 ft-lbs. of kinetic energy, including everything that is on board or otherwise attached to the aircraft, a pilot to UA ratio greater than 1:1

OQ 2.13 – Operating Requirements for Certificated Remote Air Carriers & Remote Operators

OQ 2.13	Create Operating Requirements that govern Remote Air Carrier and Remote Operating certificate holders.

INTENT: Establish a set of operating requirements in the new rule that delineate specific requirements for operation under the respective operating certificates.

RATIONALE: The FAA's framework for governing the issuance of traditional aviation operating certificates is broken into two parts: Certification (14 CFR Part 119) and Operating Requirements (14 CFR Parts 121 for air carriers and Part 135 for commercial operators). A similar structure, tailored for UAS, is appropriate for the new rule Part. See Recommendation OQ 2.11 for additional supporting rationale.

The ARC's recommended structure would place Certification under Subpart E, and Operating Requirements for both Remote Air Carrier and Remote Operating certificates under Subpart F. Including these Subparts in the new rule helps to divorce certificated UAS operations from dozens of Part 135 requirements that have zero applicability to UAS, particularly those that are related to humans being on board the aircraft (such as passenger-carrying requirements, flight attendant responsibilities, seat belts, emergency evacuations, on-board oxygen/emergency equipment, etc.), streamlining the rule and making both compliance and enforcement simpler and easier.

Given the absence of passengers and the limited amount of cargo capacity for UAS operating under the proposed rule, it is the ARC's view that there is little to distinguish Remote Air Carrier certificate operations from Remote Operating certificate operations other than the legal underpinnings of terminology (e.g., common carriage) and rule. As there are no passengers or crew on UAS, the additional passenger protections and associated enhanced safety requirements for air carrier operations largely go away. With this in mind, Operating Requirements for both certificates should be able to be supported in a single Subpart.

APPROACH: The ARC recommends that key topic areas of Part 121/135 be brought forward into Subpart F of the new rule Part. These topic areas are applicable to UAS operations conducted under a Remote Air Carrier or Remote Operating certificate and are sufficient to conduct appropriate oversight of such operations. The relevant topic areas are:

- Recordkeeping, inspections and reporting;
- Flight, operating and maintenance manuals;
- Crew qualifications and duty limitations;
- Crewmember qualification, upgrade and currency training;
- Aircraft requirements;
- Airplane Performance Operating Limitations;
- Maintenance, preventive maintenance, and alterations;
- Hazardous Materials Training (if/when applicable).

The ARC has created draft rule text for Subpart F that is included in Section XIII of this report.

<u>A note about training and qualification</u>: Except where specifically noted in Subpart E of the new Part, commercial 1-to-many UAS BVLOS operations will require a Remote Air Carrier or Remote Operating certificate. Given the wide variety and types of UA systems and automation implementations, specific training in the UA system, use case, and operational restrictions to be actually flown provides the most relevant, safe and effective training possible to support UAS BVLOS operations. The ARC has noted that this specific training and qualification is likely more applicable and more effective than a "generic" practical examination conducted by an FAA examiner, provided that the training and qualification program is reviewed and accepted by the FAA.

OQ 2.14 – Certification & Operating Requirements for Agricultural Remote Aircraft Operations

OQ 2.14	Create Certification and Operating Requirements that govern Agricultural Remote Aircraft Operations.

INTENT: Establish specific requirements in the new rule for the creation of, and operating rules under, an Agricultural Remote Aircraft Operating Certificate.

RATIONALE: The FAA's Aviation Rulemaking Charter for this ARC specifies that "*At a minimum, the ARC's recommendations must clearly address requirements to support the following concept of operations: long-line linear infrastructure inspections, industrial aerial data gathering, small package delivery, and <u>precision agriculture operations, including crop spraying</u>.*" The ARC therefore has a directed duty to enable agricultural aircraft operations for UAS.

The FAA's current framework for governing the issuance of agricultural aircraft operations is contained in 14 CFR Part 137. This part contains guidance for additional written and practical examination for agricultural aircraft operations, as well as requirements for the handling, carriage and dispensing of agricultural chemicals, including fertilizers and poisons. The ARC recognizes that at the time of this report, approximately 50 Part 137 Agricultural Aircraft Operating Certificates have been issued to support UAS-based agricultural application operations. These certificates have been issued for operations under both Part 107 (small UAS) and Part 91 (other than small UAS). Per the FAA, new applications for Agricultural Aircraft Operating Certificates continue an increasing trend toward higher and higher weights (in excess of 200 lbs. GTOW) and the need to operate beyond visual line-of-sight.

The ARC's recommended structure would place certification and operating requirements under Subpart G of the new part, and maintains the streamlined, single-reference format that the ARC has developed and implemented in this report. As Part 137 is not particularly lengthy, and since many of the provisions (particularly regarding working with chemicals) are expected to be consistent between manned and unmanned aircraft, the ARC has included proposed rule text in Section VII of this report.

APPROACH: The ARC recommends that the applicable substance of Part 137 be brought forward into Subpart G of the new rule Part, with appropriate modifications to account for the unique system and operational characteristics of unmanned aircraft. To provide the maximum accommodation for diverse types and scales of operation, the ARC's proposed rule text delineates between small UAS visual line-of-sight operations and operations conducted with larger aircraft or beyond visual line-of-sight.

The ARC supports and has included in the draft rule text the existing key components of Part 137, including:

- Certificate application, issuance and revocation;
- An additional written knowledge test that covers the unique aspects of agricultural remote aircraft operations such as site surveys, aircraft performance capabilities, chemical handling and dispensing, and the effects of economic poisons and agricultural chemicals;
- A practical examination that includes applicable aerial maneuvers at the aircraft's maximum takeoff/load weight;
- General operating rules and aircraft and dispensing requirements;
- Operations near airports and over congested areas; and
- Record keeping.

OQ 2.15 – Operational Control for 1-To-Many UAS BVLOS Flights

OQ 2.15	For UAS Operating Certificate holders, create a designated position authorized under the New Part that exercises operational control and ultimate responsibility for 1-to-many BVLOS flights conducted under their supervision.

INTENT: The ARC recommends the development of rules that are proportionate to the level of automation in the UA system and the pilot's ability to exercise operational control. For UAS Operating Certificate holders, the ARC recommends a new designated position authorized under the new rule part that exercises operational control and ultimate responsibility for 1-to-many BVLOS flights conducted under their supervision.

RATIONALE: As UA systems become more highly automated, the span of actual *operational control* by a human becomes out of balance with traditional regulatory notions of ultimate responsibility. Highly automated systems dilute the pilot's ability to exercise operational control by design. The ARC recognizes that it would be inappropriate to assign *ultimate responsibility* to an RPIC when they lack the ability to control or affect the behavior of an aircraft in a meaningful way. However, the ARC remains of the view that the responsibility does not go away. Instead, it is redistributed across a number of persons or entities.

For operations conducted under Parts 121 or 135, [74] the flight-related management and operational responsibilities are shared or distributed across a number of designated positions that are authorized under Part 119 and which hold appropriate certificates. Examples of such designated personnel include the Director of Operations, Chief Pilot, Director of Maintenance, and (for Part 121) Aircraft Dispatcher. Alone or in partnership with the pilot in command, these designated positions may hold sole or shared responsibility for the portions of the operation that lie within their span of control.

As automation levels increase, the level of direct human control decreases in ways that never occur in traditional aviation, for several reasons:

- UAS do not have human lives onboard the aircraft. While (current) traditional aircraft may use highly automated systems, the inherent risk of having persons onboard the aircraft means the human pilot must understand the automation sufficiently to troubleshoot, and if necessary, remove the automation from the loop to safely recover the aircraft to a suitable landing location. For UAS, this 1st-party risk to lives onboard does not exist. Instead, the risk of injury or fatality is limited to 2nd (air collision) and 3rd party (ground collision) outcomes. This reduced risk correspondingly reduces the requirement and complexity of contingency management to very simple options, normally simply landing or impacting the aircraft in a suitable location.

- The UAS operations within the scope of this recommendation are orders of magnitude lighter than many commercial aircraft, transfer far less kinetic energy and thus present far less impact severity in the event of a collision. In addition, the kinetic energy they do contain can be highly mitigated through design functions (such as designed break-up and component frangibility) that are unavailable to traditional aircraft due to the need to protect onboard crew and passengers. In the event of a primary automation failure, a rudimentary secondary automation system or process (such as autoland) is sufficient to mitigate potential risk to 2nd or 3rd parties in the vast majority of UA systems.

For highly automated UAS, the technical responsibility for ensuring that the system, components, or services provided are designed and manufactured to a sufficient level of reliability lies with the OEM or Service Provider (*technical risk)*. The responsibility for planning, programming, authorizing, and

[74] 14 CFR Part 135, *Operating Requirements: Commuter and On Demand Operations*, and its air carrier-focused partner directive 14 CFR Part 121: *Operating Requirements: Domestic, Flag and Supplemental Operations*.

conducting the flight, including ensuring appropriate maintenance and conformance with applicable flight rules *(operational risk)* is borne by the RPIC, or shared between the UAS Operating Certificate holder and one or more designated and certificated persons. This is similar to the existing regulatory framework for Part 135 operations.

In the case of highly automated and/or 1-to-many operations, while the control of *technical risk* remains essentially unchanged, the control of *operational risk* must clearly be assigned to a person or entity that has an authority over the flights and who is sufficiently responsible for the outcome of their decisions. In many cases, this responsible person or entity is likely to be the organization (such as the operating company) that authorizes the operation.

For one-to-many UAS operations with relatively high levels of automation (e.g., AFR 3 or AFR 4) conducted by UAS Operating Certificate holders, the ARC considered it appropriate to authorize an Operator-designated position under the new part that would be responsible for multiple UAS operating within a designated area of responsibility. This position, referred to in ARC deliberations as a "Remote Flight Operations Supervisor" (RFOS) would hold legal responsibility for all flights conducted under his or her operational control, much as a Pilot in Command does for an individual flight. This person would also supervise any non-certificated personnel supporting basic flight functions, such as flight monitoring or ground support crew positions.

Under this construct, holders of a Remote Air Carrier or Remote Operating certificate that are conducting **AFR Level 2** operations would have the option to use:

- A Remote Pilot in Command for the operation (for relatively low levels of 1:many operations); or
- Multiple Remote Pilots in Command under the supervision of a designated and assigned Remote Flight Operations Supervisor (to support higher levels of 1:many operations).

At even higher automation levels (e.g., **AFR Level 3 and higher**) there is extremely limited (or in some cases, no) control functions performed by a human pilot. In such systems, even the programming of the flight parameters is conducted and checked solely by the automated system. It is therefore disingenuous to hold a human RPIC ultimately responsible for flights over which they had no control or influence. Instead, the ARC holds the view that this responsibility lies at the first level of human operational control, which in the case 1-to-many of AFR 3 or higher BVLOS operations conducted by a Remote Air Carrier or Operating Certificate holder would rest with the RFOS as supervisor in charge of active flight operations. The RFOS would have the ability to command corrective actions such as shutting down operations in a given area due to traffic or regulatory constraints.

APPROACH: The ARC recommends that a new Remote Flight Operations Supervisor (RFOS) position be created for holders of a UAS Operating Certificate authorized under the New Part to accurately describe the appropriate span of control and responsibility of this position. This position would be designated by the Operator (similar to a Chief Pilot or Director of Operations under Part 135), and would similarly be required to hold the appropriate certificate (in this case, the Remote Pilot certificate with BVLOS rating).

For highly automated (AFR 3 and higher) 1:many operations conducted by a UAS Operating Certificate holder, a designated RFOS would assume the operational responsibility for all flights under their control, and individual RPICs would not be required due to the highly automated systems and limited human interface. In this case, the RFOS would supervise non-certificated flight support personnel and would be legally responsible for the overall operation.

For AFR 2 BVLOS 1:many operations, a BVLOS-rated Remote Pilot-in-Command rating is most often appropriate due to the reduced level of automation and consequently the greater degree of direct human interaction and control. If the operation is conducted by a UAS Operating Certificate holder, that Operator may also choose to designate an RFOS to oversee multiple RPICs to support 1-to-many flight operations as an additional operational control. If an RPIC and an RFOS are used together, the RPIC exercises operational control for the specific aircraft they are supervising, and the RFOS is responsible for the safe execution of the flight operations under their control.

For AFR 1 operations, an RPIC is always required because the operation is manually controlled or uses minimum levels of automation. The RPIC is directly responsible for all aspects of the flight, and 1-to-many operations are not allowed.

For RPIC-controlled operations that may involve multiple levels of automation in different phases, the RPIC(s) must either:

1. hold the highest level of certification required to perform any aspect of that flight profile; or
2. ensure a positive transfer of control occurs during the flight to an appropriately certificated RPIC to conduct a given phase of flight.

A Remote Pilot Certification with BVLOS rating is required for AFR Level 3 and higher BVLOS operations that are *not* conducted by a UAS Operating Certificate holder due to the lack of a supervisory control function. A BVLOS-rated RPIC is similarly required for BVLOS operations under AFR 2 as the automation level requires a higher level of human interaction.

OQ 2.16 – UAS Pilot Medical Qualification

OQ 2.16	The FAA should develop tailored medical qualifications for UAS pilots and other crew positions that consider greater accessibility and redundancy options available to UAS.

INTENT: To redefine medical requirements for UAS crew, opening the door for extensive contributions by people who would otherwise be disqualified from piloting a crewed aircraft.

RATIONALE: Phase 1 of the ARC defined the scoping efforts of Phase 2 with regard to UAS crew qualifications. As flight qualification requirements include (in most cases) holding a current FAA medical certificate or conducting an FAA-required self-evaluation of the RPIC's medical condition, the ARC felt that general recommendations on medical qualification were within its scope. Specifically, the ARC believes that there are a number of medical conditions that might preclude the safe operation of a crewed aircraft, but that are (or should not be) disqualifying for UA operations due to the substantial difference in operating environments. Some examples include:

1. UAS pilots do not use their feet (i.e., rudder pedals) to control their aircraft; and therefore, amputees might be qualified to serve as RPICs without special accommodation;
2. While flying, crewed aircraft pilots do not have ready access to quality medical care, whereas UAS pilots and crew can directly and easily access both primary and emergency medical care;
3. The growing high degree of automation in UAS operations allows for differently-abled persons to fully and completely exercise the full range of system capabilities at the same level as anyone else.

APPROACH: The ARC recommends that the FAA develop tailored medical qualifications for UAS pilots and other crew members that reflect the reduced physical requirements for flying UA (i.e., not excluding certain physical disabilities that do not preclude mental acuity or the ability to work sitting at a station through an electronic interface) while ensuring appropriate standards of overall health necessary to perform UA crew duties. The tailored medical qualification would allow UAS pilots who might not qualify for a traditional aviation medical certificate, to be approved to fly. For those who already hold an existing FAA medical certificate (e.g., Class III), concur that they should be able to exercise UAS privileges under that certificate. Holders of Class 1, 2, or 3 medical certificates would automatically qualify for a UA medical certificate, but there is no requirement for UA pilots to obtain a Class 1, 2, or 3 medical certificates.

OQ 2.17 – Remote Pilot in Command of UA for Compensation or Hire

OQ 2.17	Remote Pilots (regardless of rating) are expressly authorized to act as Remote Pilot in Command of an uncrewed aircraft operated for compensation or hire.

INTENT: To enable Remote Pilots to act as RPIC of aircraft that are conducting operations for compensation or hire, regardless of whether they are employed by or associated with an entity holding a higher-level commercial operating certificate.

RATIONALE: As both the current and proposed Remote Pilot certificate is specifically intended to support commercial UAS operations such as long-line linear infrastructure inspections, industrial aerial data gathering, small package delivery, and precision agriculture operations, the specific authorization to act as RPIC for flights conducted for compensation or hire should be contained in the privileges of the certificate.

As current holders of the Remote Pilot certificate with a Small UAS rating routinely act as an RPIC to conduct UAS operations for compensation or hire, Remote Pilots with a BVLOS rating should similarly be specifically authorized to conduct flights for compensation or hire in the privileges of their certificate.

APPROACH: The ARC recommends the FAA grant express authorization for Remote Pilots to act as RPIC for UAS flights conducted for compensation or hire. A person holding a Remote Pilot certificate would thus be authorized to act as RPIC for certain commercial operations without being employed by or associated with an entity holding a higher-level commercial operating certificate.

OQ 2.18 – Applicability to All Aircraft, Including Public Aircraft

OQ 2.18	The intent of the ARC is that the privileges and limitations of the final BVLOS rule will be available to all aircraft operating under this rule, including public agency operations.

INTENT: To ensure that public aircraft operators may take full advantage of the opportunity to conduct BVLOS operations as provided in the final rule.

RATIONALE: During the ARC's deliberations, concerns were expressed about the ability of a potential rule to support public operations such as disaster response, law enforcement/homeland security, and land management. A civil aircraft-only rule might preclude public aircraft operators from leveraging the capabilities provided in the ultimate BVLOS rule. It is, therefore, the stated intent of the ARC that public aircraft operators be afforded the same privileges and limitations under this rule.

APPROACH: During the rulemaking process, the FAA should not apply conditions or limitations that would impinge upon the ability of public aircraft operators to operate under this rule, nor impose any restrictions upon the public aircraft operator's rights to certify in accordance with FAA accepted Means of Compliance.

OQ 2.19 – Operations Near Sensitive Areas or Critical Infrastructure

OQ 2.19	Allow only appropriately vetted UAS operators that are approved by the relevant authority to conduct operations deemed to be a higher security risk.

INTENT: During Phase 1, the ARC's Security and Industry Needs Subgroups recommended that BVLOS regulations should include a path for developing a "Trusted Operator" program to enable authorization to conduct higher-security risk operations or other potentially sensitive BVLOS capabilities. Under the proposed construct, Trusted (or "Known") Operators would undergo a more stringent vetting process than the FAA currently employs as part of the award of a pilot or maintainer certificate.

A process for enhanced vetting of operators who desire or require higher-level of vetting might also be used to grant access to airspace surrounding potentially sensitive or critical infrastructure as designated by appropriate Federal authorities, including areas identified in the FAA's responsibilities under Section 2209 of the FAA Extension, Safety, and Security Act of 2016.

RATIONALE: The ARC Security Working Group, comprised of representatives from various organizations and agencies with security and law enforcement responsibilities, has expressed concerns about the potential threats and vulnerabilities associated with certain deliberate or errant UAS flights. While there may be a valid and supportable need for such flights, the ARC consensus was that a process of enhanced vetting for such operations would increase trust and help mitigate the potential threat of UAS operations being exploited by harmful actors.

To explore this possibility, the ARC queried the FAA regarding the vetting process for certificate holders. The TSA conducts a Security Threat Assessment (STA) to determine whether an Airmen Certificate holder or applicant poses or is suspected of posing a security threat. Security threat has been defined as a threat to transportation or national security, a risk of air piracy or terrorism, a threat to airline or passenger safety, or threat to civil aviation security. (49 USC 46111; 49 CFR §1540.115, §1540.117). Part 107 Remote Pilots go through the same vetting process as Part 91 Pilots. Both are vetted as required by Title 49 USC:

> *(4) 49 U.S.C. 44903(j)(2)(D): Screening of employees against watchlist. —The Administrator, in coordination with the Secretary of Transportation and the Administrator of the Federal Aviation Administration, shall ensure that individuals are screened against all appropriate records in the consolidated and integrated terrorist watchlist maintained by the Federal Government before--*
>
> > *(i)* ***being certificated by the Federal Aviation Administration****;*

The ARC concurs that TSA security vetting is indeed necessary and appropriate as a minimum requirement for holders of a Remote Pilot Certificate. The ARC does not believe that the vetting process for the Remote Pilot certificates should be more stringent than for comparable traditional aviation certificates. However, the ARC does not contest that certain types of operations, or operations in proximity to security-sensitive or critical infrastructure present a heightened security risk, for which higher screening thresholds may apply.

The ARC maintains that the application of the vetting process, including 1) identifying the requirements and types of operations for which additional vetting is necessary or beneficial; 2) setting the criteria for sufficiency of such vetting; and 3) providing a mechanism to conduct the vetting are not core functions of the FAA, and are clearly in the domain of Federal agencies charged with security responsibilities. The FAA, however, can and should require that UAS operators who wish to conduct such operations undergo vetting by the appropriate Federal agency as a condition of approval. The ARC recognizes that such vetting could also be beneficial to support the FAA's responsibilities under Section 2209 of the FAA Extension, Safety, and Security Act of 2016.

APPROACH: The ARC recommends that as requirements, criteria and mechanisms are developed by the appropriate Federal agencies to appropriately vet UAS Operators, Remote Pilots and crew that intend to conduct higher-risk UAS operations, or operations conducted in proximity to security-sensitive facilities or locations, the FAA leverage this rule to ensure that such vetting is accomplished as a condition of approval.

Note: The ARC is aware that several methods are used by law enforcement agencies, such as TSA, to assess pilots using the FAA Airmen Database. This includes a fingerprint-based Security Threat Assessment (e.g., foreign national and certain designated individuals per 49 CFR 1552), as well as a review of the holders of airmen certificates in the database without the fingerprint-based approach (e.g., authority described under ATSA). The ARC accepts that the same tools and processes can (and likely should) be used to conduct vetting under the more stringent criteria for access to security-sensitive or critical infrastructure areas as determined by the appropriate Federal agency.

OQ 2.20 – Carriage of HAZMAT by Remote Air Carrier or Remote Operating Certificate Holders

OQ 2.20	The FAA provide an exception to the restrictions and requirements for carriage of specified quantities of hazardous materials for delivery by holders of a Remote Air Carrier or Remote Operating Certificate.

INTENT: To allow carriage of limited quantities of certain hazardous materials via UA by holders of a Remote Air Carrier or Remote Operating Certificate.

RATIONALE: 49 CFR § 175.10 *Exceptions for passengers, crewmembers, and air operators* provides exceptions to the requirements and restrictions of 49 CFR Part 172, Hazardous Materials for passengers on air carriers who are carrying limited amounts of specified items containing hazardous materials. Examples include portable electronic devices (such as cell phones, tablets, and laptop computers) with dry batteries (including lithium-based batteries), medicinal and toilet articles; perfumes and colognes, mercury thermometers, dry ice and even alcoholic beverages. As the limits of such exception are set on a per-passenger basis, an air carrier aircraft may at times be carrying well over a hundred cell phones without the need to comply with the hazardous materials restrictions contained in 49 CFR Part 172.

As the FAA has thus already determined that the carriage risk for specified quantities of certain hazardous materials is acceptable in routine aviation operations, there is sufficient rationale and precedent for extending similar exceptions to carriage of the same quantities of those materials by UAS by certificated operators. These operators, as a condition of carriage, would implement the appropriate safety controls, training, and oversight appropriate for the excepted materials they choose to carry.

APPROACH: In the new rule, the FAA should provide exceptions to 49 CFR Part 172 to expressly allow the carriage of limited quantities of certain hazardous materials by holders of a Remote Air Carrier or Remote Operating Certificate. These exceptions should align with 49 CFR § 175.10, including personal electronics, non-controlled medicines and toilet articles, aerosols, lighters, perfumes and colognes, self-defense sprays and thermometers, and also include the carriage of small quantities of dry ice.

E. Third-Party Services Recommendations

The Third-Party Services section contains recommendations for the FAA to create a regulatory scheme for the use of third-party services and to further research and determine any mandatory needs for third party services in the future.

TP 2.1 – Regulatory Scheme for 3PSP in Support of UAS BVLOS

TP 2.1	The FAA should adopt a regulatory scheme for third party services to be used in support of UAS BVLOS.

INTENT: To adopt a comprehensive regulatory scheme for third party service equipment and service providers, and establish a 3PSP certificate for compliant service providers. The certificate would be awarded based on a declaration of compliance from the 3PSP that they meet the requirements of an FAA accepted MOC or other acceptable industry standard. Issuance of a certificate will allow for independent FAA oversight and the possibility of certificate action (e.g., suspension or revocation) for non-compliance with the requirements of the FAA accepted MOC which may be supported by industry consensus standard(s) when available. The FAA may also permit submission of alternative MOCs by applicants, when compliance to a specific standard is not requested for interoperability issues.

RATIONALE: The proposal is intended to be similar to other approvals that are based on a Declaration of Compliance under 14 CFR Part 89. A proposed set of regulations for accepting an MOC is also provided and is based on the process established in 14 CFR Part 89 Subpart E - Means of Compliance. The proposal is intended to provide a regulatory approach for accepting a MOC based on the process established in 14 CFR Part 89 Subpart E - Means of Compliance. This is similar to other approvals that are based on a Declaration of Compliance under 14 CFR Part 89.

For approvals requiring a certificate because the operator is using the 3PSP service as a primary means of mitigating a safety risk, the following process would occur. The 3PSP initiates the certification process by applying for a 3PSP Certificate according to the new 14 CFR Part 108 regulations governing the granting of certificates for third party service providers. In support of the application, the 3PSP submits their declaration of compliance with the FAA accepted MOC as required in the notice of availability. The 3PSP will also submit the supporting documentation that documents their level of service and the analysis and testing that has been conducted to verify the performance of the 3PSP service. The exact documentation required will be specified in the FAA notice of availability. The FAA accepts the declaration of compliance and awards a 3PSP Certificate. The FAA will use their discretion on the need to review the data submitted to determine compliance. The process will be like the process the FAA uses to issue Technical Standard Order (TSO) Authorizations. Note that if the 3PSP was a secondary risk mitigation due to the level of automation of the UA, no data would be required to accompany the declaration of compliance and no certificate would be issued.

APPROACH: Proposed regulatory text 14 CFR §108.XX

§108.XX Submission of a Means of Compliance for FAA acceptance.

1. *Eligibility*. Any person may submit a means of compliance for acceptance by the FAA.
2. *Required information.* A person requesting acceptance of a means of compliance must submit the following information to the FAA in a form and manner acceptable to the Administrator:
    a. The name of the person or entity submitting the means of compliance, the name of the main point of contact for communications with the FAA, the physical address, email address, and other contact information.
    b. A detailed description of the means of compliance.
    c. An explanation of how the means of compliance addresses all of the minimum performance requirements established in subpart X.
    d. Any substantiating material the person wishes the FAA to consider as part of the request.

3. *Testing and validation.* A means of compliance submitted for acceptance by the FAA must include testing and validation procedures for persons responsible for the production of Operation Planning and Authorization modules to demonstrate through analysis, ground test, or flight test, as appropriate, how the Operation Planning and Authorization module performs its intended functions and meets the requirements in subpart D of this part, including any applicable FAA performance requirements for radio station operation.

TP 2.2 – FAA & NASA to Study Whether Third Party Services Should be Mandatory

TP 2.2	The FAA and NASA should conduct a study to determine what level of aircraft operations in a defined volume of the airspace would trigger the need for mandatory participation in federated or third-party services.

INTENT: To ensure that any future rulemaking that requires a Third-Party Service are based on data that justifies the cost vs. the benefits.

RATIONALE: The ARC acknowledges that in the future there may be situations where some interoperable safety services such as strategic deconfliction will require the cooperation of all parties operating in a highly congested area

APPROACH: Establish a Research Transition Team (RTT) between the FAA, NASA, and industry to explore mandatory participation in federated or third-party services, and a supporting regulatory framework. These efforts should be similar to the RTT established to coordinate the UTM initiative. *See Unmanned Aircraft System Traffic Management (UTM) (faa.gov)*.

F. Environmental Recommendations

The Environmental section contains recommendations originating from the research of Phase 1 of the ARC. These include recommendations around impacts, benefits, and necessary actions and considerations under NEPA.

ER 2.1 – Finding of No Significant Impact for UAS BVLOS Rule

ER 2.1	As the FAA reviews the BVLOS Rule, the ARC recommends the FAA determine that the BVLOS Rule is unlikely to result in significant impact to the environment.

INTENT: To avoid the undue delay, cost and burden associated with an extensive environmental review under NEPA for operations that do not have a significant impact on the environment. The ARC does not find it reasonably foreseeable that a BVLOS Rule would lead to significant impacts in any of the relevant environmental impact categories specified in FAA Order 1050.1F.

RATIONALE: As a preliminary matter, a rule simply enabling BVLOS flight itself has little environmental effect, as the transition of any particular UAS operation from VLOS to BVLOS does not itself affect the environment (e.g., would not increase noise impacts), aside from the lack of presence of a human physically observing the UAS flight.

The ARC recognizes that the BVLOS Rule could enable greater scale of UAS operations. However, the ARC does not expect that the scale of operations enabled by the BVLOS Rule alone rises to the level required to generate significant environmental impacts. As noted by the Phase 1 report, numerous other barriers continue to limit the scaled operation of UAS within the United States. In other words, the BVLOS Rule is a necessary, but not sufficient, condition to scaled UAS operations at levels that would impact the environment.

As an example, the Part 107 Final Rule notes that at 400' altitude over the measurement point, using the loudest UAs available, it would take more than 25,000 flights each day to exceed the land use compatibility threshold for noise impact.[75] Similarly, the OOP Rule notes that, again using the loudest UAs available, it would take more than 28,000 landing-hover-takeoff events per year (or 77 daily) at a single point to exceed the land use compatibility threshold for noise impact.[76] For all other operators that use significantly quieter UAs, these numbers would be far greater.

It is not reasonably foreseeable that such scale of operations required to constitute a significant impact under NEPA can or will be enabled by the forthcoming BVLOS Rule, for several reasons, including:

1. As the FAA noted in prior rulemakings, there is a physical limit on the maximum number of UAS en route operations that could occur over a given point in a 24-hour period given existing aviation separation rules. Such limit is well below the figures described above. The BVLOS Rule does not alter this physical limitation, meaning that even operating the loudest and maximum number of small UAS at a single point would not exceed Day-Night Average Sound Level (DNL) 65 dB in any single location and thus it would not be reasonably foreseeable to lead to significant noise impacts.

2. The ARC is not aware of any area in the world where such concentrated operations exist, have ever existed, or are remotely close to existing even where BVLOS operations are enabled at scale. For example, industry operations in Rwanda, which can reasonably be viewed as representative of maximally scaled BVLOS operations today, do not exceed more than a few hundred flyover operations over a single point per day, well below the 3,686 flyover operations the FAA previously identified in the OOP Rule required to exceed DNL 65 dB, and far below the 25,000 operations per day identified in the Part 107 Rule. It is not reasonably foreseeable that within the U.S. airspace, the BVLOS Rule would lead to operations more than an order of magnitude greater in scale. Nor is it reasonably foreseeable that such scale could be attained by multiple operators operating within the same geographic area. As an initial matter, for example, none of the proposed UAS delivery operations within the United States, that the ARC is aware

[75] *See* footnote 57 above.

[76] FAA, *Operations of Small Unmanned Aircraft Systems over People*, 86 Fed. Reg. 4314 (Jan. 15, 2021), 86 Fed. Reg. 13630 (March 10, 2021).

of, overlap in their operational area due to commercial and investment realities. But even if they did, and even if each were operating at the maximum scale identified above, it would require over a dozen operators all simultaneously operating in the same area at maximum scale to approach the flyover operation threshold identified by the FAA to exceed DNL 65 dB. Such an outcome has not occurred anywhere else in the world and is not reasonably foreseeable.

3. Operational realities preclude such scale. Outside of UAS light shows, which feature very small and quiet vehicles, the ARC is aware of no industry participant that is technically capable of operating so many UAS over a single point, given the significant operational and deconfliction challenges associated with operating at such density. In short, the industry is not capable “f "blanketing the sky" with UAS currently, nor within the reasonably foreseeable future. This is so regardless of whether a BVLOS rule is promulgated or not. Therefore, such an outcome cannot be fairly ascribed to the reasonably foreseeable environmental impact of a BVLOS Rule. Moreover, even if a UAS operator was in fact technically capable of operating 25,000 flights per day over a single point, there is no technical barrier precluding them from doing so now, within visual line of sight – but this does not happen. There is no reason to believe that the BVLOS Rule will itself enable such a level of operations.

In short, the ARC is aware of no evidence that could reasonably suggest that the UAS industry is technically capable of operating at the scale that the FAA’s precedent has identified as the applicable significance threshold. But critically, the *benefits* of BVLOS operations can be reaped at a scale well below that scale threshold. Around the world, UA have made substantial impacts on emissions reductions, delivery of life-saving medical supplies, natural disaster response, and critical infrastructure inspection at a scale far lower than 25,000 flights per day over a single point.

For these reasons, the ARC concludes that it is not reasonably foreseeable that there will be significant environmental impacts, including noise, arising from the BVLOS Rule. As discussed in more detail below, timely, efficient, and effective environmental review will allow the FAA and industry to leverage the environmental review of the BVLOS Rule for future individual approvals enabled by the rule, including through a categorical exclusion where warranted.

ER 2.2 – Streamlined NEPA Review

ER 2.2	NEPA review of the BVLOS rule must be timely and programmatic in scope.

INTENT: In the absence of significant impacts to the environment, the facts support a streamlined environmental review. Process considerations support a similar result.

RATIONALE: The ARC urges the FAA’s NEPA review of the BVLOS rule to be completed in an efficient and timely fashion, no later (indeed in parallel to) the completion of the rulemaking process itself. Indeed, much discussion around environmental issues and UAS BVLOS use will already have occurred by the time the formal rulemaking process is in place. The ARC has included a variety of stakeholders, including environmental advocacy groups. Both Phase 1 and Phase 2 have enjoyed fulsome discussion on the topic. The FAA plans to host public meetings. Through the public comment process, the public will make its views known, including on environmental issues. The formal review process follows years of effort on the topic, and must be efficient, effective, and streamlined.

APPROACH: To be completed timely, any environmental reviews should begin well in advance of the publication of an NPRM, as soon as the office of primary responsibility has developed a proposal and understands how that proposal will change the existing regulatory environment. Further, we urge the FAA to examine how increased integration of environmental considerations in the overarching review and decision-making process could improve timelines.

In the event the FAA determines an environmental assessment is required to fully evaluate the BVLOS Rule, the FAA should conduct a comprehensive programmatic environmental review to eliminate the need for the UAS industry to seek one-off individual approvals via waivers and exemptions. Conducting review at a programmatic level would simplify the individual approval process and enable individual applicants to tier off the programmatic documents developed to support the rulemaking.

Moreover, appropriate resources must be allocated to the environmental review process to ensure a sufficient number of qualified staff are available to review proposed actions. This could be accomplished by (1) the FAA hiring dedicated NEPA practitioners to support program needs; (2) the FAA contracting for NEPA support; or (3) providing applicants with the option to retain environmental consultants at their own cost to complete environmental documentation under FAA supervision for agency approval.

ER 2.3 – Individual BVLOS Approvals Should Not Be Subject to Environmental Review

ER 2.3	Environmental reviews should not be required for individual BVLOS operations enabled by the Rule.

INTENT: The ARC seeks to avoid any requirement that environmental reviews be required for individual BVLOS approvals conducted under the rule.

RATIONALE: Conducting environmental reviews on individual BVLOS operations, particularly site-by-site, burdens the agency and creates a bottleneck given limited FAA resources. This prevents the industry from scaling, and burdens industry as applicants must wait months or years for individual environmental reviews to be completed before making a delivery or inspecting infrastructure at a particular site. Under Part 107, operators can and do conduct large-scale, wide-ranging UAS operations that have not had significant negative impacts on the environment. Gating individual BVLOS operations behind months of environmental review simply because of the absence of a visual observer on the ground does a disservice to the intended goals of NEPA.

Moreover, the fact that fossil-fuel-powered cars and trucks do not require individual environmental reviews before making trips creates an unintended regulatory disparity. From the ARC's perspective, environmental reviews of UAS operations should not exceed the environmental regulatory barriers imposed on less environmentally friendly substitutes and should be programmatic rather than site-specific.

The FAA's current NEPA review process for individual expanded operations have proven particularly problematic for UAS operators because of the tremendous uncertainty and delay that such reviews inject.

APPROACH: The ARC therefore recommends that the FAA undertake appropriate environmental review of the BVLOS Rule and leverage this review to broadly enable individual BVLOS operations pursuant to the rule. We urge the FAA to take a programmatic approach to environmental review, as noted above, to help manage and mitigate the burden for individual applicants by enabling them to tier off programmatic documents.

ER 2.4 – Interim Pathway for BVLOS Operations Pending Rulemaking

ER 2.4	The FAA should provide an interim pathway to enable BVLOS operations in the near term, pending finalization of the BVLOS Rule.

INTENT: Promote the approval of BVLOS operations to expedite the realization of the environmental benefits while the rulemaking process remains ongoing.

RATIONALE: As noted above, there is a significant gap between the scale of UAS operations that would reasonably be expected to have a significant impact on the environment and the technical capabilities of the industry today. There are also other factors which inhibit the scale that would impact the environment.

APPROACH: Until the BVLOS rulemaking has been implemented, the ARC recommends that the agency develop an interim, expedited pathway to small-scale BVLOS operations that do not present significant impacts on the environment. If such a pathway were implemented expeditiously, it would enable UAS operations at a sufficiently meaningful scale to enable the industry's viability, provide significant benefits to the American people and ensure American competitiveness, while simultaneously facilitating data collection to inform future rulemaking or environmental reviews.

ER 2.5 – NEPA Interpretation that Supports Expeditious Rulemaking

ER 2.5	The FAA interpret NEPA in a way that expedites the BVLOS rulemaking. If the FAA concludes that it is required to implement NEPA in such a way that would substantially delay either the BVLOS rulemaking or BVLOS

	operations, the ARC recommends asking Congress to consider legislative actions.

INTENT: To adhere to the purpose and requirements of NEPA while avoiding unnecessary delay in approving environmentally friendly UAS operations for the benefit of the American public.

RATIONALE: The ARC believes that the purposes of NEPA are well aligned with Congress's expressed intent to integrate UAS into the national airspace system and ensure American geopolitical leadership in this nascent industry.

APPROACH: If the FAA concludes that it is required to implement NEPA in such a way that would substantially delay either the BVLOS rulemaking or BVLOS operations, legislative action should be considered to avoid the unintended scenario where the environmental review process developed to satisfy an environmental statute hinders the adoption of sustainable, environmentally friendly modes of transportation, inspection, and monitoring.

G. General & Procedural Recommendations

The General and Procedural section contains recommendations related to how the FAA should work with the industry (in various ways and on specific issues), other Federal agencies (including the White House), and the public to resolve ambiguity around intergovernmental roles and to expedite safe BVLOS rulemaking that is aligned with international standards. The ARC recognizes that some of the General and Procedural recommendations include matters beyond the FAA's purview that must be addressed as part of the rulemaking initiative.

GP 2.1 – Societal Benefits

GP 2.1	The DOT and the FAA should assess and evaluate societal benefits from UAS BVLOS operations broadly and consider categories and types of benefits that are not easily quantifiable. This includes a holistic and comprehensive analysis of the environmental, equitable, safety, economic, security and health benefits.

INTENT: To ensure the full range of UAS BVLOS operations are captured and quantified as part of the FAA and DOT policy and regulatory initiatives.

RATIONALE: Given the current regulatory framework, actual benefits may be difficult to quantify since the operations do not yet exist at scale. Subjective assessments of qualifiable benefits are important for an overall risk and rewards balance. UAS operations have already demonstrated benefits for society, even within the current VLOS regulatory limitations. Expanded operations such as BVLOS will yield significant additional benefits for society. The DOT and FAA should account for these benefits in developing a rule, as these benefits can best be realized by a supportive regulatory framework. Further, the DOT and FAA should account for the opportunity cost of not realizing these benefits at scale, as well as the cost and burden on society of the current regulatory system of exemptions and waivers. The DOT and FAA should consider benefits across all types of communities and ensure that consideration is given to unique benefits that may exist between different types of communities (such as in rural areas or underserved areas). The agencies should also consider the impacts of delayed rulemaking, and the total costs and burdens on society associated with those delays.

APPROACH: In developing a rule and for the purpose of analyzing specific approvals, the DOT and FAA should consider holistic benefits to communities and society at large (including those outside of the aviation system) that can be achieved through enabling UAS BVLOS operations. In parallel, given these broad (often non-aviation) benefits, the FAA must consider risks holistically. The FAA should consider, for example, the benefits of UAS taking cars off the road, reducing risks for bridge inspectors or tower climbers, or reducing the risk of loss of life or property damage from wildlife. Indeed, UAS BVLOS operations will support broader societal goals in parallel with other emerging technologies and opportunities, and in its regulatory approval process the FAA must consider overall broader long-term societal needs and opportunities for benefits that might result from UAS BVLOS operations.

The FAA should consider the environmental benefits of UAS BVLOS operations as part of other activities and analyses (whether under the National Environmental Policy Act or other reviews). UAS BVLOS operations may offer significant opportunities to address critical environmental issues and challenges, while reducing the environmental impacts of more traditional modes of transportation or inspection. The ARC recognizes that UAS BVLOS operations may also enable the FAA to address issues such as noise in innovative ways. As discussed more fully in the Environmental Considerations section, environmental reviews must be streamlined and appropriately tailored to account for the risks and benefits of UAS.

Given the equity benefits of UAS BVLOS operations, the FAA has a unique opportunity to strengthen the economics of small business entry into the industry and subsequently address critical equity challenges and improve the quality of life in historically underserved areas and communities. The FAA and industry both should seek to support minority and diverse communities in training and workforce development programs. To that end, 2021 bipartisan members of Congress introduced legislation, known as the DIIG (Drone Infrastructure Inspection Grant Program) Act (H.R. 5315), to fund those critically important workforce development programs. The DOT and FAA should consider these benefits in their procurement programs, particularly those focused on disadvantaged communities (such as Disadvantaged Business Enterprise programs). The DOT and FAA should work with industry to build into the nation's STEM programs pre-apprenticeship and apprenticeship models that segue directly into employment. Additionally, Congress should fund the promising, but currently unfunded, UAS-related workforce development programs for community colleges and universities that Congress required in Section 631 and 632 of the FAA Reauthorization Act of 2018. If appropriately funded, those programs could provide a pathway to educate a new and more diverse generation of workers to take advantage of the UAS economy, as well as re-skill existing workers.

The DOT and FAA should consider the positive impacts that advances in technology are having on requisite skill sets required for UAS operators and flight crews. As aviators rely more on cognitive skills versus physical skills, the FAA should enable opportunities for those with physical limitations in the UAS sector.

Due to its importance in supporting the entire U.S. economy, the FAA should consider how UAS BVLOS operations can enhance the planning and operations of critical infrastructure and improve resilience, particularly in response to consumer needs and regulatory requirements imposed by federal, state, and local governments. Improved efficiencies reduce costs and mitigate losses in both long-line linear infrastructure inspections (electric transmission lines, pipelines, railroads, etc.) and static site monitoring (airports, refineries, telecommunication towers, wind, and solar generation facilities, railyards, etc.), which will provide a wide range of both public and private benefits realized by consumers, businesses, and governments.

GP 2.2 – Public Perception

GP 2.2	Public Perception – The industry must continue to work with all governments, including federal, tribal, state, and local, as well as directly with communities to enhance public understanding of the benefits of UAS BVLOS use.

INTENT: To enhance public understanding of the benefits of UAS BVLOS.

RATIONALE: All stakeholders agree that public perception and acceptance – in terms of how the public responds to UAS in their communities – is of utmost importance to the long-term success of the industry, including around privacy, noise and other relevant factors.[77] The industry recognizes this, and has worked with other stakeholders to develop Voluntary Privacy Best Practices on UAS use.[78] The industry has worked with all stakeholders on community outreach through the IPP and other similar programs.

APPROACH: The industry must continue to work with all governments – including federal, tribal, state, and local – as well as directly with communities to address this ongoing challenge.

GP 2.3 – Advisory Circular Should Be Developed Once Rule is Adopted

GP 2.3	Immediately after promulgating the new BVLOS rule, the FAA should issue an Advisory Circular providing guidance.

INTENT: To assist with interpretation of and compliance with the new rules.

RATIONALE: The advisory circular (AC) is intended to provide guidance in the areas of UAS BVLOS operations in the NAS to promote compliance with the amended and new regulations. UA operators

[77] *See* footnote 67 above.
[78] *See* footnote 68 above.

would be encouraged to use this information as best practice methods for developing operational programs and achieving and maintaining compliance.

APPROACH: The FAA should develop the AC in cooperation with subject matter experts and industry standards bodies.

GP 2.4 – Recommendations Should Influence Waivers & Exemptions Pending Rulemaking

GP 2.4	The FAA should continue the waiver and exemption process while the rulemaking process is progressing, considering the proposed recommendations as a basis for approval when appropriate.

INTENT: To encourage the FAA to align exemptions, waivers, and deviations with the ARC's recommendations, while the NPRM process is ongoing.

RATIONALE: Leveraging the recommendations and rationale provided by the ARC to grant such waivers, exemptions, and deviations will increase consistency between operations approved before and after the rule is enacted. This proactive alignment will also reduce disruption to ongoing operations when the BVLOS rule becomes effective.

APPROACH: The FAA should develop a process similar to the Section 333 exemption (now Section 44807: Special Authority for Certain Unmanned Systems) that was adopted with the enactment of 14 CFR Part 107 to enable small-scale BVLOS operations while the NPRM process is ongoing.

GP 2.5 – International Harmonization of Regulatory Processes

GP 2.5	International Harmonization – The FAA should work closely with international partners to streamline regulatory processes.

INTENT: To integrate scalable BVLOS operations into the NAS that are aligned, where possible, with international civil aviation authorities.

RATIONALE: Integrating scalable BVLOS operations into the NAS will require new and novel ways of approaching regulatory approvals on issues relating to airworthiness, operator certification, licensing of remote pilots and operational requirements. Standards and regulations relating to BVLOS operations that are harmonized around the world, such SORA, may streamline compliance for UAS operators and manufacturers and help drive further innovation in the development of UAS technology and their commercial applications. If the FAA, EASA and other civil aviation authorities around the world adopt different standards or approaches relating to UAS airworthiness, operator/pilot certification and/or operational requirements for BVLOS operations, UAS operators and manufacturers will face barriers to operating abroad and marketing products in foreign markets. A lack of uniformity will create uncertainty and impede the development of new and innovative UAS technologies and commercial use-cases. As one example, the ARC should advise the FAA to coordinate with other civil aviation authorities on processes related to design and operational approval. Amongst other benefits, international harmonization enables commerce, including by facilitating easier import and export of hardware, and enables regulators to draw on a shared pool of expertise and experience in safe, secure, and responsible UAS integration. The FAA should engage with other regulators to translate and harmonize guidance in US and foreign frameworks. The ARC considers partnership between the FAA and other international civil aviation authorities will greatly streamline regulatory processes.

APPROACH: As one example, the ARC should advise the FAA to coordinate with other civil aviation authorities on processes related to design and operational approval. Amongst other benefits, international harmonization enables commerce, including by facilitating easier import and export of hardware, and enables regulators to draw on a shared pool of expertise and experience in safe, secure, and responsible UAS integration.

GP 2.6 – Stakeholder Management with Federal, Tribal, State, and Local Governments

GP 2.6	Resolve Ambiguity around Intergovernmental Jurisdictional Roles. The FAA should continue an open dialogue with all interested stakeholders on jurisdictional issues. Further, the FAA should explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.

INTENT: To advance UAS integration and promote cooperation between stakeholders by providing a clearinghouse of information from certified tribal, state, and local government entities.

RATIONALE: The legal authorities of the UAS intersect with tribal, state, and local governments. The ARC supports an open dialogue with interested stakeholders and considers that a clearinghouse for relevant inputs from certified entities, especially local governments, would advance UAS industry integration.

APPROACH: The ARC urges the FAA to work with all interested stakeholders on this important topic. Advancing UA BVLOS operations would be expedited by operators/UTMs having access to all appropriate regulations related to a flight plan through a collaborative standard data exchange such as the method employed in the FAA's Low Altitude Authorization and Notification Capability (LAANC).

GP 2.7 – FAA Participation in Industry Standards Organizations

GP 2.7	The FAA should publish an order that governs FAA participation in industry standards development organizations.

INTENT: To have the FAA better define the role of the FAA participants so that feedback to the SDO is based on official FAA policy from the accountable FAA executive.

RATIONALE: Many UAS standards developed in recent years were developed in conjunction with FAA participants directing the content of the standard against the recommendations of the industry. FAA participants have influenced the content of the standards by stating that the "FAA will never accept the standard" if the document is not altered to implement the FAA representative's position. These individuals have often made the statements based on their own position rather than the position of FAA management. The Standards Development Organizations (SDO) committee leadership has no recourse with the FAA to appeal these positions and no way to understand that the position is not supported by FAA policy. Consequently, many standards have conservative requirements that increase cost and complexity of systems needed to implement UAS into the NAS.

APPROACH: The order should address:

- Training for participants on an SDO committee that clearly defines the limits of their authority to speak for the FAA.
- A quarterly review by policy organizations of the FAA representatives' positions on ongoing standards in development
- Comprehensive review by all stakeholder offices of mature draft documents for official FAA policy comments on the standard in support of the formal SDO review and comment process.
- A mechanism to appeal positions taken in SDO committees by the FAA assigned representatives
- A designated official representative of the FAA will be assigned to each SDO committee who is responsible for coordinating subject matter expert participation by FAA personnel and identifying individuals who are not following the requirements contained in the Order.
- A mechanism for SDO committees to elevate positions taken by FAA personnel that appear to conflict with the specific roles of the FAA participants as defined in the Order.
- Ensure coordination with other authorities (e.g., EASA, TCCA) to foster harmonization in the acceptability of standards as a means of compliance to the rules in line with recommendation GP 2.5 of this report.

GP 2.8 – Executive Branch Leadership to Ensure Multi-Agency Resourcing & Collaboration

GP 2.8	Executive Branch Leadership on UAS Issues – The White House and the Department of Transportation should play a leadership role in UAS BVLOS integration.

INTENT: To ensure committed government leadership and resourcing to promote UAS BVLOS integration.

RATIONALE: The countless public benefits of commercial UAS operations are in jeopardy of not being realized on a broad scale, as is America's leadership in aviation and innovation if the U.S. does not move forward quickly with the safe and secure integration of UAS into the NAS. High-level executive branch leadership is necessary for UAS integration to move forward in a timely way. The White House must exercise leadership on the issues and challenges facing UAS integration, including expanded UAS operations and UTM. To that end, the ARC urges the White House to make clear that achieving U.S. leadership in uncrewed aviation represents a national policy priority to be achieved by DOT, FAA, and other agencies, as appropriate.

APPROACH: These topics require input from and coordination among various federal agencies, including national security and law enforcement agencies. The White House is best positioned to convene key federal decision makers and drive a constructive conversation with industry stakeholders, tribal, state, and local regulators, the security industry, and other relevant stakeholders.[79]

GP 2.9 – Renew the Preventing Emerging Threats Act to Counter UAS Misuse

GP 2.9	Counter-UAS Issues – The US government should renew the Preventing Emerging Threats Act.

INTENT: While the use of UAS for good must be enabled, there must also be a means to detect and mitigate unauthorized, criminal, or rogue UA that may cause harm.

RATIONALE: In 2016, federal national security agencies prevented expanded UAS operations from moving forward through the interagency process until UAS security was properly regulated. This is because under Title 18 of the United States Code, the deployment of many forms of counter-UAS technology is illegal. The Preventing Emerging Threats Act of 2018 was therefore passed by Congress to authorize relevant national security agencies to deploy counter-UAS technology to mitigate UAS threats to select U.S. facilities or assets.[80] The Preventing Emerging Threats Act is scheduled to expire in October 2022.

APPROACH: To scale BVLOS operations in the U.S., federal national security agencies must continue to have the legal authority to protect against potential public safety and homeland security threats posed by rogue UA. If Congress does not take action to renew the Preventing Emerging Threats Act, industry worries that security concerns will continue to handicap further integration of UAS into the NAS, including the ability to scale BVLOS operations.

[79] *See* footnote 61 above.

[80] Preventing Emerging Threats Act of 2018; 6 U.S.C. § 124n - Protection of certain facilities and assets from unmanned aircraft.

GP 2.10 – FAA Extension Act

GP 2.10	FAA Extension Act – The FAA, together with national security agencies, should implement a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.

INTENT: To accommodate reasonable access to potentially sensitive or critical infrastructure that is commensurate with the risks posed by the operation.

RATIONALE: Section 2209 of the 2016 FAA Extension Act mandated that the FAA implement a process by which critical infrastructure facilities and other "fixed sites" may limit UAS use over private property. The national security agencies, as well as all security stakeholders, are following this rulemaking closely. The ARC supports the spirit of Section 2209 and views the upcoming rulemaking as a critical aspect of UAS integration. The ARC also believes that it is important to enable authorized commercial operators to fly over these fixed sites in certain situations.

APPROACH: The FAA, together with national security agencies, should implement a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.

GP 2.11 – DOT Economic Authority and Citizenship

GP 2.11	DOT Economic Authority – Congress and the Department of Transportation should review the application of the aviation citizenship laws to the UAS industry to minimize barriers to entry and operational hindrances.

INTENT: Due to how aviation citizenship laws are currently drafted and implemented, certain BVLOS operators (air carriers) may require economic authority (or registration) from the USDOT to operate. This has important implications for a variety of UAS BVLOS use cases. Congress and USDOT should examine how these laws affect American companies who may not be able to prove citizenship under the existing framework.

RATIONALE: Laws defining aviation citizenship were defined for a different industry and different era. This includes the requirement that the operator be a citizen of the United States as defined in 49 USC 40102. Foreign civil aircraft operators conducting operations other than air carrier operations in the U.S. will also need DOT authorization. One or both could have implications for a variety of UAS BVLOS use cases. The application of the aviation citizenship laws to the UAS industry often leads to absurd results where American companies are not able to prove citizenship. If not addressed, a UAS operator subject to these requirements may not be able to legally operate. The 'citizen of the United States' requirement for UAS operators therefore has many implications for UAS operator ownership and can significantly restrict ownership and investment. Further, citizenship requirements imposed for economic or competitive reasons are an unjustifiable barrier to entry for global operators and providers. These entities can help to stimulate competition and innovation in the U.S. market. U.S. companies are permitted to operate in a range of jurisdictions abroad, and the same privileges should be extended to global companies in the U.S.

APPROACH: Congress and the USDOT should consider and account for economic authority issues and how they impact this emerging industry in a new era.

GP 2.12 – Spectrum Related Issues

GP 2.12	Spectrum Related Issues – The FAA should work with the FCC and NTIA to support enabling all available spectrum technology for the industry in a timely way.

INTENT: Increase reliable and continuous access to spectrum which is essential to the continued growth of the UAS industry.

RATIONALE: Given aviation industry reliance on RF communications, the FCC has played and will continue to play an important role in enabling growth of the UAS industry. There is no one-size-fits-all approach to spectrum suitable for UAS, and so it is critical that the FCC and NTIA enable all available communications technology for the industry, including consideration of regulatory restrictions on using certain spectrum bands for airborne operations, such as the restrictions set forth in 47 CFR 22.925, as well as the "mobile except aeronautical mobile" designation set forth in the FCC's Table of Allocations (47 CFR 2.106) that applies to many spectrum bands.

APPROACH: UAS operations will require that spectrum bands with appropriate characteristics are sufficiently available to meet the needs of numerous users operating in a variety of operating environments. Without appropriate access to adequate spectrum, it will be difficult to scale UAS operations. The FAA should work with FCC and NTIA to review existing restrictions on spectrum for aviation to determine whether those restrictions are still necessary. Where they are not, the FAA should encourage the FCC to enable all available communications technology for the industry in a timely way. This includes working with FCC and industry to progress rulemakings that enable access to RF communications, such as the Aeronautical Industries Association's petition for rulemaking on C2 Link. The allocation of spectrum for UAS operations should not negatively impact crewed aviation operations.

GP 2.13 – Network Remote ID

GP 2.13	Network Remote ID Implementation – The ARC urges the national security agencies and the FAA to engage in an open dialogue with industry and civil society stakeholders to find solutions that enable network remote identification implementation.

INTENT: To promote and implement network remote ID solutions.

RATIONALE: While network remote ID is not a condition precedent for UTM operations, the FAA should explore additional identification solutions to supplement broadcast remote ID for UAS BVLOS operations. As noted in the Final Rule for Remote Identification (86 FR 4390), the FAA should strive to ensure that they, along with DHS and DOJ are "prepared to solve safety and security issues related to those concepts based on more mature understandings."

APPROACH: The ARC urges the national security agencies to engage in an open dialogue with industry stakeholders and civil society stakeholders to find solutions that enhance remote identification, specifically remote ID solutions that enable remote ID data to be accessed via a network (including the internet as well as private networks, secure networks, peer-to-peer networks, or other interconnections that may not necessarily be considered the internet), while maintaining appropriate privacy safeguards for UAS operators and customers.

GP 2.14 – Cybersecurity

GP 2.14	The FAA establish a cybersecurity working group composed of members of the UAS and aviation industry, communications industry, academics, expert agencies, and other cybersecurity experts.

INTENT: To address cybersecurity concerns across the UAS industry that is adaptable to evolving cybersecurity trends and technology.

RATIONALE: The ARC recognizes there are inherent cybersecurity risks associated with UA, but notes that these risks are not unique to BVLOS or even to UA. Any connected product is vulnerable. To address cybersecurity concerns across the industry, the ARC encourages the FAA to capitalize on existing cybersecurity work across industries and convene a working group with industry (UAS, aviation, and communication), academic, and other expert agencies to consider best practices, industry standards, and other guidance on UAS cybersecurity.

Strict cybersecurity regulations would not be ideal due to the dynamic and highly technical nature of cybersecurity. Furthermore, the FAA is not equipped to determine appropriate cybersecurity regulations for UAS. Industry standards, best practices, and guidance are more suitable because of their flexibility and adaptability to a variety of products and services, which allows industry to incorporate the practices that are most conducive to their operations. Existing cybersecurity initiatives have resulted in flexible, non-binding best practices with wide industry acceptance. JARUS is also writing a companion document to the Specific Operations Risk Assessment (SORA) Annex E (which covers Operational Safety Objectives) providing specific guidance on appropriate cyber mitigations proportionate to the operational risk.

APPROACH: Where possible, the working group should leverage existing cybersecurity efforts, which have been developed through industry-driven standards bodies, as well as public private partnerships, such as the NIST cybersecurity framework and RTCA's body of work on aircraft related cybersecurity issues. The working group should focus on the following issues:

- potential threats, vulnerabilities, and consequences;
- unique vulnerabilities with BVLOS operations assuming a nominal level of security controls and a Security Risk Management Plan (SRMP);
- critical controls and gaps in the available industry standards; and
- industry standards and best practices pertaining to data protection.

GP 2.15 – Operation Matrix as Guidance Material Pending Rulemaking

GP 2.15	Until the new rule is promulgated, the proposed framework outlined in the Operations Matrix should be leveraged as Guidance Material for applicants and reviewers under the existing FAR Part 107 Waiver Process.

INTENT: To create a more streamlined pathway to near-term operations that can inform final BVLOS rulemaking.

RATIONALE: The FAA should leverage the track record of safe operations conducted under special programs such as Pathfinder, IPP, and BEYOND, and generally under Part 107 and Part 91 waivers and exemptions. The approvals granted through these programs were subject to the SRM process. The mitigations were evaluated, were found to have lowered risk to an acceptable level, and were monitored for effectiveness. This includes many of the mitigations in the proposed framework outlined in the Operations Matrix. For example, shielded operations have been demonstrated below bridges, along power transmission lines, and over railroad tracks.

Applicants for Part 107 and Part 91 waivers should not be required to continually prove the effectiveness of these common mitigations. The FAA should use the data collected through these approved operations to inform final rulemaking.

APPROACH: The FAA should issue waiver guidance in the form of Standard Scenarios or Pre-Defined Risk Assessments based on previously demonstrated combinations and layers of air and ground risk mitigation measures that result in acceptable risk per FAA Order 8040.6 or JARUS SORA.

XI. Proposed Regulatory Text

This report provides detailed information on each recommendation, including the ARC's intent, supporting rationale, research, examples, and suggested regulatory approach. As the FAA has ultimate responsibility for developing the regulatory approach while following the public rulemaking process, the report does not provide a full draft regulatory text implementing the ARC's recommendations. However, the ARC does offer potential draft regulatory text in some cases where it was developed as part of the process of refining specific recommendations.

The following material is included as suggested language for the FAA and is not intended to be prescriptive.

XII. Proposed Modifications to Existing Regulatory Text

§1.1 General Definitions

Pilotage. Navigation by visual reference to landmarks or in the case of UAS by remote or electronic means.

Third Party Service Provider (3PSP). A person (as defined by 14 CFR 1.1) that is not an applicant, as defined by the FAA and Industry Guide to Product Certification", offering services and/or Associated Elements as a Third-Party Service to a UAS operator

Uncrewed aircraft system service supplier (USS) is a person qualified by the Administrator to provide aviation related services to uncrewed aircraft systems.

UTM Services are a set of automated functions and digital services designed to support safe, efficient, and secure access to airspace for UAS. A list of 3PSP UTM services is provided in Table 2 "PART 14 CFR § 91.xxx (or new UAS BVLOS operating rule) – UAS Service Supplier performance requirements.

- ***Definitions***

Declaration of compliance means a record submitted to the FAA by the 3PSP to attest that all the requirements of the applicable regulation have been met.

Network remote identification service is a service that ensures the remote identification of the operator throughout the flight. It shares the registration number of UAS operators as well as further details about their flights (speed, height, course) with authorized users (citizens, authorities, air traffic services).

Service level agreement (SLA) means the agreement between the 3PSP and the UAS operator covering the safety, performance, service area and security of the 3rd Party UAS Service provision as required for the UAS operator's intended operations.

Shielded Area is a volume of airspace that includes 100' above the vertical extent of an obstacle or critical infrastructure and is within 100 feet of the lateral extent of the same obstacle or critical infrastructure as defined in 42 U.S.C. § 5195c. A Shielded Operation is a UAS BVLOS operation within a Shielded Area.

Traffic information service informs UAS operators about other air traffic (both crewed and uncrewed) that may be present in proximity to their UAS.

§21.175b – Special Airworthiness Certification for Uncrewed Aircraft

Special airworthiness certificates are primary, restricted, limited, light-sport, *uncrewed aircraft systems* and provisional airworthiness certificates, special flight permits, and experimental certificates.

§ 91.103 - Pre-Flight Actions for Remote Pilots in Command (RPIC)

For a BVLOS UA flight under AFR and a flight not in the vicinity of an airport, the remote pilot in command will take appropriate steps to confirm conditions for safe operation and safe launch and landing areas by consulting relevant information, which may include weather station information, systems and sensors on-aircraft and other flight support systems.

§ 91.113 Right-of-way rules: Except water operations.

§ 91.113(b)

General. When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules, visual flight rules, or *automated flight rules* vigilance shall be maintained by each person operating an aircraft so as to ~~**see**~~ *detect* and avoid other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under, or ahead of it unless *able to maintain adequate separation* ~~**well clear**~~.

§ 91.113 (d)(4)

Uncrewed Aircraft Conducting BVLOS in Shielded Operations have right of way over all other aircraft.

§ 91.113(h)

Uncrewed Aircraft Conducting BVLOS Operations Below 500 ft AGL.

(1) Uncrewed Aircraft with a maximum kinetic energy of no more than 800,000 ft.-lbs. must yield right of way to all aircraft that are equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.

(2) The UA must:

be equipped with an FAA approved or accepted detect and avoid system that can detect ADS-B or TABS equipped aircraft or can detect all aircraft using another means
Notify other aircraft of their operation through use of a NOTAM or other means accepted by the FAA.
Be approved in accordance with 14 CFR Part 108.XX.

(3) The UA operator must:

- *For operations in controlled airspace, prior authorization from the airspace controlling facility must be obtained*
- *For operations in uncontrolled airspace, the UA operator must coordinate with the airport operator for operations within 3 nautical miles for public airports*
- *For operations in uncontrolled airspace, the UA operator must coordinate with the heliport operator for operations within ½ nautical mile of the published heliport.*

§ 91.119 – Minimum Safe Altitudes - General

(1) Helicopters, powered parachutes weight-shift-control, *and uncrewed aircraft.* If the operation is conducted without hazard to persons or property on the surface -

(2) A UA may be operated at less than the minimums prescribed in paragraph (b) or (c) of this section, provided those operations are done in accordance with 14 CFR 108.XX

§ 107.31 - Expand Visual Line of Sight Aircraft Operation to Include Extended Visual Line of Sight

(1) With vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one or more are used), or the person manipulating the flight control of the small uncrewed aircraft system must be able to see the uncrewed aircraft throughout the entire flight in order to:

(a) Know the uncrewed aircraft's location;
(b) Determine the uncrewed aircraft's attitude, altitude, and direction of flight;
(c) Monitor the airspace for other air traffic or hazards; and
(d) Determine that the uncrewed aircraft does not endanger the life or property of another.

(2) Throughout the entire flight of the small uncrewed aircraft, the ability described in paragraph (a) of this section must be exercised by either:

(a) The remote pilot in command and the person manipulating the flight controls of the small uncrewed aircraft system; or
(b) A visual observer.

(3) The remote pilot in command, the visual observer (if one is used), and the person manipulating the controls are relieved from the requirement of seeing the uncrewed aircraft throughout the entire flight if they are able to:

(a) Know the uncrewed aircraft's location;
(b) Determine the uncrewed aircraft's attitude, altitude, and direction of flight;
(c) Observe the airspace for other air traffic or hazards; and
(d) Determine that the uncrewed aircraft does not endanger the life or property of another.

(4) To be relieved of the requirement to see the uncrewed aircraft per subsection (c), the uncrewed aircraft must not be flown more than three statute miles away from the remote pilot in command, the visual observer (if one is used), or the person manipulating the controls, and the remote pilot in command, the visual observer (if one is used), or the person manipulating the controls must:

(a) Receive training on and be permitted to operate an aviation radio; and
(b) Monitor aviation frequencies for nearby air traffic.

§ 107.33 Visual observer.

If a visual observer is used during the aircraft operation, all of the following requirements must be met:

(1) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer must maintain effective communication with each other at all times.

(2) The remote pilot in command must ensure that the visual observer is able to see the uncrewed aircraft in the manner specified in § 107.31.

(3) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer must coordinate to do the following:

(a) Scan the airspace where the small uncrewed aircraft is operating for any potential collision hazard; and

(b) Maintain awareness of the position of the small uncrewed aircraft through direct visual observation.

(4) The remote pilot in command, the person manipulating the flight controls of the small uncrewed aircraft system, and the visual observer are relieved from subsections (b) and (c) if the flight is conducted in compliance with 107.31(c) and (d).

§ 107.37 Operation near aircraft; right-of-way rules.

(1) Each small unmanned aircraft must yield the right of way to all aircraft, airborne vehicles, and launch and reentry vehicles. Yielding the right of way means that the small unmanned aircraft must give way to the aircraft or vehicle and may not pass over, under, or ahead of it unless well clear.

(2) No person may operate a small unmanned aircraft so close to another aircraft as to create a collision hazard.

(3) UA operating within 100 feet of a structure have right of way over all other aircraft.

§108.XX Issuance of a 3PSP Certificate

1. ***Applicability***

   This regulation is applicable to a person who applies for a 3rd Party UAS Service Provider Certificate.

2. ***Minimum performance requirements***

   - A 3rd Party UAS Service Provision Certificate will be issued by the FAA to a person who makes a declaration of compliance to an FAA accepted means of compliance.
   - Safety-enhancing Advisory Services

   (TBD based on the following table)

   - Safety-Enhancing Service supporting a Compulsory function or Safety-Integral Advisory Services

   (TBD based on the following table)

   - Safety-Integral Service supporting a Compulsory function

   (TBD based on the following table)

3. ***Means of Compliance***

(a) Safety-enhancing Advisory Services

(TBD based on the following table)

(b) Safety-Enhancing Service supporting a Compulsory function or Safety-Integral Advisory Services

(TBD based on the following table)

(c) Safety-Integral Service supporting a Compulsory function

(TBD based on the following table)

Table TP2

The ARC proposes the following Service Specific Regulatory Text to enable recognition of a MOC for each type of service. The ARC also recommends that the FAA establish a regulatory process to issue a certificate to 3SPSP, and the information that the 3PSP must submit to the FAA declaring compliance with the accepted MOC.

	Networked Remote ID Provider	**Strategic Deconfliction Provider**	**Constraints Services**	**Conformance Monitoring**	**Operational Planning**	**C2**	**Detect and Avoid**
Definition	Remote ID USS means a USS qualified by the Administrator to provide remote identification services.	Strategic Deconfliction USS means a USS qualified by the Administrator to provide Strategic Deconfliction services.	Constraint USS means a USS qualified by the Administrator to provide Constraint services.	Conformance Monitoring USS means a USS qualified by the Administrator to provide Conformance Monitoring services	Operational Planning and Authorization USS means a USS qualified by the Administrator to provide Operational Planning and Authorization services.	C2 Link. The data link between the uncrewed aircraft and the control station for the purposes of managing the flight. C2 Link communication service provider (C2CSP). An entity which provides a portion of, or all, the C2 Link service for the operation of an UAS. *Note. — An UAS operator may also be its own C2CSP.*	Detect and Avoid (DAA). A service providing the situational awareness, alerting, and avoidance necessary to maintain safe BVLOS operation of the ownship in the presence of intruders. DAA Service Provider (DAASP). An entity which provides a portion of, or all, the DAA service for the operation of an UAS. *Note. — An UAS operator may also be its own DAASP*
Demonstrated Capabilities	Remote ID USS would be required to demonstrate four primary capabilities:	Strategic Deconfliction USS would be required to demonstrate the following primary capabilities when performing strategic deconfliction for an operational intent:	Constraint USS would be required to demonstrate the following primary capabilities:	Conformance Monitoring USS would be required to demonstrate the following primary capabilities:	Operational Planning USS would be required to demonstrate the following primary capabilities:	The FAA will issue a certificate for a C2CSP based on the FAA accepting a declaration of compliance by the C2CSP applicant to an accepted MOC. The FAA is not required to verify that the C2CSP complies with the MOC before issuing the certificate but will have the authority to audit a C2CSP at any time to verify compliance with the MOC. Minimum performance of the C2 service will be established by industry consensus-based standard(s) that the FAA can accept as an acceptable	The FAA will issue a certificate for a DAASP based on the FAA accepting a declaration of compliance by the DAASP applicant to an accepted MOC. The FAA is not required to verify that the DAASP complies with the MOC before issuing the certificate but will have the authority to audit a DAASP at any time to verify compliance with the MOC. Minimum performance of the DAA service will be established by industry consensus-based standard(s) that the FAA can accept as an acceptable Means of Compliance (MOC). Any MOC that meets the requirements in the regulation could be accepted by the FAA following the recommended process for acceptance. This FAA Acceptance process will proceed any
	(1) The ability to share the remote identification message elements in near real-time with the FAA upon request;	(1) Discover other relevant operational intents, and obtain discovered operational intents from the owning USS(s).	(1) Discover constraints that are relevant to a UAS Operator's operational intent or otherwise designated area of interest.	(1) Detect deviations of UAS flight track from planned operation intent.	(1) Confirms that submitted operational intent complies with airspace restrictions and constraints based on authoritative sources of airspace information and the capabilities of the UAS		

	(2) the ability to maintain remote identification information securely and to limit access to such information; (3) the ability to meet established technical parameters; and (4) the ability to inform the FAA when their services are active and inactive.	(2) Detect conflicts between relevant operational intents Notify the relevant operator when a conflict is detected. (3) Notify the relevant operator when an owning USS receives notification that a conflict has been detected. (4) Results in the resolution of conflicts between operational intents prior to flight. Make own operational intent discoverable by authorized services (5) Provide operational intent details of own operations when requested by authorized services	(2) Receive notifications of newly published constraints from publishing source(s) (3) Obtain constraint details from the publishing source(s) (4) Detect intersections between (a) Constraints and operational intents, and/or (b) Constraint and areas of interest (3) Notify the relevant operator when an intersection is detected	(2) Provide situational awareness to relevant USS and operators when deviation from operation intent pass a previously defined threshold. (3) Provide current position information for a non-conforming or contingent UA when requested by a relevant USS. (4) Monitor aggregate operation intent conformance over time, and notify operators when aggregate operational intent non-conformance with requirements is detected.	(2) Confirms that submitted operational intent avoids dynamic constraints from certified constraint management services (3) Confirms that submitted operational intent resolves conflicts between operational intents of other BVLOS operations as provided by certified strategic deconfliction services	Means of Compliance (MOC). Any MOC that meets the requirements in the regulation could be accepted by the FAA following the recommended process for acceptance. This FAA Acceptance process will proceed any applications by a C2CSP for approval of their service. Once the MOC has been accepted, any C2CSP can use it as a basis for their application for approval. Performance based MOC(s) is(are) needed to address the wide variety of UAS anticipated.	applications by a DAASP for approval of their service. Once the MOC has been accepted, any DAASP can use it as a basis for their application for approval. Performance based MOC(s) is(are) needed to address the wide variety of UAS anticipated.
Requirements for Issue	A Remote ID USS Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	A Strategic Deconfliction USS Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	A Constraint USS Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	A Conformance Monitoring USS Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	An Operation Planning and Authorization USS Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	A C2 Link Service Provision Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:	A DAA Service Provision Certificate will be issued by the FAA to a person who makes a statement of compliance to an FAA accepted means of compliance that establishes:

	1. Prospective Remote ID USS would enter into an MOA with the FAA, demonstrate it meets the technical requirements, and successfully test the end-to-end system and connections.	1. Prospective Strategic Deconfliction USS would enter into an MOA with the FAA, demonstrate it meets the technical requirements, and successfully test the end-to-end system and connections.	1. Prospective Constraint USS would enter into an MOA with the FAA, demonstrate it meets the technical requirements, and successfully test the end-to-end system and connections.	1. Prospective Conformance Monitoring USS would enter into an MOA with the FAA, demonstrate it meets the technical requirements, and successfully test the end-to-end system and connections.	1. An agreement between the FAA, USS service provider and the operator to demonstrate the robustness of provisioned safety services	1. Standards for integrity, availability, continuity, latency, security and other key performance indicators appropriate for each class of airspace.	1. Standards for adequate separation, acceptable risk of loss of adequate separation, acceptable risk of near midair collision, sensor performance, track accuracy and latency, and other key performance indicators appropriate for each class of airspace.
	2. Prospective Remote ID USS would also be reviewed for consistency with national security and cybersecurity requirements and export regulations.	2. Prospective Strategic Deconfliction USS would also be reviewed for consistency with national security and cybersecurity requirements and export administration regulations.	2. Prospective Constraint USS would also be reviewed for consistency with national security and cybersecurity requirements and export administration regulations.	2. Prospective Conformance Monitoring USS would also be reviewed for consistency with national security and cybersecurity requirements and export administration regulations.	2. Prospective Operational Planning and Authorization USS would enter into an MOA with the FAA, demonstrate it meets the technical requirements, and successfully test the end-to-end system and connections.	2. Requirements for the content of service level agreements (SLA) with their customers.	2. Requirements for the content of service level agreements (SLA) with their customers.
	3. FAA-qualified Remote ID USS would be subject to ongoing FAA review to ensure compliance and quality-of-service.	3. FAA-qualified Strategic Deconfliction USS would be subject to ongoing FAA review to ensure compliance and quality-of-service.	3. FAA-qualified Constraint USS would be subject to ongoing FAA review to ensure compliance and quality-of-service.	3. FAA-qualified Conformance Monitoring USS would be subject to ongoing FAA review to ensure compliance and quality-of-service.	3. Prospective Operational Planning and Authorization USS would also be reviewed for consistency with national security and cybersecurity requirements and export administration regulations.	3. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.	3. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.
	4. Requirements for the content of service level agreements (SLA) with their customers.	4. Requirements for the content of service level agreements (SLA) with their customers.	4. Requirements for the content of service level agreements (SLA) with their customers.	4. Requirements for the content of service level agreements (SLA) with their customers.	4. FAA-qualified Operational Planning and Authorization USS would be subject to ongoing FAA review to ensure compliance and quality-of-service. 5. Requirements for the content of service level agreements (SLA) with their customers.		
	5. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.	5. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.	5. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.	5. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.	6. Reporting requirements for outages that are communicated to the FAA and users any time the delivered performance does not meet the acceptable performance defined in the SLA.		

§108.XX 3PSP Certificate Eligibility

(a) Eligibility. Any 3PSP may apply for a certificate to provide a service identified in an accepted means of compliance.

(b) Application. The 3PSP will submit an application for a certificate as prescribed by the Administrator.

(c) Declaration of Compliance. The 3PSP will submit a declaration of compliance to the means of compliance as prescribed by the Administrator.

(d) Required Information. All material required by an accepted means of compliance must be prepared and submitted or archived as required by the means of compliance.

XIII. Proposed New 14 CFR Part 108

Subpart A - General

§ 108.1 Applicability.

§ 108.3 Definitions.

§ 108.5 Falsification, reproduction, or alteration.

§ 108.7 Inspection, testing, and demonstration of compliance.

§ 108.9 Accident reporting.

Subpart B - Operating Rules

§ 108.11 Applicability.

This Subpart applies to UAS BVLOS operations at the following Automated Flight Rules (AFR) Levels:

(a)For UA with 25,000 ft lbs. or less of kinetic energy, including everything that is on board or otherwise attached to the aircraft, operating at:

1. AFR Level 2 Automation: a pilot to UA ratio greater than 1:5
2. AFR Level 3 Automation: a pilot to UA ratio greater than 1:20

(b) For UA with more than 25,000 ft lbs. of kinetic energy, including everything that is on board or otherwise attached to the aircraft, operating at:

a pilot to UA ratio greater than 1:5

§ 108.12 Requirement for a remote pilot certificate.

§ 108.13 Registration.

§ 108.15 Condition for safe operation.

(a) No person may conduct a BVLOS UA operation unless the UA is in a condition for safe operation. For a BVLOS UA flight under AFR, the remote pilot in command will take appropriate steps to confirm conditions for safe operation and safe launch and landing areas by consulting relevant information, which may include weather station information, systems and sensors on-aircraft and other flight support systems. Prior to each flight, the remote pilot in command must check the uncrewed aircraft system, and associated elements, to determine whether it is in a condition for safe operation. Such checks may be conducted on-site by direct inspection; remotely via aircraft system monitoring and health ground and flight checks, or a combination of both as approved in the aircraft's flight manual.

(b) No person may continue a BVLOS UA operation when the person knows or has reason to know that the UAS, or associated elements, are no longer in a condition for safe operation.

§ 108.29 Operation at night.

§ 108.20 Operations in shielded areas.

§ 108.21 In-flight emergency.

§ 108.23 Hazardous operation.

§ 108.27 Alcohol or drugs.

§ 108.35 Operation of multiple uncrewed aircraft.

§ 108.37 Operation near aircraft; low altitude right-of-way rules.

(a) Every uncrewed aircraft operating below 500’ AGL and away from structures, must yield the right of way to all aircraft, airborne vehicles, and launch and reentry vehicles equipped and broadcasting their position via ADS-B out or Traffic Awareness Beacon Systems (TABS). Yielding the right of way means that the small uncrewed aircraft must give way to the aircraft or vehicle and may not pass over, under, or ahead of it unless there is adequate separation.

(b) Every crewed aircraft, airborne vehicle, and launch and reentry vehicle operating below 500’ AGL and away from structures, that is not equipped and broadcasting their position via ADS-B out or TABS must yield the right of way to all uncrewed aircraft. Yielding the right of way means that the crewed aircraft or vehicle must give way to the uncrewed aircraft and may not pass over, under, or ahead of it unless there is adequate separation.

c. Every uncrewed aircraft operating below 500’ AGL and within 100 feet of a structure has right of way over all other aircraft, airborne vehicles, and launch and reentry vehicles.

d. No person may operate an aircraft or an uncrewed aircraft in a manner that creates a collision hazard.

§ 108.XX Transient operations over human beings

To conduct transient operations –

1. The UA operations shall be a transient operation (with regard to flight over human beings) or includes transient flight over human beings. Transient flight over human beings is a transit route flight over people or a person. Transient operations are merely incidental to a point-to-point operation unrelated to the people or a person.
2. RPIC requirements.
    a. A remote pilot in command –
        i. Must use a UA that is eligible for transient operations pursuant to paragraph (c) of this section;
3. Uncrewed aircraft requirements for transient operations. To be eligible to conduct transient operations over human beings under this section, the UA must –
    a. Have the minimum BVLOS capabilities; and
    b. Software performs as intended.
4. Maintenance requirements for transient operations. The owner/operator must maintain the aircraft in an airworthy condition and,
    a. Uses the methods, techniques, and practices prescribed in the manufacturer’s current maintenance manual;
    b. Has the knowledge, skill, and appropriate equipment to perform the work; and
    c. Performs the maintenance, preventive maintenance, or alterations on the uncrewed aircraft in a manner using the methods, techniques, and practices prescribed in the manufacturer's current maintenance manual.

§ 108.XX Sustained operations over human beings

To conduct sustained operations over human beings –

1. The UA shall be a sustained operation (with regard to flight over human beings) or includes sustained flight over human beings. Sustained flight is hovering above people or a person, flying back and forth over people or a person, or circling above people in such a way that the unmanned aircraft remains above some portion of the person or persons.
2. RPIC requirements
    a. A remote pilot in command –
        i. Must use a UA that is eligible for sustained operations pursuant to paragraph (c) of this section;
3. Uncrewed aircraft requirements for sustained operations. To be eligible to conduct sustained operations over human beings under this section, the UA must -
    a. Meet the requirements for BVLOS operations per Subpart D
4. System requirements
    a. The UAS or associate elements performs as intended.
5. Maintenance requirements sustained operations. The owner/operator must maintain the aircraft in an airworthy condition and,
    a. Uses the methods, techniques, and practices prescribed in the manufacturer's current maintenance manual;
    b. Has the knowledge, skill, and appropriate equipment to perform the work; and
    c. Performs the maintenance, preventive maintenance, or alterations on the uncrewed aircraft in a manner using the methods, techniques, and practices prescribed in the manufacturer's current maintenance manual.

§ 108.41 Operation in certain airspace.

§ 108.43 Operation in the vicinity of airports or heliports.

§ 108.45 Operation in prohibited or restricted areas.

§ 108.47 Flight restrictions in the proximity of certain areas designated by notice to airmen.

§ 108.49 Preflight familiarization, inspection, and actions for aircraft operation.

§ 108.51 Operating limitations.

Subpart C - Certification: Remote Pilots

§ 108.56 Applicability.
§ 108.57 Offenses involving alcohol or drugs.
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Subpart D - Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS

§ 108.xx Applicability.
§ 108.xx Level 1 operations: Eligibility of aircraft and systems for BVLOS
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§ 108.xx Means of Compliance
§ 108.xx Declaration of Compliance
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Subpart E - Certification: Remote Air Carriers and Remote Commercial Operators (Part 119 equivalent)

§108.XX Applicability (From § 119.1)

1. This part applies to each person operating or intending to operate civil uncrewed aircraft - As a remote air carrier or a remote commercial operator, or both, in air commerce.

(b) This part prescribes -

The types of remote air operator certificates issued by the Federal Aviation Administration, including remote air carrier certificates and remote operating certificates;

The certification requirements an operator must meet in order to obtain and hold a certificate authorizing operation under this part and operations specifications for each kind of operation to be conducted under this part;

The requirements an operator must meet to conduct operations under this part and in its operations specifications.

Requirements affecting wet leasing of aircraft and other arrangements for transportation by air;

Requirements for obtaining deviation authority to perform operations under a military contract and obtaining deviation authority to perform an emergency operation; and

Requirements for operations and management personnel for operations conducted under this part.

(c) Persons subject to this part must comply with the other requirements of this Part, except where those requirements are modified by or where additional requirements are imposed by Subpart F of this chapter.

- (d) This part does not govern operations conducted under part 107 of this chapter.

§108.XX Certifications, authorizations, and prohibitions. (From §119.5)

(a) A person authorized by the Administrator to conduct operations as a remote air carrier will be issued a Remote Air Carrier Certificate.

(b) A person who is not authorized to conduct remote air carrier operations, but who is authorized by the Administrator to conduct remote operations as a U.S. commercial operator, will be issued a Remote Operating Certificate.

(c) No person may operate as a remote air carrier or as a remote commercial operator without, or in violation of, an appropriate certificate and appropriate operations specifications. No person may operate as a remote air carrier or as a remote commercial operator in violation of any deviation or exemption authority, if issued to that person or that person's representative.

(d) No person may operate as a direct air carrier without holding appropriate economic authority from the Department of Transportation.

(e) A certificate holder under this part may not operate aircraft under this part in a geographical area unless its operations specifications specifically authorize the certificate holder to operate in that area.

(f) No person may advertise or otherwise offer to perform an operation subject to this part unless that person is authorized by the Federal Aviation Administration to conduct that operation.

(g) No person may operate an aircraft under this part in violation of a remote air carrier certificate, remote operating certificate, or appropriate operations specifications issued under this part.

§108.XX Operations specifications. (From §119.7)

(a) Each remote certificate holder's operations specifications must contain -

(1) The authorizations, limitations, and certain procedures under which each kind of operation, if applicable, is to be conducted; and
(2) Certain other procedures under which each class and size of aircraft is to be operated.

(b) Except for operations specifications paragraphs identifying authorized kinds of operations, operations specifications are not a part of a certificate.

§108.XX Safety Management Systems. (From §119.8)

1. A person applying to the Administrator for a remote air carrier certificate or a remote operating certificate to conduct operations under this part must demonstrate, as part of the application process, that it has an SMS that is acceptable to the Administrator.

§108.XX Use of business names. (From §119.9)

(a) A certificate holder under this part may not operate an aircraft under this part using a business name other than a business name appearing in the certificate holder's operations specifications.

(b) No person may operate an aircraft under this part unless the name of the certificate holder who is operating the aircraft, or the air carrier or operating certificate number of the certificate holder who is operating the aircraft, is legibly displayed on the aircraft and is clearly visible and readable from the outside of the aircraft to a person standing on the ground at any time except during flight time. The means of displaying the name on the aircraft and its readability must be acceptable to the Administrator.

§108.XX Applicability of Operating Requirements to Different Kinds of Operations Under Parts 121, 125, and 135 of This Chapter (From Part 119 Subpart B)
N/A (reference Part 121/125/135 requirements); Deleted

§108.XX Commercial operators engaged in intrastate common carriage and direct air carriers. (From § 119.21)

N/A (reference Part 121/125/135 requirements); Deleted

§108.XX Operators engaged in passenger-carrying operations, cargo operations, or both with airplanes when common carriage is not involved. (From § 119.23)
N/A (reference Part 121/125/135 requirements); Deleted

§108.XX Rotorcraft operations: Direct air carriers and commercial operators. (§ 119.25)
N/A (reference Part 121/125/135 requirements); Deleted

§108.XX General Requirements. (From § 119.33)

(a) A person may not operate as a remote air carrier unless that person -
(2) Obtains a Remote Air Carrier Certificate; and
(3) Obtains operations specifications that prescribe the authorizations, limitations, and procedures under which each kind of operation must be conducted.

(b) A person other than a remote air carrier may not conduct any commercial cargo aircraft operation for compensation or hire under this part unless that person -
(1) Is a citizen of the United States;
(2) Obtains an Operating Certificate; and
(3) Obtains operations specifications that prescribe the authorizations, limitations, and procedures under which each kind of operation must be conducted.

(c) Each applicant for a remote air carrier or remote operating certificate under this part and each applicant for operations specifications authorizing a new kind of operation shall conduct proving tests as authorized by the Administrator during the application process for authority to conduct operations under this part. All proving tests must be conducted in a manner acceptable to the Administrator. All proving tests must be conducted under the appropriate operating and maintenance requirements of this part that would apply if the applicant were fully certificated. The Administrator will issue a letter of authorization to each person stating the various authorities under which the proving tests shall be conducted.

§108.XX Certificate application requirements for all operators. (From § 119.35)

(a) A person applying to the Administrator for a Remote Air Carrier Certificate or Remote Operating Certificate under this part (applicant) must submit an application -
(1) In a form and manner prescribed by the Administrator; and
(2) Containing any information the Administrator requires the applicant to submit.

(b) Each applicant must submit the application to the Administrator at least 90 days before the date of intended operation.

§ 119.36 Additional certificate application requirements for commercial operators.

(a) Each applicant for the original issue of an operating certificate for the purpose of conducting intrastate common carriage operations under this part must submit an application in a form and manner prescribed by the Administrator to the responsible Flight Standards office.

(b) Each application submitted under paragraph (a) of this section must contain a signed statement showing the following:

(1) For corporate applicants:

(i) The name and address of each stockholder who owns 5 percent or more of the total voting stock of the corporation, and if that stockholder is not the sole beneficial owner of the stock, the name and address of each beneficial owner. An individual is considered to own the stock owned, directly or indirectly, by or for his or her spouse, children, grandchildren, or parents.

(ii) The name and address of each director and each officer and each person employed or who will be employed in a management position described in paragraph XX for “Management Personnel”, as applicable.

(iii) The name and address of each person directly or indirectly controlling or controlled by the applicant and each person under direct or indirect control with the applicant.

(2) For non-corporate applicants:

(i) The name and address of each person having a financial interest therein and the nature and extent of that interest.

(ii) The name and address of each person employed or who will be employed in a management position described in paragraph XX for “Management Personnel”, as applicable.

(c) In addition, each applicant for the original issue of an operating certificate under paragraph (a) of this section must submit with the application a signed statement showing -

(1) The nature and scope of its intended operation, including the name and address of each person, if any, with whom the applicant has a contract to provide services as a commercial operator and the scope, nature, date, and duration of each of those contracts.

(d) Each applicant for, or holder of, a certificate issued under paragraph (a) of this section, shall notify the Administrator within 10 days after -

(1) A change in any of the persons, or the names and addresses of any of the persons, submitted to the Administrator under paragraph (b)(1) or (b)(2) of this section.

§108.XX Contents of a Remote Air Carrier Certificate or Remote Operating Certificate. (From § 119.37)

The Remote Air Carrier Certificate or Remote Operating Certificate includes -
(a) The certificate holder's name;
(b) The location of the certificate holder's principal base of operations;
(c) The certificate number;
(d) The certificate's effective date; and
(e) The name or the designator of the responsible Flight Standards office.

§108.XX Issuing or denying a certificate. (From § 119.39)

(a) An applicant may be issued a Remote Air Carrier Certificate or Remote Operating Certificate if, after investigation, the Administrator finds that the applicant -

(1) Meets the applicable requirements of this part;

(2) Holds the economic authority applicable to the kinds of operations to be conducted, issued by the Department of Transportation, if required; and

(3) Is properly and adequately equipped in accordance with the requirements of this chapter and is able to conduct a safe operation under appropriate provisions this part and operations specifications issued under this part.

(b) An application for a certificate may be denied if the Administrator finds that -

(1) The applicant is not properly or adequately equipped or is not able to conduct safe operations under this subchapter;

(2) The applicant previously held a Remote Air Carrier Certificate or Remote Operating Certificate which was revoked;

(3) The applicant intends to or fills a key position listed in paragraph XX for "Management Personnel" with an individual who exercised control over or who held the same or a similar position with a certificate holder whose certificate was revoked, or is in the process of being revoked, and that individual materially contributed to the circumstances causing revocation or causing the revocation process;

(4) An individual who will have control over or have a substantial ownership interest in the applicant had the same or similar control or interest in a certificate holder whose certificate was revoked, or is in the process of being revoked, and that individual materially contributed to the circumstances causing revocation or causing the revocation process; or

(5) That for financial reasons the applicant is not able to conduct a safe operation.

§108.XX Amending a certificate. (From § 119.41)

(a) The Administrator may amend any certificate issued under this part if -

(1) The Administrator determines, under 49 U.S.C. 44709 and part 13 of this chapter, that safety in air commerce and the public interest requires the amendment; or

(2) The certificate holder applies for the amendment and the responsible Flight Standards office determines that safety in air commerce and the public interest allows the amendment.

(b) When the Administrator proposes to issue an order amending, suspending, or revoking all or part of any certificate, the procedure in § 13.19 of this chapter applies.

(c) When the certificate holder applies for an amendment of its certificate, the following procedure applies:

(1) The certificate holder must file an application to amend its certificate with the responsible Flight Standards office at least 15 days before the date proposed by the applicant for the amendment to become effective, unless the administrator approves filing within a shorter period; and

(2) The application must be submitted to the responsible Flight Standards office in the form and manner prescribed by the Administrator.

(d) When a certificate holder seeks reconsideration of a decision from the responsible Flight Standards office concerning amendments of a certificate, the following procedure applies:

(1) The petition for reconsideration must be made within 30 days after the certificate holder receives the notice of denial; and

(2) The certificate holder must petition for reconsideration to the Executive Director, Flight Standards Service.

§108.XX Certificate holder's duty to maintain operations specifications. (From § 119.43)

(a) Each certificate holder shall maintain a complete and separate set of its operations specifications at its principal base of operations.

(b) Each certificate holder shall insert pertinent excerpts of its operations specifications, or references thereto, in its manual and shall -

(1) Clearly identify each such excerpt as a part of its operations specifications; and

(2) State that compliance with each operations specifications requirement is mandatory.

(c) Each certificate holder shall keep each of its employees and other persons used in its operations informed of the provisions of its operations specifications that apply to that employee's or person's duties and responsibilities.

§108.XX Maintaining a principal base of operations, main operations base, and main maintenance base; change of address. (From § 119.47)

(a) Each certificate holder must maintain a principal base of operations. Each certificate holder may also establish a main operations base and a main maintenance base which may be located at either the same location as the principal base of operations or at separate locations.

(b) At least 30 days before it proposes to establish or change the location of its principal base of operations, its main operations base, or its main maintenance base, a certificate holder must provide written notification to its responsible Flight Standards office.

§108.XX Contents of operations specifications. (From § 119.49)

(a) Each certificate holder conducting remote operations must obtain operations specifications containing all of the following:

(1) The specific location of the certificate holder's principal base of operations and, if different, the address that shall serve as the primary point of contact for correspondence between the FAA and the certificate holder and the name and mailing address of the certificate holder's agent for service.

(2) Other business names under which the certificate holder may operate.

(3) Reference to the economic authority issued by the Department of Transportation, if required.

(4) Type of aircraft, registration markings, and serial numbers of each aircraft authorized for use, each operating location to be used in scheduled operations.

(i) Subject to the approval of the Administrator with regard to form and content, the certificate holder may incorporate by reference the items listed in paragraph (a)(4) of this section into the certificate holder's operations specifications by maintaining a current listing of those items and by referring to the specific list in the applicable paragraph of the operations specifications.

(ii) The certificate holder may not conduct any operation using any aircraft or operating location not listed.

(5) Kinds of operations authorized.

(6) Authorization and limitations for areas of operations.

(8) Time limitations, or standards for determining time limitations, for overhauling, inspecting, and checking airframes, engines, propellers, rotors, appliances, and emergency equipment.

(9) Authorization for the method of controlling weight and balance of aircraft.

(11) Aircraft wet lease information, where applicable.

(12) Any authorized deviation and exemption granted from any requirement of this chapter.

(13) An authorization permitting, or a prohibition against, accepting, handling, and transporting materials regulated as hazardous materials in transport under 49 CFR parts 171 through 180.

(14) Any other item the Administrator determines is necessary.

§108.XX Amending operations specifications. (From § 119.51)

(a) The Administrator may amend any operations specifications issued under this part if -

(1) The Administrator determines that safety in air commerce and the public interest require the amendment; or

(2) The certificate holder applies for the amendment, and the Administrator determines that safety in air commerce and the public interest allows the amendment.

(b) Except as provided in paragraph (e) of this section, when the Administrator initiates an amendment to a certificate holder's operations specifications, the following procedure applies:

(1) The responsible Flight Standards office notifies the certificate holder in writing of the proposed amendment.

(2) The responsible Flight Standards office sets a reasonable period (but not less than 7 days) within which the certificate holder may submit written information, views, and arguments on the amendment.

(3) After considering all material presented, the responsible Flight Standards office notifies the certificate holder of -

(i) The adoption of the proposed amendment;

(ii) The partial adoption of the proposed amendment; or

(iii) The withdrawal of the proposed amendment.

(4) If the responsible Flight Standards office issues an amendment to the operations specifications, it becomes effective not less than 30 days after the certificate holder receives notice of it unless -

(i) The responsible Flight Standards office finds under paragraph (e) of this section that there is an emergency requiring immediate action with respect to safety in air commerce; or

(ii) The certificate holder petitions for reconsideration of the amendment under paragraph (d) of this section.

(c) When the certificate holder applies for an amendment to its operations specifications, the following procedure applies:

(1) The certificate holder must file an application to amend its operations specifications -

(i) At least 90 days before the date proposed by the applicant for the amendment to become effective, unless a shorter time is approved, in cases of mergers; acquisitions of operational assets that require an additional showing of safety (e.g., proving tests); changes in the kind of operation as defined in § 110.2; resumption of operations following a suspension of operations as a result of bankruptcy actions; or the initial introduction of aircraft not before proven for use in air carrier or commercial operator operations.

(ii) At least 15 days before the date proposed by the applicant for the amendment to become effective in all other cases.

(2) The application must be submitted to the responsible Flight Standards office in a form and manner prescribed by the Administrator.

(3) After considering all material presented, the responsible Flight Standards office notifies the certificate holder of -

(i) The adoption of the applied for amendment;

(ii) The partial adoption of the applied for amendment; or

(iii) The denial of the applied for amendment. The certificate holder may petition for reconsideration of a denial under paragraph (d) of this section.

(4) If the responsible Flight Standards office approves the amendment, following coordination with the certificate holder regarding its implementation, the amendment is effective on the date the Administrator approves it.

(d) When a certificate holder seeks reconsideration of a decision from the responsible Flight Standards office concerning the amendment of operations specifications, the following procedure applies:

(1) The certificate holder must petition for reconsideration of that decision within 30 days of the date that the certificate holder receives a notice of denial of the amendment to its operations specifications, or of the date it receives notice of an FAA-initiated amendment to its operations specifications, whichever circumstance applies.

(2) The certificate holder must address its petition to the Executive Director, Flight Standards Service.

(3) A petition for reconsideration, if filed within the 30-day period, suspends the effectiveness of any amendment issued by the responsible Flight Standards office unless the responsible Flight Standards office has found, under paragraph (e) of this section, that an emergency exists requiring immediate action with respect to safety in air transportation or air commerce.

(4) If a petition for reconsideration is not filed within 30 days, the procedures of paragraph (c) of this section apply.

(e) If the responsible Flight Standards office finds that an emergency exists requiring immediate action with respect to safety in air commerce or air transportation that makes the procedures set out in this section impracticable or contrary to the public interest:

(1) The responsible Flight Standards office amends the operations specifications and makes the amendment effective on the day the certificate holder receives notice of it.

(2) In the notice to the certificate holder, the responsible Flight Standards office articulates the reasons for its finding that an emergency exists requiring immediate action with respect to safety in air transportation or air commerce or that makes it impracticable or contrary to the public interest to stay the effectiveness of the amendment.

§108.XX Wet leasing of aircraft and other arrangements for transportation by air. (From § 119.53)

(a) Unless otherwise authorized by the Administrator, prior to conducting operations involving a wet lease, each certificate holder under this part authorized to conduct common carriage operations under this subchapter shall provide the Administrator with a copy of the wet lease to be executed which would lease the aircraft to any other person engaged in common carriage operations under this subchapter, including foreign air carriers, or to any other foreign person engaged in common carriage wholly outside the United States.

(b) No certificate holder under this part may wet lease from a foreign air carrier or any other foreign person or any person not authorized to engage in common carriage.

(c) Upon receiving a copy of a wet lease, the Administrator determines which party to the agreement has operational control of the aircraft and issues amendments to the operations specifications of each party to the agreement, as needed. The lessor must provide the following information to be incorporated into the operations specifications of both parties, as needed.

(1) The names of the parties to the agreement and the duration thereof.

(2) The nationality and registration markings of each aircraft involved in the agreement.

(3) The kind of operation (e.g., domestic, flag, supplemental, commuter, or on-demand).

(4) The airports or areas of operation.

(5) A statement specifying the party deemed to have operational control and the times, airports, or areas under which such operational control is exercised.

(d) In making the determination of paragraph (c) of this section, the Administrator will consider the following:

(1) Crewmembers and training.

(2) Airworthiness and performance of maintenance.

(3) Dispatch.

(4) Servicing the aircraft.

(5) Scheduling.

(6) Any other factor the Administrator considers relevant.

(e) Other arrangements for transportation by air: Except as provided in paragraph (f) of this section, a certificate holder under this part operating under this part may not conduct any operation for another certificate holder under this part unless it holds applicable Department of Transportation economic authority, if required, and is authorized under its operations specifications to conduct the same kinds of operations (as defined in § 110.2). The certificate holder conducting the substitute operation must conduct that operation in accordance with the same operations authority held by the certificate holder arranging for the substitute operation.

§108.XX Obtaining deviation authority to perform an emergency operation. (From § 119.57)

(a) In emergency conditions, the Administrator may authorize deviations if -

(1) Those conditions necessitate the transportation of supplies for the protection of life or property; and

(2) The Administrator finds that a deviation is necessary for the expeditious conduct of the operations.

(b) When the Administrator authorizes deviations for operations under emergency conditions -

(1) The Administrator will issue an appropriate amendment to the certificate holder's operations specifications; or

(2) If the nature of the emergency does not permit timely amendment of the operations specifications -

(i) The Administrator may authorize the deviation orally; and

(ii) The certificate holder shall provide documentation describing the nature of the emergency to the responsible Flight Standards office within 24 hours after completing the operation.

§108.XX Conducting tests and inspections. (From § 119.59)

(a) At any time or place, the Administrator may conduct an inspection or test to determine whether a certificate holder under this part is complying with title 49 of the United States Code, applicable regulations, the certificate, or the certificate holder's operations specifications.

(b) The certificate holder must -

(1) Make available to the Administrator at the certificate holder's principal base of operations.

(i) The certificate holder's Remote Air Carrier Certificate or the certificate holder's Remote Operating Certificate and the certificate holder's operations specifications; and

(ii) A current listing that will include the location and persons responsible for each record, document, and report required to be kept by the certificate holder under title 49 of the United States Code applicable to the operation of the certificate holder.

(2) Allow the Administrator to make any test or inspection to determine compliance respecting any matter stated in paragraph (a) of this section.

(c) Each employee of, or person used by, the certificate holder who is responsible for maintaining the certificate holder's records must make those records available to the Administrator.

(d) The Administrator may determine a certificate holder's continued eligibility to hold its certificate and/or operations specifications on any grounds listed in paragraph (a) of this section, or any other appropriate grounds.

(e) Failure by any certificate holder to make available to the Administrator upon request, the certificate, operations specifications, or any required record, document, or report is grounds for suspension of all or any part of the certificate holder's certificate and operations specifications.

(f) In the case of operators conducting intrastate common carriage operations, these inspections and tests include inspections and tests of financial books and records.

§108.XX Duration and surrender of certificate and operations specifications. (From § 119.61)

(a) A Remote Air Carrier Certificate or Remote Operating Certificate issued under this part is effective until -

(1) The certificate holder surrenders it to the Administrator; or

(2) The Administrator suspends, revokes, or otherwise terminates the certificate.

(b) Operations specifications issued under this part are effective unless -

(1) The Administrator suspends, revokes, or otherwise terminates the certificate;

(2) The operations specifications are amended as provided in paragraph XX for Amendment of Certification;

(3) The certificate holder does not conduct a kind of operation for more than the time specified in paragraph XX for Recency of Operations and fails to follow the procedures of paragraph XX for Recency of Operations upon resuming that kind of operation; or

(4) The Administrator suspends or revokes the operations specifications for a kind of operation.

(c) Within 30 days after a certificate holder terminates operations under this part, the operating certificate and operations specifications must be surrendered by the certificate holder to the responsible Flight Standards office.

§108.XX Recency of operation. (From § 119.63)

(a) Except as provided in paragraph (b) of this section, no remote certificate holder may conduct a kind of operation for which it holds authority in its operations specifications unless the remote certificate holder has conducted that kind of operation within the preceding 90 days.

(b) If a certificate holder does not conduct a kind of operation for which it is authorized in its operations specifications within the number of calendar days specified in paragraph (a) of this section, it shall not conduct such kind of operation unless -

(1) It advises the Administrator at least 5 consecutive calendar days before resumption of that kind of operation; and

(2) It makes itself available and accessible during the 5 consecutive calendar day period in the event that the FAA decides to conduct a full inspection reexamination to determine whether the certificate holder remains properly and adequately equipped and able to conduct a safe operation.

§108.XX Management personnel required for operations conducted under this part. (From § 119.69)

(a) Each certificate holder must have sufficient qualified management and technical personnel to ensure the safety of its operations. Except for a certificate holder using only one pilot in its operations, the certificate holder must have qualified personnel serving in the following or equivalent positions:

(1) Director of Operations.

(2) Chief Pilot.

(3) Director of Maintenance.

(b) The Administrator may approve positions or numbers of positions other than those listed in paragraph (a) of this section for a particular operation if the certificate holder shows that it can perform the operation with the highest degree of safety under the direction of fewer or different categories of management personnel due to -

(1) The kind of operation involved;

(2) The number and type of aircraft used; and

(3) The characteristics of the operating environment.

(c) The title of the positions required under paragraph (a) of this section, or the title and number of equivalent positions approved under paragraph (b) of this section shall be set forth in the certificate holder's operations specifications.

(d) The individuals who serve in the positions required or approved under paragraph (a) or (b) of this section and anyone in a position to exercise control over operations conducted under the operating certificate must -

(1) Be qualified through training, experience, and expertise;

(2) To the extent of their responsibilities, have a full understanding of the following material with respect to the certificate holder's operation -

(i) Aviation safety standards and safe operating practices;

(ii) 14 CFR Chapter I (Federal Aviation Regulations);

(iii) The certificate holder's operations specifications;

(iv) All appropriate maintenance and airworthiness requirements of this part; and

(v) The manual required by paragraph XX for Manual Requirements and

(3) Discharge their duties to meet applicable legal requirements and to maintain safe operations.

(e) Each certificate holder must -

(1) State in the general policy provisions of the manual required by paragraph XX for Manual Requirements the duties, responsibilities, and authority of personnel required or approved under paragraph (a) or (b), respectively, of this section;

(2) List in the manual the names and business addresses of the individuals assigned to those positions; and

(3) Notify the responsible Flight Standards office within 10 days of any change in personnel or any vacancy in any position listed.

§108.XX Management personnel: Qualifications for operations conducted under this part. (From § 119.71)

(a) To serve as Director of Operations under paragraph XX for Management Personnel for a certificate holder conducting any operations for which the pilot in command is required to hold an Advanced BVLOS Remote Pilot certificate a person must hold an Advanced BVLOS Remote Pilot certificate and:

(1) Have at least 3 years supervisory or managerial experience within the last 6 years in a position that exercised operational control over commercial UAS operations.

(b) To serve as Chief Pilot under paragraph XX for Management Personnel for a certificate holder conducting any operation for which the pilot in command is required to hold an Advanced BVLOS Pilot certificate a person must hold an Advanced BVLOS Pilot certificate and be qualified to serve as pilot in command in at least one aircraft used in the certificate holder's operation.

(c) To serve as Director of Maintenance under paragraph XX for Management Personnel a person must be a repair technician that has met the qualifications specified by the certificate holder or the aircraft system OEM, hold a mechanic certificate with airframe and powerplant ratings and:

(1) Have 3 years of experience within the past 6 years maintaining UAS, including, at the time of appointment as Director of Maintenance, experience in maintaining the type of UAS as the certificate holder uses.

(d) A certificate holder may request a deviation to employ a person who does not meet the appropriate airmen experience requirements, managerial experience requirements, or supervisory experience requirements of this section if the Manager of the Air Transportation Division, AFS-200, or the Manager of the Aircraft Maintenance Division, AFS-300, as appropriate, find that the person has comparable experience, and can effectively perform the functions associated with the position in accordance with the requirements of this chapter and the procedures outlined in the certificate holder's manual. The Administrator may, at any time, terminate any grant of deviation authority issued under this paragraph.

§108.XX (NEW) Flight supervisory personnel that may be designated for operations conducted under this part.

(a) In the case of certain highly automated systems, responsibility for the operation of more than one aircraft simultaneously may be assigned to a designated Remote Flight Operations Supervisor.

When designated by a Remote Air Carrier certificate holder or a Remote Commercial Operations certificate holder, the Remote Flight Operations Supervisor;

- Must be designated before the flight(s) over which they are assigned responsibility;
- Must have an assigned and specific scope of responsibility that may be defined as a geographic area or through the assignment of a set of specific aircraft registration numbers;
- Is directly responsible for and is the final authority as to the operation of aircraft for which they have been assigned responsibility;
- Ensures that the small, unmanned aircraft will pose no undue hazard to other people, other aircraft, or other property in the event of a loss of control of the small unmanned aircraft for any reason.
- Ensures that the aircraft complies with all applicable regulations of this chapter.

(b) The individuals designated by the certificate holder under paragraph (a)(1) of this section must -

(1) Be qualified through training, experience, and expertise;
(2) To the extent of their responsibilities, have a full understanding of the following material with respect to the certificate holder's operation -
    (i) Aviation safety standards and safe operating practices;
    (ii) 14 CFR Chapter I (Federal Aviation Regulations);
    (iii) The certificate holder's operations specifications;
    (iv) All appropriate airworthiness requirements of this part; and
    (v) The manual required by (reference section number for “Manual Requirements”) and
(3) Discharge their duties to meet applicable legal requirements and to maintain safe operations.

§108.XX (New) Flight supervisory personnel: Qualifications for operations conducted under this part.

(a) To serve as a Remote Flight Operations Supervisor under paragraph XX for Flight supervisory personnel that may be designated for a certificate holder conducting any operation for which a pilot in command is required to hold an Advanced BVLOS Pilot certificate a person must hold an Advanced

BVLOS Pilot certificate and be qualified to serve as pilot in command of at the aircraft used in the certificate holder's operation for which the RFOS has supervisory control, and:

(1) In the case of a person becoming a Remote Flight Operations Supervisor for the first time ever, have at least 2 years' experience, within the past 5 years, as a pilot of more than one aircraft operating simultaneously conducting commercial operations.

(2) In the case of a person with previous experience as a Remote Flight Operations Supervisor, have at least 2 years' experience as pilot of more than one aircraft operating simultaneously conducting commercial operations.

§108.XX Employment of former FAA employees. (From § 119.73)

(a) Except as specified in paragraph (c) of this section, no certificate holder conducting operations under this part may knowingly employ or make a contractual arrangement which permits an individual to act as an agent or representative of the certificate holder in any matter before the Federal Aviation Administration if the individual, in the preceding 2 years -

(1) Served as, or was directly responsible for the oversight of, a Flight Standards Service aviation safety inspector; and

(2) Had direct responsibility to inspect, or oversee the inspection of, the operations of the certificate holder.

(b) For the purpose of this section, an individual shall be considered to be acting as an agent or representative of a certificate holder in a matter before the agency if the individual makes any written or oral communication on behalf of the certificate holder to the agency (or any of its officers or employees) in connection with a particular matter, whether or not involving a specific party and without regard to whether the individual has participated in, or had responsibility for, the particular matter while serving as a Flight Standards Service aviation safety inspector.

(c) The provisions of this section do not prohibit a certificate holder from knowingly employing or making a contractual arrangement which permits an individual to act as an agent or representative of the certificate holder in any matter before the Federal Aviation Administration if the individual was employed by the certificate holder before October 21, 2011.

Subpart F - Operating Requirements: Remote Air Carriers and Remote Commercial Operators

§108.XX Risk Class and Type of Operations

Subpart G - Agricultural Remote Aircraft Operations

(From § 137.1) Applicability.

(a) This part prescribes rules governing -

(1) Agricultural remote aircraft operations within the United States; and

(2) The issue of agricultural remote aircraft operator certificates for those operations.

(b) In a public emergency, a person conducting agricultural remote aircraft operations under this part may, to the extent necessary, deviate from the operating rules of this part for relief and welfare activities approved by an agency of the United States or of a State or local government.

(c) Each person who, under the authority of this section, deviates from a rule of this part shall, within 10 days after the deviation send to the responsible Flight Standards office a complete report of the aircraft operation involved, including a description of the operation and the reasons for it.

(From § 137.3) Definition of terms.

For the purposes of this part -

Agricultural remote aircraft operation means the operation of an aircraft for the purpose of (1) dispensing any economic poison, (2) dispensing any other substance intended for plant nourishment, soil treatment, propagation of plant life, or pest control, or (3) engaging in dispensing activities directly affecting agriculture, horticulture, or forest preservation, but not including the dispensing of live insects.

Economic poison means (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, except viruses on or in living man or other animals, which the Secretary of Agriculture shall declare to be a pest, and (2) any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant.

(From § 137.11) Certificate required.

(a) Except as provided in paragraphs (c) and (d) of this section, no person may conduct agricultural remote aircraft operations without, or in violation of, an agricultural remote aircraft operator certificate issued under this part.

(b) An operator that complies with this part may conduct agricultural remote aircraft operations with a rotorcraft with external dispensing equipment in place without a rotorcraft external-load operator certificate.

(c) A Federal, State, or local government conducting agricultural remote aircraft operations with public aircraft need not comply with this subpart.

(From § 137.15) Application for certificate.

An application for an agricultural remote aircraft operator certificate is made on a form and in a manner prescribed by the Administrator, and filed with the responsible Flight Standards office for the area in which the applicant's home base of operations is located.

(From § 137.17) Amendment of certificate.

(a) An agricultural remote aircraft operator certificate may be amended -

(1) On the Administrator's own initiative, under section 609 of the Federal Aviation Act of 1958 (49 U.S.C. 1429) and part 13 of this chapter; or

(2) Upon application by the holder of that certificate.

(b) An application to amend an agricultural remote aircraft operator certificate is submitted on a form and in a manner prescribed by the Administrator. The applicant must file the application with the responsible Flight Standards office for the area in which the applicant's home base of operations is located at least 15 days before the date that it proposes the amendment become effective, unless a shorter filing period is approved by that office.

(c) The responsible Flight Standards office grants a request to amend a certificate if it determines that safety in air commerce and the public interest so allow.

(d) Within 30 days after receiving a refusal to amend, the holder may petition the Executive Director, Flight Standards Service, to reconsider the refusal.

(From § 137.19) Certification requirements.

(a) General. An applicant for a visual line-of-sight (VLOS) agricultural remote aircraft operator certificate is entitled to that certificate if the applicant meets the requirements of paragraphs (b), (d), and (e) of this section. An applicant for a beyond visual line-of-sight (BVLOS) agricultural aircraft operator certificate is entitled to that certificate if the applicant meets the requirements of paragraphs (c), (d), and (e) of this section. However, if an applicant applies for an agricultural remote aircraft operator certificate containing a prohibition against the dispensing of economic poisons, that applicant is not required to demonstrate the knowledge required in paragraphs (e)(1) (ii) through (iv) of this section.

(b) VLOS operator - pilot. The applicant must hold a current Remote Pilot Certificate with small UAS Rating issued under Part 107 of this chapter.

(c) BVLOS operator - pilots. The applicant must have available the services of at least one person who holds a current U.S. Remote Pilot Certificate with BVLOS rating issued under this Part. The applicant may be the person available.

(d) Aircraft. The applicant must have at least one qualified uncrewed aircraft in a condition for safe operation and equipped for agricultural operation.

(e) Knowledge and skill tests. The applicant must demonstrate, or have the person who is designated as the chief supervisor of agricultural remote aircraft operations demonstrate, that the applicant has satisfactory knowledge and skill regarding agricultural remote aircraft operations, as described in paragraphs (e) (1) and (2) of this section.

(1) The test of knowledge consists of the following:

(i) Steps to be taken before starting operations, including survey of the area to be worked.

(ii) Safe handling of economic poisons and the proper disposal of used containers for those poisons.

(iii) The general effects of economic poisons and agricultural chemicals on plants, animals, and persons, with emphasis on those normally used in the areas of intended operations; and the precautions to be observed in using poisons and chemicals.

(iv) Primary symptoms of poisoning of persons from economic poisons, the appropriate emergency measures to be taken, and the location of poison control centers.

(v) Performance capabilities and operating limitations of the aircraft to be used.

(vi) Safe flight and application procedures.

(2) The test of skill consists of the following maneuvers that must be shown in any of the aircraft specified in paragraph (d) of this section, and at that aircraft's maximum certificated take-off weight, or the maximum weight established for the special purpose load, whichever is greater:

(i) Short-field and soft-field takeoffs (fixed-wing UAS only).

(ii) Approaches to the working area.

(iii) Flare-outs.

(iv) Swath runs.

(v) Pull-ups and turnarounds.

(vi) Rapid deceleration (quick stops) in rotorcraft UAS only.

(From § 137.21) Duration of certificate.

An agricultural remote aircraft operator certificate is effective until it is surrendered, suspended, or revoked. The holder of an agricultural remote aircraft operator certificate that is suspended or revoked shall return it to the Administrator.

(From § 137.23) Carriage of narcotic drugs, marihuana, and depressant or stimulant drugs or substances.

If the holder of a certificate issued under this part permits any aircraft owned or leased by that holder to be engaged in any operation that the certificate holder knows to be in violation of § 91.19(a) of this chapter, that operation is a basis for suspending or revoking the certificate.

(From § 137.29) Operating Rules - General.

(a) Except as provided in paragraphs (d) and (e) of this section, this subpart prescribes rules that apply to persons and aircraft used in agricultural remote aircraft operations conducted under this part.

(b) [Reserved]

(c) The holder of an agricultural remote aircraft operator certificate may deviate from the provisions of part 91 of this chapter without a certificate of waiver, as authorized in this subpart for dispensing operations, when conducting non-dispensing aerial work operations related to agriculture, horticulture, or forest preservation in accordance with the operating rules of this subpart.

(d) Sections 137.31 through 137.35, (From § 137.41, and 137.53 through 137.59 do not apply to persons and aircraft used in agricultural remote aircraft operations conducted with public aircraft.

(From § 137.31) Aircraft requirements.

No person may operate an aircraft unless that aircraft meets the requirements of **§ 108.XX**

(From § 137.33) Carrying of certificate.

(a) No person may operate an aircraft under this Subpart unless a facsimile of the agricultural remote aircraft operator certificate, under which the operation is conducted, is maintained on file by the holder of the agricultural remote aircraft operating certificate. The facsimile shall be presented for inspection upon the request of the Administrator or any Federal, State, or local law enforcement officer.

(From § 137.35) Limitations on VLOS agricultural aircraft operator.

Except when authorized by the administrator, no person may conduct an agricultural aircraft operation under the authority of a VLOS agricultural aircraft operator certificate -

(a) Using an unmanned aircraft weighing 55 pounds or more on takeoff;

(b) In excess of the operating limitations specified in Part 107.51 of this chapter;

(c) Beyond visual line-of-sight; or

(d) Over a congested area.

(From § 137.37) Manner of dispensing.

No persons may dispense, or cause to be dispensed, from an aircraft, any material or substance in a manner that creates a hazard to persons or property on the surface.

(From § 137.39) Economic poison dispensing.

(a) Except as provided in paragraph (b) of this section, no person may dispense or cause to be dispensed from an aircraft, any economic poison that is registered with the U.S. Department of Agriculture under the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 135-135k) -

(1) For a use other than that for which it is registered;

(2) Contrary to any safety instructions or use limitations on its label; or

(3) In violation of any law or regulation of the United States.

(b) This section does not apply to any person dispensing economic poisons for experimental purposes under -

(1) The supervision of a Federal or State agency authorized by law to conduct research in the field of economic poisons; or

(2) A permit from the U.S. Department of Agriculture issued pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 135-135k).

(From § 137.40) Employment of former FAA employees.

(a) Except as specified in paragraph (c) of this section, no certificate holder may knowingly employ or make a contractual arrangement which permits an individual to act as an agent or representative of the certificate holder in any matter before the Federal Aviation Administration if the individual, in the preceding 2 years -

(1) Served as, or was directly responsible for the oversight of, a Flight Standards Service aviation safety inspector; and

(2) Had direct responsibility to inspect, or oversee the inspection of, the operations of the certificate holder.

(b) For the purpose of this section, an individual shall be considered to be acting as an agent or representative of a certificate holder in a matter before the agency if the individual makes any written or oral communication on behalf of the certificate holder to the agency (or any of its officers or employees) in connection with a particular matter, whether or not involving a specific party and without regard to whether the individual has participated in, or had responsibility for, the particular matter while serving as a Flight Standards Service aviation safety inspector.

(c) The provisions of this section do not prohibit a certificate holder from knowingly employing or making a contractual arrangement which permits an individual to act as an agent or representative of the certificate holder in any matter before the Federal Aviation Administration if the individual was employed by the certificate holder before October 21, 2011.

(From § 137.41) Personnel.

(a) Information. The holder of an agricultural remote aircraft operator certificate shall insure that each person used in the holder's agricultural remote aircraft operation is informed of that person's duties and responsibilities for the operation.

(b) Supervisors. No person may supervise an agricultural remote aircraft operation unless the person has met the knowledge and skill requirements of **§ 108.XX.**

(c) Pilot in command. No person may act as pilot in command of an aircraft unless the person holds a pilot certificate and rating prescribed by **§ 108.XX**, as appropriate to the type of operation conducted. In addition, the person must demonstrate to the holder of the Agricultural remote aircraft Operator Certificate conducting the operation that they meet the knowledge and skill requirements of **§ 108.XX**. If the holder of that certificate has designated a person under **§ 108.XX** to supervise his agricultural remote aircraft operations the demonstration must be made to the person so designated. However, a demonstration of the knowledge and skill requirement is not necessary for any pilot in command who -

(1) Is, at the time of the filing of an application by an agricultural remote aircraft operator, working as a pilot in command for that operator; and

(2) Has a record of operation under that applicant that does not disclose any question regarding the safety of his flight operations or his competence in dispensing agricultural materials or chemicals.

(From § 137.43) Operations in controlled airspace designated for an airport.

(a) Except for flights to and from a dispensing area, no person may operate a remote aircraft within the lateral boundaries of the surface area of Class D airspace designated for an airport unless authorization for that operation has been obtained from the ATC facility having jurisdiction over that area.

(b) No person may operate a remote aircraft in weather conditions below VFR minimums within the lateral boundaries of a Class E airspace area that extends upward from the surface unless authorization for that operation has been obtained from the ATC facility having jurisdiction over that area.

(From § 137.45) Nonobservance of airport traffic pattern.

(a) At an airport with an operating control tower, the pilot in command of an aircraft will comply with ATC instructions governing the operation, including geographic or altitude restrictions.

(b) At an airport without a functioning control tower, the pilot in command will:

(1) Coordinate the application operation with the airport management concerned;

(2) Deviations are limited to the agricultural aircraft operation;

(3) Except in an emergency or as specifically authorized by ATC, landing and takeoffs are not made on ramps, taxiways, or other areas of the airport not intended for such use; and

(4) The aircraft at all times remains clear of, and gives way to, aircraft conforming to the traffic pattern for the airport.

(From § 137.51) Operation over congested areas: General.

(a) Notwithstanding part 91 of this chapter, an aircraft may be operated over a congested area at altitudes required for the proper accomplishment of the agricultural remote aircraft operation if the operation is conducted -

(1) With the maximum safety to persons and property on the surface, consistent with the operation; and

(2) In accordance with the requirements of paragraph (b) of this section.

(b) No person may operate an aircraft over a congested area except in accordance with the requirements of this paragraph.

(1) Prior written approval must be obtained from the appropriate official or governing body of the political subdivision over which the operations are conducted.

(2) Notice of the intended operation must be given to the public by some effective means, such as daily newspapers, radio, television, or door-to-door notice.

(3) A plan for each complete operation must be submitted to, and approved by appropriate personnel of the responsible Flight Standards office for the area where the operation is to be conducted. The plan must include consideration of obstructions to flight; the emergency landing capabilities of the aircraft to be used; and any necessary coordination with air traffic control.

(4) Except for helicopters, no person may take off a loaded aircraft, or make a turnaround over a congested area.

(From § 137.53) Operation over congested areas: Pilots and aircraft.

(a) General. No person may operate an aircraft over a congested area except in accordance with the pilot and aircraft rules of this section.

(b) Pilots. Each pilot in command must have at least -

(1) 10 hours of Remote Pilot-in-Command flight time including at least 25 flights operating the make and basic model of the aircraft, which must have been acquired within the preceding 12 calendar months; and

(2) 15 hours of flight experience including at least 50 flights as Remote Pilot in Command in dispensing agricultural materials or chemicals.

(c) Aircraft.

(1) Each aircraft must -

(i) Have been inspected by qualified maintenance personnel designated by the holder of the agricultural remote aircraft certificate IAW the aircraft's approved maintenance manual;

(2) If other than a helicopter, it must be equipped with a device capable of jettisoning at least one-half of the aircraft's maximum authorized load of agricultural material within 45 seconds. If the aircraft is equipped with a device for releasing the tank or hopper as a unit, there must be a means to prevent inadvertent release by the remote pilot or other crewmember.

(From § 137.55) Business name: Commercial agricultural remote aircraft operator.

No person may operate under a business name that is not shown on his commercial agricultural remote aircraft operator certificate.

(From § 137.57) Availability of certificate.

Each holder of an agricultural remote aircraft operator certificate shall keep that certificate at his home base of operations and shall present it for inspection on the request of the Administrator or any Federal, State, or local law enforcement officer.

(From § 137.59) Inspection authority.

Each holder of an agricultural remote aircraft operator certificate shall allow the Administrator at any time and place to make inspections, including on-the-job inspections, to determine compliance with applicable regulations and his agricultural remote aircraft operator certificate.

(From § 137.71) Records: Commercial agricultural remote aircraft operator.

(a) Each holder of a commercial agricultural remote aircraft operator certificate shall maintain and keep current, at the home base of operations designated in his application, the following records:

(1) The name and address of each person for whom agricultural remote aircraft services were provided;

(2) The date of the service;

(3) The name and quantity of the material dispensed for each operation conducted; and

(4) The name, address, and certificate number of each pilot used in agricultural remote aircraft operations and the date that pilot met the knowledge and skill requirements of (From § 137.19(e).

(b) The records required by this section must be kept at least 12 months and made available for inspection by the Administrator upon request.

(From § 137.75) Change of address.

Each holder of an agricultural remote aircraft operator certificate shall notify the FAA in writing in advance of any change in the address of his home base of operations.

(From § 137.77) Termination of operations.

Whenever a person holding an agricultural remote aircraft operator certificate ceases operations under this part, the person shall surrender that certificate to the responsible Flight Standards office last having jurisdiction over his operation.

XIV. Definitions and Glossary of Terms

A. Abbreviations and Acronyms

Abbreviation	Meaning
3GPP	3rd Generation Partnership Project
3PSP	Third-Party USS or Third-Party Service Supplier
AAM	Advanced Air Mobility
AC	Advisory Circular
ADS-B	Automatic Dependent Surveillance-Broadcast
AE	Associated Elements
AFR	Automated Flight Rules
AGL	Above Ground Level
ALR	Acceptable Level of Risk
AMC	Acceptable Means of Compliance
ARC	Aviation Rulemaking Committee
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
B4UFLY	Before you fly
BLUF	Bottom Line Up Front
BVLOS	Beyond Visual Line of Sight
C2	Command and Control
C2CSP	Command and Control Communication Service Provider
CA	Collision Avoidance
CAL	Cybersecurity Assurance Levels
CBO	Community Based Organization
CFR	Code of Federal Regulations
CNPC	Control & Non-Payload Communication

CNS	Communications, Navigation and Surveillance
COA	Certificate of Waiver or Authorization
COTS	Commercial-off-the-shelf
C-UAS	Counter UAS
CV2X	Cellular Vehicle-to-Everything
DAA	Detect and Avoid
DBE	Disadvantaged Business Enterprise
DF	Destructive Factor
DNL	Day-Night Average Sound Level
DOC	Declaration of Compliance
DOS	Denial of Service
ES	External Services
EVLOS	Extended Visual Line of Sight
e-VTOL	Electric Vertical take-off and landing
FAFM	Failover Management
FIMS	Flight Information Management System
FPV	First Person View
GUTMA	Global UTM Association
HSM	Hardware Security Module
ICAO	The International Civil Aviation Organization
IDS/IPS	Intrusion Detection and Prevent Systems
IFR	Instrument Flight Rules
JARUS	Joint Authorities for Rulemaking of Unmanned Systems
LAANC	Low Altitude Authorization and Notification Capability
LSA	Light Sport Aircraft
MEMS	Microelectromechanical systems
MOC	Means of Compliance
MOSAIC	Modernization of Special Airworthiness Certificates
NAS	National Airspace System
NOTAM	Notice To Airmen
NPRM	Notice of Proposed Rulemaking
OEM	Original Equipment Manufacturer
OOP	Operations Over People
OST	Office of the Secretary of Transportation
PDRA	Pre-Defined Risk Assessments
PSP	Partnership for Safety Plan
RFOS	Remote Flight Operations Supervisor
RID	Remote Identification (ID)
ROW	Right of Way (Rules)
RPIC	Remote Pilot in Command
SAC	Special Airworthiness Certificate
SARPs	Standard and Recommended Practices
SDSP	Supplemental Data Service Provider (within a UTM system)
SFRA	Special Flight Rules Area
SGI	Special Government Interest

SIEM	Security Incident and Event Management
SL	Sidelink
SLA	Service Level Agreement
SMS	Safety Management System
SORA	Specific Operational Risk Assessment
STS	Standard Scenarios
TABS	Traffic Awareness Beacon System
TLS	Target Level of Safety
UA	Uncrewed Aircraft
UAS	Uncrewed Aircraft Systems
UASFM	UAS Facility Map
UPP	UTM Pilot Program
USC	United States Code
USS	UAS Service Supplier
UTM	UAS Traffic Management
V2V	Vehicle-to-Vehicle
VFR	Visual Flight Rules
VLOS	Visual Line of Sight

B. Definitions

The following definitions apply specifically within the context of the ARC Final Report and associated documents. All definitions are based on deliberations that occurred through the BVLOS ARC. Other sources are indicated as applies.

#

3GPP. The 3rd Generation Partnership Project (3GPP) is an umbrella term for a number of standards organizations which develop protocols for mobile telecommunications.

A

Associated Elements (AE). Systems and equipment not affixed to the airframe. AE may be provided in the form of a service and may or may not use External Services (ES). Examples include Remote Pilot Station (facilities, equipment, compute devices, other hardware, and software including algorithms, interfaces, and displays); Launch and Recovery Equipment (hardware and software). Command and control links (hardware and software for over the air transmission and data backhaul). Ground-Based Detect and Avoid (ground-based sensors, data links, hardware, and supporting software algorithms, interfaces, and displays).

Approval. Approval, when used with reference to a regulatory endorsement, means approval by the FAA or any person to whom the FAA has delegated its authority in the matter concerned. The FAA affirms approval by letter, stamp of approval, issuance of Operation Specifications (OpSpecs), or some other official means. This affirmation signifies the FAA's or an FAA-delegated person's assessment that the "item at issue" is acceptable and authorized for incorporation and/or use.

Automated Flight Rules (AFR). A concept proposed by this ARC. A set of flight rules that includes parts of current VFR and IFR rules, plus rules that are unique to the safe operation of uncrewed aircraft (UA). Because VFR and IFR rules cannot be fully applied to UAS operations, the need exists to develop new Automated Flight Rules (AFR) to ensure that UAS operators understand the risks to other users operating in the same airspace.

Automation. The use of machines or computers instead of people to perform a task.

Automation Risk Matrix. A risk matrix created by this ARC which classifies risk levels based on the degree of human interface in automated flight operations.

Autonomous Flight System. The autonomous flight system conducts all Control, guidance and navigation, Monitoring, and Communication functions with Airspace Users including ATC.

Autonomous Systems. Systems that have the ability and authority of decision making, problem solving and/or self-governance under possibly bounded, variable or abnormal conditions (Deterministic or Non-deterministic).

B

Beyond Visual Line of Sight (BVLOS). BVLOS is a broad spread of existing and potential UAS operations whose only common factor is the Uncrewed Aircraft (UA) being out of the direct visual line of sight of the remote pilot.

C

Collision Avoidance. The responsibility to avoid a collision with another aircraft.

Command and Control (C2) Links. Logical connection between the uncrewed aircraft and control station for the purpose of safely managing the flight [RTCA Inc. DO-377A, "MASPS for C2 Link Systems Supporting Operation of Uncrewed Aircraft Systems in US Airspace"]

Conformance Monitoring. A service that provides real-time alerting of non-conformance with intended Operation Volume/trajectory to an Operator or another airspace user. [FAA UTM CONOPS V2.0]

Conformance Monitoring USS. A USS qualified by the Administrator to provide Conformance Monitoring services. (USS defined below)

Control Station. (See Remote Pilot Station)

Constraint USS. A USS qualified by the Administrator to provide Constraint services.

Cooperative Aircraft. An aircraft equipped with and transmitting according to 14 CFR Part §91.225 "Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use."

Critical Infrastructure as defined in 42 U.S.C. § 5195c.

D

Day-Night Average Sound Level. A noise metric used by the FAA to reflect cumulative exposure to sound over a 24-hour period. It is expressed as the noise level for the average day of the year on the basis of annual aircraft operations.

Declaration of compliance (DOC). A record submitted to the FAA to attest that all the requirements of the proposed regulation have been met.

Denial of Service (DOS). A Denial of Service is a type of cyber-attack that floods a website or network with malicious traffic with the objective of making the website or network unavailable for normal use.

Destructive Factor (DF). Destructive Factor is a force or influence on a physical body (an aircraft in this situation) which causes physical damage to the aircraft. The level of destructive factor can render the aircraft to remain air-worthy or make it incapable of continuing flight.

Detect and Avoid (DAA) The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action to comply with the applicable rules of flight. [ICAO Definition https://www.icao.int/meetings/uas/documents/circular%20328_en.pdf]

Deterministic. For a given particular input, the system will always produce the same output going through the same states. (See also, Non-Deterministic)

Droneport. An airport or heliport whose physical design characteristics, visual aids, navigation aids, and infrastructure are created to support safe and effective uncrewed aircraft systems operations in and out of densely populated urban areas as well as to and from rural areas.

E

e-VTOL Aircraft. An electric vertical take-off and landing (eVTOL) aircraft uses electric power to hover, take off, and land vertically.

Extended VLOS (E-VLOS). An Uncrewed Aircraft System (UAS) operation whereby the Pilot in Command (PIC) maintains an uninterrupted situational awareness of the airspace in which the UAS operation is being conducted via visual airspace surveillance, possibly aided by technology means. The PIC has a direct control of the UAS at all times. [Source: JARUS]

External Services (ES). Services provided by the government or other entities over which the manufacturer or 3PSP does not have direct control. Examples include: Internet connectivity (ISP), SATCOM, and other data links which may be used to form end-to-end UA command and control links, global positioning and other navigation services, government furnished geospatial data, and existing aviation services such as ADS-B, SSR, and voice radio.

F

Failover Management (FAFM). Failover Management is an Information Technology term and is defined as the capability to seamlessly and automatically switch from a primary to a reliable backup system. For example, an Air Traffic Control information system would require instantaneous failover management to allow Air Traffic Controllers to manage air traffic without any interruptions from their air traffic management systems.

Flight Notification. An indication made in advance of a BVLOS flight operation that alerts other airspace users of the intended operation. This is NOT an ICAO flight plan, but is instead more akin to (and could be) a NOTAM.

Future-Proof. Used in reference to this ARC's rulemaking goals. Ensuring the rule(s) that come from these recommendations remain relevant for as long as possible, in light of evolving technology.

G

General Aviation. Non-commercial aviation activity and non-scheduled commercial aviation activity, including On-Demand operations conducted under 14 CFR Part 135.

Ground-Based Detect and Avoid. One of a UA's potential associated elements (AE's). A ground-based detect and avoid is inclusive of its ground-based sensors, data links, hardware, and supporting software algorithms, interfaces, and displays.

H

High AFR. A volume of airspace above 400' AGL, but below 14,500' MSL that is inside Class G airspace and outside of the horizontal extents of Class B, C, D and E airspace (i.e., Class G below those classes) and outside the Mode C veil of a primary Class B airport. (Also see Low AFR and Automated Flight Rules (AFR)).

Hardware Security Module (HSM). A physical device which provides added data security protection to information stored on the device. The protection may include data encryption as well as added physical security such as bomb proofing a storage enclosure.

Human-in-the-Loop. A method of system control in which a human is directly providing inputs and evaluating outputs to manage system parameters. (Also see Human-off-the-Loop and Human-on-the-Loop)

Human-off-the-Loop. A method of system control in which no human is monitoring the system control. A machine provides inputs and evaluate outputs to manage system parameters. (Also see Human-**in**-the-Loop and Human-**on**-the-Loop)

Human-on-the-Loop. A method of system control in which a human is monitoring a machine which provides inputs and evaluates outputs to manage system parameters. The human may take over the control at any point (come into the loop). (Also see Human-**in**-the-Loop and Human-**off-**the-Loop)

I

Intrusion Detection and Prevent Systems (IDS/IPS). Intrusion Detection (IDS) is part of information technology network infrastructure. IDS analyzes and monitors a network for signs of a cyber-attack. An Intrusion Prevention System (IPS) works in concert with an IDS and provides the automated function to deny network access to a known security threat (as defined by the IDS).

L

Launch and Recovery Equipment. One of an Uncrewed Aircraft's potential associated elements. Launch and recovery equipment is inclusive of its hardware and software

Low AFR. A volume of airspace below 400' above the ground, and within Class G airspace below 400' AGL which is coupled with automated flight rules covering the UAS and operations conceived utilizing low altitude BVLOS. Low AFR does not include the airspace immediately above and around an uncontrolled airport in Class G airspace. (Also see High AFR and Automated Flight Rules (AFR))

M

Manufacturer. Under an uncrewed aircraft (UA) type and/or production certification program: a person (as defined by 14 CFR 1.1) that is an Applicant seeking UAS approval of a specific aircraft, aircraft component, or installation, as defined by "The UAS And Industry Guide to Product Certification". For associated elements (AE) and for UA not under a UA type and/or production certification program: a person (as defined by 14 CFR 1.1) who manufactures a product or has a product designed or manufactured; and markets that product under their name or trademark. A manufacturer may produce UA, or AE, or may produce a UAS. Under appropriate agreements, and unless otherwise prohibited, a manufacturer may integrate combinations of UA and AE produced by other manufacturers to produce a UAS.

Means of Compliance (MOC). A detailed design standard that, if met, accomplishes the safety intent of the regulation, is used to show compliance with regulations, and accepted by the Administrator. A means of compliance is one method, but not the only method, to show compliance with a regulatory requirement.

Methods of Compliance. A description of how compliance will be shown (e.g., ground test, flight test, analysis, similarity, etc.). The description of the method of compliance should be sufficient to determine that all necessary compliance-related data will be collected, and all findings can be made.

Microweather. Specialized weather data provided to enable reduce the risk of adverse weather for low altitude operations of UAS.

N

Network Remote Identification Service. A capability designed to provide certain identification, location, and performance information for the UA, and location information for operator. This is achieved by leveraging network services, such as cellular technology that people on the ground and other airspace users can receive.

Non-Cooperative Aircraft. An aircraft that is not equipped with and transmitting according to 14 CFR Part §91.225 "Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use."

Non-Deterministic. For the same input, the system may produce different output in different circumstances. (See also, Deterministic)

O

Obstacle. Any object of natural growth, terrain, or permanent or temporary construction or alteration, including equipment or materials used and any permanent or temporary apparatus. [14 CFR Part 77, "Subpart C - Standards for Determining Obstructions to Air Navigation or Navigational Aids or Facilities, § 77.13 Applicability"]

Operational Mitigation. Risk mitigation strategies designed to reduce the effects of hazards associated with an aircraft and/or Operator that are required to obtain and operating certificate. (e.g., flight crew and maintenance training

Operational Planning and Flight Authorization. A capability (or service) that confirms that submitted operational intent: complies with airspace restrictions and constraints based on authoritative sources of airspace information and the capabilities of the UAS; avoids dynamic constraints from certified constraint management services; and resolves conflicts between operational intents of other BVLOS operations as provided by certified strategic deconfliction services.

Operational Planning USS. A USS qualified by the FAA Administrator to provide services to support operational planning and flight authorization to UAS operators.

Operation Risk Matrix. A Matrix created by the BVLOS ARC based on strategic and technical air and ground risk mitigations applied to UAS operations.

Operator. Modified from 14 CFR Part 1.1, *Definitions and Abbreviations*: "A person who uses, causes to use or authorizes to use aircraft, for the purpose (except as provided in § 91.13 of this chapter) of air navigation including the piloting of aircraft, with or without the right of legal control (as owner, lessee, or otherwise).

Ownship. Ownship is a term used in a Detect and Avoid scenario to define which aircraft the pilot is operating, and which aircraft is being detected. For example, my ownship detected a crewed aircraft through my on-board ADS-B and I was able to take evasive action with plenty of time to continue to fly with a well clear distance between the two aircraft.

P

Preventing Emerging Threats Act. House Resolution (H.R.) 6401 Formal title is the "Preventing Emerging Threats Act of 2018." To assist the Department of Homeland Security in preventing emerging threats from [uncrewed] aircraft and vehicles, and for other purposes.
https://www.congress.gov/bill/115th-congress/house-bill/6401/text?q=%7B%22search%22%3A%5B%22hr+6401%22%5D%7D&r=1

Pilotage. Navigation by visual reference to landmarks or in the case of UAS by remote or electronic means.

R

Remote Identification (RID). (See UAS Remote Identification)

Remote ID USS. A USS qualified by the Administrator to provide remote identification services.

Remote Flight Operations Supervisor (RFOS). An individual designated by a holder of a Remote Operating Certificate or a Remote Air Carrier Certificate that has authority over, and is responsible for, the operation of multiple aircraft by the certificate holder. An RFOS must meet the experience requirements of this subpart, and be qualified and current as an Advanced BVLOS Remote Pilot in Command in order to perform these duties.

Remote Pilot Stations. "The station at which the remote pilot manages the flight of an [uncrewed] aircraft." [ICAO Definition https://www.icao.int/meetings/uas/documents/circular%20328_en.pdf] One of a UA's potential associated elements (AE's). A remote pilot station i**ncludes facilities, equipment, compute devices, other hardware, and software including algorithms, interfaces, and displays.**

Right of Way. The Right of Way is defined as a set of rules informing pilots what action to take to maintain well clear distances from other aircraft. Right of Way normally includes "Yielding Right of Way" meaning which aircraft should yield and which aircraft may continue on its heading.

Risk Classes. Classes of risk determined by this ARC, based on the maximum kinetic energy of the UAS.

U

UAS Flight Authorization Service. A strategic deconfliction tool. It ensures that UAS operations are free of intersection in space and time with any other notified UAS flight authorization within the same portion of airspace. The service does not cover authorizations provided by competent authorities such as national and local authorities in controlled airspace.

UAS Remote Identification (ID). Remote identification (commonly known as Remote ID) is the capability of an uncrewed aircraft in flight to provide certain identification, location, and performance information that people on the ground and other airspace users can receive. https://www.federalregister.gov/documents/2021/01/15/2020-28948/remote-identification-of-unmanned-aircraft **(Also seen as Remote Identification or Remote ID)**

Uncrewed Aircraft (UA). The airframe and all onboard systems and equipment affixed to the airframe. Examples include the propulsion, electrical, fuel, GNC (autopilot, FMS, sensors), and C2 systems including all hardware and firmware/software.

Uncrewed Aircraft Systems (UAS). means an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft) that are required for the operator to operate safely and efficiently in the national airspace system.

Uncrewed Aircraft System Service Supplier (USS). A USS is a person (as defined by 14 CFR 1.1) qualified by the Administrator to provide Associated Element or Supplemental Data provided as a service to uncrewed aircraft systems.

UAS Traffic Management (UTM). A set of automated functions and digital services designed to support safe, efficient, and secure access to airspace for UAS. A list of 3PSP UTM services is provided in Table 2 "PART 14 CFR § 91.xxx (or new UAS BVLOS operating rule) – UAS Service Supplier performance requirements.

S

Safe Harbor Rule. Would potentially allow the agency to specify a particular technology or standard that is automatically deemed compliant (unless proven otherwise) while still allowing for alternative compliances now (and in the future).

SDSP. Supplemental Data Service Providers (SDSP) as described in UTM CONOPS 2.0 reference: UAS Traffic Management 2.0, https://www.faa.gov/uas/research_development/traffic_management/media/UTM_CONOPS_v2.pdf. [Phase I Report]

Shielded Area. Shielded Area is a volume of airspace that includes 100’ above the vertical extent of an obstacle or critical infrastructure and is within 100 feet of the lateral extent of the same obstacle or critical infrastructure as defined in 42 U.S.C. § 5195c. A Shielded Operation is a UAS BVLOS operation within a Shielded Area.

Service level agreement (SLA). The agreement between the 3PSP and the UAS operator covering the safety, performance, service area and security of the 3rd Party UAS Service provision as required for the UAS operator’s intended operations.

Strategic Deconfliction USS. A USS qualified by the FAA Administrator to provide Strategic Deconfliction services. A capability (or service) that discovers the operational intents of UAS in a designated area of interest, detects conflicts between relevant operational intents, notifies the relevant operators when a conflict is detected or when an owning USS receives notification that a conflict has been detected, results in the resolution of conflicts between operational intents prior to flight, makes own operational intent with details discoverable by authorized services.

Strategic Mitigation. Mitigation strategies designed to reduce the effects of hazards prior to flight (e.g., operations restricted from being conducted over densely populated areas) (See also Technical Mitigation)

Supplemental Data. USSs data elements of operation intent (e.g., Operation Volume(s) location and entry/exit times) to enable automatic distribution of spatially and temporally relevant advisories, constraints, weather, and data relevant to planning and flight execution needs.

Sustained Operations (with regard to flight over people). Sustained operations with regard to flight over people includes hovering above people or a person, flying back and forth over people or a person, or circling above people in such a way that the small uncrewed aircraft remains above some portion of the person or persons. Sustained flight over people does not include a brief, transitory route over people or a person. [Source: modified language from the Operations Over People Rule, Preamble https://www.faa.gov/sites/faa.gov/files/2021-08/OOP_Final%20Rule.pdf] (See also, Transient Operations)

Systems. When used in the phrase 'aircraft and systems' means the Uncrewed Aircraft and the Associated Elements.

T

TABS. Traffic Awareness Beacon System equipment that conforms to FAA TSO C-199 for aircraft that are not currently required to have ADS-B under 14 CFR § 91.225

Technical Mitigation. Mitigation strategies designed to reduce the effects of hazards associated with technical system states such as software and hardware. Strategic mitigations reduce risk prior to flight, while Technical mitigations reduce risk inflight.

Third Party Service (3PS). An Associated Element or Supplemental Data provided as a service to a UAS operator. This could include command and control links, GBSAA, or other services such as launch and recovery automation, remote pilot stations, or dispatch automation of a mixed fleet of Uncrewed Aircraft.

Third Party Service Provider (3PSP). A person (as defined by 14 CFR 1.1) that is not an applicant, as defined by the FAA and Industry Guide to Product Certification", offering 'services and/or AE as a Third-Party Service to a UAS operator.

Traditional Aircraft. Aircraft that are addressed by the FAA aircraft certification regulations and policy that exist as of the writing of this report.

Traffic Information Service. A service that informs UAS operators about other air traffic (both crewed and uncrewed) that may be present in proximity to their UAS.

Transient Operations (with regard to flight over people). As opposed to sustained operations. Transient operations, transient flight over people, is a brief, transitory route flight over people of a person.

Transient Operations are merely incidental to a point-to-point operation unrelated to the people or a person. [Source: modified language from Operations Over People Rule, Preamble https://www.faa.gov/sites/faa.gov/files/2021-08/OOP_Final%20Rule.pdf] (See also, Sustained Operations)

V

Visual Line-of-Sight (VLOS) Operation. An operation in which the remote crew maintains direct visual contact with the aircraft to manage its flight and meet separation and collision avoidance responsibilities. [ICAO Definition https://www.icao.int/meetings/uas/documents/circular%20328_en.pdf]

Appendix A – Future Considerations

In the course of its deliberations, the ARC identified certain issues that should be considered for rulemaking initiatives, but were beyond the ARC's purview. The issues listed below are topics that future ARCs should address. Much of the information was developed by Phase 2 Working Group 2.5 as part of their analysis of Automated Flight Rules to facilitate BVLOS operations.

1. Droneports

Operations near airports in Class G airspace will be necessary and vital as UA operations expand, including within the Mode C veil and under the controlled airspace. The ARC encourages the FAA to examine public airport and published heliport integration for UAS.

2. Air Traffic Control Services for Uncrewed Aircraft

Although out of scope, the ARC considers that as AFR operations expand in the future, the ATC system will need to evolve to accommodate the expected mix of crewed and uncrewed aircraft in the NAS.

3. First Person View

FPV technology has advanced dramatically over the last five years, and FPV is expanding beyond recreational use. The FAA should consider FPV regulations that are suitable for the missions and consistent with this ARC's recommendations. For example, aircraft type certification should not be required where the pilot is manually controlling the FPV UAS. However, type certified aircraft, pilot certification, and some type of practical testing could be considered as the mission complexity and risks increase. A robust regulatory regime will help to accelerate innovation, improve safety, and optimize productivity.

4. Operations – Non-Compliance

Volume 14 of FAA Order 8900.1 covers the Flight Standards Compliance and Enforcement policies and procedures. The ARC did not identify any reasons to change the language, policies, and procedures currently being used for traditional aviation. If a UA or GA operator does something that poses a safety risk, they should be held responsible for any consequences of that action. However, the ARC encourages the FAA and the states to consider requirements for aviation liability insurance.

5. Urban Air Mobility (UAM)

UAM is beyond the scope of the ARC, but the ARC recognizes the significant attention that UAM is receiving from FAA and Congress, and recognizes that UAS and UAM could present some complementary regulatory policy issues.

Appendix B - Recommendation List

Air & Ground Risk Recommendations

	Air & Ground Risk Recommendations	Recommendation Intent
AG 2.1	The acceptable level of risk (ALR) for UAS should be consistent across all types of operations being performed, and no more restrictive than the accepted fatality rates of general aviation.	The expectation is that operators will be able to meet the UAS ALR through qualitative or quantitative methods, or a hybrid approach. This is similar to existing Safety Management System constructs where a value is assigned and both qualitative and quantitative approaches can be used to demonstrate compliance.
AG 2.2	The rules should be predicated on the risks of operation based on UA capability, size, weight, performance, and characteristics of the operating environment as opposed to the purpose of the operation.	To base the FAA's framework for managing air and ground risk on the characteristics of the operating environment rather than distinguishing between operations for different purposes, establishing a scheme that can greatly reduce the number of persons exposed to risk by broadly regulating how operations are conducted.
AG 2.3	BVLOS operations to the greatest extent possible should be allowed to occur through compliance with the regulation alone without the need for a waiver or exemption.	As much as possible, the rule should allow BVLOS operations to occur solely through compliance with requirements outlined in the rule itself, rather than requiring those conducting operations to navigate the process of obtaining waivers or exemptions.
AG 2.4	The FAA should encourage voluntary reporting in accordance with the UAS Aviation Safety Reporting System (ASRS).	To collect data to provide a quantitative framework for qualitative and comparative analysis. Reporting via existing processes, such as the ASRS, already protects against punitive purposes.
AG 2.5	The rule should enable carriage of hazardous materials beyond the specified quantities (per OQ 2.19). Carriage of hazardous materials beyond the specified quantities of OQ 2.19 shall have appropriate mitigations, as established via a performance-based industry consensus standard that is proportionate to the risk of the operation.	To develop HAZMAT rules that reflect the specific characteristics of UAS BVLOS operations, including factors that mitigate risk, such as the relatively low quantities of HAZMAT that UA can carry and the absence of humans onboard, while incorporating sufficient protections to guard against relevant risks.
AG 2.6	The rule should allow UAS to conduct transient flight over people. The rule should allow sustained flight over non-participants with strategic and/or technical mitigations applied.	To allow transient flight over people and sustained flight over non-participants in circumstances that reflect mitigated risks, such as when people are sheltered, using PPE, or aware of the risks from the flight. The selection of risk mitigation methods (strategic, technical or a combination of both) used to meet the ALR

		should be left to the UAS operator based on the environment and system performance.
AG 2.7	The rule should be based on a minimum capability needed to safely perform the operation, not a minimum equipment list.	The rule should focus on identifying a minimum capability needed to safely perform UAS BVLOS operations rather than on establishing equipage requirements which may be prohibitive for some UAS.
AG 2.8	The FAA should develop pathways to support innovation and accommodate emerging technology. The FAA should give consideration to approvals for low-risk Research and Development initiatives.	To leverage R&D activities and provide the FAA with critical information in areas such as Detect and Avoid, UAS Communications, Human Factors, System Safety, and Certification, all of which will aid in the FAA's efforts to safely integrate UAS into the NAS.
AG 2.9	The FAA should incorporate uncrewed aviation into existing surveys or deploy a survey similar to the General Aviation and Part 135 Activity Survey.	To allow the FAA to capture safety information and develop a set of safety metrics, the ARC intends to ensure that data collected via the existing processes reflects uncrewed aviation activities.

Flight Rules Recommendations

	Flight Rules Recommendations	**Recommendation Intent**
FR 2.1	The FAA should amend Part 91.113 (b) to allow a range of sensing methodologies and clarify adequate separation.	To change 'see and avoid' to 'detect and avoid' to allow all aircraft to utilize technical or non-technical means to detect other aircraft. Replace 'see and avoid' with 'detect and avoid' and remove the phrase 'well clear' and replace it with 'adequate separation'.
FR 2.2	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400') yield right of way to crewed aircraft equipped with ADS-B or TABS and broadcasting their position.	To give crewed aircraft equipped and broadcasting with ADS-B or TABS right of way over UA in low altitude Non-Shielded Areas.

FR 2.3	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400') have right of way over crewed aircraft that are not equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.	To give UA right of way over crewed aircraft that are not equipped with an ADS-B or TABS in low altitude Non-Shielded Areas.
FR 2.4	The FAA should amend FAR Rule Part 91.113(d) to give UA Right of Way for Shielded Operations	To maximize the use of shielded areas for UA operations and reduce GA accidents and fatalities that occur when crewed aircraft conduct missions in shielded areas.
FR 2.5	Pilots should be educated to associate obstacles and structures along their flight path with uncrewed flight operations to increase situational awareness during both preflight planning and actual operations.	To leverage existing training practices for low altitude flight operations to reduce the risk of collision between UA and GA and safely integrate UA in low altitude operations.
FR 2.6	The FAA should revise §91.103 to include a new part (c) to accommodate UA operations.	To amend existing regulations to create references to Automated Flight Rules (AFR) as required.
FR 2.7	The FAA should amend § 91.119 to allow UA operations below the Minimum Safe Altitude restrictions	To allow operations below current minimum safe altitudes to accommodate Shielded and Non-Shielded Low Altitude UAS Operations.
FR 2.8	The FAA should amend FAR Rule Part 107.31 to include Extended Visual Line of Sight	This technical modification to Part 107 allows for operations where a RPIC does not see the UAS, but a trained crewmember has situational awareness of the airspace around the UAS.
FR 2.9	The FAA should amend FAR Rule Part 107.33 to allow a visual observer to assist and support BVLOS operations	To allow a visual observer to assist and support BVLOS operations and describe visual observer roles and responsibilities

Aircraft & Systems Recommendations

	Aircraft and Systems Recommendations	Recommendation Intent
AS 2.1	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of uncrewed aircraft and systems. The rule should be applicable to uncrewed aircraft up to 800,000 ft-lb of kinetic energy in accordance with the Operating Environment Relative Risk Matrix.	To establish a new alternative regulatory pathway for qualification of uncrewed aircraft and systems to enable commercial BVLOS operations offering clear public benefit in operating environments where the oversight of the type and production certification process will not provide additional safety benefit.
AS 2.2	The new BVLOS rule should address Maintenance, Repair, and Modifications of UA.	To ensure the continued safe operation of UA and serviceability of Associated Elements (AE) is the function of maintenance, repair, and modifications performed throughout the service life of the UAS. The responsibilities between OEM/integrator and operators should be clear and enable safety and efficiency.
AS 2.3	The new BVLOS rule should address software qualification for UA and AE.	To establish software qualification requirement for UA and AE appropriate for the level of risk.
AS 2.4	The new rules should include UA noise certification requirements appropriate to the operating environment. Compliance should be demonstrated through a simple testing methodology.	To address noise certification requirements for UA.
AS 2.5	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of the associated elements of an uncrewed aircraft system.	To establish a process for qualification of the associated elements of an uncrewed aircraft system.
AS 2.6	The new rule should define who must make a declaration of compliance.	To ensure the rule accommodates market organization.
AS 2.7	Establish a new Special Airworthiness Certification for the UAS category under Part 21.	To create a regulatory framework for UA that is similar to that of Light-Sport Category aircraft using an FAA accepted declaration of compliance to an FAA-accepted means of compliance, which includes industry standards.

AS 2.8	The FAA should establish a Repairperson Certification for the UAS Category to perform inspection, maintenance, and repair of UAS holding SAC under this proposed rule.	To ensure repairpersons are adequately trained and define the scope of their privileges.
AS 2.9	Recommend exemption from Production Certification requirements IF TC applicants declare compliance to the LSA standard for a quality system.	Production Certification should be tailored to various levels of complexity and applicants.
AS 2.10	The FAA should consider allowing third party test organizations to audit compliance.	To develop a method of ensuring conformity and assessing compliance to standards. Audits should be commensurate with risk and not unduly burdensome.

Operator Qualifications Recommendations

Operator Qualifications Recommendations		Recommendation Intent
OQ 2.1	The FAA create a new 14 CFR Part that governs UAS BVLOS Pilot and Operator certification requirements and operating rules.	The FAA should create a new rule Part that governs UAS BVLOS Pilot and Operator certification requirements and operating rules.
OQ 2.2	The FAA adopt the categories defined in the Automation Matrix for BVLOS training and qualification requirements.	The FAA should adopt the four levels of automation (defined in the Automation Matrix) as a framework for BVLOS training and qualification requirements, allowing tailored training programs that focus on functions that the pilot has the ability to control or affect through the system.
OQ 2.3	The FAA modify 14 CFR Part 107 to enable limited BVLOS operations under the existing Remote Pilot with Small UAS Rating certificate.	The FAA should modify 14 CFR Part 107 to enable limited BVLOS operations for holders of a Part 107 Remote Pilot certificate with Small UAS Rating.

OQ 2.4	The FAA expand the knowledge test for the 14 CFR Part 107 Remote Pilot Certificate with Small UAS Rating to cover topics associated with EVLOS and shielded UAS operations	As limited BVLOS capabilities are enabled under the Part 107 Remote Pilot Certificate with Small UAS Rating, the associated knowledge test should be expanded to cover additional topics associated with limited BVLOS operations.
OQ 2.5	The FAA establish a new BVLOS rating for the Remote Pilot certificate under the new 14 CFR Part.	To create a new level of pilot certification that sets knowledge and examination requirements for conducting UAS BVLOS operations beyond the scope of Part 107 limited BVLOS.
OQ 2.6	The FAA's required UAS pilot knowledge areas and skills for the BVLOS rating should include the knowledge areas required by the FAA for the 14 CFR Part 107 Remote Pilot certificate.	After an extensive review and comparison, the ARC recommends that the existing knowledge areas required by the FAA in the 14 CFR Part 107 Remote Pilot examination be incorporated into the requirements for the BVLOS Rating.
OQ 2.7	The BVLOS rating process should incorporate additional knowledge and examination areas to support advanced BVLOS and 1-to-many operations.	The ARC recommends that the training and qualification areas and thresholds for the BVLOS rating reflect the different use cases, capabilities and operational concepts that are unique to operations enabled under the new rule Part. The ARC further recommends that these qualification areas and thresholds recognize and provide for the need to conduct multiple simultaneous (a.k.a. "1-to-many") UAS BVLOS operations at higher levels of automation.
OQ 2.8	The FAA provide both direct and progressive paths to achieving the Remote Pilot Certificate with BVLOS rating.	To provide tailored paths to achieving the Remote Pilot with BVLOS rating for both currently certificated Remote Pilots and new applicants.
OQ 2.9	Remote Pilots certificated under Part 107 that have completed a BVLOS training program certified by a public aircraft operator entity (as defined in 14 CFR Part 1) should be able to receive their BVLOS rating via online training, similar to the existing Part 107 certification pathway for current Part 61 pilots.	To provide an alternative pathway to the BVLOS rating for Part 107 certificated Remote Pilots with a Small UAS rating who have completed a BVLOS training program certified by a public entity.

OQ 2.10	UAS BVLOS guidance and advisory materials should establish a clear and traceable path for operational control and specific training/qualification/currency requirements.	The ARC intends to ensure that, for each operational construct within the scope of the BVLOS rule, there is a clear designation of the individual(s) who is/are the final authority and hold ultimate responsibility for the conduct of the UAS flight.
OQ 2.11	Create two levels of Operating Certificates for commercial UAS operations: a Remote Air Carrier certificate and a Remote Commercial Operating certificate.	To establish two levels of Operating Certificates to exercise economic authority for certain flight operations conducted for compensation or hire: a Remote Air Carrier certificate and a Remote Operating certificate.
OQ 2.12	Set threshold requirements for certain UAS BVLOS operations beyond which a Remote Air Carrier Certificate or Remote Operating Certificate is required.	To require that UAS operators who exceed certain threshold requirements hold a Remote Operating Certificate or Remote Air Carrier Certificate, as appropriate, to conduct operations at higher pilot-to-aircraft ratios or above designated takeoff weight.
OQ 2.13	Create Operating Requirements that govern Remote Air Carrier and Remote Operating certificate holders.	To establish a set of operating requirements in the new rule that delineate specific requirements for operation under the respective operating certificates.
OQ 2.14	Create Certification and Operating Requirements that govern Agricultural Remote Aircraft Operations.	Establish as set of certification criteria and operating requirements that govern Agricultural Remote Aircraft Operations.
OQ 2.15	For UAS Operating Certificate holders, create a designated position authorized under the New Part that exercises operational control and ultimate responsibility for 1-to-many BVLOS flights conducted under their supervision.	The ARC recommends the development of rules that are proportionate to the level of automation in the UA system and the pilot's ability to exercise operational control. For UAS Operating Certificate holders, the ARC recommends a new designated position authorized under the new rule part that exercises operational control and ultimate responsibility for 1-to-many BVLOS flights conducted under their supervision.
OQ 2.16	The FAA should develop tailored medical qualifications for UAS pilots and other crew positions that consider greater accessibility and redundancy options available to UAS.	To redefine medical requirements for UAS crew, opening the door for extensive contributions by people who would otherwise be disqualified from piloting a crewed aircraft.

OQ 2.17	Remote Pilots (regardless of rating) are expressly authorized to act as Remote Pilot in Command of an uncrewed aircraft operated for compensation or hire.	To enable Remote Pilots to act as RPIC of aircraft that are conducting operations for compensation or hire, regardless of whether they are employed by or associated with an entity holding a higher-level commercial operating certificate.
OQ 2.18	The intent of the ARC is that the privileges and limitations of the final BVLOS rule will be available to all aircraft operating under this rule, including public agency operations.	To ensure that public aircraft operators may take full advantage of the opportunity to conduct BVLOS operations as provided in the final rule.
OQ 2.19	Allow only appropriately vetted UAS operators that are approved by the relevant authority to conduct operations deemed to be a higher security risk.	During Phase 1, the ARC's Security and Industry Needs Subgroups recommended that BVLOS regulations should include a path for developing a "Trusted Operator" program to enable authorization to conduct higher-security risk operations, enact differentiated privacy standards, or other potentially sensitive BVLOS capabilities. Under the proposed construct, Trusted (or "Known") Operators would undergo a more stringent vetting process than the FAA currently employs as part of the award of a pilot or maintainer certificate.
OQ 2.20	The FAA provide an exception to the restrictions and requirements for carriage of specified quantities of hazardous materials for delivery by holders of a Remote Air Carrier or Remote Operating Certificate.	To allow carriage of limited quantities of certain hazardous materials via UA by holders of a Remote Air Carrier or Remote Operating Certificate.

Third Party Services Recommendations

	Third Party Services Recommendations	Recommendation Intent

TP 2.1	The FAA should adopt a regulatory scheme for third party services to be used in support of UAS BVLOS.	To adopt a comprehensive regulatory scheme for third party service equipment and service providers, and establish a 3PSP certificate for compliant service providers. The certificate would be awarded based on a declaration of compliance from the 3PSP that they meet the requirements of an FAA accepted MOC or other acceptable industry standard. I
TP 2.2	The FAA and NASA should conduct a study to determine what level of aircraft operations in a defined volume of the airspace would trigger the need for mandatory participation in federated or third-party services.	To ensure that any future rulemaking that requires a Third-Party Service are based on data that justifies the cost vs. the benefits.

Environmental Recommendations

	Environmental Recommendations	Recommendation Intent
ER 2.1	As the FAA reviews the BVLOS Rule, the ARC recommends the FAA determine that the BVLOS Rule is unlikely to result in significant impact to the environment.	To avoid the undue delay, cost and burden associated with an extensive environmental review under NEPA for operations that do not have a significant impact on the environment. The ARC does not find it reasonably foreseeable that a BVLOS Rule would lead to significant impacts in any of the relevant environmental impact categories specified in FAA Order 1050.1F.
ER 2.2	NEPA review of the BVLOS rule must be timely and programmatic in scope.	In the absence of significant impacts to the environment, the facts support a streamlined environmental review. Process considerations support a similar result.
ER 2.3	Environmental reviews should not be required for individual BVLOS operations enabled by the Rule.	The ARC seeks to avoid any requirement that environmental reviews be required for individual BVLOS approvals conducted under the rule.

ER 2.4	The FAA should provide an interim pathway to enable BVLOS operations in the near term, pending finalization of the BVLOS Rule.	Promote the approval of BVLOS operations to expedite the realization of the environmental benefits while the rulemaking process remains ongoing.
ER 2.5	The FAA interpret NEPA in a way that expedites the BVLOS rulemaking. If the FAA concludes that it is required to implement NEPA in such a way that would substantially delay either the BVLOS rulemaking or BVLOS operations, the ARC recommends asking Congress to consider legislative actions.	To adhere to the purpose and requirements of NEPA while avoiding unnecessary delay in approving environmentally friendly UAS operations for the benefit of the American public.

General Recommendations

	General Recommendations	Recommendation Intent
GP 2.1	The DOT and the FAA should assess and evaluate societal benefits from UAS BVLOS operations broadly and consider categories and types of benefits that are not easily quantifiable. This includes a holistic and comprehensive analysis of the environmental, equitable, safety, economic, security and health benefits.	To ensure the full range of UAS BVLOS operations are captured and quantified as part of the FAA and DOT policy and regulatory initiatives.
GP 2.2	Public Perception – The industry must continue to work with all governments, including federal, tribal, state, and local, as well as directly with communities to enhance public understanding of the benefits of UAS BVLOS use.	To enhance public understanding of the benefits of UAS BVLOS.
GP 2.3	Immediately after promulgating the new BVLOS rule, the FAA should issue an Advisory Circular providing guidance.	To assist with interpretation of and compliance with the new rules.

GP 2.4	The FAA should continue the waiver and exemption process while the rulemaking process is progressing, considering the proposed recommendations as a basis for approval when appropriate.	To encourage the FAA to align exemptions, waivers, and deviations with the ARC's recommendations, while the NPRM process is ongoing.
GP 2.5	International Harmonization – The FAA should work closely with international partners to streamline regulatory processes.	To integrate scalable BVLOS operations into the NAS that are aligned, where possible, with international civil aviation authorities.
GP 2.6	Resolve Ambiguity around Intergovernmental Jurisdictional Roles – The FAA should continue an open dialogue with all interested stakeholders on jurisdictional issues. Further, the FAA should explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.	To advance UAS integration and promote cooperation between stakeholders by providing a clearinghouse of information from certified tribal, state, and local government entities.
GP 2.7	The FAA should publish an order that governs FAA participation in industry standards development organizations.	To have the FAA better define the role of the FAA participants so that feedback to the SDO is based on official FAA policy from the accountable FAA executive.
GP 2.8	Executive Branch Leadership on UAS Issues – The White House and the Department of Transportation should play a leadership role in UAS BVLOS integration.	To ensure committed government leadership and resourcing to promote UAS BVLOS integration.
GP 2.9	Counter-UAS Issues – The US government should renew the Preventing Emerging Threats Act.	While the use of UAS for good must be enabled, there must also be a means to detect and mitigate unauthorized, criminal, or rogue UA that may cause harm.
GP 2.10	FAA Extension Act – The FAA, together with national security agencies, should implement a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.	To accommodate reasonable access to potentially sensitive or critical infrastructure that is commensurate with the risks posed by the operation.

GP 2.11	DOT Economic Authority – Congress and the Department of Transportation should review the application of the aviation citizenship laws to the UAS industry to minimize barriers to entry and operational hindrances.	Due to how aviation citizenship laws are currently drafted and implemented, certain BVLOS operators (air carriers) may require economic authority (or registration) from the USDOT to operate.
GP 2.12	Spectrum Related Issues – The FAA should work with the FCC and NTIA to support enabling all available communications technology for the industry in a timely way.	Increase reliable and continuous access to spectrum which is essential to the continued growth of the UAS industry.
GP 2.13	Network Remote ID Implementation – The ARC urges the national security agencies and the FAA to engage in an open dialogue with industry and civil society stakeholders to find solutions that enable network remote identification implementation.	To promote and implement network remote ID solutions.
GP 2.14	The FAA establish a cybersecurity working group composed of members of the UAS and aviation industry, communications industry, academics, expert agencies, and other cybersecurity experts.	To address cybersecurity concerns across the UAS industry that is adaptable to evolving cybersecurity trends and technology.
GP 2.15	Until the new rule is promulgated, the proposed framework outlined in the Operations Matrix should be leveraged as Guidance Material for applicants and reviewers under the existing FAR Part 107 Waiver Process.	To create a more streamlined pathway to near-term operations.

Appendix C - Suggested Regulation by Recommendation

Air & Ground Risk Recommendations

Air & Ground Risk Recommendations		Potential Rule Location
AG 2.1	The acceptable level of risk (ALR) for UAS should be consistent across all types of operations being performed, and no more restrictive than the accepted fatality rates of general aviation.	Subpart B – Operating Rules § 108.11 Applicability.
AG 2.2	The rules should be predicated on the risks of operation based on UA capability, size, weight, performance, and characteristics of the operating environment as opposed to the purpose of the operation.	Subpart B – Operating Rules § 108.11 Applicability. Subpart F – Operating Requirements: Remote Air Carriers and Remote Commercial Operators §108.XX Risk Class and Type of Operations
AG 2.3	BVLOS operations to the greatest extent possible should be allowed to occur through compliance with the regulation alone without the need for a waiver or exemption.	Subpart A – General § 108.1 Applicability. Subpart B – Operating Rules § 108.11 Applicability. Subpart B – Operating Rules § 108.13 Registration.
AG 2.4	The FAA should encourage voluntary reporting in accordance with the UAS Aviation Safety Reporting System (ASRS).	Subpart A – General § 108.9 Accident reporting.

AG 2.5	The rule should enable carriage of hazardous materials beyond the specified quantities (per OQ 2.19). Carriage of hazardous materials beyond the specified quantities of OQ 2.19 shall have appropriate mitigations, as established via a performance-based industry consensus standard that is proportionate to the risk of the operation.	Subpart B – Operating Rules § 108.23 Hazardous operation
AG 2.6	The rule should allow UAS to conduct transient flight over people. The rule should allow sustained flight over non-participants with strategic and/or technical mitigations applied.	Subpart B – Operating Rules §108.XX Transient Operations Over Human Beings Subpart B – Operating Rules §108.XX Sustained Operations or Operations Over Human Beings
AG 2.7	The rule should be based on a minimum capability needed to safely perform the operation, not a minimum equipment list.	Subpart B – Operating Rules § 108.15 Condition for safe operation.
AG 2.8	The FAA should develop pathways to support innovation and accommodate emerging technology. The FAA should give consideration to approvals for low-risk Research and Development initiatives.	Subpart A – General § 108.1 Applicability.
AG 2.9	The FAA should incorporate uncrewed aviation into existing surveys or deploy a survey similar to the General Aviation and Part 135 Activity Survey.	Subpart A – General § 108.9 Accident reporting.

Flight Rules Recommendations

	Flight Rules Recommendations	Potential Rule Location
FR 2.1	The FAA should amend Part 91.113 (b) to allow a range of sensing methodologies and clarify adequate separation.	§ 91.113 (b)
FR 2.2	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400') yield right of way to crewed aircraft equipped with ADS-B or TABS and broadcasting their position.	Subpart A – General § 108.37 (a)
FR 2.3	The ARC recommends that UA operations in Non-Shielded Low Altitude Areas (i.e., below 400') have right of way over crewed aircraft that are not equipped with an ADS-B out as specified in 14 CFR § 91.225 or TABS.	Subpart A – General § 108.37 (b)
FR 2.4	The FAA should amend FAR Rule Part 91.113(d) to give UA Right of Way for Shielded Operations	§ 91.113 (d)(4)
FR 2.5	Pilots should be educated to associate obstacles and structures along their flight path with uncrewed flight operations to increase situational awareness during both preflight planning and actual operations.	14 CFR 61 – Subpart D – PART 61 - Certification: Pilots, Flight Instructors, and Ground Instructors

FR 2.6	The FAA should Revise §91.103 to include a new part (c) to accommodate UA operations.	§ 91.103 – Pre-Flight Actions for Remote Pilots in Command (RPIC)
FR 2.7	The FAA should amend § 91.119 to allow UA operations below the Minimum Safe Altitude restrictions	§91.119 Right-of-way rules: Except water operations.
FR 2.8	The FAA should amend FAR Rule Part 107.31 to include Extended Visual Line of Sight	§ 107.31 – Expand Visual Line of Sight Aircraft Operation to Include Extended Visual Line of Sight.
FR 2.9	The FAA should amend FAR Rule Part 107.33 to allow a visual observer to assist and support BVLOS operations	§ 107.33 Visual observer.

Aircraft & Systems Recommendations

Aircraft and Systems Recommendations	Potential Rule Location

AS 2.1	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of uncrewed aircraft and systems. The rule should be applicable to uncrewed aircraft up to 800,000 ft-lb of kinetic energy in accordance with the Operating Environment Relative Risk Matrix.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS
AS 2.2	The new BVLOS rule should address Maintenance, Repair, and Modifications of UA	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS §108.XX - Aircraft Maintenance, Alteration, and Repair
AS 2.3	The new BVLOS rule should address software qualification for UA and AE	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS §108.XX UA and AE Software Qualification and Approval
AS 2.4	The new rules should include UA noise certification requirements appropriate to the operating environment. Compliance should be demonstrated through a simple testing methodology.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS § 108.XX UA Noise Certification Requirements
AS 2.5	The FAA should establish a new 'BVLOS' Rule which includes a process for qualification of the associated elements of an uncrewed aircraft system.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS §108.XX AE Qualification and Approval and §108.XX – AE Maintenance, Alteration, and Repair
AS 2.6	The new rule should define who must make a declaration of compliance.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS

AS 2.7	Establish a new Special Airworthiness Certification for the UAS category under Part 21.	§21.175 (b) Special Airworthiness Certification for Uncrewed Aircraft or in a new subpart
AS 2.8	The FAA should establish a Repairperson Certification for the UAS Category to perform inspection, maintenance, and repair of UAS holding SAC under this proposed rule.	14 CFR 65 – Subpart D – PART 65 – Certification: Airmen Other than Flight Crewmembers
AS 2.9	Recommend exemption from Production Certification requirements IF TC applicants declare compliance to the LSA standard for a quality system.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS §108.XX Certifications, authorizations, and prohibitions.
AS 2.10	The FAA should consider allowing third party test organizations to audit compliance.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS 108.XX Certifying Third Party Compliance Monitoring Organizations.

Operator Qualifications Recommendations

Operator Qualifications Recommendations	Potential Rule Location

OQ 2.1	The FAA create a new 14 CFR Part that governs UAS BVLOS Pilot and Operator certification requirements and operating rules.	Part 108 as a whole
OQ 2.2	The FAA adopt the categories defined in the Automation Matrix for BVLOS training and qualification requirements.	Subpart A – General § 108.3 Definitions Subpart B – Operating Rules § 108.12a Knowledge requirements for RPIC/RFOS certificate holders.
OQ 2.3	The FAA modify 14 CFR Part 107 to enable limited BVLOS operations under the existing Remote Pilot with Small UAS Rating certificate.	Part 107 Subpart C – Remote Pilot Certification § 107.63 Issuance of a remote pilot certificate with a small UAS rating.
OQ 2.4	The FAA expand the knowledge test for the 14 CFR Part 107 Remote Pilot Certificate with Small UAS Rating to cover topics associated with EVLOS and shielded UAS operations	Part 107 Subpart C – Remote Pilot Certification § 107.73 Knowledge and training.
OQ 2.5	The FAA establish a new BVLOS rating for the Remote Pilot certificate under the new 14 CFR Part.	Subpart C – Certification: Remote Pilots § 108.56 Applicability.

OQ 2.6	The FAA's required UAS pilot knowledge areas and skills for the BVLOS rating should include the knowledge areas required by the FAA for the 14 CFR Part 107 Remote Pilot certificate.	Subpart B – Operating Rules § 108.12a Knowledge requirements for RPIC/RFOS certificate holders. Subpart C – Certification: Remote Pilots § 108.63 Issuance of a remote pilot certificate with a BVLOS rating.
OQ 2.7	The BVLOS rating process should incorporate additional knowledge and examination areas to support advanced BVLOS and 1-to-many operations.	Subpart B – Operating Rules § 108.12a Knowledge requirements for RPIC/RFOS certificate holders. Subpart C – Certification: Remote Pilots § 108.63 Issuance of a remote pilot certificate with a BVLOS rating.
OQ 2.8	The FAA should provide both direct and progressive paths to achieving the Remote Pilot Certificate with BVLOS rating.	Subpart B – Operating Rules § 108.12a Knowledge requirements for RPIC/RFOS certificate holders. Subpart C – Certification: Remote Pilots § 108.63 Issuance of a remote pilot certificate with a BVLOS rating.
OQ 2.9	Remote Pilots certificated under Part 107 that have completed a BVLOS training program certified by a public aircraft operator entity (as defined in 14 CFR Part 1) should be able to receive their BVLOS rating via online training, similar to the existing Part 107 certification pathway for current Part 61 pilots.	Subpart B – Operating Rules § 108.12a Knowledge requirements for RPIC/RFOS certificate holders. Subpart C – Certification: Remote Pilots § 108.63 Issuance of a remote pilot certificate with a BVLOS rating.

OQ 2.10	UAS BVLOS guidance and advisory materials should establish a clear and traceable path for operational control and specific training/qualification/currency requirements.	Subpart B - Operating Rules § 108.12 Requirement for a remote pilot certificate. § 108.12a Knowledge requirements for RPIC/RFOS certificate holders. § 108.19 Remote pilot in command. Subpart C – Certification: Remote Pilots § 108.65 Aeronautical knowledge recency Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators §108.XX (NEW) Flight supervisory personnel that may be designated for operations conducted under this part.
OQ 2.11	Create two levels of Operating Certificates for commercial UAS operations: a Remote Air Carrier certificate and a Remote Commercial Operating certificate.	Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators §108.XX General Requirements
OQ 2.12	Set threshold requirements for certain UAS BVLOS operations beyond which a Remote Air Carrier Certificate or Remote Operating Certificate is required.	Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators §108.XX Applicability

OQ 2.13	Create Operating Requirements that govern Remote Air Carrier and Remote Operating certificate holders.	Subpart F – Operating Requirements: Remote Air Carriers and Remote Commercial Operators
OQ 2.14	Create Certification and Operating Requirements that govern Agricultural Remote Aircraft Operations.	Subpart G - Agricultural Remote Aircraft Operations
OQ 2.15	For UAS Operating Certificate holders, create a designated position authorized under the New Part that exercises operational control and ultimate responsibility for 1-to-many BVLOS flights conducted under their supervision.	Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators §108.XX (NEW) Flight supervisory personnel that may be designated for operations conducted under this part.
OQ 2.16	The FAA should develop tailored medical qualifications for UAS pilots and other crew positions that consider greater accessibility and redundancy options available to UAS.	Subpart C – Certification: Remote Pilots § 108.61 Eligibility. Subpart E – Certification: Remote Air Carriers and Remote Commercial Operators
OQ 2.17	Remote Pilots (regardless of rating) are expressly authorized to act as Remote Pilot in Command of an uncrewed aircraft operated for compensation or hire.	Subpart C – Certification: Remote Pilots

OQ 2.18	The intent of the ARC is that the privileges and limitations of the final BVLOS rule will be available to all aircraft operating under this rule, including public agency operations.	Subpart A – General § 108.1 Applicability.
OQ 2.19	Allow only appropriately vetted UAS operators that are approved by the relevant authority to conduct operations deemed to be a higher security risk.	Subpart A – General § 108.1 Applicability.
OQ 2.20	The FAA provide an exception to the restrictions and requirements for carriage of specified quantities of hazardous materials for delivery by holders of a Remote Air Carrier or Remote Operating Certificate.	Subpart B – Operating Rules § 108.23 Hazardous operation

Third Party Services Recommendations

Third Party Services Recommendations		Potential Rule Location
TP 2.1	The FAA should adopt a regulatory scheme for third party services to be used in support of UAS BVLOS.	Subpart D – Qualification: Procedures for Uncrewed Aircraft and Systems for BVLOS
TP 2.2	The FAA and NASA should conduct a study to determine what level of aircraft operations in a defined volume of the airspace would trigger the need for mandatory participation in federated or third-party services.	NA

Environmental Recommendations

Environmental Recommendations		Potential Rule Location
ER 2.1	As the FAA reviews the BVLOS Rule, the ARC recommends the FAA determine that the BVLOS Rule is unlikely to result in significant impact to the environment.	NA
ER 2.2	NEPA review of the BVLOS rule must be timely and programmatic in scope.	NA

ER 2.3	Environmental reviews should not be required for individual BVLOS operations enabled by the Rule.	NA
ER 2.4	The FAA should provide an interim pathway to enable BVLOS operations in the near term, pending finalization of the BVLOS Rule.	NA
ER 2.5	The FAA interpret NEPA in a way that expedites the BVLOS rulemaking. If the FAA concludes that it is required to implement NEPA in such a way that would substantially delay either the BVLOS rulemaking or BVLOS operations, the ARC recommends asking Congress to consider legislative actions.	NA

General Recommendations

	General Recommendations	**Potential Rule Location**
GP 2.1	The DOT and the FAA should assess and evaluate societal benefits from UAS BVLOS operations broadly and consider categories and types of benefits that are not easily quantifiable. This includes a holistic and comprehensive analysis of the environmental, equitable, safety, economic, security and health benefits.	NA

GP 2.2	Public Perception – The industry must continue to work with all governments, including federal, tribal, state, and local, as well as directly with communities to enhance public understanding of the benefits of UAS BVLOS use.	NA
GP 2.3	Immediately after promulgating the new BVLOS rule, the FAA should issue an Advisory Circular providing guidance.	NA
GP 2.4	The FAA should continue the waiver and exemption process while the rulemaking process is progressing, considering the proposed recommendations as a basis for approval when appropriate.	NA
GP 2.5	International Harmonization – The FAA should work closely with international partners to streamline regulatory processes.	NA
GP 2.6	Resolve Ambiguity around Intergovernmental Jurisdictional Roles – The FAA should continue an open dialogue with all interested stakeholders on jurisdictional issues. Further, the FAA should explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.	NA
GP 2.7	The FAA should publish an order that governs FAA participation in industry standards development organizations.	NA

GP 2.8	Executive Branch Leadership on UAS Issues – The White House and the Department of Transportation should play a leadership role in UAS BVLOS integration.	NA
GP 2.9	Counter-UAS Issues – The US government should renew the Preventing Emerging Threats Act.	NA
GP 2.10	FAA Extension Act – The FAA, together with national security agencies, should implement a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.	NA
GP 2.11	DOT Economic Authority – Congress and the Department of Transportation should review the application of the aviation citizenship laws to the UAS industry to minimize barriers to entry and operational hindrances.	NA
GP 2.12	Spectrum Related Issues – The FAA should work with the FCC and NTIA to support enabling all available communications technology for the industry in a timely way.	NA
GP 2.13	Network Remote ID Implementation – The ARC urges the national security agencies and the FAA to engage in an open dialogue with industry and civil society stakeholders to find solutions that enable network remote identification implementation.	NA

GP 2.14	The FAA establish a cybersecurity working group composed of members of the UAS and aviation industry, communications industry, academics, expert agencies, and other cybersecurity experts.	NA
GP 2.15	Until the new rule is promulgated, the proposed framework outlined in the Operations Matrix should be leveraged as Guidance Material for applicants and reviewers under the existing FAR Part 107 Waiver Process.	NA

Appendix D – Technical Research

The ARC cites UAS XCEL ENERGY BVLOS PROJECT AIRSPACE ANALYSIS CAT062 Track Counts and P(LWC), Tony Boci, Systems Engineering Scientist, Surveillance & Automation Solution, July 17, 2020 in support of its recommendations at footnote 28 of the report. This study is not publicly available, but is included here with permission for reference.

UAS XCEL Energy
BVLOS Project Airspa

Appendix E - ARC Member Responses and Voting Results

The ARC believes this report fulfills the three tasks in the mission of the Charter:

- To identify safety and environmental considerations for UAS BVLOS operations, accounting for the security needs of the United States government,
- To identify societal benefits for UAS BVLOS operations, and,
- To recommend and provide rationale for requirements to enable UAS BVLOS operations.

The recommendations contained in this report were robustly debated before submission to the FAA. The report evolved as specific comments and feedback from ARC members forced in-depth conversations and understanding towards a common goal. Since the UAS-BVLOS ARC membership represented diverse interests and viewpoints, the ARC was unable to achieve unanimity on some of the recommendations, but remains confident that the final report represents a majority and that opposing viewpoints are presented in a thorough and balanced manner to assist the FAA.

In support of a transparent ARC process, members were offered the opportunity to include a (1 page) concurrence or non-concurrence on the final document. All submissions are included in this report.

The ARC completed its deliberations and report drafting on February 24, 2022. Voting ballots were distributed to the 86 voting ARC members on February 25, 2022. The voting tally is as follows:

44 – Concur as Written

20 – Concur with Comment

10 – Non-Concur

8 – No Ballot Submitted

4 – Abstentions

Organization	Primary Representative	Alternate Representative	Voting Response
National Association of Counties (NACo)	Jessica Jennings		Abstain
National Conference of State Legislatures (NCSL)	Ben Husch	Kristen Hildreth	Abstain
National Governors Association (NGA)	Chris Kelenske	Walter "Pete" Landon	Abstain
National League of Cities (NLC)	Brittney Kohler		Abstain
Aerovironment	Chaim Kaltgrad	Farzad Behboodi	Concur as Written
Air Methods	Eileen Lockhart		Concur as Written
Airobotics	Niv Russo	Issac Sela	Concur as Written
Airports Council International (ACI)	Chris Oswald	Paul Eubanks	Concur as Written
Amazon	Sean Cassidy	Ben Berlin	Concur as Written
American Association of Airport Executives (AAAE)	Justin Barkowski	Jeremy Valcich	Concur as Written
American Petroleum Institute (API)	Suzanne Lemieux	Chris Boness	Concur as Written
ANRA Technologies	Amit Ganjoo	Brent Klavon	Concur as Written
AriAscend/DSPA	Kenji Sugahara	Scott Shtofman	Concur as Written
Association for Unmanned Vehicle Systems International (AUVSI)	Brian Wynne	Michael Robbins	Concur as Written
Association of Fuel and Petrochemical Manufacturers (AFPM)	Michael Burnside	Jeffrey Gunnulfsen	Concur as Written
ASSURE UAS Center of Excellence	Lux Luxion	Kurt Carraway	Concur as Written
AURA Network	Jim Williams	Tamara Casey	Concur as Written

BNSF Railway	Todd Graetz	Nicholas Dryer	Concur as Written
Cherokee Nation	JC Coffey	Kyle Snyder	Concur as Written
Choctaw Nation	James Grimsley	Marcus Hartman	Concur as Written
CNN	Greg Agvent		Concur as Written
Dominion Energy	Nate Robie	Thomas Butler	Concur as Written
DroneResponders	Charles Werner	Christopher Todd	Concur as Written
DroneUp	John Vernon	Tom Walker	Concur as Written
Echodyne	Leo McCloskey		Concur as Written
Edison Electric Institute	Emily Fisher	Sean Murphy	Concur as Written
First Person View Freedom Coalition	David Messina	Dan Oachs	Concur as Written
Flight Safety Foundation (FSF)	Deborah Kirkman	Jan de Regt	Concur as Written
Florida Power and Light	Eric Schwarz		Concur as Written
Indianapolis Airport Authority	Mario Rodriguez	Keith Berlen	Concur as Written
Insitu	Jeff Decker	Alison "Ali" Faddis	Concur as Written
L3 Harris	Robert Gettler	Jon Standley	Concur as Written
Matternet	Jim O'Sullivan	Tom Rehwinkel	Concur as Written
National Air Traffic Controllers Association (NATCA)	Jimmy Smith	Tom Adcock	Concur as Written
National Association of Tower Erectors (NATE)	Sam McGuire		Concur as Written
Northern Plains UAS Test Site	Trevor Woods	Erin Roesler	Concur as Written
Percepto	Neta Gliksman	Ariel Avitan	Concur as Written

Phoenix Air	William Lovett	William Wheeler	Concur as Written
SAE International	Judith Ritchie	Mark DeAngelo	Concur as Written
State Farm	Todd Binion	Maria Hagglund	Concur as Written
T-Mobile	Sean Murphy	Pete Dawson	Concur as Written
University of Alaska Test Site	Cathy Cahill	Nick Adkins	Concur as Written
UPS Flight Forward	Eric Bergesen	Gloria Hatcher	Concur as Written
Vigilant Aerospace	Kraettli Epperson	Zach Peterson	Concur as Written
Virginia Tech UAS Test Site	Tombo Jones	John Coggin	Concur as Written
Women and Drones	Sharon Rossmark	Desi Ekstein	Concur as Written
Women in Aviation International (WAI)	Allison McKay		Concur as Written
Aloft Technologies Inc.	Jon Hegranes	Brad Llewellyn	Concur with Comment
American Association of State Highway and Transportation Officials (AASHTO)	Bob Brock		Concur with Comment
American Robotics	Vijay Somandepalli		Concur with Comment
ASTM International	Philip Kenul	Adam Morrison	Concur with Comment
AT&T	Peter Musgrove	Art Pregler	Concur with Comment
Commercial Drone Alliance (CDA)	Lisa Ellman	Matt Clark	Concur with Comment
Conference of Minority Transportation Officials (COMTO)	Terrence Hicks	Robert Lancaster	Concur with Comment
Consumer Technology Association (CTA)	Doug Johnson		Concur with Comment
CTIA	Avonne Bell	Jennifer Richter	Concur with Comment

Iris Automation	Jon Damush	Gabrielle Wain	Concur with Comment
National Association of State Aviation Officials (NASAO)	Ben Spain	Greg Pecoraro	Concur with Comment
News Media Coalition	Chuck Tobin	Emmy Parsons	Concur with Comment
NUAIR Test Site	Ken Stewart	Andy Thurling	Concur with Comment
One Sky	Chris Kucera	Ted Driver	Concur with Comment
Organization of Black Aerospace Professionals (OBAP)	Albert Glenn	Albert "AC" Glenn	Concur with Comment
Qualcomm	Drew Van Duren	Stefano Faccin	Concur with Comment
Skydio	Jenn Player	Brendan Groves	Concur with Comment
Verizon/Skyward	Melissa Tye	David Lincoln	Concur with Comment
Wing	Margaret Nagle	Dallas Brooks	Concur with Comment
Zipline	Okeoma Moronu	Lauren Haertlein	Concur with Comment
Aerospace Industries Association (AIA)	Karina Perez	Hector Garcia	Non-Concur
Air Line Pilots Association (ALPA)	Vas Patterson	Mark Reed	Non-Concur
Airbus	Scot Campbell	Rob Eagles	Non-Concur
Aircraft Owners and Pilots Association (AOPA)	Chris Cooper	Jim McClay	Non-Concur
American Civil Liberties Union (ACLU)	Jay Stanley	Daniel Gillmor	Non-Concur
Electronic Frontier Foundation (EFF)	Andres Arrieta	Jon Callas	Non-Concur
Electronic Privacy Information Center (EPIC)	Jeramie Scott	Jake Wiener	Non-Concur
General Aviation Manufacturers Association (GAMA)	Jens Hennig	Christine Bernat	Non-Concur

Helicopter Association International (HAI)	Chris Martino	Mike Hertzendorf	Non-Concur
Praxis Aerospace Concepts (PACI)	Jonathan Daniels		Non-Concur
African American Mayors Association	Steven Reed	Melvin Carter	Vote Not Submitted
AgEagle	Jesse Stepler		Vote Not Submitted
AirMap	Andreas Lamprecht	Avinash Chugh	Vote Not Submitted
Alliance for Drone Innovation (ADI)	Jenny Rosenberg	Zac Hills	Vote Not Submitted
FedEx	Anne Bechdolt	Joel Murdock	Vote Not Submitted
Latino Pilots Association	Chad Lipsky	Michael Cerrato	Vote Not Submitted
Missouri University of Science and Technology	Chen Genda	Rafael Cardona Huerta	Vote Not Submitted
National Forum for Black Public Administrators	Marshall Taggart	Justina Mann	Vote Not Submitted
The Nature Conservancy	Gustavo Lozada	Sam Linblom	Vote Not Submitted

Appendix F - ARC Member Ballots and Supporting Materials

Combined Voting Ballots.pdf

Appendix G - ARC Members By Working Group (Phase 1 and Phase 2)

Organization	Primary Representative	Alternate Representative	Phase 1 Working Group	Phase 1 Role	Phase 2 Working Group	Phase 2 Role
Aerospace Industries Association (AIA)	Karina Perez	Hector Garcia	WG 1.2	Member	WG 2.2	Member
Aerovironment	Chaim Kaltgrad	Farzad Behboodi	WG 1.1	Member	WG 2.2	Member
African American Mayors Association	Steven Reed	Melvin Carter	WG 1.1	Member	WG 2.1	Member
AgEagle	Barrett Mooney	Jesse Stepler	WG 1.2	Member	WG 2.2	Member
Air Line Pilots Association (ALPA)	Vas Patterson	Mark Reed	WG 1.3	Member	WG 2.4	Member

Air Methods	Eileen Lockhart		N/A	Co-chair	N/A	Co-chair
Airbus	Scot Campbell	Rob Eagles	WG 1.1	Member	WG 2.3	Member
Aircraft Owners and Pilots Association (AOPA)	Chris Cooper	Jim McClay	WG 1.1	Member	WG 2.5	Member
AirMap	Andreas Lamprecht	Avinash Chugh	WG 1.2	Member	WG 2.3	Member
Airobotics	Niv Russo	Issac Sela	WG 1.2	Member	WG 2.2	Member
Airports Council International (ACI)	Chris Oswald	Paul Eubanks	WG 1.1	Member	WG 2.1	Member
Alameda County Sheriff's Office	Tom Madigan	Rick Hassna	WG 1.1	Observer		Observer

Alliance for Drone Innovation (ADI)	Jenny Rosenberg	Zac Hills	WG 1.3	Member	WG 2.2	Member
Aloft Technologies Inc.	Jon Hegranes	Brad Llewellyn	WG 1.2	Member	WG 2.1	Member
Amazon	Sean Cassidy	Ben Berlin	N/A	Co-chair	N/A	Co-chair
American Association of Airport Executives (AAAE)	Justin Barkowski	Jeremy Valcich	WG 1.2	Member	WG 2.5	Member
American Association of State Highway and Transportation Officials (AASHTO)	Bob Brock		WG 1.3	Member	WG 2.4	Member
American Civil Liberties Union (ACLU)	Jay Stanley	Daniel Gillmor	WG 1.1	Member	WG 2.3	Member
American Petroleum Institute (API)	Suzanne Lemieux	Chris Boness	WG 1.1	Member	WG 2.5	Member

American Robotics	Vijay Somandepalli		WG 1.3	Member	WG 2.5	Member
ANRA Technologies	Amit Ganjoo	Brent Klavon	WG 1.1	Member	WG 2.3	Member
AriAscend/DSPA	Kenji Sugahara	Scott Shtofman	WG 1.1	Member	WG 2.5	Member
Association for Unmanned Vehicle Systems International (AUVSI)	Brian Wynne	Michael Robbins	WG 1.2	Member	WG 2.1	Member
Association of Fuel and Petrochemical Manufacturers (AFPM)	Michael Burnside	Jeffrey Gunnulfsen	WG 1.2	Member	WG 2.4	Member
ASSURE UAS Center of Excellence	Lux Luxion	Kurt Carraway	WG 1.1	Member	WG 2.1	Member
ASTM International	Philip Kenul	Adam Morrison	WG 1.3	Member	WG 2.3	Member

AT&T	Peter Musgrove	Art Pregler	WG 1.1	Member	WG 2.3	Member
AURA Network	Jim Williams	Tamara Casey	WG 1.3	Member	WG 2.3	WG Lead
Australia CASA	Luke Gumley		WG 1.3	Observer	WG 2.1	Observer
BNSF Railway	Todd Graetz	Nicholas Dryer	WG 1.3	Member	WG 2.5	WG Lead
Cherokee Nation	JC Coffey	Kyle Snyder	WG 1.1	Member	WG 2.4	Member
Choctaw Nation	James Grimsley	Marcus Hartman	WG 1.2	Member	WG 2.2	Member
City of Reno	Calli Wilsey	JW Hodge	WG 1.2	Member	WG 2.1	Member

CNN	Greg Agvent		WG 1.2	Member	WG 2.4	Member
Commercial Drone Alliance (CDA)	Lisa Ellman	Matt Clark	WG 1.2	WG Lead	WG 2.2	Member
Conference of Minority Transportation Officials (COMTO)	Terrence Hicks	Robert Lancaster	WG 1.2	Member	WG 2.3	Member
Consumer Technology Association (CTA)	Doug Johnson		WG 1.1	Member	WG 2.2	Member
CTIA	Avonne Bell	Jennifer Richter	WG 1.3	Member	WG 2.3	Member
Cybersecurity and Infrastructure Security Agency (CISA)	Sarah Jacob	Scott Parker	WG 1.1	Observer	WG 2.1	Observer
Department of Commerce (DOC)	Jonathan Alvear		WG 1.2	Observer	WG 2.2	Observer

Department of Defense (DoD)	James Taylor	Joel Castillo	WG 1.1	Observer		Observer
Department of Homeland Security (DHS)	Jim Elmore	Rick Londrie	WG 1.1	Observer		Observer
Department of Justice (DOJ)	Joe Mazel		WG 1.1	Observer		Observer
Department of the Interior (DOI)	Mark Bathrick	Brad Koeckeritz	WG 1.1	Observer	WG 2.4	Observer
Department of Transportation (DOT)	Ryan Steinbach	Peter Irvine	N/A	Observer	WG 2.5	Observer
Department of Transportation (DOT) - Council's Office	Alex Zektser	Betsy Kohl	WG 1.1	Observer	WG 2.1	Observer
Dominion Energy	Nate Robie	Thomas Butler	WG 1.2	Member	WG 2.5	Member

DroneResponders	Charles Werner	Christopher Todd	WG 1.1	Member	WG 2.4	Member
DroneUp	John Vernon	Tom Walker	WG 1.2	Member	WG 2.2	Member
Echodyne	Leo McCloskey		WG 1.2	Member	WG 2.2	Member
Edison Electric Institute	Emily Fisher	Sean Murphy	WG 1.2	Member	WG 2.1	Member
Electronic Frontier Foundation (EFF)	Andres Arrieta	Jon Callas	WG 1.1	Member	WG 2.5	Member
Electronic Privacy Information Center (EPIC)	Jeramie Scott	Jake Wiener	WG 1.1	Member	WG 2.4	Member
European Union Aviation Safety Agency (EASA)	Ludovic Aron	Natale Di Rubbo	WG 1.3	Observer	WG 2.2	Observer

FedEx	Anne Bechdolt	Joel Murdock	WG 1.2	Member	WG 2.1	Member
First Person View Freedom Coalition	David Messina	Dan Oachs	WG 1.1	Member	WG 2.5	Member
Flight Safety Foundation (FSF)	Deborah Kirkman	Jan de Regt	WG 1.3	Member	WG 2.1	Member
Florida Power and Light	Eric Schwarz		WG 1.1	Member	WG 2.4	Member
Fortem Technologies	Adam Robertson	Dan Bezzant	WG 1.2	Observer	WG 2.3	Observer
General Aviation Manufacturers Association (GAMA)	Jens Hennig	Christine Bernat	WG 1.1	Member	WG 2.5	Member
Helicopter Association International (HAI)	Chris Martino	Mike Hertzendorf	WG 1.1	Member	WG 2.1	Member

Indianapolis Airport Authority	Mario Rodriguez	Keith Berlen	WG 1.1	Member	WG 2.1	Member
Insitu	Jeff Decker	Alison "Ali" Faddis	WG 1.1	Member	WG 2.2	Member
Iris Automation	Jon Damush	Gabrielle Wain	WG 1.1	Member	WG 2.5	Member
L3 Harris	Robert Gettler	Jon Standley	WG 1.1	Member	WG 2.5	Member
Latino Pilots Association	Chad Lipsky	Michael Cerrato	WG 1.1	Member	WG 2.5	Member
Matternet	Jim O'Sullivan	Tom Rehwinkel	WG 1.3	Member	WG 2.1	Member
Missouri University of Science and Technology	Chen Genda	Rafael Cardona Huerta	WG 1.1	Member	WG 2.2	Member

National Aeronautics and Space Administration (NASA)	Jaewoo Jung	Joey Rios	WG 1.2	Observer	WG 2.3	Observer
National Air Traffic Controllers Association (NATCA)	Jimmy Smith	Tom Adcock	WG 1.3	Member	WG 2.3	Member
National Association of Counties (NACo)	Jessica Jennings		WG 1.2	Member	WG 2.5	Member
National Association of State Aviation Officials (NASAO)	Ben Spain	Greg Pecoraro	WG 1.3	Member	WG 2.1	Member
National Association of Tower Erectors (NATE)	Sam McGuire		WG 1.2	Member	WG 2.3	Member
National Conference of State Legislatures (NCSL)	Ben Husch	Kristen Hildreth	WG 1.1	Member	WG 2.5	Member
National Forum for Black Public Administrators	Marshall Taggart	Justina Mann	WG 1.1	Member	WG 2.4	Member

National Governors Association (NGA)	Chris Kelenske	Walter "Pete" Landon	WG 1.1	Member	WG 2.5	Member
National League of Cities (NLC)	Brittney Kohler		WG 1.2	Member	WG 2.3	Member
National Oceanic and Atmospheric Administration (NOAA)	Darren Goodbar	Paul Hemmick	WG 1.1	Observer	WG 2.4	Observer
National Security Council (NSC)	Michael Hardin		WG 1.1	Observer		Observer
NAV Canada	Alan Chapman	Alexandra Officer	WG 1.2	Observer	WG 2.1	Observer
New York City Fire Department	Michael Leo	Fred Carlson	WG 1.1	Observer		Observer
News Media Coalition	Chuck Tobin	Emmy Parsons	WG 1.1	Member	WG 2.1	Member

Northern Plains UAS Test Site	Erin Roesler	Trevor Woods	WG 1.3	Member	WG 2.1	WG Lead
NUAIR Test Site	Ken Stewart	Andy Thurling	WG 1.2	Member	WG 2.2	Member
Office of Management and Budget	Kyle Gardiner		N/A	Observer	WG 2.3	Observer
One Sky	Chris Kucera	Ted Driver	WG 1.3	Member	WG 2.4	Member
Organization of Black Aerospace Professionals (OBAP)	Albert Glenn	Albert "AC" Glenn	WG 1.1	Member	WG 2.4	Member
Percepto	Neta Gliksman	Ariel Avitan	WG 1.2	Member	WG 2.1	Member
Phoenix Air	William Lovett	William Wheeler	WG 1.2	Member	WG 2.4	Member

Praxis Aerospace Concepts (PACI)	Jonathan Daniels		WG 1.3	Member	WG 2.3	Member
PrecisionHawk	Sky Andrew		WG 1.3	Observer	WG 2.2	Observer
Qualcomm	Drew Van Duren	Stefano Faccin	WG 1.2	Member	WG 2.5	Member
SAE International	Judith Ritchie	Mark DeAngelo	WG 1.1	Member	WG 2.2	Member
Skydio	Jenn Player	Brendan Groves	WG 1.3	Member	WG 2.2	WG Lead
State Farm	Todd Binion	Maria Hagglund	WG 1.3	Member	WG 2.4	Member
Swiss FOCA	Benoit Curdy	Andreea Perca	WG 1.3	Observer	WG 2.3	Observer

The Nature Conservancy	Gustavo Lozada	Sam Linblom	WG 1.1	Member	WG 2.4	Member
T-Mobile	Sean Murphy	Pete Dawson	WG 1.2	Member	WG 2.2	Member
Transport Canada	Kelsie Doyle	Jeannie Stewart-Smith	WG 1.2	Observer	WG 2.3	Observer
Transportation Research Board, Aviation Committee	Daniel Friedenzohn		WG 1.2	Observer	WG 2.5	Observer
U.S. Coast Guard	Chad Thompson	John Walters	WG 1.2	Observer	WG 2.4	Observer
U.S. Government Accountability Office	Heather Krause	Susan Zimmerman	WG 1.3	Observer		Observer
UK Civil Aviation Authority	Germaine Faulkner		WG 1.3	Observer	WG 2.2	Observer

United Kingdom – NATS	Andrew Sage		N/A	Observer	WG 2.1	Observer
University of Alaska Test Site	Cathy Cahill	Nick Adkins	WG 1.3	Member	WG 2.5	Member
UPS Flight Forward	Eric Bergesen	Gloria Hatcher	WG 1.3	WG Lead	WG 2.4	Member
Verizon/Skyward	Melissa Tye	David Lincoln	WG 1.1	Member	WG 2.3	Member
Vigilant Aerospace	Kraettli Epperson	Zach Peterson	WG 1.3	Member	WG 2.2	Member
Virginia Tech UAS Test Site	Tombo Jones	John Coggin	WG 1.1	Member	WG 2.1	Member
White House Office of Science and Technology Policy	Drew Beasley	Drew Beasley	WG 1.2	Observer	WG 2.2	Observer

Wing	Margaret Nagle	Dallas Brooks	WG 1.3	Member	WG 2.4	WG Lead
Woman in Aviation International (WAI)	Allison McKay		WG 1.2	Member	WG 2.4	Member
Women and Drones	Sharon Rossmark	Desi Ekstein	WG 1.1	Member	WG 2.4	Member
Xcel Energy	Tom Stegge		N/A	Member	N/A	Member
Zipline	Okeoma Moronu	Lauren Haertlein	WG 1.1	WG Lead	WG 2.5	Member

Appendix H - Phase 1 Report

UAS Beyond Visual Line-of-Sight Operations Aviation Rulemaking Committee Phase I Report

January 27, 2022

I. Introduction

It is widely understood that the safety and efficiency benefits of commercial Uncrewed Aircraft Systems (UAS) are significant. Commercial UAS provide countless public benefits and essential services to the American public, including delivering critical supplies, life-saving medicines, and commercial products. UAS are helping to improve safety and efficiency by inspecting critical infrastructure at scale, enhancing access to essential goods and services, connecting communities, and supporting first responders.

Notwithstanding these benefits for the American public, current Federal Aviation Administration (FAA) regulations do not enable the domestic UAS beyond visual line-of-sight (BVLOS) industry to scale and achieve meaningful results from those benefits. The existing aviation regulatory framework either assumes a pilot onboard the aircraft or makes it extremely difficult for UAS market participants to adopt as written. FAA rules do not define any entity other than a pilot-in-command that may pilot an aircraft.[81]

Meanwhile, the kinds of competencies needed to safely operate highly automated UAS vary significantly from legacy aviation paradigms. Moreover, it is precisely the expansion of UAS BVLOS operations and associated UAS capabilities which offers significant economic and societal benefits to the American public. Communities, companies, and industrial sectors are eager to realize these benefits and have invested substantial resources in developing UAS technologies. Technology exists today that enable UAS to deliver medicines to hard-to-reach areas, extend services to economically disadvantaged communities (including reliance on personal transportation), enhance safety to remotely inspect critical infrastructure, and promote sustainable transportation solutions—all while ensuring America's continued leadership in aviation innovation.

Uncrewed aircraft flying beyond an individual's visual line-of-sight present unique challenges to the FAA's existing regulatory framework. The FAA, therefore, chartered the UAS BVLOS Aviation Rulemaking Committee (ARC) to develop recommendations for performance-based regulatory requirements to:

- Normalize safe, scalable, economically viable, and environmentally advantageous UAS BVLOS operations that are not under positive air traffic control (ATC).
- Identify safety and environmental considerations for UAS BVLOS operations, accounting for the security needs of the U.S. government.
- Identify societal benefits of UAS BVLOS operations, including economic, environmental, public health, and safety benefits.
- Recommend requirements to enable BVLOS operations based on the safety and environmental considerations and societal benefits identified by the ARC.

This ARC furthers the FAA's work over the last several years to integrate UAS into the National Airspace System (NAS). In June 2016, FAA issued Part 107 of Title 14 of the Code of Federal Regulations, the final rule for "Operation and Certification of Small Unmanned Aircraft Systems."[82] This rule established requirements for routine operation of small uncrewed aircraft in the NAS. It requires operators to obtain a Remote Pilot Certificate, but it does not include requirements for UAS design, manufacturing, or production. Instead, it limits small UAS counter operations to certain areas (e.g., at or below 400 feet in class G airspace) and conditions (e.g., operations within visual line-of-sight (VLOS)), with the intent to prevent UAS from interfering with other aircraft in flight or posing an undue hazard to people or property on the ground. Other recent rulemakings (registration, Ops over People and remote ID) take incremental steps forward but do not enable UAS BVLOS operations.

The ARC conducted its tasks in two phases. During Phase 1, the ARC established the following three workgroups to examine issues affecting FAA's development of regulations for UAS BVLOS operations:

Working Group 1.1 Community Interest: Safety, Environment, and Security
Working Group 1.2 Market Drivers
Working Group 1.3 Regulatory Challenges

[81] 14 C.F.R. 1.
[82] See footnote 75 above.

This Phase 1 report represents the culmination of the ARC's best efforts over a period of time to compile and organize a large body of information relevant to the ARC's activities. The Phase 1 report was considered throughout the work of Phase 2. Some Phase 1 recommendations appear in the Phase 2 report, while others do not. The Phase 2 report represents the final set of recommendations of the ARC. Phase 1 workgroup tasking, activities, and initial findings are discussed below.

II. Community Interest: Safety, Environment and Security (Working Group 1.1)

Working Group 1.1 discussed community interests related to UAS BVLOS operations. In particular, the Working Group considered:

- Safety objectives of the uncrewed aircraft operation and the risk it represents to the aircraft and to the people and property on the ground
- Concepts of BVLOS operations and its potential environmental impacts across environmental resources (for example noise, emissions, endangered, species, visual, etc.)
- Approaches to evaluating community response to UAS noise and concepts of operations that may have limited or no community noise exposure
- Whether and how UAS BVLOS can enhance environmental justice
- Solutions that address security concerns related to BVLOS operations

Working Group 1.1 divided its workstreams into three subgroups: Subgroup 1.1.1 on Safety, Subgroup 1.1.2 on Environment and Community, and Subgroup 1.1.3 on Security Considerations.

III. Safety (Subgroup 1.1.1)

A. Key Findings and Principles

Fundamental differences between legacy aircraft and UAS inform acceptable levels of safety: The starting point for defining an acceptable level of risk for UAS must begin with an acknowledgment that there are fundamental differences between legacy aircraft and UAS that inform acceptable levels of risk. Unlike traditional aircraft, uncrewed aircraft (UA) do not have onboard pilots or passengers, and therefore the only risk to human life stems from the UA potentially colliding with a traditional aircraft or colliding with an individual on the ground. Traditional frameworks for evaluating aviation risk contemplate the presence of individuals onboard an aircraft. For this reason, existing frameworks for evaluating aviation risk are not appropriate for establishing acceptable levels of risk for UAS BVLOS operations.

Consider safety benefits holistically: A risk-benefit analysis that focuses solely on safety benefits and risks to the NAS could decrease overall levels of safety. Establishing a baseline level of acceptable risk must account for safety benefits broadly and across transportation modes, recognizing that some UAS BVLOS operations will increase safety both inside and outside the aviation system. If risks (including inter-modal risk trade-offs) can be appropriately compared, and the use of UAS decreases overall risk, then the UAS operation should be permitted. Acceptable levels of safety for UAS BVLOS operations must reflect this notion.

There is a data gap: There was general consensus in the subgroup that data limitations generally result from the limited scope of current approvals in the U.S. Moreover, existing data associated with traditional aircraft operations may not be appropriate when applied to UAS BVLOS operations because of the fundamental risk differences that exist between legacy aircraft and UAS. To help inform future

BVLOS rulemaking activity, the Working Group recommends including data reporting requirements aimed at informing BVLOS safety metrics (together with obligations for the FAA to use the data in certain ways) in the BVLOS.

Focus on risk profile, not use cases. While use cases can serve as a convenient tool for understanding the depth and breadth of societal and environmental benefits to UAS BVLOS operations, use cases in and of themselves are a poor proxy for determining the risk profile of BVLOS operations. Rather than regulating based on use cases, it is essential that regulators focus on component characteristics, including combinations of characteristics that influence overall levels of ground and air risks associated with BVLOS operations.

The public's risk tolerance is evolving. The public's risk tolerance will continue evolving over time as operations become routine and normalized. As operations increase, technology continues to improve and society realizes the benefits of the technology, the public's tolerance for safety will evolve.

Regulatory processes must be streamlined, transparent, and consistent. The current FAA approaches for granting certifications, approvals and exemptions do not meet the needs of industry. As discussed more fully by Working Group 1.2, new methodology for analyzing safety risk and approving operations is required to meet the market cycle. Moreover, a uniform method of analysis will create predictability for stakeholders allowing industry to fully realize the benefits of BVLOS operations while maintaining an acceptable level of risk for society.

UAS BVLOS integration into the NAS may mean changing the "Rules of the Sky." With the integration into the NAS of UAS BVLOS operations, ranging from piloted to autonomous, the FAA may need to reconsider the responsibilities in the NAS of all stakeholders to ensure the safe, efficient, and fair use of the airspace by all its users.

Subgroup 1.1.1 on safety was tasked to report to the broader ARC on the safety objectives of BVLOS operations, in particular from the public's point of view. For example, considerations include societal acceptance of risk and reward, and how to measure this.

Questions posed to Subgroup 1.1.1 include: What is the public's current risk tolerance? Is there a net safety gain associated with using the NAS versus other methods of transportation? What data do we need to develop safety objectives for ground and air risk? Who bears the burden of collision avoidance responsibility?

At a high level, it is important to note that UAS technology differs in very relevant ways from legacy crewed aviation and these differences fundamentally impact acceptable levels of safety for UAS. UAS are smaller, quieter, and, most important, do not carry people onboard the aircraft. This has important ramifications for how society views risk. When a traditional/legacy aircraft experiences a mishap, people on the aircraft are endangered. This is not the case for UAS. Therefore, from the Working Group's perspective, regulatory focus for UAS BVLOS operations should not be on the safety risk of collision or crash of the UA. Instead, the focus should more narrowly be on ensuring the safety of people on the ground, and other aircraft in the air.

B. Acceptable Level of Risk

While technology has moved quickly forward, policy and practice has lagged behind. Unlike for traditional aviation operations, the FAA has not developed guidance concerning an acceptable level of risk (ALR) for UAS. Therefore, decisions related to approving waivers and exemptions lack industry-appropriate underlying guidelines, such as those that the FAA routinely applies to commercial and general aviation. Without this guidance the FAA often applies experience from traditional aircraft where it is not appropriate.

Defining ALR for UAS must begin with an acknowledgement that there are fundamental differences between legacy aircraft and UAS that inform acceptable levels of risk. Unlike traditional aircraft, UAS do not have onboard pilots or passengers, and therefore the only risk to human life stems from the UA potentially colliding with a traditional aircraft or a collision with an individual on the ground. In other words, there is little to no risk of human injury if a UA crashes, particularly in less populated areas. Reliance upon traditional frameworks for evaluating aviation risk that contemplate or otherwise make unstated/silent assumptions regarding potential risk of harm to individuals onboard an aircraft is inappropriate for evaluating acceptable levels of risk for UAS BVLOS operations.

As the ARC seeks to recommend a set of safety recommendations for UAS BVLOS operations, it is important to note that the FAA is familiar with safety continuums. For example, the Uniform Safety Continuum defines ALR by aviation sector. The Safety Continuum organizes sectors on a scale, based on public tolerance for risk. The tolerance for risk informs safety performance targets, decisions on accepting risk in Safety Management System (SMS) and the level of FAA involvement and oversight that may be necessary.

[*Source: FAA*]

Chart 1 – Uniform Safety Continuum

While this framework is useful from a process perspective, the ARC should recommend that the FAA develop a safety continuum that is unique and appropriate to govern UAS BVLOS operations. One topic discussed by the group was that acceptable levels of risk should be driven by various characteristic of a BVLOS operation, rather than use-case. Thus an analogous safety continuum for UAS operations would weigh the various characteristics the ARC believes most influence ground/air risks for BVLOS operations.

C. Target Level of Safety

As noted above, existing safety target levels for legacy aircraft, which assume that there are people onboard the aircraft, are not appropriate for UAS. However, there are currently no established safety targets for UAS. While a crash involving a legacy aircraft will likely result in some level of human injury or death, the same is not true for a UA that has no onboard pilot or passengers. For UAS BVLOS operations, the risk of human injury or death stems from a potential impact with a person on the ground or a collision with a legacy aircraft with people onboard the aircraft. If a UA crashes in an unpopulated area, there is no risk of injury to anyone on the ground. Similar considerations could be given to UA that collide with property, especially the property of the operator. In such an instance there is little to no risk of injury to persons on the ground. For this reason, the FAA's target level of safety must focus on protecting individuals on the ground and preventing collisions with traditional aircraft, not preventing a UA crash.

The FAA has established aviation safety targets informed by decades of experience in legacy aviation and public feedback. The current targets are:

U.S.-owned Commercial Carrier Fatalities per 100 million Persons on Board: 5.4 (FY21)
U.S. General Aviation Fatal Accidents per 100,000 Flight Hours: 0.96 (FY21)[83]

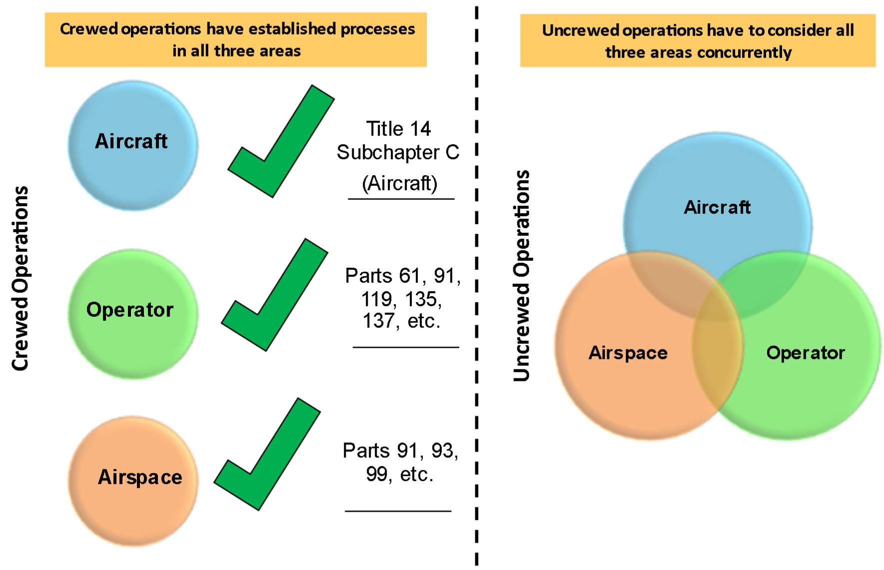
The Subgroup considered how these existing level of safety targets may (or may not) be relevant to UAS operations and recognized that a regulated entity may utilize a range of mitigations to achieve the Target Level of Safety. The FAA should acknowledge a range of mitigations and apply a performance-based approval framework and develop a range of alternative means of compliance or standard scenarios.

Regulating Safety

Traditionally, the FAA approaches the safety considerations of the aircraft, the operator and the airspace separately. To date, uncrewed operations have had to consider all three areas concurrently. (See Chart 1 below) As Working Group 1.2 discussed, this approach to regulation also reflects the safety characteristics of legacy aviation. The focus of traditional aviation regulation has been validating the reliability of the aircraft and the fitness and competence of flight crew.

[83] Drone Advisory Committee "Public eBook", October 27, 2021; p 37 https://www.faa.gov/uas/programs_partnerships/advanced_aviation_advisory_committee/previous_dac_meetings_and_materials/media/Public_eBook_10272021.pdf.

FAA Approach to UAS SRM

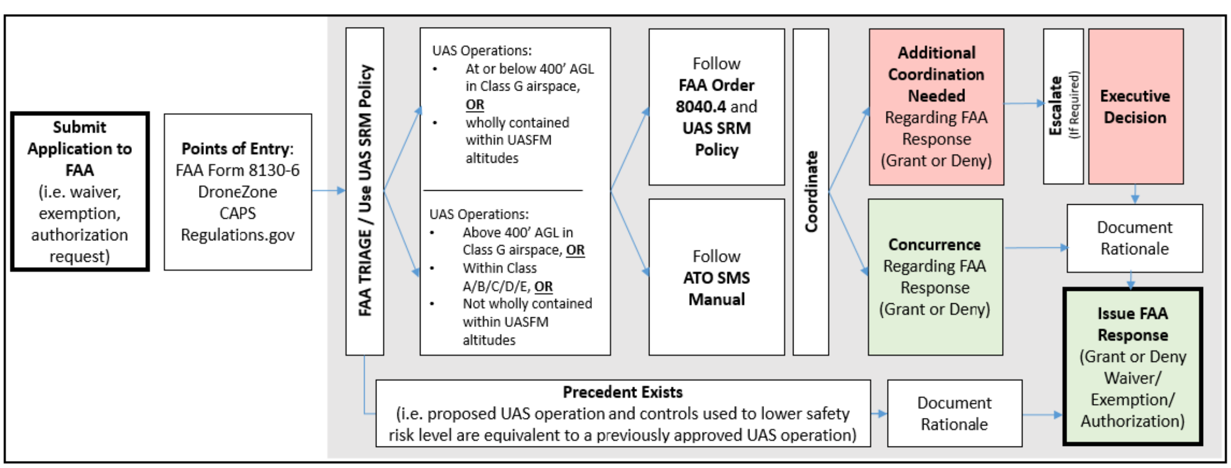


[*Source*: FAA]

Chart 2 – FAA Approach to UAS SRM

This approach to safety does not work for various reasons, most significantly because it does not reflect the level of integration that exists within many of these UAS operations or account for the increased autonomy that is leveraged by many of these systems. As will be discussed more fully by Working Group 1.2 below, the current FAA policy does not reflect the design of the UAS industry.

Even UAS-specific policies draw heavily from the legacy aviation space. For example, the FAA has published a new FAA Order 8040.6 Unmanned Aircraft Systems Safety Risk Management Policy that supplements FAA Order 8040.4 and provides the process for evaluating specific UAS operations. The policy implements the agreement between AVS and the ATO on SRM in low altitude airspace. Chart 3 below outlines the 8040.6 process for specific UAS requests.



[*Source*: FAA]

Chart 3 – 8040.6 Process for Specific UAS Requests

D. Process

Not only are current FAA policies ill-designed for the UAS marketplace, but the processes suffer from challenges. For example, in practice, applicants have found the process of coordinating concurrently and across multiple offices in the FAA too slow, bureaucratic, and inconsistent. Given the novelty of the policy and regulatory issues raised by UAS operations, FAA staff may need to elevate risk issues/decision on a case-by-case basis which impacts the FAA's efficiency and limits the agency's ability to provide timely responses to regulatory applications. Without transparency and collaboration between FAA, industry, and the public on the level of safety that the public accepts, the UAS industry has found the FAA bureaucratic, slow and conservative in its decision-making and industry remains unsure about the target level of safety they are to be measured by. To be sure, the current approach does not enable innovation in a way that is safe and secure.

E. Mitigations and Risk Tradeoff

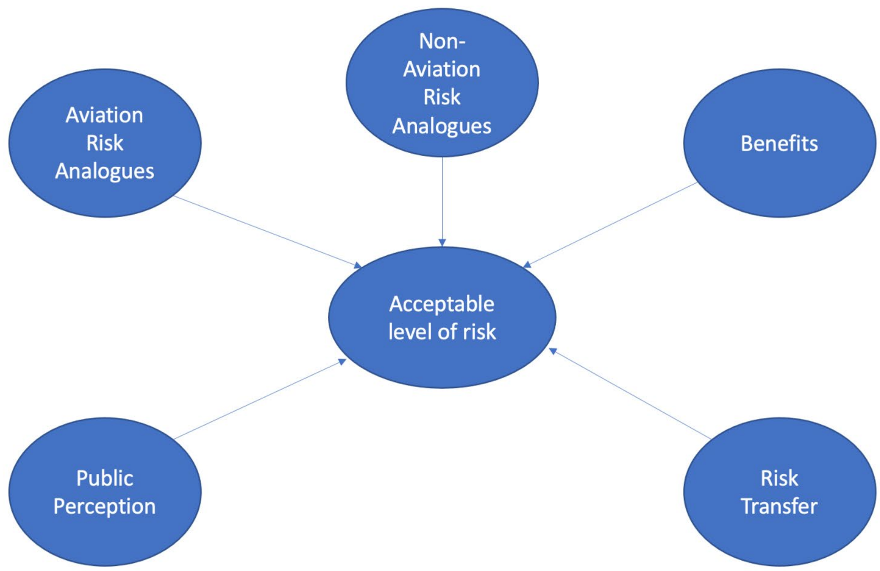


Figure 1 - Inputs into developing the acceptable level of risk.

Given the differences between traditional legacy aviation and UAS, as discussed above, Working Group 1.1.1 believes the ARC and the FAA should consider the following factors to determine the acceptable level of risk for UAS BVLOS operations:

Public Perception: The public's belief or opinion on the benefits and risks of BVLOS operations. Note that fear of new technologies is not unique to UAS. Indeed, public perception traditionally evolves as people are educated about the benefits of new technologies. UAS stakeholders, including the FAA and industry, ought to work together to educate the public about the many benefits of UAS (described more fully below by Working Group 1.2). There is also reason to believe that there exists a level of excitement from the general public in bringing the benefits of BVLOS operations to their communities based on the number of applicants nationally that expressed interest in participating in the UAS Integration Pilot Program (IPP).

Aviation and Non-Aviation Risk Analogues: The relevance of data and research released by FAA, National Transportation Safety Board (NTSB), Department of Transportation (DOT)[84] and Occupational Safety and Health Administration (OSHA) and other agencies which could help inform overall levels of safety associated with UAS BVLOS operations, including impacts to safety which extend beyond the NAS. For example, acceptable levels of risk for ground vehicles, autopilots, general aviation, and commercial space transportation.

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[84] U.S. Department of Transportation, Bureau of Transportation Statistics. https://data.bts.gov/browse?q=fatalities&sortBy=relevance

Public Benefits of UAS Operations: The economic, public health, environmental and societal benefits of BVLOS operations, which must be weighed against any real or perceived increases in risk to the NAS.

Risk Transference: Where BVLOS operations replace higher risk operations, as well as where risk can be transferred to industry through accountability, liability and insurance requirements.

Figure 2 below depicts an example of a framework to determine whether an operation meets an acceptable level of risk. In Column 1, "scenario" represents a generic use case that has been called out in the ARC charter. The Safety Working Group has worked to break out the scenarios into components. The sample below is simplistic but illustrates how scenarios can have many different potential characteristics. Each characteristic has an associated ground and/or air risk which is the result of not only the base level of risk but any mitigations that may be utilized. This risk can be quantified using data. The first step is identifying which data is relevant, then using the data to model the risk. These risks feed into the lens of risk tolerance that takes into account the public's perception of risk as well as the benefits provided by operations.

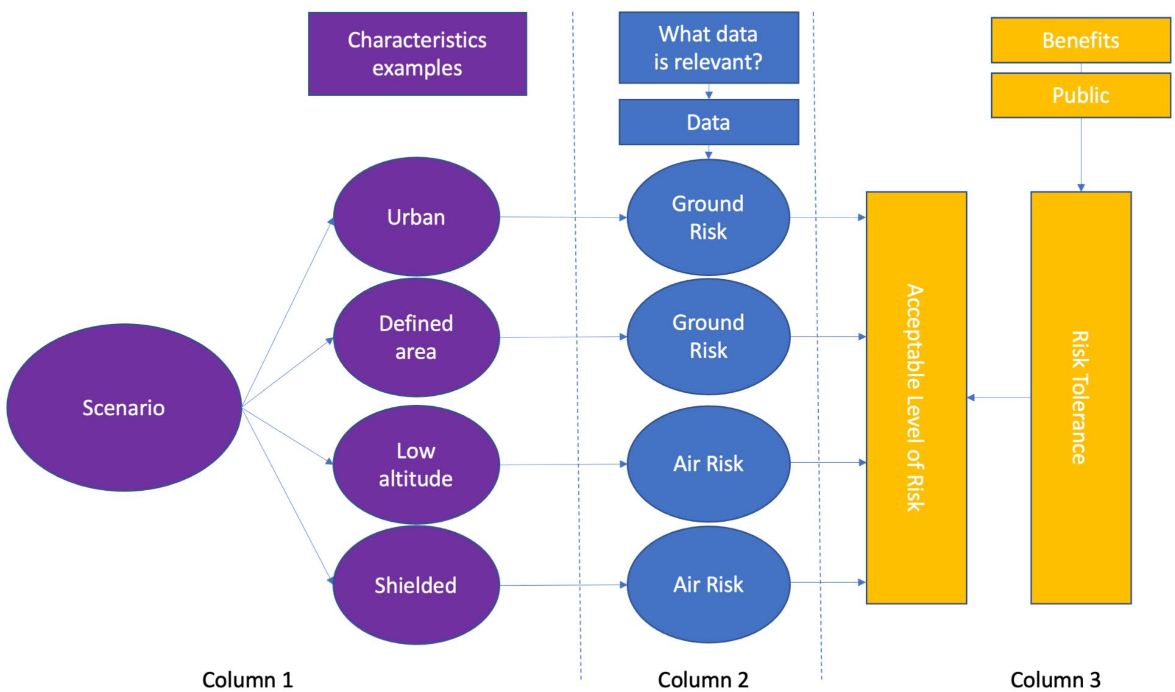

Figure 2 – Sample Framework for ALR

F. Recommendations

<u>Acknowledge the Fundamental Differences Between Legacy Aircraft and UAS that Inform Acceptable Levels of Safety</u>. Defining an acceptable level of risk for UAS requires a recognition of the fundamental differences between legacy aircraft and UAS that inform acceptable levels of risk. UAS do not have onboard pilots or passengers, and therefore the only risk to human life stems from the UA potentially colliding with a traditional aircraft or a collision with an individual on the ground. Reliance upon traditional frameworks for evaluating aviation risk that contemplate the presence of individuals onboard an aircraft are not appropriate for establishing acceptable levels of risk for UAS BVLOS operations.

Evaluate the Aggregate Benefit/Risk Tradeoff. The FAA's risk analysis framework has traditionally focused narrowly on safety benefits and risks to the NAS. This myopic approach to conducting a risk-benefit analysis fails to account for benefits of UAS BVLOS operations that can increase safety outside of the NAS. For example, when analyzing the risks of BVLOS infrastructure inspection operations, the FAA should consider the much larger risk of having people climb or rappel on such infrastructure to conduct such inspections.

Both aggregate risks and benefits should be considered for all BVLOS operations. This provides a larger pool on which to base both the benefits and risks. Just as traditional insurance has "high risk pools" for any operations or characteristics that significantly increase risks, consideration should be made to separate those risks for the aggregate pool. Benefits are also an important ingredient to acceptable risk as the society's acceptance of risk increases as the public sees the benefits from normalized BVLOS operations. These may include economic benefits as well as increased risk shifting from other modes of transportation such as risk of traffic collisions as well as decreased injury rates from infrastructure inspection.

Develop a Transparent and Consistent Approval Process. The Safety Subgroup recommends transparency and consistency with requirements for issuance of waivers, exemptions or other approvals and transparency of characteristics that require additional review. While the primary pathway to operation should be compliance with a broad performance-based regulation, another process that provides additional flexibility should be available for those operations that seek to conduct operations outside the regulatory framework. In those cases, we recommend that there be a SMS/SORA-like process.

Joint Authorities for the Rulemaking of Unmanned Systems (JARUS)/ Specific Operations Risk Assessment (SORA) - Support the development of an objective, risk-based, performance-based framework that leverages the existing methods of risk analysis like JARUS SORA, which is clear, adaptable, established, and becoming widely adopted internationally.

Target Level of Safety - Acknowledging the importance of balancing industry's need for clarity and adaptability in the rules, the Safety Subgroup recommends that Phase 2 codify the elements of the target level of safety and how they will be considered and measured. The subgroup members recommend that any risk limit rate or number should be included within the preamble rather than within the specific language of the rule.[85]

Allocation of Risk - Consider whether the FAA has assumed too much responsibility and whether private entities should be allowed to assume some of the responsibility (e.g., through insurance) especially with lower to medium ground risk operations. Further consider whether ground risk can be addressed through current regulations or addressed through other avenues than FAA rulemaking. Consider whether there are risks introduced by BVLOS operations that are unique or new that would require different treatment.

[85] Having the rate within the rule would allow industry flexibility in choosing how to comply with the rule and rate but would create an issue of a case-by-case (CONOPS by CONOPS) approval by the FAA. This would likely result in delays because of limited personnel within the FAA as well as providing qualifying data before being able to conduct operation. Placing the rate within the preamble would allow for specific mitigations for specific operational characteristics. As noted elsewhere, the required mitigations should fall along the risk continuum from a very light touch with low air and ground risk to more robust mitigations for higher risk operations. This would allow for quicker approval of operations that require FAA involvement that fall within those characteristics while allowing those needing more flexibility to go through the waiver or exemption process.

Focus on Hazards with Appreciable Likelihood. The FAA should not focus only on low-probability worst-case-scenarios, as the FAA tends now to do. The FAA should instead focus on the realistic and likely outcomes, and on issues that most affect safety and establish rules, standards and guidelines around those identified issues.[86]

Promote Transparency and Accountability. The FAA should provide applicants with accurate timelines and status updates as their applications progress through the processes. Where applicants are unable to comply with the regulatory process, the FAA should adopt a SMS/SORA-like process. Ideally, the approval process would be adaptable and predictable, though members acknowledged that there is a natural tension between those two priorities. The members recommend prioritizing adaptability and enabling greater transparency where there is a lack of predictability in the process. For example, as discussed more fully by Working Group 1.2 below, the FAA should implement flexible rules while providing non-exhaustive Means of Compliance or other such guidance so the industry knows how it may comply.

Utilize Risk Profiles. Rather than associating risk with use cases, BVLOS risk as well as required mitigations should be associated with risk profiles for each type of characteristic of the operation (e.g., population density, exposed groups, airspace, air traffic density, C2 link and communication between the UAV, GCS and/or UTM system etc.). The risk profiles for these operations should be based upon operational risk and performance targets of aircraft as well as factor in the severity and likelihood of incidents and other credible outcomes. The risk profiles should focus on likelihood of injury to those in the air or on the ground, recognizing that the vehicles themselves do not carry people.

Leverage Existing Data and Frameworks to the Extent Possible. When there are data limitations due to the current state of limited approvals, where appropriate, leverage existing data sets from similar UAS operations, traditional aviation (including general aviation and helicopters), non-aviation, military data, and data from operations outside of the United States. As noted above, it is essential that the FAA remain mindful in reviewing other data sources that the risk profile for UAS BVLOS operations differs fundamentally from legacy aviation. Industry must advise the FAA as to what data to use and the level of quality required. Specific data to consider includes:

Event sequences, precursors to incidents
Aggregate UA exposure hours without incidents[87]
Routine maintenance performed which may predict potential issues
Incidents, incident rates, exposure groups, phases of flight and risk factors

[86] *See, e.g.,* MITRE report titled Unmanned Aircraft System Air Collision Risk Hazard in the National Airspace System (NAS), https://www.ntu.edu.sg/docs/librariesprovider8/default-document-library/events/amuse2021/post-event/amuse2021ppt_presentation4-3_mikegirbert_mitrecaasd.pdf?sfvrsn=f57e8882_2, March 2021.

[87] A source of data includes the flight safety analysis detailed on pages 5-9 of DJI Technology, Inc. comments to the FAA Remote ID NPRM. Their flight data showed there were 9,632,454 flights in the United States in 2019 with an average flight time of 7.1 minutes. Extrapolating the number of flights showed that it was likely that there were over 27 million flights on DJI platforms alone. DJI estimates that there were over 10.3 million hours of flights by small UA in 2019 alone. The acceptable level of safety for GA in 2021 is considered 0.96 fatal accidents per 100,000 flight hours. The equivalent level of safety would be 98.88 fatal drone accidents for 10.3 million hours of flight.

Leveraging existing data will enable expanded operations by using analogous data to justify the safety case. This data will help establish the target level of safety as well as the key performance indicators which will shift as operations increase and data is accumulated.

Develop a Safety Continuum. There should be a safety continuum for approvals which range from operations exempt from FAA requirements to those requiring stricter oversight. Operations that present a low safety risk would be expected to have minimal FAA oversight. On the other extreme, more complex operations with a higher safety risk should require more involvement by the FAA. Both strategic and tactical mitigations should play an important role in assigning risk values and should be appropriate for the specific risk of the operation.

A risk-based approach is appropriate. Setting requirements for approval based upon the level of risk of the operation is a more efficient method of dealing with risk than a "one-size fits all" approach. Using traditional crewed aviation as an analogy, risk appropriate requirements will enable more types of operations with appropriate oversight with less economic and regulatory burden.

Any certification or approval framework for UAS should account for the extent to which the UAS leverages automatic and autonomous behavior in their BVLOS operations. In many cases, for example, increasing levels of autonomy can enhance safety by reducing the chance for human error.

As risk increases so does the importance of regulation, guidelines, levels of integrity and assurance and standards.

To avoid over-regulation of very low-risk BVLOS operations, consider changing the definition of "visual line of sight" in Part 107 to include situational awareness. This would save FAA time and resources over-regulating very low-risk operations.

Consider a Validation Process for International Approvals. Recommend Phase 2 Working Groups consider a method for accepting or leveraging approvals from competent safety authorities from other civil aviation authorities to fulfill the validation requirements for FAA approval. This will provide a path for increased economic efficiency without increasing the level of risk. If other competent safety authorities have approved an operation, the proponent should not have to repeat the validation exercises. While this does not release the FAA from examining whether the proposed operation meets the national acceptable level of risk standard, it does relieve the proponent from expending additional capital testing.

Promote Shared Responsibility in the NAS. The Subgroup favors exploring a more comprehensive framework of right-of-way responsibility among all users of the NAS and accounting for how collision avoidance responsibility may change over time. Such a framework should consider aircraft capabilities, airspace characteristics and assumption of risk for off-nominal operations.

Consider Prioritization of Life-Saving Operations. The Subgroup recommends Phase 2 consider whether the specific UAS mission should entitle the operations to any prioritization, such as public safety, emergency supply delivery, organ transport, or other life-saving operations. Mission types as well payloads can differ greatly across use cases. For example, there is a high level of public interest in ensuring that missions that are time critical for life-saving operations not be interrupted. These may include delivery of organs, delivery of time critical medicines, disaster response, or public safety operations.

IV. Environment and Community (Subgroup 1.1.2)

A. Key Findings and Principles

UAS have a different environmental footprint than crewed aircraft. As UAS are designed without space for humans and supportive systems onboard, they often are smaller, lighter, slower, and made of different materials while often using electric energy associated with smaller noise footprints than crewed aircraft with loud combustion engines.

Traditional environmental review processes may not apply to UAS. UAS should be considered differently from crewed aircraft when addressing environmental requirements as the key system-wide assumptions that differ between crewed and uncrewed aircraft outweigh their similarities.

A flexible, science-based environmental approach is key to Agency success. The FAA's regulatory processes must properly account for the different ranges and types of noise (e.g., from electric propulsion) as opposed to legacy aviation.

The public's perception of environmental impacts will evolve. The public's tolerance of environmental impacts will change over time as operations become routine and normalized, and as the benefits of the technology are more widely recognized.

The transition from VLOS to BVLOS itself may not drive significant environmental impact. Whether a UAS operation is conducted VLOS or BVLOS does not, itself, typically produce significant differences in environmental impact.

The legacy aviation environmental regulatory process does not meet industry's needs. Due to critical differences between the UAS industry and the traditional aviation industry as described by Working Group 1.2, the legacy process for conducting noise certification and environmental assessments is not appropriate for the UAS industry.

BVLOS operations may enable more environmentally friendly operations. Enabling BVLOS operations can facilitate the replacement of more environmentally harmful operations when conducted at scale.

Focusing on "use cases" is beneficial but may be insufficient. Understanding the equipage and characteristics of a use case can inform the environmental considerations. However, characterizing a use case is not sufficient to understanding its potential environmental impact.

There are data limitations due to limited scope of current operations. The FAA and industry are limited in their analysis of safety and environmental impact by the limited scope of current scaled BVLOS operations in the US.

UAS BVLOS Operations have the potential to enhance Environmental Justice (EJ). BVLOS operations benefit communities which have been, or could be, adversely impacted environmentally because of industrial activity, pollution, or the presence of chemicals, for example.

Operators should consider possible impacts to EJ in their communities. To avoid adverse impacts to EJ, BVLOS operators should consider how their operations could impact nearby communities and seek ongoing opportunities for local outreach and feedback.

The Environmental Subgroup was tasked with identifying environmental considerations necessary to enable UAS BVLOS operations. Understanding such environmental considerations will help maximize and distribute the benefits of UAS BVLOS operation across communities, while minimizing the environmental impacts that would constrain the scaled and responsible growth of UAS BVLOS operations.

The Subgroup's work was guided by FAA's responsibilities under the National Environmental Policy Act (NEPA), which requires federal agencies to consider the environmental consequences of their proposed actions in decision-making and disclose significant impacts to the public, including, but not limited to, air quality and climate, noise, EJ, and more.

Where guidance exists for UAS activity related to environmental concerns, including equity and inclusion, the Subgroup has tried to consult or include those materials. The City of Los Angeles working with an industry group for advanced air mobility recently published "Principles of the Urban Sky" which identify specific concerns and possible ways forward for public adoption of advanced aerial technologies, including UAS.[88] Among these principles are sustainability, equity of access, local workforce development, and low noise. Mitigating EJ biases toward disparate impact is fundamentally important to societal adoption and will largely focus on the perceived trade-off between negative and positive effects of operations by the local communities. It is therefore in the interest of the FAA and industry to ensure that priority is given to operations with the most significant and expansive public benefits.

The Environmental Subgroup was tasked with identifying and documenting:

Concepts of BVLOS operations and their potential environmental impacts across environmental resources areas (e.g., noise, emissions, endangered species, visual).
Approaches to evaluating community response to UAS noise and identification of concepts of operations that may have limited or no community noise exposure.
Whether and how UAS BVLOS operations can enhance EJ.
Environmental and public health benefits of enabling UAS BVLOS operations within the scope of the ARC's objective.
The level of FAA involvement and certification oversight that is appropriate to address environmental considerations.

B. Concepts of BVLOS Operations and Potential Environmental Impacts

As a first step, the Environmental Subgroup identified major use case categories including but not limited to: small package delivery, public safety, agriculture, infrastructure inspection, aerial data

[88] https://www.weforum.org/reports/principles-of-the-urban-sky/principles-of-the-urban-sky#report-nav.

gathering, recreation[89] and entertainment content creation.[90] Within these seven categories, the Subgroup identified where the equipage and operation characteristics (where/how/what/when) in addition to benefits were sufficiently different to prompt evaluation for a range of environmental impact. Phase 2 should consider whether and to what extent BVLOS operations in the enabled use cases could increase environmental impacts, and if so, the potential degree of impact, and likely mitigations to those impacts.

The Subgroup noted that UAS operations are significantly different than crewed aircraft for a number of key reasons that effect environmental impact. Uncrewed aircraft are often not as fast or large,[91] often use electric energy, and have smaller noise footprints than crewed aircraft. As documented by Working Group 1.2, UAS also have significant environmental benefits.

The Environmental Subgroup further noted that while increased *scale* of BVLOS operations would likely have a meaningful impact on noise and community response, the transition from VLOS to BVLOS operation itself is unlikely to have an environmental impact. The environmental impact of any given UAS operation is independent of whether the UA is operated VLOS or BVLOS. For example, there almost certainly will be VLOS operations with more significant and direct environmental impacts than BVLOS operations, and any impact is likely to be greatest in areas of increased use.

There was general consensus within the Environmental Subgroup that certain use cases would have a lower environmental impact and therefore the Subgroup proposes that Phase 2 consider a simplified process for those uses. Use cases that have a lower environmental impact may be those, for example, which take place infrequently and over unpopulated or sparsely populated areas. Use cases that have a higher potential environmental impact are those which occur on a regular basis, at higher volumes, and in proximity to large numbers of people. It is important for both industry and the FAA to develop a comprehensive list of characteristics associated with low, medium, and high environmental impacts to begin any analysis.

C. Approaches to Evaluating Community Response to Noise

Current approaches to evaluating community response to noise remain relatively limited and have yet to explore differences between various types of UAS operation. For now, the Subgroup identified two potential approaches to evaluating community response to UAS noise.

The first approach attempts to identify the differences arising from small UAS as compared to other forms of transportation such as road noise or crewed aircraft. For example, a NASA paper[92] concluded, “Initial analysis of the data from this test indicates that there may be a systematic difference between the annoyance response generated by the noise of the UAS and the road vehicles included in this study.” An article titled, “Drone Noise Levels”[93] in Airborne Drone shows comparisons of decibel levels of a variety of available UAS in comparison to common examples of noises including a jet engine at 100

[89] Note that some stakeholders consider recreational use of UAS outside the scope of the ARC’s activities.
[90] BVLOS ARC Working Group 1.1 Environment’s Environmental Use Case 7-14-21.xlsx.
[91] Larger UAS can more often be found in higher altitudes or in military use cases, though both instances are beyond the scope of this ARC.
[92] Initial Investigation into Psychoacoustic Properties of Small Unmanned Aerial System Noise, Andrew Christian and Randolph Cabell, NASA Langley Research Center, 2017.
[93] “Drone Noise Levels”, Airborne Drones, January 13, 2020, https://www.airbornedrones.co/drone-noise-levels/.

meters, a jackhammer at close range and traffic noises. While some members of the Subgroup disagreed with the recommendation, the article recommends the development of quieter UAS as many of today's consumer and small UAS used in commercial environments come close to the 85-decibel threshold of hearing damage.

A second approach leverages survey and research data on community response to existing operations. The Subgroup reviewed Virginia Tech's 2021 study[94] of a town with commercial UAS delivery which noted that while noise was cited by 17% of respondents as a concern, 75% of respondents who mentioned noise nevertheless felt positively about UAS delivery, and 61% reported being likely to use it. This initial study shows that while sound will be a consideration for communities, it may not be a serious concern due to the small noise footprint of these aircraft. The Subgroup acknowledged that further research and data would be needed but noted that data is limited for BVLOS operations due to the limited approvals in the U.S.

As part of the analysis into the environmental impact of UAS for BVLOS use, the ARC should consider all the available data or studies that could inform the FAA's position on community response to UAS sounds, including:

> As appropriate, analogous noise data from non-aviation and crewed aircraft;
> Existing UAS noise data from IPP and international operations; and
> Research on the impact of UAS sound emissions on humans.

A research paper on the noise emissions and effects on humans[95] concluded that, "the source strength primarily depends on the UAS model and payload, as well as on the operating state and flight maneuver." This supports the conclusion above that an analysis that incorporates equipage and flight characteristics is important in categorizing UAS noise impacts.

The Subgroup also found it valuable to categorize use cases as it relates to positive community response. For example, different emergency medical UAS operations could reasonably be classified as sharing a similarly positive community response independent of its specific concept of operations. The Subgroup therefore encourages Phase 2 to recommend that the FAA explore identifying certain categories of use cases which have an expected or demonstrated positive community response to streamline the evaluation of community response to UAS BVLOS approvals.

Additional research is needed to more definitively establish community response and annoyance both to noise and overflight during scaled BVLOS operations similar to research that the FAA has undertaken to assess noise annoyance for crewed aircraft. In the meantime, and to facilitate more rapid action on a BVLOS rule, the Environmental Subgroup recommends that the FAA and industry work collaboratively to assess whether use cases with potentially high impact on noise would exceed noise thresholds currently associated with high community noise annoyance under likely near- and mid-term operating scenarios. The FAA should also consider whether BVLOS operations normally do not individually or cumulatively

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[94] Perspectives on Drone Delivery, Virginia Tech, Spring 2021.

[95] "Drone Noise Emission Characteristics and Noise Effects on Humans – A Systematic Review. Beat Schaffer, Reto Pieren, Kurt Heutschi, Jean Marc Wunderli, and Stefan Becker. Published in June 2021 in International Journal of Environmental Research and Public Health.

have a significant impact on the environment, and if so, the extent to which some FAA actions to enable UAS BVLOS operations may qualify for a categorical exclusion from environmental review under NEPA.

D. Enhancing Environmental Justice

The extent to which UAS BVLOS operations will enhance EJ depends on an array of factors—including the types of missions BVLOS rules will enable, the locations and populations over which these missions will fly, and steps BVLOS operators take to limit disproportionate adverse environmental impacts over low-income or minority populations. It is also worth noting that members representing EJ communities were invited to participate as members in this ARC to facilitate the inclusion of their perspective in the recommended rules.

The Environmental Subgroup assessed the extent to which BVLOS operations could affect EJ, both positively and negatively. In addition to responding to challenge questions suggested by the FAA, the Subgroup considered elements that could be built into BVLOS operational plans to address potential adverse EJ impacts, assessed what parties might take these actions, and evaluated the extent to which the FAA would need to monitor these efforts.

The FAA has adopted the following definition of environmental justice (EJ):

> *The fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental effects resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and tribal programs and policies.*[96]

This definition is identical to the definition initially established by the U.S. Environmental Protection Agency (EPA) Office of Environmental Justice. The Desk Reference also describes how EJ is considered by the FAA in environmental reviews[97]:

> *Environmental justice analysis considers the potential of Federal actions to cause disproportionate and adverse effects on low-income or minority populations. Environmental justice ensures no low-income or minority population bears a disproportionate burden of effects resulting from Federal actions.*

Enabling BVLOS operations is central to how UAS operations can enhance EJ for two key reasons. First, where the proposed UAS operation serves EJ by operating in areas with inadequate existing transportation infrastructure, the lack of such infrastructure often is what requires such operations to be BVLOS instead of VLOS. Second, many UAS operations that enhance EJ face significant funding and cost difficulties. As such, BVLOS operation is often a necessary (but not sufficient) predicate to pilot and scale such UAS operations that would not otherwise be financially viable if operated VLOS. In other words, many of these benefits would not be realized but for BVLOS approval and are therefore relevant to the decision to approve BVLOS operation.

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[96] Chapter 10, p, 1. *Environmental Desk Reference for Airport Actions,* FAA Office of Airports, October 2007. See also Executive Order 12898 and DOT Order 5610.2.
[97] *Ibid*.

Focusing first on how UAS BVLOS operations could enhance EJ, BVLOS capabilities will enhance air transportation access to EJ communities, including low-income communities and tribal lands. Because they are more cost-effective to operate than larger, conventional crewed aircraft, UA involved in small package delivery (inclusive of medical equipment, test, and pharmaceutical delivery), public safety and emergency response, and infrastructure inspections BVLOS operations would bring benefits that other types of aircraft cannot, at speeds that cannot be matched by ground vehicles.

UAS provide lower cost ways for Americans to access the NAS than crewed aircraft, lowering barriers to entry for individuals and companies of a wider income strata to take advantage of this access. At the highest level, the costs associated with training and becoming a certificated remote pilot are far less than becoming a Part 61 certificated pilot, providing individuals a more affordable path into aviation. This has a further positive impact on STEM, employment and technology transfer. Lower cost of entry into the UAS business is also another positive advantage. At a deeper level, services and goods may be provided to communities that were previously inaccessible by other means of delivery due to technical or affordability issues.

UAS BVLOS operations may also adversely affect EJ; such impacts would be highly mission-specific, defined by the location of operation, volume, time of day, aircraft type, and mission type, among other factors. Similar to noise and general community overflight considerations, missions that are itinerant or infrequent (e.g., infrastructure inspections, emergency response) will likely have negligible impacts, while those that involve repeated operations over the same locations may warrant more detailed evaluation.

The Environmental Subgroup also agreed that many adverse EJ impacts could be avoided entirely or substantially mitigated through effective operational planning and community outreach. For missions that involve recurring operations, for example small package delivery from a central distribution center, flight routes could be established to avoid concentrations of flight activity over low income and minority neighborhoods. Those seeking to fly such missions could engage in community outreach in advance as they plan their operations to ensure that EJ considerations have been addressed prior to starting service in the same way that air risk for UAS BVLOS operations is potentially mitigated through the use of corridors.

E. Environmental and Public Health Benefits

There are significant environmental and public health benefits that can be unlocked by UAS BVLOS operations. For example, carbon emission offset is an obvious public health and environmental benefit that is to be realized through the enabling of UAS BVLOS operations. Many UAS use battery-powered motors as opposed to combustion engines. A 2011 Department of Interior (DOI) study of environmental impact concluded an expected benefit of an electric vehicle was a 38% reduction in energy consumption accompanied with a 23% reduction in CO_2 emissions when compared to the gasoline vehicle.[98] And for physics reasons, electric UAs consume nearly 50x less energy per mile than electric ground vehicles.[99] As the scaling of operations increase the number of operations conducted BVLOS when compared to VLOS operations, it is expected that the use of traditional combustion engine vehicles that were used to

[98] Energy Consumption and CO2 Emissions Evaluation for Electric and Internal
Combustion Vehicles using a LCA Approach, Faias, Sousa, Xavier, Ferreira, May 2011.

[99] How Sustainable Are Drone (UAV) Deliveries?, Miguel Figliozzi, Portland State University ("Per-unit distance the UAV is almost 50 times more energy efficient than the van assuming a 5kg payload Why? Physics!").

complete these operations will decrease. Examples of traditional combustion engine vehicle usage that is likely to be offset by using battery-powered UAS or even small combustion engine UAS include: 1) UAS performing linear infrastructure inspections or news media gathering instead of helicopters, 2) package delivery UAS instead of trucks, 3) agricultural UAS used instead of fixed-wing and helicopters and 4) UAS for insurance operations instead of cars or trucks. A recent study on the economic impact of enabling UAS delivery at a high-density metropolitan area revealed:

> *communities save 95.8-183.2 million miles per year in avoided travel across seven commercial centers, equivalent to 8,333-15,932 cars off the road (including 9.4-10.7% of all delivery and pickup cars).*
> *communities save 36.5-69.9 thousand tons of CO2 per year … (equivalent of 14.6–27.9 thousand acres of new forest).*[100]

Another benefit to be realized by conducting UAS BVLOS operations is the health of people who perform these operations. Inspections of power line utilities have traditionally been performed by helicopters, other crewed flights, or ground-based options. VLOS requirements significantly limit the ability of utilities to use UAS for these operations given the distances to be traveled and other terrain considerations. Helicopter accidents in and around power lines largely occur with crews performing inspections of these lines or by Part 137 agricultural operators performing spraying missions in close proximity to the lines. A Helicopter Association International (HAI) safety guide for utility operators highlighted the dangers associated with these operations citing 25 helicopter accidents resulting in 43 fatalities over the last four decades.[101] The establishment of rules that will allow for these inspection BVLOS will greatly increase the efficiency of these inspections allowing utilities to perform many inspections using a UAS instead of a helicopter, therefore reducing risk of accidents that result in injuries or fatalities.

In most of these use cases where UAS are utilized in place of trucks or helicopters, it should be expected that a reduction in noise exposure for operators and bystanders will be realized as louder vehicles and aircraft are replaced by UAS. Examples of use cases where this would be most realized include infrastructure inspection and news media traditionally performed by helicopter and package delivery performed traditionally by truck.

The use of UAS to perform package delivery has the potential to offset the number of cars and trucks on the road. The Virginia Tech Study referenced above on the impact such missions would have on a high-density metropolitan area revealed between 244-466 fewer car crashes per year for a given city. This reduction would yield a health benefit through the reduction in car accidents.

Other health benefits likely realized through the expansion of UAS operations under BVLOS rules include the delivery of potential lifesaving equipment such as Automated External Defibrillators, commonly known as AEDs, a lifesaving tool which is most likely to be effective when delivered in the first five minutes of a heart attack. The median arrival time of EMS services in the U.S. via ground transportation is eight minutes with remote areas being as long as 30 minutes. Delivery via UAS has the potential to cut

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[100] Virginia Tech Measuring the Effects of Drone Delivery in the United States, Lyon-Hill, Ellis, September 2020
[101] HELICOPTER ASSOCIATION INTERNATIONAL Utilities, Patrol and Construction Working Group UPAC Safety Guide for Helicopter Operators, July 2020.

these times significantly. [102] Other lifesaving devices such as epi pens for insulin injections and organ transplants also could benefit from faster delivery facilitated by UAS. Further information on the health benefits of scaled BVLOS operations can be found in Working Group 1.2's report.

The Subgroup noted that it may be useful to identify use case categories with positive environmental benefits. For example, different UAS forest conservation operations could reasonably be classified as sharing a similarly positive environmental benefit independent of each operation's specific concept of operations. The Subgroup recommends that Phase 2 consider the benefits of identifying certain categories of use cases with positive environmental benefits to streamline the evaluation of

F. FAA Involvement in Certification and Oversight

FAA's usual level of involvement in certification and oversight for environmental compliance in traditional, crewed aircraft is not suitable for UAS, especially small UAS (sUAS), for both market-related and environmental reasons. Given their shorter product development and life cycles, more rapid means of modification, and reduced environmental impact based on size and propulsion, FAA should consider UAS differently when addressing environmental requirements.

To enable BVLOS operations at scale, given all the different factors discussed in this report, the FAA should rely on an approach to approval and oversight whereby specified actions or operations qualify for a categorical exclusion. Refer to the report of Working Group 1.2 for additional information on the dynamics of the market and the report of Working Group 1.3 on the specific regulatory rules that should be considered.

Privacy Considerations

The Environmental Subgroup could not reach consensus on whether the general public's response to privacy considerations are within the scope of the UAS BVLOS environment & community tasking. For purposes of this discussion, the general public includes those individuals in areas with BVLOS operations who are not directly involved in the operations.

Members of the Subgroup noted that UAS may at times be equipped with powerful surveillance devices, and that there will be uses of the technology that spark objections in communities. The Subgroup discussed the history of the FAA's position regarding regulation of privacy, and the scope of environmental impact and community response under consideration. The Subgroup did not reach consensus as to whether BVLOS operations warrant the FAA's reconsideration of its past positions. A portion of the Subgroup remains concerned about the privacy implications from expanded BVLOS operations. Those members proposed consideration be given to (1) transparency around UAS' capabilities and operations, (2) ensuring baseline privacy safeguards, and (3) the inclusion of mechanisms by which privacy problems that emerge can be addressed to the satisfaction of the communities affected by those problems.

G. Findings and Recommendations

Findings:

Public's perception of environmental impacts will evolve. The public's tolerance of environmental impacts will change over time as operations become routine and normalized. As operations increase,

[102] Drone Delivery of an Automated External Defibrillator, N Engl J Med 2020.

the benefits of the technology are realized by society and the technology improves, it is likely that the public's perception of the environmental impacts will evolve.

The transition from VLOS to BVLOS itself may not drive significant negative environmental impact but will likely drive positive societal outcomes. Whether a UAS operation is conducted VLOS or BVLOS may not, itself, typically produce significant differences in environmental impact. Rather the environmental impact is most relevant to approvals for normalized, scaled operations. Enabling BVLOS will in many cases facilitate such scaled operations, and in most cases, it will be the scale of operations that chiefly drives an increased environmental impact, rather than the transition from VLOS to BVLOS. Therefore, any scale that qualified for a categorical exclusion under VLOS rules should qualify for the same categorical exclusion under the BVLOS rules.

The legacy aviation environmental regulatory process does not meet industry's needs. Due to critical differences between the UAS industry, including the technology and concepts of operations, and the traditional aviation industry as described by Working Group 1.2, the legacy process for conducting environmental reviews is not appropriate for the UAS industry. The traditional approaches for granting certifications, approvals and exemptions and conducting lengthy environmental/NEPA reviews do not meet the needs of industry. A new methodology for approval of noise, analyzing environmental impact and approving operations is required to meet the market cycle and smaller vehicular footprint.

Traditional environmental review may not apply to UAS. UAS should be considered differently from crewed aircraft when addressing environmental requirements. The transient nature of UAS use does not lend itself toward the current environmental analyses often focused on infrastructure (airports, control towers, transportation access). An FAA approach that relies on assessing the environmental impact of UAS operations on a case-by-case basis would be burdensome to FAA as well as industry and make it impossible to scale BVLOS operations.

BVLOS operations may replace operations with a greater environmental impact. Enabling BVLOS operations can replace more environmentally harmful operations. The Environmental Subgroup agreed that in certain circumstances more environmentally-friendly BVLOS operations will replace traditional vehicle operations which have a greater environmental impact – for example with delivery of small packages. These gains (reduction of packaging, reduction in vehicular traffic, new modes of supply chain integrations that increase efficiency and reduce waste) should be considered when weighing the restrictiveness of policies and regulations that could significantly delay or hamper the realization of the reduced environmental impact of BVLOS operations.

BVLOS operations may have increased health benefits over traditional operations. Many traditional services that offer health benefits such as those performed by first responders, emergency services and general medical accessibility can be greatly improved through speed of delivery with UAS BVLOS operations. Additional, non-contact deliveries (including during global pandemics) can reduce exposure through BVLOS operations when compared to VLOS or traditional ground deliveries. The health benefits gained through BVLOS operations should be considered when weighing the restrictiveness of policies that may dissuade the development of UAS and operations for these use cases.

UAS BVLOS operations have the potential to enhance EJ. BVLOS operations benefit communities which have been, or could be, adversely impacted environmentally because of industrial activity, pollution, the presence of chemicals, etc. Aerial data gathering by UAS could enable improved monitoring and mitigation of environmental degradation at lower cost, reducing barriers to accessing data, while also assisting in rural and urban planning that avoids such negative impacts. Small package deliveries by UAS may reduce the volume of ground transportation in or through communities. In some cases, BVLOS operations will replace helicopter operations over EJ communities, reducing noise and emissions impacts.

Operators should consider possible EJ impacts in their communities. To avoid adverse EJ impacts, operators conducting UAS BVLOS operations should consider how their operations could impact nearby communities and seek ongoing opportunities for community outreach and feedback. Operators should not only consider the impact their operations have on nearby communities but whether the impact of the operations falls disproportionately on marginalized communities.

Recommendations:

Leverage existing frameworks for noise certification and environmental assessments. The Environmental Subgroup determined that the FAA should be encouraged to leverage, to the extent possible, existing applicable frameworks to provide UAS with categorical exclusions under NEPA, broader exemptions from certifications or assessments and to identify potential areas for harmonization on BVLOS rulemaking.

- **Consider whether potentially high impact operations exceed existing noise thresholds.** The Subgroup recommends that the FAA and industry work collaboratively to assess whether use cases with potentially high impact on noise would exceed noise thresholds currently associated with high community noise annoyance under likely near- and mid-term operating scenarios.
- **Leverage existing P107 findings.** For certain BVLOS operations, for example those with a small noise footprint and minimal operations over non-participating populations, it may be appropriate to continue to leverage and rely on the research and data that was collected in support of the P107 categorical exclusion.
- **Explore broader categorical exclusions and exemptions**. To enable BVLOS operations at scale, FAA should rely on an approach whereby specified actions or operations are categorically excluded from environmental processing. The Federal Communications Commission's approach to telecommunications facilities as described in 47 CFR § 1.1306 provides an instructive example.
- **Explore areas of international harmonization**. Explore UAS Noise regulations by other Civil Airworthiness authorities like EASA for areas of harmonization on BVLOS rulemaking.[103]

Utilize programmatic assessment techniques in the evaluation of UAS BVLOS operations' environmental impacts to expedite the rulemaking process. It is difficult to forecast with certainty the range, volume, and characteristics of UAS BVLOS activity that will occur following issuance of a BVLOS rule. Given these uncertainties, a programmatic approach to UAS BVLOS rule environmental impact assessment (which does not require a location-by-location analysis) may be warranted.

[103] *See* Easy Access Rules for Airworthiness and Environmental Certification (Regulation (EU) No 748/2012).

This approach would enable subsequent tiered analyses of specific UAS BVLOS operations as these concepts of operations are defined and impacts can be more accurately estimated without holding up a more general BVLOS rule until these parameters are definitively known. This approach would also enable use cases with lower potential environmental impacts to undergo environmental evaluation early and possibly enable their qualification for categorical exclusion as suggested in the prior recommendation.

Utilize industry community outreach data and environmental assessments. BVLOS operators should proactively seek to engage with communities, understand the environmental impact of their operations and avoid placing a disproportionate amount of the burden of operations on traditionally marginalized communities. Phase 2 should consider whether there are opportunities for the FAA to rely on the community surveys or environmental impact assessments conducted by operators (or third parties) and create opportunities for self-certification.

> **Review Best Practices.** Any best practices for community outreach, notification and feedback gained from the UAS Integration Pilot Program (IPP) or subsequent BEYOND program should be considered and promoted.[104]

Consider the Environmental and Public Health Tradeoff. When considering rules that might restrict UAS BVLOS operations that could be realized, Phase 2 should encourage the FAA to consider:

> **Environmental Tradeoff**: The effect any rules will have on enabling a technology and industry that could promote a reduction in environmental impact when compared with vehicles currently used for comparable operations.
>
> **Public Health Benefits Tradeoff:** The direct impact that delaying or denying BVLOS operations may have on the health outcomes of individuals at risk. disconnected communities otherwise unable to access services and goods equitably, and the lifesaving possibilities these operations might offer.

V. Security Considerations (Subgroup 1.1.3)

A. Key Findings and Principles

Differing and evolving security concerns. BVLOS security regulations should not be static or uniform, but rather must reflect the varying degrees of security risk that different types of operations, operators, or other elements create.

Benefit/risk tradeoff. Security requirements should reflect the risk and benefits of UAS operations.

Regulations should enable near-term operations. BVLOS regulations should provide an immediate path forward for BVLOS operations.

UTM may become necessary in a future state. Complex, large-scale BVLOS operations may require UTM.

[104] As of the time of this report, the IPP report has not been made available to the UAS BVLOS ARC. Consequently, the ARC has not been able to consider learnings from the IPP experiences; and two members of the ARC sent a letter to DOT on July 27, 2021, to request access to the IPP data and any draft reports regarding the UAS IPP.

Technology-neutral. BVLOS regulations must be technology neutral, performance-based, and, when possible, leverage internationally-recognized standards.

Federal certification. Federal regulators should have sole authority to certify and vet UAS operators.

Regulate only to the extent necessary. New or enhanced security concerns from BVLOS should be addressed and mitigated through measured proposals that also protect privacy interests.

The Security Subgroup focused on how to identify and address BVLOS security risks such that the benefits of BVLOS operations could be realized without compromising public safety and national security. The Subgroup considered what sort of regulations, processes and technologies could be employed by private and public entities to protection the NAS and associated infrastructure, as well as reduce the risk of malicious actors, with respect to BVLOS operations.

B. Categories of Security Concerns Relevant to BVLOS

Per the ARC charter, the Subgroup focused on security concerns specific to BVLOS. The Security Subgroup identified five issue areas for security to frame the discussion:

- **Security framework**: What BVLOS regulations and infrastructure are necessary to enable BVLOS in the near term, while evolving to manage BVLOS operations as industry scales over time?
- **Operator Authorization**: What security-related measures or process should be required before an operator is authorized to fly BVLOS?
- **Privacy:** How should the ARC address the tension between having the ability to identify UAS conducting BVLOS operations in order to engage in risk assessment and mitigation, versus the cost to privacy interests from increased transparency about UAS operations and operators?
- **Cybersecurity**: How can we collectively protect against increased cybersecurity vulnerabilities posed by BVLOS operations?
- **Physical security**: What are potential solutions for airspace access near sensitive sites and significant events as well as for physical security of relevant equipment?

The Security Subgroup felt that the important security concerns raised by BVLOS operations could be organized in the above categories; no other security concerns or principles were raised by members, the FAA, or security agencies that were not addressed by the five categories above.

The Security Subgroup also considered whether to organize its discussions around specific use cases, and ultimately decided against doing so. While there is recognition that not all types of operations pose the same levels of security risks–for example, UAS operations to start controlled burns of forests are likely to raise greater security concerns than UAS operations to deliver grocery items or to conduct newsgathering operations–any BVLOS regulations should ultimately account for the varying degrees of security concerns.

C. Security Considerations

Security Agency Feedback

Relating particularly to UAS BVLOS operations, the Department of Justice (DOJ) stated that it desires "full vetting by security agencies of all proposed UTMs and Network-based Remote ID service suppliers." This statement warrants further consideration during Phase 2 and the ARC ought to consider the views of all relevant stakeholders. In particular, Phase 2 should determine whether "full vetting" is required, what "full vetting" constitutes, who would manage that vetting, how to ensure the requirements are performance-based and risk based and whether that would subject UAS to stricter security standards than crewed aviation. Phase 2 should recommend that the security agencies and the FAA engage with industry about the security concerns and how to tackle them. The current process for LAANC UAS Service Suppliers, including performance, security, and data management requirements should serve as a valuable benchmark.

Cybersecurity

To the extent Phase 2 develops cybersecurity recommendations, Phase 2 should consider the following key focus areas:

32. Recognize that many cybersecurity issues are not unique to UAS, but shared across many technology platforms;
33. Identify potential threats, vulnerabilities, and consequences;
34. Identify unique vulnerabilities with BVLOS operations assuming a nominal level of security controls and a Security Risk Management Plan (SRMP);
35. If appropriate for the ARC to do, define a plausible attacker profile; and
36. Identify critical controls as well as gaps in the available industry standards

To address supply chain threats and assess the security risks to technical effectiveness and functions, and address weaknesses and vulnerabilities, the Security Subgroup suggests undertaking a review of existing protocols and procedures in place to enable traceability, verification, and validation such as by using a documented plan that includes a process for managing (identifying, assessing, and addressing) the risks introduced by the supply chain.

While these considerations look at the design and production of the aircraft, further controls of the equipment that interfaces with the vehicle as well as the software of those components external to the vehicle needs to be taken into consideration to maintain airworthiness.

Although there are a few similarities between the aircraft and the Ground Control Station security interfaces, the GCS's function and role allows it to take advantage of other types of solutions, such as physical security.

With respect to the performance requirements of the command and control (C2) link, a target level of resilience should be defined and the FAA should recognize a range of mitigations to meet that target level depending on the C2 sensitivity of specific operations. This includes how to identify and mitigate threats to the C2 link, and how to determine the suitable security risk control measures to be applied for the C2 link as well as the accepted C2 link cybersecurity techniques and procedures for the recovery of control of a lost UAS.

Privacy[105]

With respect to privacy, Phase 2 should consider the following:

Protecting First Amendment activities such as newsgathering operations and political activism activities from any new consideration of general public privacy.

[105] The ARC should also consider the existing NTIA Privacy Best Practices for the UAS Industry.

- Adding certain requirements, such as proportionality, data minimization, privacy impact reports, and guidance regarding which privacy issues should fall within the FAA's purview to regulate and which should be deferred to other agencies and communities; and
- As appropriate, recommending the FAA require operators to stay within the parameters of operations outlined in their authorization to the extent applicable

HAZMAT

Phase 2 should review the regulations and processes in place required to transport HAZMAT and other items with restrictive designation, such as weapons. Such regulations pertain to crewed aviation, and Phase 2 should consider whether these regulations are appropriate for BVLOS operations. Are the regulations appropriate given the small size of UAS, and the fact that UAS do not carry passengers? Are they an overly cumbersome barrier to entry for small operators and excessive relative to the security benefits gained?

D. Scope Considerations

Privacy

The Security Subgroup could not reach consensus on whether the general public's privacy concerns are within the scope of BVLOS security considerations. For purposes of this discussion, the general public includes those individuals in areas with BVLOS operations who are not directly involved in such flights.

With respect to certain categories of BVLOS operations, including First Amendment and civil liberties use cases such as newsgathering operations and political activism, the Subgroup agreed that the privacy considerations of the general public are not within the scope of BVLOS security concerns. That is, because of the constitutional implications of journalism and political activism, the privacy interests of the general public in the vicinity of these operations are out of scope, and to the extent general public privacy is brought within the scope of Phase 2 considerations, these activities should be carved out from that discussion.

The Subgroup also discussed the history of the FAA's position regarding regulation of privacy in the rulemakings for Part 107, Remote ID and Surveillance, and Flight Operations Over People. The Security Subgroup acknowledged that in these prior rulemakings, the FAA determined that the privacy of the general public was out of scope. The Subgroup did not, however, reach consensus as to whether BVLOS operations warrant the FAA's reconsideration of these past decisions, but agreed that given the time constraints of this ARC, this process is not suited for drafting comprehensive privacy laws.

A portion of the Subgroup remains concerned about the privacy implications, which it views as an enhanced security risk from expanded BVLOS operations related to: (1) the activities of law enforcement, (2) the collection and storage of data (whether intentional or inadvertent) during delivery operations, and (3) any information-sharing agreement between law enforcement and commercial UAS operators.

Physical Security

While physical security risks exist with VLOS operations, the introduction of BVLOS has the potential to increase these risks. Notably, the FAA is currently considering UAS physical security issues through its forthcoming (separate) rulemaking on implementation of Section 2209 of the 2016 FAA Extension Act.

Federal security agencies have expressed concerns that BVLOS offers new tools for would-be terrorists or other malicious actors. However, there was not consensus among members of the Security Subgroup that physical security is differently relevant to BVLOS operations than general VLOS operations.

Members of the Subgroup expressed concerns that if physical security is not addressed in the ARC report, industry will miss its opportunity to provide its views on an issue for which security agencies will require consideration in any BVLOS rules. For that reason, those members urge Phase 2 to address physical security considerations, including the following:

- The sanctuary provided to operators by geographic remote control of a UAS operation
- How to increase the physical security of sensitive ground sites during BVLOS operations, such as through a delegation of authority to USS
- Whether the FAA has jurisdiction over the security of the operator and drone itself, and if so, how to secure operators and UAS, which if threatened or hijacked create a new security issue.

E. Findings and Recommendations

Findings:

Differing and evolving security concerns. BVLOS security regulations should not be static or uniform, but rather must reflect the varying degrees of security risk that different types of operations, operators, or other elements create.

Benefit/risk tradeoff. The more benefit a specific BVLOS operation, or category of BVLOS operation, affords to society, the more "risk" the public should be willing to assume with respect to security.

Regulations should enable near-term operations. BVLOS regulations should provide an immediate path forward for BVLOS operations.

UTM may become necessary in a future state. Complex, large-scale BVLOS operations may require UTM.

Technology-neutral. BVLOS regulations must be technology neutral, performance-based, and, when possible, leverage internationally-recognized standards.

Federal certification. Federal regulators should have sole authority to certify and vet UAS operators.

Regulate only to the extent necessary. New or enhanced security concerns from BVLOS should be addressed and mitigated through measured proposals that also protect privacy interests.

Recommendations:

Security requirements for BVLOS should be implemented in a phased approach that allows for a limited number of BVLOS operations through an initial rulemaking, while a larger regulatory and physical framework is developed to address industry-wide BVLOS operations as the industry scales over time.

There was wide-spread consensus that supporting multiple complex BVLOS operations will require a federated cloud-based UAS traffic management system, commonly referred to as uncrewed traffic management (UTM). However, that system will take time to develop, while many UAS operators are already capable of safely conducting BVLOS operations, and many simpler BVLOS operations involving lower risk levels may not require a high degree of oversight or coordination. Regulations should provide a near-term solution that will allow such operators the ability to conduct BVLOS operations immediately after the regulations are finalized. Initially, the number of operators capable of conducting complex BVLOS operations will be limited, therefore the security requirements for BVLOS may be more cumbersome, e.g., less automated, than the envisioned but eventual, UTM system.

Regardless of whether the rules are intended to address simple, small-scale BVLOS operations or pertain to the development of a full-scale UTM, rules must be technologically neutral and performance-based (e.g., state the outcome, not the process).

Near-Term BVLOS Operations

Phase 2 should look to simply extending existing systems, such as Remote ID or LAANC for the initial regulatory framework and corresponding infrastructure for BVLOS operations. Expanding Remote ID to require network connectivity could resolve identification and authentication (if a commercial mobile network is used) concerns for medium- to high-risk operations. LAANC provides a framework for a trusted operator approval process, as well as airspace restriction communication.

The following security factors should be considered, but are not dispositive, in determining whether an operator can fly in early stage BVLOS:

- Trusted operator status (see below)
- The security of the UAS being flown
- Geographic risk assessment (e.g., urban, rural)
- Network availability (or lack thereof)
- Cybersecurity measures implemented

Complex BVLOS Operations

As noted above, there was consensus that complex, scaled BVLOS operations will benefit from a UTM system. UTM should ensure safe and secure airspace access while having sufficient flexibility to adapt to new technologies, use cases, security risks, and more. To that end, with respect to security considerations, the UTM must:

- Limit USS service providers to entities that meet enumerated security benchmarks set forth in FAA regulation and administered by the FAA leveraging internationally-recognized standards.
- Include an authentication system for any operator attempting to access the UTM.
- Limit external access to UTM information to the needs of the requesting party (e.g., restrict access to personally identifiable information (PII)).
- Implement proactive cybersecurity measures to constantly check and probe (through manual and automated processes) the UTM systems for weaknesses and or breaches. This is to ensure a robust system-wide time to recovery when incidents occur. Be a federated "system of systems" with consistent cybersecurity protections and capabilities in each system.

- Provide scalable services that account for the different security needs of different operations, operators, and other use case factors, such as:
- Identity verification (e.g., “trusted operator” status)
- Conformance monitoring and tracking
- Intruder alert
- Dynamic airspace configuration

In particular, the Security Subgroup recommends that Phase 2 refer to the FAA UPP2 Security Analysis for recommendations on UTM security.

<u>BVLOS regulations should include a path for certification as a “Trusted Operator,” which would be administered by the federal government and allow certified operators streamlined access to BVLOS operations.</u>

There was general consensus among the Security Subgroup that FAA should establish a “Trusted Operator” program, where UAS operators that meet established parameters may receive special designation authorizing higher-risk operations, differentiated privacy standards, or other BVLOS capabilities not available to operators outside of the program.

Trusted Operator status should include heightened security requirements and approvals that establish a “meaningful bar”. Doing so will not only justify any reduction in security protocols, but will also give communities confidence that such operations pose a low security risk. Additionally, the framework should include parameters for when and how a Trusted Operator would lose its status.

Phase 2 should consider how a Trusted Operator program would be administered, whether by the FAA or another agency directly, or if the federal government could authorize other entities to administer the designations. LAANC may be instructive in this regard, along with TSA’s “trusted” or “known” operator or user programs such as Pre-Check, Known Shipper, and Global Entry. Such programs have supported the government’s ability to identify legitimate threats while minimizing the burden on system participants. A similar voluntary and user-funded program to pre-vet operators for security purposes would enable the FAA to maintain a database of approved UAS BVLOS operators, which would help the relevant agencies and public safety officials with threat discrimination and streamline the process for authenticating UAS operators.

Phase 2 should consider what information a Trusted Operator application should require. Items for consideration include:

- Part 107 (or other BVLOS-related (see below)) licensing information
- Increased security vetting for pilots and (as applicable) commercial entities
- Increased security vetting Operator(s) and (as applicable) commercial entities.
- Information on the specific UAV to be used
- Operation locations

Approved Trusted Operators should receive the benefit of heightened privacy and less intrusion by either law enforcement or the general public into their identifying information. For instance, in exchange for obtaining the Trusted Operator status, such operations should be protected by a higher threshold before law enforcement can access personal identifying information (PII), such as “probable cause" or "reasonable suspicion." This possibility of greater privacy could incentivize more operators to obtain this certification, which would, in general, mitigate overall security concerns with expanded BVLOS operations.

Phase 2 should also consider whether Trusted Operators would receive any additional benefits.

FAA must establish a process for authorizing BVLOS operations outside of Trusted Operator certification, including the parameters of the authorization. As with other security-related considerations, the extent of the authorization should be commensurate with the risks posed by the operation.

Phase 2 must set forth the information that should be required to receive authorization for BVLOS operations. The Security Subgroup recommends considering information such as:

- Size (weight) of UAV
- Duration of operation
- Use case
- Operating speed
- Location of flight
- Network connectivity and reliability
- Distance of operation from the operator, size of UAS
- Payload (whether and type)
- Proximity to people (and number of people) or sensitive sites
- Public entity, public contractor, or private entity
- Privacy policy
- System security

Phase 2 must also address whether BVLOS will require pilot licensing separate or beyond Part 107. Whether or not such licensing is necessary from a security perspective is not clear. First, the stringency of and the process behind the security vetting under Part 107 is opaque, and therefore, difficult to assess whether Part 107 security vetting is sufficient for BVLOS operators. Additionally, a similar situation exists with respect to security vetting for crewed aviation, although it seems unlikely that BVLOS operators should routinely require stricter security review that pilots operating 747 jets carrying passengers. Phase 2 should conduct a deeper review of security vetting under Part 107 as well as crewed aviation and make appropriate recommendations based on the specific nature of UAS BVLOS operations.

If determined to be in scope, Phase 2 must also consider whether hobbyist BVLOS operations warrant any different, or additional, security-mitigation measures. Whereas commercial UAS operators have an incentive to be "good actors" in order to maintain their certification, hobbyists may be more likely to pose security risks, whether inadvertently or deliberately, and as such, may warrant more transparency regarding their BVLOS operations.

The general public should have available a process to report actual, articulable harms, whether privacy, security or safety related, related to a specific BVLOS operation and receive reassurance that the operation is lawful.

Although there was consensus that the general public should not have access to PII and other identifying information regarding UAS operators, there was general consensus that there should be a process for reporting and receiving assurance about the lawfulness of a particular BVLOS operation. Where possible Phase 2 should recommend that the FAA and other agencies rely on existing reporting mechanisms. In addition, while there is general consensus that such a process could be aided by the implementation of UTM, it is less clear whether a path exists for such a process prior to the establishment of UTM. An expanded Remote ID system may provide one path forward for providing the general public with certain assurances about the lawfulness of an operation in the near-term for medium to high-risk operations. Phase 2 should consider whether this is feasible and if it would delay the deployment of near-term BVLOS. Moreover, as discussed more fully elsewhere, the ARC should recommend that industry actively reach out to communities in the course of deploying operations, particularly in the proximity of residential areas.

BVLOS rules should leverage existing methods for operator authentication.

Operator authentication verifies that the UAS operator is the individual or entity that they claim to be. Lack of authentication is a vulnerability that could allow a nefarious UAS operator to claim the identity of a trusted or approved operator in order to conduct prohibited operations without identification. User authentication exists in many industries outside of UAS, and is an important cybersecurity consideration whenever anyone attempts to connect to a network resource using a specific identity.

Phase 2 should look to existing authentication methods, such as those used by cell phone network operators, banks, and others, that verify customer identification before allowing a user to proceed with higher risk operations. This is important and relevant because operator identification will necessarily occur remotely, through digital, network systems and certification of operators is worthless if the operator identity cannot be ensured.

Cybersecurity considerations are not unique to UAS, and therefore, BVLOS rules should leverage existing technical, certification, and onboarding standards.

UAV security design should align with the philosophy set forth in FAA Policy Statement *Establishment of Special Conditions for Cyber Security*, PS-AIR-21.16.02 Rev.2 with respect to non-government networks, software loading, access to control systems versus, and any points of connection to the internet.

Security design should also include software assurance and hardware assurance at the component, sub-system, and system level. RTCA DO-178, Software Considerations in Airborne Systems and Equipment Certification, may be instructive.

Key cybersecurity areas of vulnerability for UTM and UTM-related entities are message security, key management, Denial of Service (DoS) protection, and identity management. These vulnerabilities are not unique to UAS, and therefore, rather than attempt to create new BVLOS rules should leverage existing technical, certification, and onboarding standards such as ASTM F3411-19, *Standard Specification for Remote ID and Tracking*; ASTM WK63418, *New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability*; and ISO/IEC 27001, *Information Security Management* to address those concerns. CTA R14 WG3 – Small UAS Cybersecurity Standard (ANSI/CTA-2088.1) and publications by the GSMA/GUTMA Aerial Connectivity Joint Activity (ACJA), including the study of the use of IEEE 1609.2 cryptographic credential and security services certificates, may also be instructive.

Compliance with FIPS 140-2 for Encryption and authentication requirements should rely on FIPS 140-2, which is technology neutral and evolves to meet the ever-changing cybersecurity landscape. To be FIPS 140-2 certified or validated, the software (and hardware) must be independently validated by one of 13 NIST specified laboratories. Current FIPS 140-2 compliance requires AES256 encryption. Both data at rest and in transit should be secured with end-to-end encryption. Further, both data inside of the ecosystem as well as sensitive design data about ecosystem elements should be secured and encrypted, as access to critical design data can allow attackers to bypass all security layers installed. LAANC UAS Service Suppliers are already required to meet this level of encryption.

The Security Subgroup also recommends leveraging the International Civil Aviation Organization (ICAO) Global Aviation Trust Framework, which provides a high-level, globally inter-operable architecture that proposes a multilayer defense to cyberattacks and outlines the characteristics of a global resilient aviation network, building on the capabilities of public key infrastructure, internet protocol version 6 (IPv6), a domain name system, and information security management systems.

Additionally, the Security Subgroup recommends leveraging IEEE, Aircraft Systems Information Security Protection (ASISP) policy, including:

- Development Assurance Industry Process Standards
- RTCA DO-178C "Software Development Guidance"
- RTCA DO-254 "Airborne Electronic Hardware Development Guidance"
- ARP 4754a "Guidelines for Development of Civil Aircraft and Systems"
- ARP 4761 "Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems"
- AIR7121 Applicability of Existing Development Assurance and System Safety Practices to Unmanned Aircraft Systems (currently under development).

It is strongly recommended that FAA leverage the security analysis from UPP2 Security Analysis. Key mitigation controls can be considered, and the Security Subgroup recommends those listed below at a minimum aligning with ISO 270001 standards and the ICAO Aviation Trust Framework:

- Attack and Penetration Testing
- Security code reviews
- Static code analysis for security purposes
- Security Trend and Performance Monitoring (using secure logging and a Security Incident and Event Management (SIEM) system)
- Implementation of Intrusion Detection and Prevent Systems (IDS/IPS)
- Message signing
- Physical security tests
- Trust Monitoring and Revocation process
- Use of a protected credentials storage and monitoring for access to keys/tokens and the key life cycle (e.g., including monitoring of expiration and revocation status)

In addition to the resources above, BVLOS cybersecurity should be considered from a system perspective, including the following elements: hardware (drone, GCS, and operations interfaces); software (hosted on the drone or GCS); Communications link; and data (in transit and at rest).

Hardware elements inside of the ecosystem should be trusted to the fundamental design components. Phase 2 should consider existing rules around firmware-over-the-air (FOTA) updates and restrictions on use of foreign-made UAS, although given widespread current use of foreign-made UAS, careful consideration will need to be given to balancing security considerations vs. costs to operators and whether grandfathering or other solutions that will not require wholesale replacement of operators' existing fleets are appropriate in order to conduct BVLOS operations. Semiconductors and Integrated Circuits may warrant consideration based on country of origin, while personal devices serving as GCS or operations interface may contain vulnerabilities in their ecosystems from ransomware attacks. Protection of personal devices should be considered via device management software or other solution.

The Security Subgroup agreed that both data at rest and in transit should be secured with end-to-end encryption. Further, both data inside of the ecosystem as well as sensitive design data about ecosystem elements should be secured and encrypted, as access to critical design data can allow attackers to bypass all security layers installed.

To ensure that performance issues do not pose security risks, the Security Subgroup recommended that communications links should use small packet transfers with end-to-end encryption of all data. Packets should be 128kb or less in size, including those for firmware and software updates. The Subgroup noted that it would be consistent with FAA policy for devices to be updated only when in maintenance mode via scheduled or routine maintenance, where the update can be done in an offline fashion on a protected network.

Additionally, all networks involved in the UAS operations must be secure, with secure handshaking occurring across all network elements. The level of network security required for BVLOS should take into consideration different communications links and modes of operations. Phase 2 should consider how 5G and associated industry standards issued by 3GPP can protect against cybersecurity vulnerabilities. Phase 2 should encourage regulators to establish high-level risk- and performance-based rules for the security of C2 communications that can be addressed by industry standards issued by the appropriate standards bodies.

BVLOS regulations should consider the privacy interests of UAS operators and customers.

The Security Subgroup agreed that having transparency into UAS operations may mitigate security risks, but further agreed that transparency comes at a cost to privacy of UAS operators and customers and that consideration must be paid for how much transparency is needed to mitigate security risks.

The Security Subgroup identified three categories of individuals/entities whose privacy may be implicated by security concerns: (1) UAS operators and remote pilots, (2) UAS customers, and (3) the general public, but could not reach a consensus on whether the general public's privacy concerns are within the scope of BVLOS security considerations

For example, with respect to UAS operators (e.g., pilots in command and the companies behind the operation), enhanced security risks and privacy concerns from BVLOS operations may be mitigated by having greater transparency into the company that operates the UAS without needing greater transparency into the identity of that company's specific UAS pilot.

With respect to UAS customers, such as those who receive a service via UAS, like a prescription delivered via UA, in general it seems unlikely that increased transparency into who is receiving the service, or what the service is, will have an impact on mitigating security risks. For example, the frequency with which a household receives package deliveries is not generally relevant to mitigating a security concern. Therefore, the Security Subgroup favored a presumption of privacy that reflects minimal data gathering and intrusion into customer privacy absent either (1) a determination that a specific type of UAS customer poses a greater security concern and warrants heightened transparency or (2) an actual articulated security risk. Phase 2 should also address where the responsibility or burden should lie for gathering, and making transparent, any customer data. Possibilities include the FAA, the UAS operator, or the customer.

Phase 2 should consider:

- The type of activity being conducted on behalf of the customer;
- The extent to which even seemingly innocuous information, like flight paths, could be triangulated and correlated in a way that intrudes on customers' privacy for low-risk BVLOS operations; and
- Who should bear the responsibility and burden for gathering, and making public, any customer data that must be made public? The FAA? The UAS operator? The customer?

The ability to identify which UAS belongs to which operator, and which type of operation(s) that UAS has been cleared to conduct, is likely sufficient information to enable the FAA and law enforcement to identify security concerns. Additionally, BVLOS regulations should utilize the general framework established by Remote Identification – session ID plus the Part 48 database (registration and marking) – for information sharing and access.

Any additional information required for BVLOS operations should not be included in the Part 48 database. Phase 2 should consider what information is necessary to mitigate security concerns, and limit the scope of information in the Part 48 database to mitigate the privacy intrusion by the FAA and law enforcement to specific operations.

As with the Remote ID Final Rule, the public should not have access to specific, identifying information about BVLOS operations, whether in real-time or more generally.

BVLOS regulations should include a provision that any law enforcement inquiries into PII of UAS operators are subject to FOIA.

The public should be provided with insight into whether law enforcement is abusing its ability to gather information about UAS operations under the guise of new or enhanced security/law enforcement concerns from BVLOS. Phase 2 should further consider language that makes clear such inquiries are, presumptively, not exempt from disclosure pursuant to any of the FOIA exemptions contained in 5 U.S.C. 552(b)(7*).*

VI. Market Drivers (Working Group 1.2)

As has been discussed, regulatory frameworks in the U.S. have lagged behind technology. Current regulatory frameworks track legacy crewed aviation, but the UAS industry looks and acts differently from legacy aviation in important ways. As this report will describe, the UAS industry is diverse and funded by a range of backers, with expectations of commercial viability. It is difficult or impossible to demonstrate commercial viability in BVLOS applications given existing regulatory approaches. However, UAS are demonstrating significant benefits for the public, and safely realizing these benefits at scale should be the goal of any rulemaking for routine BVLOS integration. It is also notable that a supportive regulatory environment for BVLOS depends on more than just one rule. The industry is ready and willing to provide much of what the industry needs to scale BVLOS, including infrastructure and UTM. Still, for certain capabilities, the federal government needs to enable the industry to act. Moreover, there are elements outside of the FAA's direct authority that impact the industry's ability to scale, and in some cases, legislation will likely be necessary.

As the ARC considers the question of how to enable BVLOS operations, Working Group 1.2, Market Drivers, sought to lay the foundation by answering critical questions such as: How is the market organized and funded, and what does that mean for the economic viability of the industry? How significant are the societal benefits of these operations, for both industry and the public, and what is the opportunity cost of delaying these benefits? What are BVLOS use cases, and how can the regulatory framework account for diverse operations and systems? What does industry need to scale UAS BVLOS operations, and how is scalability affected by current approaches to regulation? How do we suggest the FAA define priorities for the rule, based on these considerations? And more generally how does industry justify its need for a risk-based, performance-based, flexible rule that generally enables a wide variety of beneficial BVLOS use cases?

In tackling these questions, Working Group 1.2 decided to split workstreams into three Subgroups: Subgroup 1.2.1 on Market Organization, Subgroup 1.2.2 on Societal Benefits, and Subgroup 1.2.3 on Industry Needs. After summarizing the group's findings and recommendations, we report on the work of each Subgroup in turn.

A. Summary of Key Findings and Recommendations

The following list summarizes the findings of Working Group 1.2, as well as critical implications and recommendations. Detailed recommendations can be found in the relevant sections and conclusion.

The UAS market is diverse. The UAS industry is diverse and rapidly evolving. Different operations may use a range of systems with different capabilities and operate in different environments for different purposes. It is essential that regulations account for these variations rather than imposing blanket requirements that may not be appropriate for specific operations.

Recommendation 1. The FAA should adopt a **risk-based, performance-based,** and **adaptable** approach to regulation that accounts for the current and future diversity of airspace users. The FAA should consider eliminating separate airworthiness, operational, airspace, and personnel approval processes and establishing instead a streamlined, scalable and holistic application process that accounts for the specific characteristics of different operations, and provides flexibility for different operators to seek any subset of approvals at one time. The FAA should ensure that these processes are:

> **Risk-based.** Requirements should reflect the risk of a specific operation in its proposed operating environment.
> **Performance-based.** Approval processes should recognize a range of mitigations to achieve the required level of safety. The level of safety achieved by a given operation must be the focus. The ARC should seek to enable the broadest possible array of BVLOS operations
> **Adaptable.** Approval processes must enable companies to scale their operations. Approval processes should be flexible to permit future design or operational changes (e.g., for technological improvements or changing community expectations) without costly recertification or reapproval.

Recommendation 2. Integrating diverse BVLOS operations at scale will benefit from a framework for sharing information between dissimilar airspace users. For BVLOS operations, this information can be used for purposes such as conflict detection and strategic deconfliction. To that end, the FAA should:

> **Establish rules and validation processes for USS that offer conflict detection and strategic deconfliction services to operators.** These rules should be performance-based, non-prescriptive, and build on existing standards, such as the ASTM standards on Remote Identification and UTM.
> **Formally recognize standards-based frameworks for USS interoperability.** Examples of safe, secure, and scalable frameworks for interoperability include the Discovery and Synchronization framework described in the ASTM standards, which has been successfully applied to a range of UTM trials and implementations worldwide.
> **Establish airspace integration policies to promote cooperation in high-demand VLL airspace.** Cooperation between UAS BVLOS via UTM will help ensure that all operators can safely share the airspace.

Recommendation 3. The ARC should consider cybersecurity and recommend that industry standards bodies examine **cybersecurity** in greater detail. The federal government should also establish a Trusted or Known UAS Operator program that would mitigate risks.

The UAS market is expected to demonstrate viability. Ongoing UAS investment, innovation, and competition depend on industry participants demonstrating **economic viability**. After years of investment, financial backers expect the industry to achieve a minimum level of commercial sustainability. This depends on UAS operating at scale, BVLOS, across a range of populated and unpopulated environments, and in shared airspace. However, existing approaches to BVLOS regulation could make it difficult or impossible to achieve viability soon. These constraints include:

Diversity. Existing rules for BVLOS operations do not recognize the full range of operational and design mitigations available to operators. The current framework imposes requirements that may inhibit diversity, competition, and innovation in the UAS marketplace.

Automation. Existing rules do not anticipate or support highly automated operations featuring many aircraft overseen by few or nil personnel. This is likely to make it difficult or impossible to sustain UAS operations at scale for various use cases and may compromise safety and security.

Validation. Approval processes for BVLOS operators and aircraft are costly, complex and very lengthy. This presents a major barrier to new entrants and established companies alike.

By comparison, performance-based approaches to regulation will help to foster a diverse, competitive, and scalable UAS industry that supports a range of players, from small to large, integrated to specialized, and established companies to new entrants.

Recommendation 4. Noting how quickly the marketplace is shifting and evolving, it is important for the FAA to consider not just the design of the marketplace today, but how the technology is evolving, in crafting its BVLOS regulations. The FAA must **future-proof regulations**. For example, the market is trending toward increasing levels of automation. The FAA should enable safe, **highly automated operations** with minimal or no human intervention. In these operations, personnel may play no role in the execution of the flight and may instead play a supervisory role over multiple aircraft or operating sites simultaneously. Automation can promote better safety and security outcomes, especially for BVLOS operations in complex environments. Automated operations should be supported by a holistic operational approval process that avoids prescriptive personnel requirements. The FAA should seek to enable high-value, lower risk automated operations immediately while working toward a comprehensive regulatory solution for highly automated operations that may present higher levels of risk.

Recommendation 5. Regulatory **predictability** and **certainty** are important to provide the marketplace with stability. The FAA should seek to improve consistency and predictability in approvals. For example:

After establishing a robust target level of safety, the FAA should identify **feasible, realistic, and non-exhaustive means of compliance**. These may include pre-validated standard scenarios where possible informed by the work of JARUS SORA, EASA, and CASA.

The FAA should **conduct all aspects of the approval process in parallel** rather than sequentially so that the industry can reasonably plan for market entry without undue or unpredictable delays.

The FAA should commit to and communicate clear definitions of requirements and **reasonable timelines** for processing approvals. The FAA should also **scale-up resources** as necessary to account for the expected growth in applications. The FAA should also make allowances for

expedited approval of low-risk R&D activities that may need to be approved on rapid timelines to meet institutional or financial deadlines.

Recommendation 6. The FAA and DOT should pursue or support several other reforms outside the scope of a BVLOS rulemaking that may be necessary to support BVLOS integration at scale. These include:

- **Modernizing or abolishing requirements for an economic authority:** These requirements pose a significant barrier to entry for both U.S. and global companies, impeding competition, stifling innovation, and potentially setting back efforts to share expertise and experience in matters of safety.
- **Asserting the FAA's vital safety oversight role in harmonized airspace management and regulation:** The FAA should utilize their existing authority to advance and scope operations for BVLOS quickly as well as harmonize their efforts with tribal, state and local government partners.

The UAS market can generate significant benefits for the public. UAS are demonstrating **significant safety, economic, health, environmental, security, and equity benefits.** Establishing a framework for routine BVLOS operations will help to realize these benefits at scale across the U.S. Conversely, further delay in enabling BVLOS operations could impose significant opportunity costs for the public.

Recommendation 7. The Executive Branch should play a **leading role in promoting the benefits** of UAS for the American public. The Executive Branch should take all necessary steps to accelerate BVLOS integration, consistent with regulatory modernization efforts abroad, to promote a thriving, competitive, and innovative domestic industry.

Recommendation 8. The FAA should **account for the benefits** of UAS in developing risk targets for complex BVLOS operations. In addition, the FAA should **consider the opportunity cost to the American public of any delay** in promulgating a BVLOS rule. This may take the form of diminished safety, economic, social, environmental, security, or equity outcomes.

Recommendation 9. Transparent and **consistent standards** will lead to safer operations as the UAS industry continues to grow. We urge the FAA to consider implementing clear acceptable means of compliance, as well as Standard Scenarios (STS) or Pre-Defined Risk Assessments (PDRAs) which industry can reference for guidance in its applications. It is important to understand that STS or PDRAs could be implemented well in advance of a BVLOS rule. As such, STS and PDRA could be a way of enabling safe, high-value, and lower risk BVLOS operations now while the FAA develops and releases for public comment a rule on BVLOS.

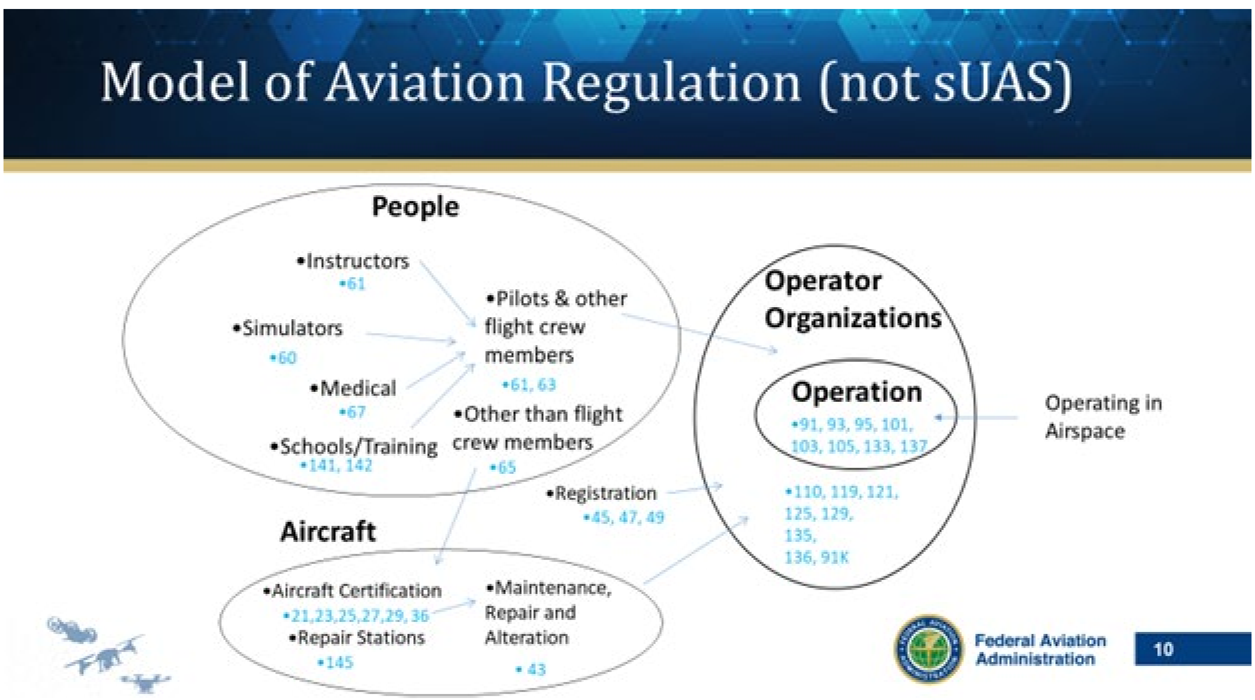
B. Market Organization (Subgroup 1.2.1)

Subgroup 1.2.1, Market Organization was tasked to report to the ARC on how the UAS industry is organized and funded, to lay the foundation for a future UAS BVLOS rulemaking. Questions posed to the Subgroup included: How is the industry funded, and what are the expectations for commercial sustainability? How is the UAS market organized, and who are the participants? How do the participants relate and work together? What are BVLOS use cases, and how diverse is the industry?

To better understand the task at hand, the Subgroup hosted FAA subject matter experts to clarify how FAA regulatory frameworks traditionally align with and reflect existing business practices.

Traditional aviation regulation validates the operating entity, personnel, and aircraft separately. In part, that approach to regulation reflects the design of the traditional crewed aviation marketplace, which consists of distinct operators, pilots, designers, and manufacturers. For example, the FAA requires separate categories of approvals: Type certificates are unique to a design; production certificates are unique to a manufacturer; airworthiness certificates are unique to an aircraft; operator certificates are unique to an airline; flight crew certificates are unique to individual personnel; and air traffic clearances are unique to a flight. As the chart below illustrates, various parts of the federal aviation regulations place requirements on various actors within the traditional aviation marketplace.

That approach to regulation also reflects the safety characteristics of legacy aviation. For example, it is assumed that a crewed aircraft may cause a fatality of a person onboard in the event of a critical failure. A collision will likely result in serious injury or fatality. As such, the focus of traditional aviation regulation has been validating the reliability of the aircraft and the fitness and competence of flight crew, or limiting the area of operations until those aspects can be demonstrated.



[*Source*: FAA]

The Market Organization Subgroup sought to characterize the UAS industry and identify how it is structured differently to traditional aviation. As the UAS industry has grown and evolved, it has become clear that the UAS industry and the traditional crewed aviation industry are different, reflecting their different capabilities, missions, and needs. In particular, the UAS industry features a mix of highly integrated players that design, manufacture, and operate UAS for specific applications, as well as specialized players that offer capabilities or services.

In addition, the safety characteristics of UAS are different, too. Many UAS apply mitigations that not only ensure a high level of reliability (e.g., through distributed electric propulsion), but also lower the risk of personnel failure (e.g., through automation), lower the risk of a collision (e.g., by carrying goods instead of people or by inspecting infrastructure at low altitudes) and lower the risk of injury or damage in the unlikely event of a collision (e.g., by reducing impact characteristics through size, weight, and contingency mitigations). Many of these mitigations are not available to traditional crewed aviation and are not recognized or credited within the existing regulatory system.

Current aviation regulations are therefore ill-equipped to regulate the UAS industry. As such, complex UAS operations have instead relied on a waiver and exemption-based approach to approval which is unsustainable and unpredictable: In recent years, for example the FAA has been inundated with thousands of waiver requests including for BVLOS, with a 10 percent approval rate as of recently and several months to year-long processing times.[106]

To succeed, the UAS BVLOS rulemaking must consider and reflect the industry it is seeking to regulate. The Market Organization Subgroup identifies industry funding sources, market organization and BVLOS use cases. The Subgroup then developed recommendations from these findings.

1. UAS Industry Funding and Organization

The UAS industry is funded and organized differently from the conventional aviation marketplace. Private venture capital is a major source of funding for larger companies, supplemented by a range of other funding sources, while many smaller companies are self-funded. After years of research, development, and pilot programs, investors have clear expectations of commercial viability and return on investment (ROI) and a decreasing appetite for continued losses and lack of tangible progress. The UAS marketplace is also organized differently than legacy aviation, which has important ramifications for the work of the ARC.

UAS Industry Funding

Venture Capital: By far the most common funding type for UAS companies, venture capital (VC) is responsible for over 75% of UAS funding.[107] This is primarily because most drone companies are mature startups, and VC specifically targets this funding segment. VC typically supplies different levels of investment that grow in line with the company's valuation and capital needs. The first round of official funding is typically anywhere from $10,000 to $2 million in funding, valuing the company at between $3.0 - $6.0 million. This is followed by a Series A round of fundraising when the company has gained traction and delivered on its seed round milestones, with funding ranging from $2.0 - $15.0 million ($5.0 million being the most common) at a pre-money valuation up to $23.0 million. Most of the well-known UAS VCs include Accel, Lux Capital, Andreessen Horowitz, and Sequoia Capital. Less than half of seed-funded companies will go on to raise Series A rounds. Once a company has reached Series B round and

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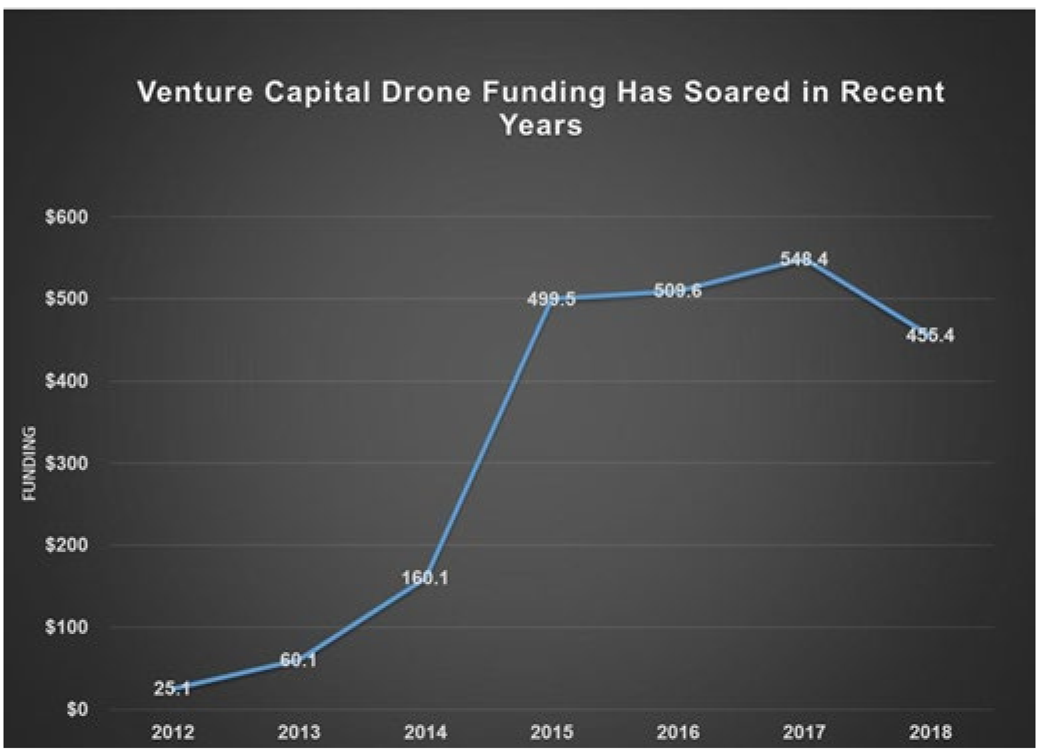
[106] See pages 7-8 of DOT OIG report entitled "Opportunities Exist for FAA To Strengthen Its Review and Oversight Processes for Unmanned Aircraft System Waivers" November 2018.

[107] Over the past 5 years, VC contribution has varied between 68%-95%. See https://www.wsj.com/articles/SB10000872396390443720204578004980476429190. See also Finbold: https://finbold.com/drone-industry-investments-grow-by-67-to-record-high-at-1-2-billion/ and Drone Industry Insights: https://droneii.com/money-talks-2019-drone-investments-break-new-records (quantifying the percentage of investments that come from VC by year).

onward, they are past the development stage and raising capital to meet rapidly growing demand for the company's product or service. Most Series B companies raise around $20.0 - $30.0 million in funding and have pre-money valuations between $30.0 million and $60.0 million, with an average of $58.0 million. A Series C, D or E round is typically when VC funding gives way to private equity, hedge funds or other institutional investors. This is typically the final round before an acquisition by a bigger player or an Initial Public Offering. These events can value a company at hundreds of millions or billions of dollars, depending on the product and industry.

ROI Tolerance Level: These investors have high expectations for ROI, as venture capital funds make significant investments in anticipation of extraordinary returns. The magnitude of these investments in UAS reflects the capital-intensive requirements of funding new companies developing new technologies in a new industry. VCs generally expect a ROI within 3-7 years. While estimates vary, experts have reported that up to 75% of VC-funded companies fail and never provide a return on their money.[108] Therefore, it is more important than ever for companies to show a sustained growth pattern, achieving key milestones to continue receiving capital infusions from VCs. It is also critical to show a clear path to profitability. After years of investment under various programs (IPP, PSP, BEYOND) BVLOS operations remain highly constrained, burdensome and unprofitable including when to projecting to future scale.

The graphic below is an illustrative chart that summarizes total dollars invested in UAS companies by VCs over the past few years, including some of the larger externally funded UAS companies such as Skydio, Zipline, and DroneDeploy.



108 https://scalefinance.com/the-venture-capital-secret-75-of-startups-fail/

[Source: Forbes[109]]

Private Equity: A smaller player than typical VC due to the later stage investment, private equity is often utilized once a company has reached maturity. Private Equity (PE) and VC have similar infrastructure, investing methodology, and risk tolerance. The biggest difference between the two is the stage of investing, as PE tends to step in from Series C onward. PEs also have more experience exiting their investments, as most funds target a three-to-five-year turnover in their investments compared to a longer shelf life in VC.

ROI Tolerance Level: PE has high expectations of ROI for the same reason as VC. As later-stage investors, the fail rate of PE is closer to 30 percent compared to VC's 75 percent fail rate.[110]

Strategic Investor (private or publicly traded company): Typically, strategic investments are a "one-and-done" funding route where a public or private supplier, distributor or other business partner looks to acquire equity to pursue strategic advantages rather than simply financial returns. One recent newsworthy strategic investment in a UAS company was the recently announced Walmart investment in DroneUp.[111] This is an example of a strategic investor who is not an aviation company – as Walmart is a traditional retailer and ecommerce company – that has clear goals of using UAS to help grow the scope of their primary business. An example of a traditional aviation company getting involved in a strategic investment would be Boeing's Matternet and Robotic Skies investments. Boeing's goals with their strategic investments are to support the future of medical UAS delivery and urban air mobility infrastructure and safety, respectively, in partnership with the Boeing Global Services business unit.

ROI Tolerance Level: These investors may have more modest expectations for ROI as the investments are made more for indirect strategic advantages than direct returns.

Joint Venture: While not as popular a funding route, there have been a few high-profile joint ventures in the UAS space. Examples include *SkyFund*, a first-of-its-kind joint venture investment vehicle between drone manufacturer DJI and venture capital firm Accel that will help fund the UAS developer ecosystem through access to capital, technology and resources;[112] and *Aerosense*, a Japan-based joint venture drone company between Sony, robot technology company ZMP Inc. and Sumitomo Corp that will provide industrial automation solutions with cloud data analysis services.[113]

ROI Tolerance Level: Partners in a joint venture may have more modest expectations for ROI since risks and returns are diversified and split across the partners in the joint venture, giving the invested entities more wiggle room.

Initial Public Offering (IPO): An IPO refers to the process of offering shares of a private corporation to the public in a new stock issuance. That new issuance allows a company to raise capital from public

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[109] https://www.forbes.com/sites/philipfinnegan/2019/07/22/vc-funding-for-drones-surges-in-2019-with-more-focused-bets/?sh=5f336b2b34d3.
[110] https://www.buyoutsinsider.com/private-eye-lps-rightly-want-to-see-a-low-loss-ratio/
[111] Walmart, Press Release, *Walmart Invests in DroneUp, the Nationwide On-Demand Drone Delivery Provider* (June 17, 2021), https://corporate.walmart.com/newsroom/2021/06/17/walmart-invests-in-droneup-the-nationwide-on-demand-drone-delivery-provider.
[112] Skyfund, Accel + DJI, http://www.skyfund.vc/more/.
[113] CNET, *Sony Takes Flight with Drone Joint Venture*, July 22, 2015, https://www.cnet.com/tech/mobile/sonys-mobile-division-inks-joint-venture-on-drones/.

investors and offer liquidity and an exit opportunity to private investors. Typically, institutional and retail investors in an IPO are willing to be more patient with their owned shares, and capital is typically easier to raise on the public market rather than the private market (especially if liquidity is strong) but being public also makes you vulnerable to macroeconomic trends that can depress stock prices and the possibility of bad news sinking prices to an unrecoverable point.

<u>ROI Tolerance Level:</u> Public investors may have varying expectations of ROI. Public investors are diverse. There is also significant due diligence before the public offering.

State and Federal Funding, Loans and Grants: A popular source of funding for UAS companies focusing on government and defense use cases, government funding sources can offer greater flexibility than private investment. Many loans and grants can in some cases be forgivable, significantly capping the downside. At the state level we have seen various levels of investment. For example, New York state has invested $35 million through NUAIR, while North Dakota invested $100 million in UTM programs. Despite the benefits of government funding, these contracts, grants, and funds are difficult to win due to the large amount of competition in the government sector.

<u>ROI Tolerance Level:</u> Government funding may have a lower expectation of ROI, primarily due to the forgivability standards of government funding. Compared to VCs and PEs, who typically want a Board seat along with the large equity stake, government funding is given with no strings attached and no expectation of return. Therefore, UAS companies that receive this type of funding typically have the highest return tolerance of this entire list.

Personal Investment and Operational Income: A strategy for many smaller to medium-sized companies is to self-fund through personal investment or through operational income. A recent survey of over 640 active UAS operators conducted by a well-respected firm showed that close to 66.7% of operators have revenues less than $100,000.[114] These small and medium-sized businesses are responsible for a majority of active operations that occur in the $3 billion market.[115] UAS companies of this size are diverse in scope and are one of the primary drivers of the UAS industry. For companies of this size, inefficient and uncertain regulatory frameworks impede growth.

<u>ROI Tolerance Level</u>: Operators of this size are very sensitive to ROI. Many companies of this size or stage need to maximize their income in order to grow, or even survive. Some of these companies seek other avenues of funding previously described as a pathway to growth, but many choose to grow organically in order to preserve equity or control. Once a company has achieved a stable level of income, sensitivity does decrease but growth may still be inhibited by lack of certainty caused by the regulatory process.

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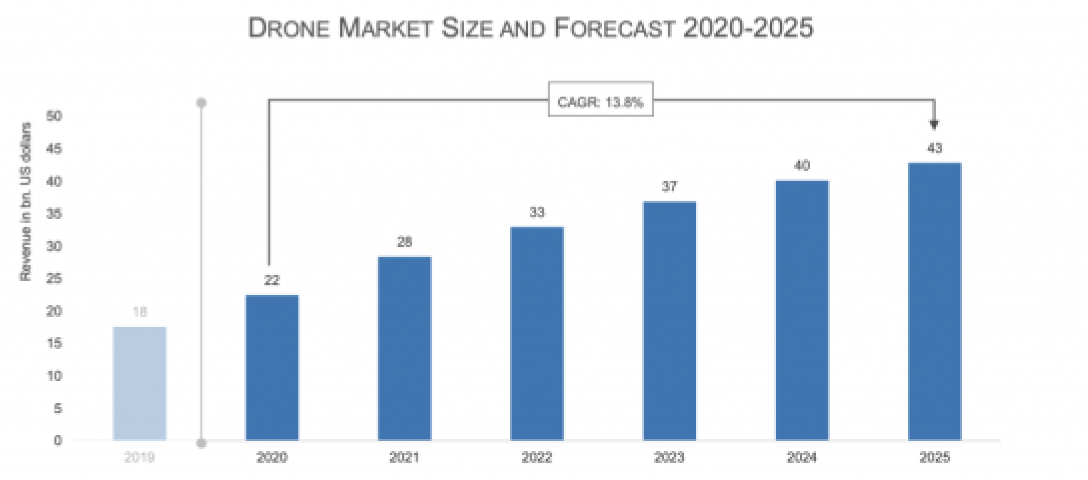
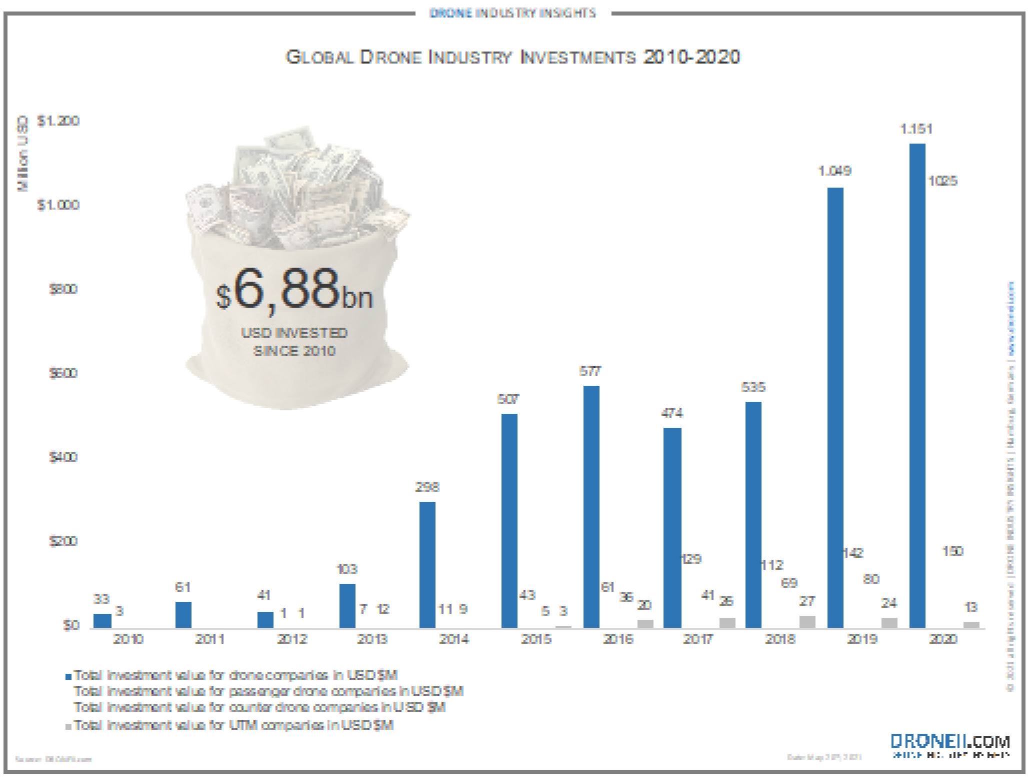
[114] DroneAnalyst 2021 Drone Market Sector Report.
[115] Levitate Capital White Paper, Enterprise Market 2020, p. 29.



Source: Drone Industry Insights May 2021

What Types of UAS Companies Are Funded?

Thus far, investment has been targeted primarily to UAS designers and manufacturers. UTM (including UAS Service Supplier and Supplemental Data Service Provider) investment has declined as the industry currently lacks any certain path to regulatory approvals, particularly after the FAA finalized the final Remote ID rule and eliminated network connectivity via UTM as an option for compliance. This highlights the sensitivity in the market to a path to profitability as these businesses rise and collapse based on expectations versus results in the regulatory framework. Solutions that drew investment have been replaced with alternative solutions that contract the market potential.



Source: Drone Industry Insights May 2021

U.S. As a Funding Leader

American competitiveness in the global economy and U.S. leadership in global aviation is at risk due to a lack of regulatory certainty and risk-appropriate oversight for UAS. It is notable that, while the U.S. historically has seen a large share of investment, industry consensus is that U.S. leadership is in jeopardy not only for UAS but also for adjacent technology, such as UTM, and Advanced Air Mobility. Investors and the UAS industry more broadly are losing patience as technology has far outpaced policy in the U.S.

Indeed many U.S. based companies have invested heavily in, and in some cases moved, operations overseas (including to Australia, Asia, Africa, Europe, and the United Kingdom, as well as to other regions) as foreign regulatory bodies have taken proactive steps to enable the UAS marketplace, such as the comprehensive operational and UTM regulations implemented by the European Union. These investments are reaping rewards and are beginning to show a path to scale and viability, which is uncertain in the U.S. Some companies have closed their businesses because of the regulatory hurdles in the U.S. If companies can iterate new models of aircraft and operations and scale their businesses in other countries and not in the U.S., the U.S. may experience a loss of UAS investment, innovation, and competition.

Global competitiveness and American global leadership in innovation are of strong importance to Working Group 1.2. Working Group 1.2 therefore urges the BVLOS ARC to consider these issues in moving forward diligently to enable UAS BVLOS operations in the United States.

Implications of Industry Funding for UAS BVLOS

As noted above, while the list of funding types is varied, investors generally have high expectations for ROI. Thus, UAS companies need to show tangible "success" – the achievement of technical or regulatory milestones, and continued growth – to justify continued funding. As a result, many promising companies have left the UAS marketplace, as a lack of certainty and adaptability in the regulatory framework made it difficult to demonstrate progress:

Aria Insights, also known as CyPhy Works, shut down after $39 million of VC[116]
Airware shut down operations despite $118 million in venture backing[117]
Facebook's Aquila discontinued development[118]
DHL shut down operations[119]
AiRXOS, part of GE Aviation, disbanded despite $30 million in funding[120]

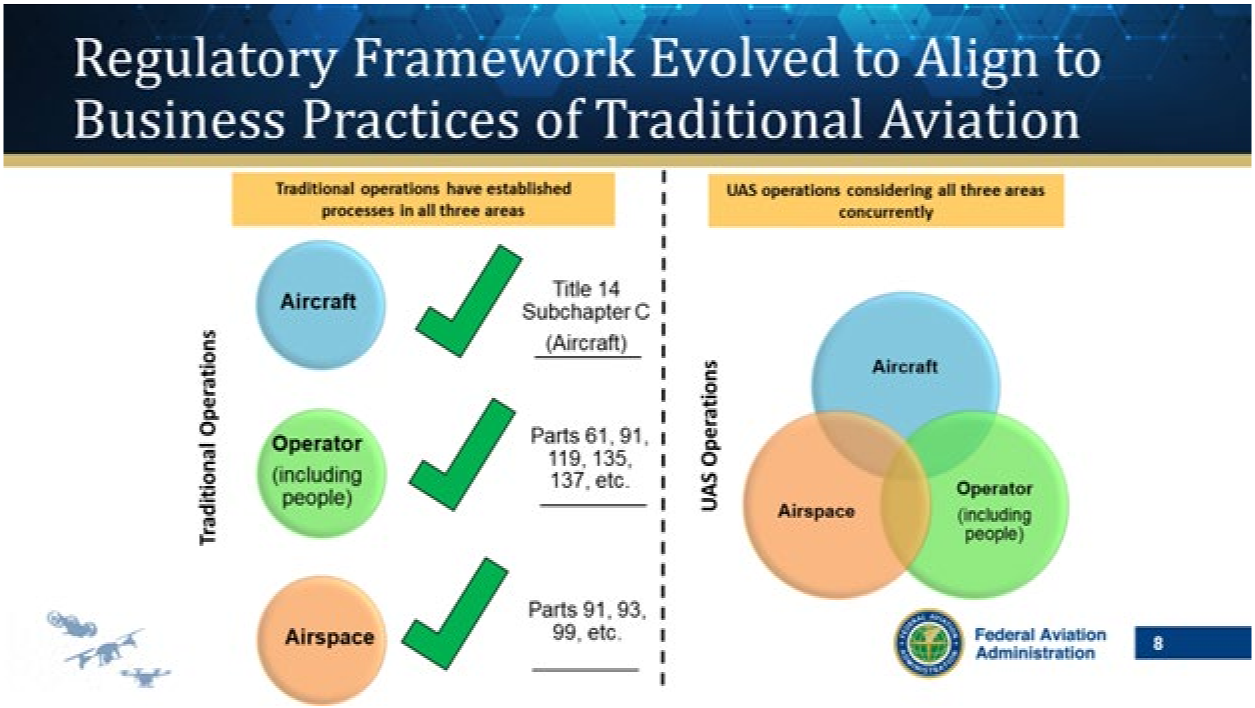
As described here, the UAS marketplace is diverse and funded by a range of backers, with expectations of commercial viability challenging given existing regulatory approaches. Working Group 1.2 therefore urges the ARC to account for the market's funding challenges in its recommendations to the FAA. UAS companies and their investors have committed significant resources over many years to enable complex UAS operations in the public interest which will be difficult to sustain without a path towards routine BVLOS operations.

UAS Market Organization

The UAS market is not only funded differently from traditional aviation, but it is also structured differently. As noted above, based on the organization of the crewed aviation marketplace in which there is a clear distinction between OEMs and operators, the FAA requires separate categories of approvals for operators, manufacturers, or personnel.

This regulatory framework does not reflect the structure of the UAS industry, which differs from legacy crewed aviation. For example, traditional regulatory requirements focus on the role of personnel (flight crew or ATC). However, many UAS are highly automated, reducing and modifying the role of humans to gain efficiency. In addition, different players may be highly integrated, designing, manufacturing, and operating UAS in-house. Other players may be highly specialized, providing a narrow set of technologies or capabilities to other operators, including both UAS and UTM capabilities. These variations are not reflected in the traditional approach to regulation.

[116] https://www.therobotreport.com/aria-insights-cyphy-works-shuts-down/
[117] https://techcrunch.com/2018/09/14/airware-shuts-down/
[118] https://www.theverge.com/2018/6/26/17507826/facebook-aquila-internet-drone-project-shut-down
[119]https://www.freightwaves.com/news/dhl-pulling-its-parcelcopter-drone-ceasing-drone-development.
[120] See Pitchbook; also https://www.suasnews.com/2021/01/important-announcement-about-airxos/



Source: FAA

Design of UAS Industry

At a high level, the UAS market can be understood as three separate segments: Hardware, Software and Services, with Subgroups within each area. Hardware includes companies such as vehicle or component manufacturers. Software includes companies providing flight control, data analytics, flight planning, fleet management, navigation, detection, and UTM/USS/Supplemental Data Service Provider (SDSP) capabilities. Services include companies that operate UAS for specific applications or offer ancillary services such as personnel, insurance, advice, training, test sites, or research and development support.

Many companies will straddle more than one category. In surveying the UAS marketplace, it became clear to Working Group 1.2 that there is no one-size-fits-all model for a UAS business. Sometimes specialized companies provide systems, capabilities, or components to third-party operators (we'll call these "independent" vendors). Other times, they are one integrated company (consider Wing, Zipline and Amazon) (we'll call these "consolidated" companies).

The current design of the regulatory system challenges both independent and consolidated vendors. For example, operators of third-party systems developed by independent providers will not have access to deep design or manufacturing data that the FAA may request to issue a complex waiver or approval. The challenges are more acute in BVLOS operations. Operators may depend on a range of independent vendors (e.g., flight control software, vehicle hardware, UTM capabilities) for their safety case. This leads to significant inefficiencies in the FAA regulatory process for many members of the UAS industry. Given this dynamic, BVLOS waiver or exemption processes can take years, which (given the nature of how the industry is funded) leads to companies leaving the market or moving abroad to enable R&D and commercial operations.

Consolidated companies that act as OEM, operator, and airspace service supplier (for example) run into their own set of challenges with the FAA's regulatory framework. As described previously, the FAA requires several sets of approvals to operate, meant for different actors in the system: e.g., TC for the manufacturer, operator approval for the operator, COA for the airspace, etc. This imposes costly and highly duplicative requirements on companies, requiring significant resources for the application and compliance. This may pose an insurmountable barrier to entry for smaller or newer UAS entrants.

Market Evolving Quickly

The market is evolving quickly, with a trend towards highly automated systems. Software may replace individual pilots. Drone-in-a-box systems may inspect and repair themselves. The mix of market participants will shift. From an industry perspective, flexibility in how regulations are designed is therefore critical.

Findings and Recommendations: UAS Industry Funding and Organization

<u>Findings:</u>

The UAS market is expected to demonstrate viability. Ongoing UAS investment, innovation, and competition depend on industry participants demonstrating **economic viability**. After years of investment, financial backers expect the industry to achieve a minimum level of commercial sustainability. This depends on UAS operating at scale, BVLOS, across a range of populated and unpopulated environments, and in shared airspace. However, existing approaches to BVLOS regulation could make it difficult or impossible to achieve viability soon. These constraints include:

- **Market Diversity.** Existing rules for BVLOS operations do not recognize the full range of operational and design mitigations available to operators. The current framework imposes requirements that may inhibit diversity, competition, and innovation in the UAS marketplace.
- **Automation.** Existing rules do not anticipate or support highly automated operations featuring many aircraft overseen by few or no personnel. This is likely to make it difficult or impossible to sustain UAS operations at scale for various use cases and may compromise safety and security.
- **Validation.** Approval processes for BVLOS operators and aircraft are costly and complex. This is likely to pose a major barrier to entry for small or new entrants.

<u>The UAS marketplace is diverse and rapidly evolving</u>. Different operations may use a range of systems with different capabilities and operate in different environments. It is essential that regulations account for these variations rather than imposing blanket requirements that may not be appropriate for specific operations.

<u>The UAS marketplace is organized differently than traditional aviation</u>. The commercial UAS industry is organized differently than the crewed aviation industry, and lines between manufacturer/operator/service supplier are often gray. This leads to challenges for the UAS industry to operate successfully under traditional aviation rules.

Recommendations:

Performance-based approaches to regulation will help to foster a diverse, competitive, and scalable UAS industry that supports a range of players, from small to large, integrated to specialized, and established companies to new entrants.

Scaled BVLOS Operations. To enable commercial UAS BVLOS operations at scale, the FAA must reduce the cost, complexity, and timeframe for applications for approval.

Streamline Process. In particular, the FAA should **streamline the process** by eliminating individual airworthiness, operational, airspace, and personnel approval processes and establish instead a streamlined, scalable and holistic application process that accounts for the specific characteristics of different operations and provides flexibility for different operators to seek any subset of approvals at one time. As part of this one holistic process, the FAA should enable all relevant workstream processes (whether related to airworthiness, operational, airspace, or other) to move forward on a parallel track. The FAA should **require transparency** in communications between the agency and stakeholders about what the process will entail, and expected timelines. The FAA must also **promote internal accountability** to ensure processes are followed at the staff level.

The FAA should ensure that these processes are:

> **Risk-based.** Requirements should reflect the risk of a specific operation in its proposed operating environment.
> **Performance-based.** Approval processes should recognize a range of mitigations to achieve the required level of safety. The level of safety achieved by a given operation must be the focus. The ARC should seek to enable the broadest possible array of BVLOS operations
> **Adaptable.** Approval processes must enable companies to scale their operations. Approval processes should be flexible to permit future design or operational changes (e.g., for technological improvements or changing community expectations) without costly recertification or reapproval.

Improve consistency. Given how the industry is funded, and expectations for commercial viability, the FAA must improve consistency and predictability in approval processes. This includes the need for clear and consistent definitions and expectations. The FAA should establish and commit to a robust target level of safety with feasible and realistic means of compliance. The FAA also must build accountability into its review and ensure harmonization across FAA lines of business and offices.

Establish, share, and agree upon reasonable timelines. The FAA should ensure that all lines of businesses are communicating with each other, and with the industry, about requirements. To assist with planning, the FAA should share, agree upon with industry, and stick to reasonable timelines for reviewing and approving an application. If the timeline is unworkable or likely to impose significant costs, the applicant can adjust their plans.

Enable research & development. While the focus of the ARC is to enable scalable UAS BVLOS operations, the R&D cycle is also important to consider. R&D is critical America's competitive advantage, and these operations directly lead to success and economic impact for the UAS marketplace. Current

R&D processes do not enable broad testing in the US in a timely way. The FAA should properly place R&D operations on a risk continuum and make allowances for expedited approval of low-risk R&D activities that may need to be approved on rapid timelines to meet institutional or financial deadlines. The FAA should expand the universe of R&D tools available to the UAS industry, build flexibility into experimental approvals for UAS BVLOS operations, and grant flexibility to test sites and pilot program participants to enable experimentation outside the scope of current rules. The FAA should also clearly define data testing requirements and smoothen the transition from R&D to commercial operations.

Future-proof regulations. Noting how quickly the marketplace is shifting and evolving, it is important for the FAA to consider not just the design of the marketplace today, but how the technology is evolving, in crafting its BVLOS regulations. For example, the market is trending toward increasing levels of automation.

Provide predictability. Regulatory **predictability** and **certainty** are important to provide the marketplace with stability. The FAA should seek to improve consistency and predictability in approvals. For example:

- After establishing a robust (performance based) target level of safety, the FAA should identify **feasible, realistic and non-exhaustive means of compliance**. These may include pre-validated standard scenarios where possible.
- The FAA should **conduct all aspects of the approval process in parallel** rather than sequentially so that the industry can reasonably plan for market entry without undue or unpredictable delays.
- The FAA should commit to **reasonable timelines** for processing approvals and **scale-up internal resources** to account for the expected growth in applications. The FAA should also make allowances for **expedited approval of low-risk R&D activities** that may need to be approved on rapid timelines to meet institutional or financial deadlines.

2. UAS BVLOS Use Cases

Working Group 1.2 sought to provide a representative list of real and potential UAS BVLOS use cases, so that the ARC understands the breadth of the potential impact of a BVLOS rule. Working Group 1.2 sought to capture a sampling relevant to virtually every virtual market sector.

UAS are diverse. Different operations use different systems, with different capabilities, across a range of different environments. As such, they can apply a range of mitigations to meet an acceptable target level of safety. In addition, BVLOS operations can be conducted by an external operator or by a company that may conduct its own operations. It is essential that regulations account for these variations rather than imposing blanket requirements that may not be appropriate for specific operations or may encourage design choices that are less safe or less scalable. Due to the lower risk posed by the nature of operations and/or equipment, constraints to maintain a target level of safety may be lessened to allow for greater flexibility and evolution or iteration of operating concepts. This is in contrast to highly constrained unprofitable and narrow operations where the operator may not be able to demonstrate a path to efficient operations and future profitability.

Working Group 1.2 identified dozens of applicable UAS BVLOS use cases. These use cases can be categorized into three main categories:

- **Package Delivery:** Parcel delivery flights performed for medical or commercial purposes.
- **Data Collection:** Wide range of possible applications such as inspection, remote sensing etc.
- **Other:** All UAS BVLOS operations that cannot be categorized as delivery or data collection.

The following table provides further details regarding the applicable use cases for each category. We expect that additional use cases will continuously be discovered as technology advances with more intelligent systems and regulations or oversight change. This is not meant to be an exhaustive list of use cases but to ensure most of today's use cases are represented.

Category	**Use Case**	**Possible Application**	**Industry**
Package Delivery	Medical Delivery	AED, blood samples, vaccines, critical organ delivery	Medical
	Commercial Delivery	Consumer goods, food, B2B etc.	Pharmaceutical, retail
Data Collection	Inspection	Utility inspection, real estate documentation, insurance claims adjusting, change detection and management	Electric utilities, infrastructure, oil and gas pipeline and Security industries
	Maritime	Wildlife management, offshore infrastructure, shark alert, search and rescue	
	Imaging/Remote sensing	Public safety, surveying, remote surveillance, media, sports broadcasting and event/disaster management	Electronic news gathering/sports broadcasting
Other	Agriculture	Spraying, planting, cloud seeding, precision irrigation and fertilization	
	Disaster Management	WIFI/Cellular Hotspot	First responders

Risk Factors

The level of risk for any operation depends on multiple variables. All characteristics of operation, as well as mitigations, should be considered while approving BVLOS operations. Below is a list of characteristics potentially applicable to BVLOS operations.

- **Operational Characteristics.** Aerial and ground aspects. Includes environment characterization (rural, suburban, urban, controlled-access site), population density, topography, infrastructure availability, road crossings, vehicle traffic volume, type of airspace (Class G, E, D, C, B, A), proximity to airports/helipads etc.
- **Flight Profile.** Duration, route, altitude, payload, time of day, infrastructure shadowing/masking, etc.
- **UA Technical Aspects.** Impact characteristics (weight, wingspan, power source, speed, trajectory), system reliability, normal and abnormal/contingency operations
- **Human factors.** Aircrew qualifications, currency, proficiency, flight planning (if done manually), maintenance aspects etc.

Environment

The different environments in which UAS operate is as expansive as the many use cases. The ends of the spectrum range from densely populated urban areas to sparsely populated rural environments and remote and closed-access industrial sites. Ground risk has historically been scrutinized as heavily as the airspace environment when assessing the level of risk in an operation. But the focus should be on the acceptable level of risk. As such, a BVLOS risk analysis should include consideration of the environment. By defining an acceptable level of risk, operators can assess flight profiles that meet the provisions.

The following table presents examples of the different risk factors per use case:

UAS operate in a range of different environments (Current)		
Use case	**Typical ground environment**	**Typical air environment**
Inspection	Unpopulated and closed or restricted-access	Shielded VLL*
Agricultural	Unpopulated	Rural VLL
Maritime	Unpopulated	Rural VLL
Delivery	Unpopulated to populated	Rural to populated VLL
Imaging	Unpopulated to populated	Populated VLL

*VLL stands for “Very Low Level” Airspace (<400 ft AGL)

Different operations may apply a range of mitigations depending on their capabilities and environment	
Example mitigations for ground risk	**Example mitigations for air risk**
● Use of closed or restricted-access sites -Protective headwear worn at industrial sites -Infrastructure / terrain shielding -Lightweight, lower risk drones (such as those weighing less than a few pounds) -Redundant systems ● Frangible airframes ● Parachute devices ● Automated contingency management ● Flight planning	● Cooperative traffic solutions (ADS-B in). Visual observers (today, EVLOS) ● Detect and avoid ● Strategic deconfliction via UTM ● Notification and outreach to other operators ● Segregation (VLL <400ft AGL flight) ● Infrastructure / terrain shielding ● Flight over populated / congested areas ● Airspace usage (B, C, D, Mode C veil) ● Operations outside airport traffic patterns

3. Recommendations

Recommendation #1: Risk-Based Approach: As noted above, given the diversity of the industry, it is very important for the FAA to adopt a risk-based, performance-based, flexible approach that enables the full universe of use cases with variations based on levels of risk and mitigations. As described more fully below, many use cases bring substantial economic and societal benefit. It is critical that all types of BVLOS operations are enabled to operate safely.

Recommendation #2: Transparency: Because the BVLOS use case list is so diverse, with so many different environments, mitigations and systems implicated in this rule, it is critical that the FAA communicate its approach clearly to the industry. We urge the FAA to consider implementing clear acceptable means of compliance, as well as Standard Scenarios (STS) or Pre-Defined Risk Assessments (PDRAs) which industry can reference for guidance in its applications. It is important to understand that STS or PDRAs could be implemented well in advance of a BVLOS rule. As such, STS and PDRA could be a way of enabling safe, high-value, and lower risk BVLOS operations now while the FAA develops and releases for public comment a rule on BVLOS. In developing STS or PDRA, the FAA should review important and highly useful examples developed by JARUS SORA and issued with slight changes by EASA in Europe and CASA in Australia. STS and PDRA benefit both the regulator and the regulated industry by providing clear direction on the level of safety to be achieved and the range of appropriate mitigation measures. Transparent and consistent standards will lead to safer operations as the UAS industry continues to grow.

VII. Societal Benefits (Subgroup 1.2.2)

The DOT and FAA have previously recognized the significant value associated with UAS operations. However, many important UAS applications require BVLOS operations. Over the past five years, the FAA has engaged in multiple pilot programs and partnership arrangements – including the Pathfinder Program, UAS Integration Pilot Program (IPP), Partnership for Safety Plans (PSPs), and currently BEYOND – to further both the agency's and stakeholder community's collective understanding of the benefits of such operations.[121]

The Society Benefits Subgroup was tasked with identifying and documenting the societal benefits of UAS BVLOS operations. Societal benefits include both the benefits to those stakeholders with a direct and immediate economic interest as well as the broader benefits to the public. To advance with a BVLOS rulemaking effort, the FAA must demonstrate to the interagency community, as well as to the public, that the benefits of updated regulation exceed the costs, and that there is a net positive benefit to society. To lay the proper foundation, therefore, the Working Group 1.2.2 Subgroup worked to identify, quantify, and rationalize compelling and defendable examples of benefits for society associated with UAS BVLOS operations.

[121] See, e.g., FAA IPP Report (found at https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/media/IPP_Final_Report_20210712.pdf).

As a first step, the Subgroup sought to identify a suitable set of categories that could be used to accurately and efficiently describe the various types of societal benefits that may be achieved through UAS BVLOS operations. Traditionally, both economic and safety benefits to society have been used to justify aviation rulemaking. Building on this past precedent the Subgroup sought to ensure that the categories of societal benefits were comprehensive and reflected the current state of broader values recognized and accepted by society.

To begin, the Subgroup used a generalized set of four types of benefits that mirror the “four pillars” that are priorities for the current administration: *economy*, *safety*, *environment,* and *equity*. A set of use case examples were created and then used to validate the adequacy of this initial set of categories. After group discussion and analysis, it was decided to expand the categories to include *health* and *security* benefits.

The Subgroup realized that almost all UAS BVLOS operations had the potential for crosscutting societal benefits that would align with and across multiple categories. For example, a UAS BVLOS operation might simultaneously provide *economic*, *safety* and *equity* benefits. The Subgroup initially chose examples of BVLOS use cases and operations that had a clear and compelling societal benefit for one of the main categories.

The *economic benefits* category describes BVLOS missions and use cases that provide an economic benefit such as cost savings and expanded market opportunities. This category breaks down further into *private* and *public* economic benefits. A company using UAS BVLOS operations to reduce costs might be described as receiving a “private economic benefit”, whereas BVLOS operations adding convenience, lower costs, and more access to products for consumers is a “public economic benefit”. Ultimately, it was recognized that virtually all economic benefits examples could be classified as “public economic benefits”, since society at large ultimately benefits.

The *safety* category captures the benefits of BVLOS operations that result in improved safety either for an individual, group, or community. For example, using UAS BVLOS operations for infrastructure inspection tasks that previously would have required a human worker to operate in a dangerous or risky environment demonstrates a case of safety benefits for an individual worker. *Public safety* is another important category of safety benefits and refers to the use of UAS BVLOS operations by law enforcement to provide situational awareness in case of emergency.

The *security* benefits category captures benefits of BVLOS operations such as monitoring the perimeter of a large critical infrastructure facility.

The *environmental* benefits category describes those BVLOS uses cases where some type of benefit to the environment could be identified and quantified. For example, UAS BVLOS operations can perform helpful weather measurements or combat climate change.

The *health benefits* category grew out of the realization that UAS BVLOS operations could potentially lead to opportunities to improve both individual and community health. The humanitarian work underway in Africa and elsewhere is an example of BVLOS missions that can improve health and health outcomes. For example, this category could involve UAS delivery of vaccines or important medications.

Finally, the *equity* benefits category describes those operations that provide benefits or opportunities for traditionally disadvantaged communities. As described more fully below, UAS BVLOS operations can be a potential “equalizer” of access to opportunities for previously disadvantaged areas, regions, and communities.

With these benefits in mind, the Subgroup identified the availability of market surveys, academic papers and economic reports that could be used to validate and support quantifiable assessments and estimates of the benefits from UAS BVLOS operations.

We provide the results of initial research and work of the Subgroup below. The Subgroup’s work benefitted from several pre-existing UAS market surveys.[122] Multiple subject matter experts (SMEs) shared their data, research, and methodology with the ARC, including Levitate Capital, Virginia Tech University, and others. The market studies utilize a variety of methodologies, some of which may be more accurate and/or reliable than others. To remain within the scope of the ARC, we attempted to find data that focused 1) specifically on the US (rather than global) marketplace, 2) particularly on the commercial UAS marketplace (rather than military or recreational), and 3) on small(er) UAS (not passenger-carrying vehicles).

As we reviewed market surveys, we noticed that many use cases have a variety of benefits, which affirmed early observations that many societal benefits are typically “crosscutting.” We attempted to account for that overlap below.

Finally, we note that for any new technology, including UAS, many of the best use cases are simply not yet known until legal and regulatory frameworks enable regular research and development and ultimately broader operations. Since UAS BVLOS operations are generally not allowed in the United States today, many beneficial viable use cases for society may not even yet exist. A recognizable example from recent history is when cell phones were first introduced, initially nobody assumed that we would eventually do virtually everything using our smartphones – from email to banking and shopping. The same could well be true for UAS BVLOS operations; the benefits of UAS BVLOS operations are limited only by the collective imagination of entrepreneurs and innovators, and ultimately the needs of society. While this is difficult to quantify in the nascent stages of the industry, it is likely that the benefits of UAS BVLOS operations exceed the estimates provided here and will likely be yet another example of Amara’s law associated with technology adoption and acceptance by society.

From our perspective, even given all these caveats and the uncertainty inherent in this exercise, one top line message clearly shines through: The societal benefits of UAS BVLOS operations are significant, and in some cases *very* significant.

A. Economic Benefits

Economic benefits of UAS BVLOS operations are broad, and can result from cost savings, cost avoidance, and/or creation of new market opportunities resulting from expanded UAS BVLOS operations. Economic benefits can be classified as *private* or *publi*c economic benefits.

Even today’s limited UAS operations have provided a glimpse of the potential for UAS BVLOS operations to provide economic benefits to society. To date, everything from donor organs to meals to convenience

[122] Note that some market surveys are proprietary and confidential, and therefore we lacked access to that universe of market surveys.

items such as aspirin and toothpaste have been delivered by UAS under limited and controlled conditions.

Global events have also heightened interest in disruptive technologies such as UAS BVLOS operations. As an example, during the height of the COVID-19 pandemic, people needed to be kept at a safe distance and supply chains were stretched to the limit. At this time many realized just how valuable this technology could be when used at scale to revolutionize how we transport goods in rural, suburban, and urban environments.

Early in the development of the commercial UAS industry, a primary benefits focus was on cost savings and cost avoidance. This continues to be an important consideration.[123] The Levitate Capital Report to the ARC stated that there is a significant potential for economic savings (approximately $3.5 billion) as a result of enterprise UAS operations including:

- Construction companies could save ~$160 million annually on surveying
- DOTs could save ~$560 million annually on bridge inspections
- The U.S. economy could save up to $920 million annually using utility drones
- Tower operators could save ~$220million annually on inspections
- Police departments could save ~$920 million annually using drones
- Precision agriculture UAS BVLOS operations could save ~$700 million annually[124]

Private Benefit to Industry

We started with an assumption that UAS BVLOS operations have significant potential to provide private economic benefits to society, supported by private industry's recent significant investment in the commercial drone industry. The Levitate Capital study estimates that more than $5.74 billion has been invested globally in drone companies.[125] The United States attracted more than 60 percent of total drone investments in 2020 (approximately $700 million invested in non-passenger U.S.-based drone companies in 2020).[126]

It is important to note that the U.S. enterprise UAS market today is still emerging. Advances in hardware, software, and expected ease of regulatory restrictions on both commercial and delivery UAS operations will drive future growth as enterprise revenues shift from primarily hardware sales to

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[123] See e.g., Ark Investment, "Big Ideas 2021" (Jan 26 2021) (page 72-78) ("ARK believes that drone delivery platforms will generate roughly $275 billion in delivery revenues, $50 billion in hardware sales, and $12 billion in mapping revenue by 2030"); Levitate Capital, The Future of the Drone Economy: A Comprehensive Analysis of the Economic Potential, Market Opportunities, and Strategic Considerations in the Drone Economy (Dec. 2020) (found at https://levitatecap.com/levitate/wp-content/uploads/2020/12/Levitate-Capital-White-Paper.pdf); Ernst & Young, UAV Market Potential and Development Issues (May 2020) (found at https://assets.ey.com/content/dam/ey-sites/ey-com/en_ru/topics/advisory/ey-uav-survey-eng.pdf); Canaccord Genuity, US Equity Research, "Age of Autonomy: Economic Opportunities in the New Drone Industry" (22 January 2020); PwC, Clarity from above - PwC global report on the commercial applications of drone technology, found at https://www.pwc.com/kz/en/services/drones-technologies/clarity-from-above-eng.pdf (May 2016); Pamela Cohn, Alastair Green, Meredith Langstaff, and Melanie Roller, McKinsey - Commercial Drones are Here: The Future of Unmanned Aerial Systems, found at https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems.

[124] Levitate Capital White Paper, Enterprise Market 2020, p. 6.

[125] *Id.* at p. 4.

[126] *Id.*

software and services sales by 2025.[127] The market for last-mile logistics drones is inextricably linked to easing of regulations.

The "last mile" cost of package delivery is economically significant. Whether delivery takes place in an urban or rural environment, the highest cost segment of that delivery tends to be in the final phase of that operation. Moreover, the vast majority of delivered packages are under 5 pounds in weight (86 percent of Amazon deliveries) and therefore eligible for delivery via UAS.[128] Utilization of electric propulsion and distributed electric propulsion (DEP) results in many external benefits, including the predictable and consistent cost of charging. Studies have also shown that consumers place a high value not just on the speed of delivery, but on real-time information on package location. Apart from weather factors, UAS delivery affords much greater predictability along with real-time information about package location and availability.

Economic benefits can also flow to local small businesses participating in UAS delivery programs. For example, one study of UAS local delivery programs found that local participating retailers could experience up to $208,000 a year in increased business opportunity, and local restaurants could generate up to $284,000 in additional sales, by expanding the footprint of serviceable customers.[129]

Small- and medium-sized UA service providers also stand to benefit from BVLOS operations. Local BVLOS will enable greater time savings in the enterprise sector enabling more efficient operations in precision agriculture as well as infrastructure inspections.

Public Benefit to Society

The clearest examples of public economic benefits involve UAS BVLOS use cases where public expenditures can be reduced or eliminated through improved efficiencies of operations or cost avoidance (or both).

Some private economic benefits will generate broader economic benefits for the public. For instance, a company using UAS to achieve immediate cost savings, would pass those savings along to consumers and to the public.

Public economic benefits of BVLOS operations flow from municipalities to constituents in the form of tax savings. For example, transportation planning and economic development mapping for improvements are often expensive for rural, small, mid-sized, and disadvantaged communities. UAS integration may lessen the financial demands to collect this required information.

Infrastructure inspection operations conducted by small UAS offer substantial public benefits. As mentioned, it is estimated that state departments of transportation could save $560 million annually on bridge inspections--a staggering sum.[130] The American Association of State Highway and Transportation Officials (AASHTO) estimated that inspecting a single bridge with a UAS is roughly 3.8 times less expensive ($4,600 for traditional methods compared with $1,200 for UAS-based inspections) than

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[127] *Id.* at 16.
[128] *Id.* at 14.
[129] https://www.newswise.com/pdf_docs/160018187481745_Virginia%20Tech%20%20Measuring%20the%20Effects%20of%20Drone%20Delivery%20in%20the%20United%20States_September%202020.pdf. (at page 16)
[130] *Id.* at 8.

traditional methods of inspection.[131] In 2019, AASHTO conducted a survey to determine drone use among state DOTs.[132] The survey indicated that 49 out of 50 states are using UAS and drone technologies in some way, and 36 out of 50 state DOTs (72%) are funding programs to operate drones.[133]

Likewise, small UAS package delivery using UAS BVLOS operations has the potential to provide both private and public economic benefits for society. For example, Levitate Capital estimated that there will be $105 million in economic savings by 2025 and an estimated $2 billion economic savings in 2030.[134] In a single U.S. city, UAS delivery could help a consumer in a lower density community save 31-56 hours per year in avoidable travel, or help a higher denser community save time equivalent to $582.5 million per year.[135] A private entity may initially seek to utilize UAS BVLOS deliveries to improve profitability and realize cost savings. However, those cost savings may be passed on to consumers resulting in overall lower costs of products and services. UAS BVLOS deliveries can also reduce the amount of road and highway traffic, which can reduce the chances of road accidents which result in added expense (not to mention safety ramifications). The reduction in road traffic reduces the cost and impacts of traffic on the transportation infrastructure, thereby reducing public transportation expenditures for maintenance and repairs.

B. Safety/Public Safety Benefits

As one of the original four pillars that was considered by the Subgroup, the *safety* benefits category was further expanded into two subcategories: 1) *operational safety benefits;* and 2) *public safety and first responder benefits*.

Operational Safety Benefits

A major benefit of using UAS is the immediate safety benefits that can be achieved in comparison to traditional legacy transportation. For example, tower inspections traditionally have subjected workers to hazards and risks. UAS BVLOS operations can inspect a cluster or grouping of towers while improving worker safety and reducing injury and death.

UAS can create safer work environments. For example, many types of safety inspections require crewed helicopters.[136] UAS BVLOS operations can reduce those helicopter flight hours by 44,000 hours per year

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[131] AASHTO, Mission Control: 2019 AASHTO UAS/Drone Survey of All 50 State DOTs, https://www.transportation.org/wp-content/uploads/2019/05/MissionControl_Drones3.pdf.
[132] *See* AASHTO Survey Finds Drone Use Exploding Among State DOTs (May 24, 2019) (found at https://aashtojournal.org/2019/05/24/aashto-survey-finds-drone-use-exploding-among-state-dots/) .

[133] *Id.*; AASHTO*, Evolution of Drones Part Three, State DOTs Hiring Next-Gen Workforce to Fly Drones Saving Lives, Time, and Money*; AASHTO News*, Survey Finds State DOTs Hiring Next-Gen Workforce to Run Drone Operations* (May 20, 2019).
[134] *Id.* at 18.
[135] https://cece.vt.edu/content/dam/econdev_vt_edu/projects/technology/Virginia%20Tech%20%20Measuring%20the%20Effects%20of%20Drone%20Delivery%20in%20the%20United%20States_September%202020.pdf
[136] https://rotormedia.com/unmanned-systems-save-lives-in-high-risk-manned-operations/. See "Identifying How UAS.OPA Can Reduce Fatal Accidents in High Risk Manned Helicopter Operations" prepared by Mark Colborn, Scott Burgess, Ph.D., and Wayne M. Keeton – H-SE 90 SME Team, United States Helicopter Safety Team (USHST), Feb. 2, 2019.

which can statistically eliminate 1.6 helicopter accidents.[137] In addition, UAS BVLOS delivery operations can lead to 1.5 billion fewer road mile deliveries by freight in 2025, and 29 billion fewer road miles by 2030.[138] Some modeling by Virginia Tech suggests that at scale, UAS delivery could help to avoid 580 road accidents per year in a single U.S. city such as Austin, TX, or Columbus, OH.[139]

As another example, UAS-based inspections of critical infrastructure facilities and assets can remove employees from dangerous operations, allow for early detection of leaks or failures, and increase asset optimization, all of which benefit the public through increased safety and operational efficiency of critical infrastructure. UAS-based collection and analytics can inspect more energy production, transmission and storage infrastructure per day compared to a manual, ground-based inspection, which significantly increases the opportunity to detect and remedy leaks and other issues. UAS BVLOS operations can significantly increase inspection efficiency, allowing for additional inspections to be performed on a more routine basis to find leaks or failures and ameliorate problems before additional issues occur or existing problems worsen and become safety critical. Allowing for remote inspections with BVLOS capable UAS operations also removes inspectors from possible exposure to hazardous chemicals during the inspection process.

UAS BVLOS critical infrastructure inspections can also increase road safety, as illustrated by the remote BVLOS inspections in the Permian Basin. Public roads and highways in the Permian Basin have a disproportionately high number of accidents accounting for almost one hundred fatalities in one year, primarily involving oil and gas workers traveling in the Permian Basin for work-related efforts.[140] In fact, according to statistics published by the Texas Department of Transportation, a vehicular fatality occurred every 37 hours across 16 counties in the Permian basin for the first 4 months of 2018.[141] Increasing the efficiency and allowable usage of UAS can limit the required driving for inspectors who can now operate out of a centralized location without travelling from one location to the next to perform operations.

These examples not only increase safety and efficiency, but there are direct economic benefits stemming from reductions in Worker's Compensation and insurance claims, for example.

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[137] Levitate Capital White Paper, Enterprise Market 2020, p. 19.
[138] Levitate Capital White Paper, Enterprise Market 2020, p. 19.
[139] https://wing.com/resource-hub/articles/why-do-we-need-drone-delivery/
[140] https://www.dallasnews.com/business/energy/2018/07/30/death-highway-in-texas-permian-basin-sees-accidents-fatalities-pick-up-as-oil-price-rises/
[141] SWEPI LP COMMENTS ON DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION DOCKET ID NUMBER FAA-2018-0263 (July 2018).

Public Safety and First Responder Benefits

UAS BVLOS applications to support public safety personnel and first responders have unique and quantifiable benefits. For example, many jurisdictions are constrained on the number of public safety personnel that can be employed due to budget and funding constraints. UAS BVLOS operations can help in situations where there is concern about the safety at a scene or incident, and a quick threat assessment is needed so that public safety officials can deploy proper proportional response teams.[142] For these types of scenarios, Levitate Capital estimates that UAS BVLOS operations could save police departments as much as $920 million each year in the United States.[143]

UAS can also reduce emergency response times, as demonstrated by research. In one study researchers simulated out-of-hospital cardiac arrests to a UAS command crew who simultaneously dispatched a UA carrying a defibrillator and an ambulance to the location of the incident, where paramedics performed CPR on a mannequin until arrival of the ambulance. By comparison, the response time to cover 4.1 miles took 7.5 minutes by ambulance and 5.8 minutes by UAS.[144] In another example, a UAS flight covered 5.8 miles in 11-13 minutes whereas the ambulance covered 12.4 miles in 19-20 minutes, since UAS BVLOS operations can follow a straight and direct path.[145]

C. Security Benefits

Security benefits are an important separate category. UAS are frequently utilized in emergency situations, including helping communities recover after hurricanes and other natural disasters. For example, UAS have provided internet connectivity and assisted cleanup efforts after disasters. UAS can also be used in conjunction with artificial intelligence after a natural disaster to automatically identify buildings and make an initial determination of whether they are damaged and how serious that damage might be.

UAS may also augment or replace security guards. Security personnel are finding new ways to improve their department efficiency and capability. Security managers are also seeing the usefulness of overall team productivity when UAS programs are implemented for aerial data collection. This translates to a reduced amount of time required for data analysis and a larger reduction of resources required to complete security-related assignments.

D. Environmental Benefits

UAS BVLOS operations have the potential to provide significant environmental benefits to society. One example is the use of UAS BVLOS operations to more accurately study and measure the planetary boundary layer (PBL) to enhance understanding of the lower atmosphere and to improve storm predictions and warnings. In 2009, the National Academies of Science, Engineering and Medicine released a report stating that a better understanding of the PBL was critical in improving our understanding of the atmosphere and improving our ability to forecast and predict severe storms.[146]

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[142] See, e.g., work as part of the Chula Vista UAS Integration Pilot Program.
[143] Levitate Capital White Paper, Enterprise Market 2020, p. 11.
[144] https://www.healio.com/news/cardiology/20200708/drone-delivery-of-aed-for-cardiac-arrest-may-result-in-earlier-cpr
[145] Id.
[146] National Research Council. 2009. Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks. Washington, DC: The National Academies Press. https://doi.org/10.17226/12540.

Small UAS are already proving useful in this area because of ongoing research at Oklahoma State University (OSU) and multiple other research groups. UAS BVLOS operations are necessary to achieve significant improvements in this area and create a new level of meteorological sensing capabilities.

UAS also play a very direct role in slashing carbon emissions. With respect to infrastructure inspections operations, expanded use of UAS used in lieu of crewed helicopters have the potential to reduce CO2 emissions by 11,000 metric tons per year.[147] For context, "heavy duty bucket trucks" used for bridge inspections get "approximately 5 miles per gallon, while crewed helicopters consume fuel at a rate of less than two miles per gallon."[148] Electric UAS, by contrast, have zero direct emissions. With respect to public safety, UAS used in lieu of vehicles could have the potential to reduce Co2 emissions by 42,000 metric tons per year.[149]

With respect to package delivery, UAS deliveries occurring over a period of 5 years would equate to a reduction of 294 million miles of road travel.[150] This is equivalent to taking 25,000 vehicles off the road, which could reduce carbon emissions by up to 113,000 tons of Co2 per year in a metro area.[151] This reduction in Co2 is equivalent to planting 46,000 acres of new forest.[152]

Another example of environmental benefits involves the use of UAS to enter sensitive natural ecosystems where a human presence on the ground might disrupt the ecosystem. This could involve missions where the UAS obtains physical samples or surveys an area. This will be increasingly critical in the future as fragile and sensitive ecosystems face growing threats. For example, UAS BVLOS operations can be used to monitor wildlife and safely monitor animal behavior from a distance.[153]UAS are also increasingly being used to combat climate change - for example, to gather data that assists in carbon capture estimation, timber value estimation, deforestation monitoring, advanced growth forecasting, fugitive emissions from landfills, forest management and more.[154] Moreover, UAS have emerged as an important tool for state environmental agencies to quickly obtain data, more effectively respond to emergencies, and ensure worker safety while improving environmental results.

UAS BVLOS operations can also help our nation recover after wildfires. Over the last 10 years, the U.S. has lost millions of forest acres to wildfires annually each year. Currently, the most effective and common reforestation technique is human planters carrying sacks of seedlings and planting them in rugged, forest terrain. Herbicides, which protect new seedling growth, also need to be sprayed by crews on foot, carrying heavy loads on steep, dangerous terrain. UAS can seed six times faster than human planters, and the systems can propagate 40 acres per day. [155] UAS BVLOS operations can help restore

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[147] Levitate Capital White Paper, Enterprise Market 2020, at p.21
[148] Commercial UAV News.
[149] Levitate Capital White Paper, Enterprise Market 2020, p. 11.
[150] Virginia Tech, *Measuring the Effects of Drone Delivery in the United States* (September 2020), September 2020, found at https://vtechworks.lib.vt.edu/bitstream/handle/10919/100104/Effects%20of%20Drone%20Delivery%20US_September%202020.pdf?sequence=1&isAllowed=y.
[151] *Id*.
[152] *Id*.
[153] https://money.cnn.com/2018/02/13/technology/drones-counting-wildlife-conservation/index.html
[154] https://www.treeswift.com/.
[155]https://droneseed.com/?gclid=CjwKCAjwruSHBhAtEiwA_qCppiX4wQdgAxqZZhOwxNsLbY-ec3ThsB5FS_hZqcc3DnyRPcrG-32nuRoCEKEQAvD_BwE.

the environment and accelerate reforestation in a scalable manner by planting seeds and protecting seedlings in areas devastated by wildfires. The process of revegetating is the most effective method of carbon sequestration. Global emissions can be reduced through replanting trees, rangelands, and fire response and restoration. The use of UAS in reforestation efforts also significantly improves safety by reducing worker exposure to dangerous environments.

UAS BVLOS operations can also precisely target invasive plant species with herbicides to minimize disruption of the surface and soil - which will ultimately help our native flora and fauna thrive. For example, in some rural communities, UAS BVLOS operations may be used to combat proliferation of eastern red cedar plants. The spread of eastern red cedar in many parts of the United States is adversely impacting the environment when they become invasive and spread beyond their original natural areas. UAS BVLOS operations can precisely target eastern red cedars with herbicides to minimize disruption of the surface and soil and to focus on just the eastern red cedar trees.

E. Equity Benefits

Equity is another important benefit of UAS BVLOS operations. For example, UAS may be used in "pharmacy deserts" to help rural communities with delivery of critical items such as prescription medication, anti-venom for snake bites and EpiPens. UAS delivery of EpiPens can help reduce deaths in the U.S. in areas where immediate access to these medications is not always immediate (i.e., – in rural or sparsely populated regions). It is estimated that there are about 2.4 EpiPen-preventable deaths from food anaphylaxis per million people in the U.S. per year.[156] As many as 780 people die per year due to lack of access to an EpiPen in the United States.[157] If 10% of those could be saved because of an expedited access to EpiPens through UAS delivery, the net economic benefit to society could exceed $90 million.[158]

By enabling efficient options for deliveries of essential public consumption items, the federal government can create fair and just competition between conventional ground transportation barriers. It is also more expedient for consumers to get items quickly and efficiently.

More broadly, UAS have democratized aviation, enabling access to the skies without the expense or difficulty of traditional aviation. The wide availability, and relatively low cost, of small UAS technology enables a new and more diverse generation of pilots to experience the wonder of flight and the power and promise of STEM (science, technology, engineering and math). The more the aviation regulatory system accommodates advanced and scalable uses of UAS, the larger the impact UAS will have on our society, and the higher the likelihood that UAS technology will be able to reach historically undeserved communities and usher in a more diverse generation of aviation professionals.

Using BVLOS operations to gather industrial aerial data is a benefit to urban communities with a proliferation of industrial complexes, many of which exist near disadvantaged communities. Virtually all industries gather data to monitor and improve production in a low-cost way, which tends to benefit the surrounding communities from which workers are employed. BVLOS urban mission environments will include industrial plants, mining operations, construction sites, and offshore platforms, among many others.

In the past, many types of infrastructure inspection and monitoring have relied on rigorous physical activities, such as climbing towers, or physically maneuvering through dangerous and rugged terrains. Legacy aviation has also imposed various medical requirements, including physical mobility and vision, as prerequisites for flying airplanes. As a result, individuals who have limited mobility (such as being confined to wheelchairs) have not been allowed to participate in these types of job and economic opportunities, even when they have the cognizant abilities and skills to otherwise do so. UAS BVLOS operations should not require the same medical standards; the FAA must match the skills actually needed for operating a UAS and open up the economic benefits of the industry to all. For example,

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[156] Forbes, *Calculating the Value of an EpiPen* (Aug. 29, 2016), https://www.forbes.com/sites/frankdavid/2016/08/29/epipen/?sh=2434ccb74f30.

[157] *Id.*

[158] The statistical value of a human life in 2020 was $11.6 million, according to the U.S. Department of Transportation "Departmental Guidance on Valuation of a Statistical Life in Economic Analysis" found at https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis.

BVLOS operations may not actually require any direct human input. UAS BVLOS operations can provide new career and employment opportunities that, in the past, have been denied.

The UAS industry offers exciting opportunities for training and access for women and minorities who seek quality jobs in the aviation industry. Based on our findings in this report, Working Group 1.2 urges the federal government through its Disadvantaged Business Enterprise (DBE) program to create a prequalification category whereas firms that are 51 percent owned by women, minorities and socially and economically challenged firms have an opportunity to compete for bid opportunities.

F. Public Health Benefits

UAS BVLOS operations have the potential for broad applications to improve both individual health, and health of communities. The Market Drivers Working Group highlighted several examples:

UAS BVLOS can efficiently deliver test kits to areas in need, expedite safe transfer of testing samples from a centralized facility to laboratories, deliver critical supplies like medical goods and prescriptions to households, and expedite logistics to enhance efficiencies as personnel are forced to stay home.
UAS BVLOS can be a valuable tool to enable workers to work contact-free, without much – if any – human interaction. UAS can enable social distancing in a world where quarantining and social distancing are required to stay healthy.
Private industry has successfully performed missions delivering a human kidney between facilities in Maryland and delivering medical samples through the IPP (and at scale in other countries).

While the potential for public health benefits resulting from UAS operations during pandemics is excellent, these benefits have thus far been very limited in the United States due to regulatory challenges. Unfortunately, during the global pandemic, opportunities to beneficially leverage UAS technology for missions such as contactless delivery were thwarted by the slow pace of regulatory change. The entire global community fundamentally changed how we all work, shop, and conduct our daily lives. Society was ready, and even anticipating, similar benefits from UAS technology, but the regulatory environment prevented society from realizing those potential benefits. This was demonstrated in a case involving a small community within the Choctaw Nation of Oklahoma that went to great lengths to solicit assistance from the FAA to enable UAS delivery to protect assisted living care facilities, but the exemption and waiver process proved too slow to respond.

Public health benefits of UAS go beyond pandemics. Indeed, mosquitos are considered the deadliest creatures in the world. The use of UAS BVLOS operations to combat mosquito problems can improve overall community health and reduce the number of deaths. UAS can be used to conduct data collection and control in remote areas (e.g., brackish salt marsh, irrigation field) that are difficult to reach by land but may have mosquito production sites that impact residential or other public areas. Routine BVLOS operations can improve the effectiveness of using UAS to combat the outbreak of mosquito populations, especially in areas where it is difficult to access their breeding waters.

Another invaluable use case is using UAS BVLOS operations to deliver Automated External Defibrillator (AED) equipment. Immediate and rapid access to AED equipment can help save the lives of heart attack victims. The more time a person spends in cardiac arrest before treatment, the lower their chance of survival becomes. The average response time for traditional first responders once 911 is called is 8-12 minutes.[159] For every minute that defibrillation is delayed, survival decreases by 7-10%.[160] More than 350,000 cardiac arrests happen across the United States outside of a hospital setting.[161] In an out-of-hospital cardiac arrest event, a person's chance of survival is about 1 in 10.[162] Reducing time to defibrillation is the most important factor for increasing survival in OHCA.

One study found that consumers could benefit from enhanced health outcomes with UAS delivery service. For consumers, UAS delivery could help 22,000 people in a single U.S. city obtain and adhere to prescription medications that were delivered via UAS.[163]

G. Findings and Recommendations

Working Group 1.2 identified six societal benefits that directly result from UAS BVLOS operations. The Subgroup successfully synthesized a set of broad UAS BVLOS use cases to validate these categories. Virtually all these use cases had a potential for broad cross-cutting social benefits beyond just a single category of benefits. As a result of the Subgroup's analysis and deliberations, a set of recommendations were created to summarize the work and provide a roadmap for next steps in Phase 2 of the ARC.

The following recommendations to the full ARC reflect the consensus findings of the Subgroup:

Recommendation #1: The DOT and FAA must assess and evaluate societal benefits from UAS BVLOS operations broadly and consider those categories and types of benefits that are not easily quantifiable. Given the current regulatory framework, actual benefits may be difficult to quantify since the operations do not yet exist at scale. Subjective assessments of qualifiable benefits are important for an overall risk and rewards balance.

Recommendation #2: UAS operations have already demonstrated benefits for society, even within the current VLOS regulatory limitations. The Subgroup believes that expanded operations such as BVLOS will yield significant additional benefits for society. The DOT and FAA should account for these benefits in developing a rule, as these benefits can best be realized by a supportive regulatory framework. Further, the DOT and FAA should account for the opportunity cost of not realizing these benefits at scale, as well as the cost and burden on society of the current regulatory system of exemptions and waivers. The FAA should also consider the impacts of delayed rulemaking, and the total costs and burdens on society associated with those delays.

Recommendation #3: In developing a rulemaking and for the purpose of analyzing specific approvals, the DOT and FAA should consider holistic benefits to communities and society at large (including those outside of the aviation system) that can be achieved through enabling UAS BVLOS operations. In parallel, given these broad (often non-aviation) benefits, the FAA must consider risks holistically. The FAA should consider, for example, the benefits of UAS taking cars off the road, reducing risks for bridge inspectors or tower climbers, or reducing the risk of loss of life or property damage from wildlife. Indeed, UAS BVLOS operations will support broader societal goals in parallel with other emerging technologies and opportunities, and in its regulatory approval process the FAA must consider overall

[159] The American Red Cross, *What is AED?*, https://www.redcross.org/take-a-class/aed/using-an-aed/what-is-aed.
[160] American Red Cross CPR/AED for Professional and Health Care Providers Handbook, p. 15.
[161] American Heart Association, CPR Facts & Stats, https://cpr.heart.org/en/resources/cpr-facts-and-stats.
[162] https://www.medscape.com/answers/1344081-122892/what-are-the-survival-rates-for-patients-with-cardiac-arrest-treated-with-cardiopulmonary-resuscitation-cpr
[163] Virginia Tech Measuring the Effects of Drone Delivery in the United States, Lyon-Hill, Ellis, September 2020.

broader long-term societal needs and opportunities for benefits that might result from UAS BVLOS operations.

Recommendation #4: The DOT and FAA should consider benefits across all types of communities and ensure that consideration is given to unique benefits that may exist between different types of communities (such as in rural areas or underserved areas).

Recommendation #5: The FAA should consider the environmental benefits of UAS BVLOS operations as part of other activities and analyses (whether under the National Environmental Policy Act or other reviews). UAS BVLOS operations may offer significant opportunities to address critical environmental issues and challenges, while reducing the environmental impacts of more traditional modes of transportation or inspection. The Subgroup recognizes that UAS BVLOS operations may also enable the FAA to address issues such as noise in innovative ways. Environmental reviews must be streamlined and appropriately tailored to account for the risks and benefits of UAS.

Recommendation #6: Given the equity benefits discussed here, the FAA has a unique opportunity to strengthen the economics of small business entry into this industry and subsequently address critical equity challenges and improve the quality of life in historically underserved areas and communities. The FAA and industry both should seek to support minority and diverse communities in training and workforce development programs. The DOT and FAA should consider these benefits in their procurement programs, particularly those focused on disadvantaged communities (such as Disadvantaged Business Enterprise programs). The DOT and FAA should work with industry to build into the nation's STEM programs pre-apprenticeship and apprenticeship models that segue directly into employment. Additionally, Congress should fund the promising, but currently unfunded, UAS-related workforce development programs for community colleges and universities that Congress required in Section 631 and 632 of the FAA Reauthorization Act of 2018. If appropriately funded, those programs could provide a pathway to educate a new and more diverse generation of workers to take advantage of the UAS economy, as well as re-skill existing workers.

Recommendation #7: The DOT and FAA should consider the positive impacts that advances in technology are having on requisite skill sets required for UAS operators and flight crews. As aviators rely more on cognitive skills versus physical skills, the FAA should enable opportunities for those with physical limitations in the UAS sector.

Recommendation #8: Due to its importance in supporting the entire U.S. economy, the FAA should consider how UAS BVLOS operations can enhance the planning and operations of critical infrastructure and improve resilience, particularly in response to consumer needs and regulatory requirements imposed by federal, state, and local governments. Improved efficiencies reduce costs and mitigate losses in both long-line linear infrastructure inspections (electric transmission lines, pipelines, railroads, etc.) and static site monitoring (airports, refineries, telecommunication towers, wind, and solar generation facilities, railyards, etc.), which will provide a wide range of both public and private benefits realized by consumers, businesses, and governments.

VIII. Industry Needs (Subgroup 1.2.3)

The Industry Needs Subgroup (1.2.3) focused on identifying and rationalizing what the industry needs to scale UAS BVLOS operations, such that the industry ultimately can provide the societal benefits identified by the Subgroup. The Subgroup utilized the work of the Market Organization Subgroup in terms of defining the industry. The Subgroup recognized that some needs would require regulatory reform, while other industry needs such as physical infrastructure can be provided by industry.

The group started by identifying the universe of topics appropriate to explore. It was noted that industry needs will vary depending on various factors including vertical market sector as well as economic and market drivers, and industry needs will also evolve as technology continues to develop and improve.

The Subgroup agreed on five core needs: physical and technological infrastructure, uncrewed traffic management, cybersecurity, training and workforce development, and laws/rules/policy issues outside of the immediate UAS BVLOS rulemaking. It is important to note at the outset that not all these needs pertain to all BVLOS operations.

The Industry Needs Subgroup sought to answer challenge questions such as the following:

What (physical, technological) infrastructure is necessary to support the commercial BVLOS industry, and how is industry thinking about this?
How does industry envision supporting UTM (and what role will UTM play)?
How is the marketplace addressing the industry's cybersecurity needs?
What is the industry doing to promote training and workforce development?
What laws/rules/policies outside of this FAA rulemaking are hindering UAS BVLOS operations at scale?
What market forces affect industry's ability to scale BVLOS?

The Subgroup also agreed that factors including public acceptance and clarity/certainty are necessary to enable the industry to scale BVLOS operations. However, we do not go into detail on these topics here, because they are being covered by other BVLOS ARC Working Groups.

As the Subgroup initiated the effort, it immediately became clear that a supportive regulatory environment for BVLOS depends on more than just a single rule. The private sector is ready and willing to provide much of what the industry needs to scale UAS BVLOS operations, including infrastructure and UTM, but for certain capabilities it will be necessary for the public sector, including the federal government, to take steps to enable and support private sector initiatives. We report on each of these topics in turn.

A. Infrastructure Needs

The Industry Needs Subgroup addressed the physical and digital infrastructure needs of the UAS industry and regulatory authorities necessary to enable UAS BVLOS operations at scale. The Subgroup notes that not all UAS BVLOS operations require the full range of these infrastructure asset types, and some will only be required for specific operational approvals.

<u>Physical Infrastructure</u>: Locations for Takeoff and Landing

Suitable takeoff and landing locations are vital to safe UAS BVLOS operations. Dependent on various factors, including location, zoning of takeoff and landing may require context sensitive design, environmental impact studies, and community engagement given the unique location/conditions, future automation, and security needs.

Recommendation: As necessary, ensure appropriate information is available for zoning of takeoff and landing locations commensurate with operational risk that would mitigate local concerns.

Communications Infrastructure

The Subgroup recognized that availability of communications infrastructure is an important consideration for safe UAS BVLOS operations.

Clear performance-based rules and guidance are important for the industry to scale. For example, the operational approval process should identify the required level of *command and control* (C2) availability and reliability in the context of a specific operation in a specific environment.

The FAA must incorporate flexibility into the analysis. Indeed, assessment of specific operations will need to consider the risk of the operation, and the role of the C2 link in the system of mitigations. For example, the ARC should consider addressing a range of operational circumstances and paths to approval.

The Subgroup discussed whether Quality-of-Service assurances should be required, so that capacity constraints on the provider do not adversely impact flight operations. It was agreed that it would be helpful to industry to scale to have access to Quality-of-Service information.

Notably, throughput is critical to many use cases. This may require guaranteed quality of service in higher risk use cases. Providers may need to ensure that certain traffic can be prioritized over other traffic in shared networks.

Since we anticipate that changes in environment and flight conditions will require modification of flight plans dynamically, the FAA should consider communications system risk (and mitigations) in the operational approval process.

While Vehicle-to-Vehicle (V2V) communications is an enabler of DAA in BVLOS operations, some DAA communications may require C2 link availability. Thus, regulatory clarity on the availability of the C2 link 'as required for safety-relevant network DAA functions' would be helpful.

Recommendation: Industry would benefit from clear performance requirements for conditions that mandate connectivity, in a way that enables flexibility and promotes scalability.

Recommendation: Industry service providers need help to understand eligibility and process to apply for a spectrum license based on ability to meet and performance requirements.

Location and Other Sensor Services

Positioning, Detect-and-Avoid and other safety-related sensor capabilities provide assurance to BVLOS operations. Highly automated operations and UAS autonomy also depend on the availability and assurance of such sensors. In some cases, a single sensor source such as GPS for location may be insufficient for operational safety minima in given scenarios. In other cases, GPS may not be necessary at all.

Generally, the required robustness of any sensor need should be determined through the operational approval process after assessing the risk of the operation and applicable mitigations. For example, in known GPS-denied BVLOS operational environments such as urban canyons or areas topographically restricted from sky view, vision-based, dead reckoning, or other positioning services should be recognized as viable alternatives.

Recommendation: Define approaches to the operational approval process that account for the UAS characteristics, environment, flight profile(s) and associated risks in requirements, if any, for required sensor capabilities, redundancy, and assurances.

Digital Infrastructure

The software and digital components of the infrastructure are critical to the success of BVLOS operations. The FAA should exercise careful diligence in determining which information sources are supplied, and how they are supplied, by the agency.

Recommendation: In cases where real-time data is required, define SLA requirements for SDSPs.

Recommendation: In cases where UTM services need authoritative data from the FAA, then the requisite interface, access and potentially certification requirements for UTM to access these sources should be provided.

Risk Mitigation/Conflict Management Needs

The Subgroup identified the following areas where infrastructure enhancements would help to support scaled BVLOS operations:

New or enhanced data sources on microclimates: Hyper-localized surface and low altitude wind data, temperature, and other atmospheric conditions can impede UAS operations and introduce a variety of contingency scenarios related to aircraft stability and control and energy reserves. It was noted that wind speeds as a ratio of UAS airspeed can be high, causing UAS to prematurely expend energy reserves or entirely fail to reach an intended destination. Accurate micro-climate situational awareness may help to support a wider variety of operations, including among smaller UAS.

Recommendation: Support microclimate monitoring in circumstances where the operational, location, UAS type/capabilities and atmospheric norms necessitate greater consideration of the microclimate.

Standardized Population Density Definitions: Subgroup participants noted that UAS risk depends, in part, on the densities of people and structures. Future regulations will likely need to be defined as a function of population density vs. simply ‘urban’ vs. ‘rural’.

Recommendation: Provide definitions for population density such that regulations and/or operational constraints can be associated with them where needed in order to promote wider understanding and delineation of risk.

Standardized Airspace Density Definitions: Participants also noted that airspace densities and the ability of UAS BVLOS to operate in different density levels (e.g., Detect and Avoid capabilities, autonomous decision making) require standardized density levels. Regulatory language as it relates to UAS or infrastructure service requirements would benefit from clear airspace density definitions. In addition, the FAA should make available more detailed and timely airspace data to help operators characterize their air risk profile.

Recommendation: Promote wider understanding, delineation, and definitions for airspace density such that regulations and/or operational constraints can be associated with them where needed. Perhaps industry consensus bodies could address ways of defining airspace density beyond just airspace type.

Night Operations Specific Equipment

Many beneficial UAS BVLOS operations may occur at night. The ARC should therefore consider mitigations for BVLOS operations at night.

Recommendation: Enable BVLOS at night and develop performance-based rules for BVLOS flight at night.

Automation

Automation describes the systems, applications, definitions, and processes that enable safe, secure, and reliable BVLOS operations with minimal human intervention. To characterize and define performance requirements for automated systems and applications (e.g., autonomous pilot), the Subgroup identified the need for the FAA to recognize highly automated operations featuring large fleets of UAS. In these operations, personnel may play limited to no role in the conduct of the flight and will instead supervise the operation or the service.

Automation should be recognized and enabled by the FAA to achieve higher safety and security outcomes. For example, the FAA should outline clear performance criteria for operations featuring one pilot overseeing multiple aircraft and / or multiple operating sites simultaneously.

Industry would benefit from a streamlined and clear regulatory approach to automation, which may include defining various levels of automation.

Recommendation: In Phase 2 of the ARC, collaborate with industry to identify examples of automation approaches that support defined target levels of safety for the UAS industry.

B. Uncrewed Traffic Management (UTM)

UTM services, in particular traffic deconfliction in many scenarios, provides a critical foundation to enable UAS BVLOS flight at scale by providing a system within which multiple operators can connect, communicate, and collaborate. Without an approved, secure, and scalable UTM system, it will be difficult to integrate multiple operators safely and efficiently at scale, perhaps apart from certain operations such as those at very low altitudes masked by infrastructure and terrain.

This is critical for the low-altitude and uncontrolled airspace within the purview of the ARC, but most importantly sets up the NAS for long-term intelligent integration into more complex airspace with other types of aircraft and operations.

To quote Administrator Dickson, "Our answer is UTM, which, as you know, is a foundational capability to unlock the full potential of this sector" [164] and below are our recommendations that include the critical path to UTM and BVLOS, including:

- Airspace -- with clear and operable airspace
- Automation -- with recognition of the "fourth A" of aviation
- Authoritative -- with a framework to approve UTM providers

Across each of these areas the Subgroup focused intently on performance and risk-based rule making that is based on data and the unwavering commitment to unlock the potential of UAS technology for the United States Airspace and Traffic Management.

Objective: Develop the most efficient and effective means to create operable airspace for low-altitude UAS BVLOS flight in uncontrolled airspace.

The Subgroup explored different global approaches to optimizing low-altitude airspace for drone flight. As the distinction between controlled and uncontrolled airspace is largely centered around traditional aviation, there was a discussion of the European approach to integration (such as "U-Space"). While there are potential benefits to the U-Space approach, airspace policy recommendations should be considered in Phase 2.

Because the ARC is focused first on uncontrolled airspace, the Industry Needs Subgroup analyzed stakeholder and activity data to develop a risk-based and efficient approach to create how UAS can fly in low-altitude, uncontrolled airspace. We started by recognizing the types of aircraft that currently occupy this airspace, which is dominated by UAS. There are over half a million registered UAS that occupy this airspace, compared to half as many general aviation aircraft (with rotorcraft being the primary general aviation aircraft that may occupy this airspace). [165]

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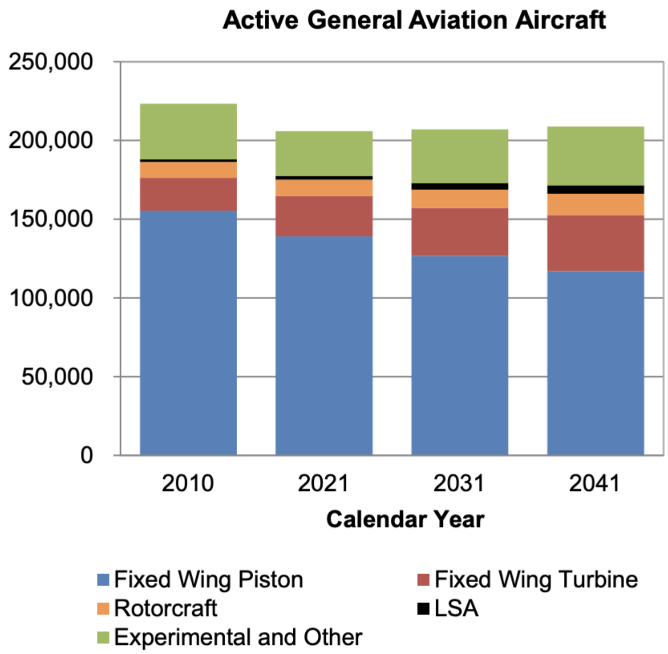
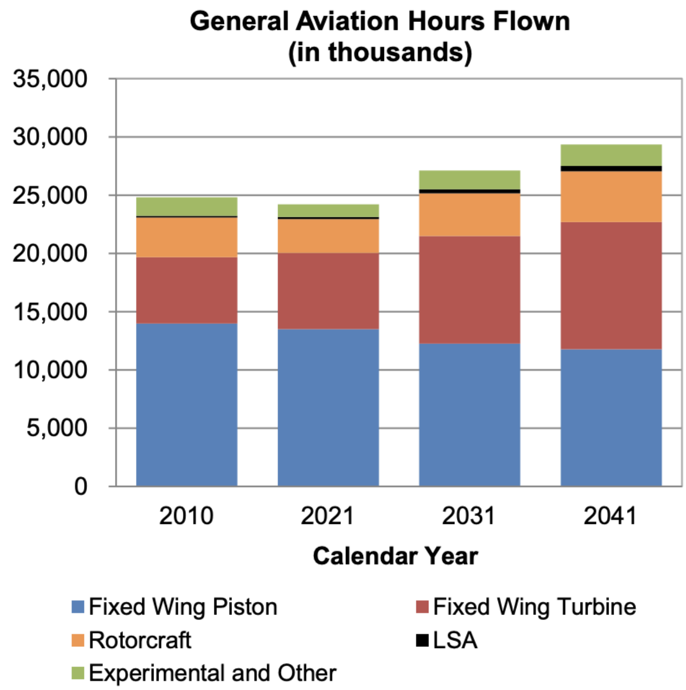
[164] FAA Administrator Steve Dickson: Episode III Keynote, June 9, 2021, https://www.faa.gov/news/speeches/news_story.cfm?newsId=26180

[165] FAA Aerospace Forecast Fiscal Years 2021-2041, https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2021-41_FAA_Aerospace_Forecast.pdf.



Total Commercial/Non-Model Fleet (Thousand sUAS Units)

Fiscal Year	Low	Base	High
Historical			
2020	488	488	488
Forecast			
2021	543	589	691
2022	569	665	871
2023	583	729	1,028
2024	601	784	1,094
2025	614	835	1,144



Not only are the aircraft numbers for UAS to rotorcraft favored roughly 50-1, but also the activity numbers with general aviation and notably rotorcraft are flying less than 5 million hours a year.

Recommendation: For operations under 400 feet in uncontrolled airspace, UAS will be operating alongside other UAS, e-VTOL aircraft, and potentially others. The ARC should recommend the FAA promote cooperation between crewed and uncrewed operations, including potentially altering right-of-way requirements and promoting interoperable communication.

Operational Considerations

The Subgroup also reviewed the multiple types of operations that would benefit from UTM services, especially for deconfliction. As the major use cases identified by the ARC will rely on UTM to operate at scale, we transitioned to thinking about operational attributes versus the use case supported by the operation.

We note this because there are a significant number of use cases where local, tactical, and manual flights (such as a bridge inspection) are effectively "BVLOS", just as a long-range autonomous delivery flight. To this end, an infrastructure inspection operation could utilize both local and long-range BVLOS. Whether the regulated entity is a food delivery company or a railroad, BVLOS rules must enable all of these scenarios in a risk-based way and inform how any operation can utilize UTM technologies to take flight in a compliant and safe manner.

Particularly with rulemaking, we recommend considering the type of operation and related requirements instead of a use case-based approach for UTM.

Longer-Term Considerations

Subgroup C recognizes that the scope of the ARC is limited to uncontrolled airspace, and while the Subgroup is focused on the 99% of the NAS that is uncontrolled, we recommend that the FAA consider longer-term needs for BVLOS drone flight to operate in controlled airspace.

Since there is already a current means to get authorization to fly UAS in controlled airspace with LAANC, we recommend that future rulemaking push beyond the LAANC infrastructure. For example, the ceiling limits in most cases are not risk-based and it will be critical for lifesaving and safety-enhancing UAS flights to enter the vast 0-foot LAANC ceiling areas across many controlled airspace areas.

Beginning with risk-based rules based on airspace complexity and actual air-traffic trajectories, augmented by authoritative UTM systems, we recommend that today's rulemaking consider other airspaces. Given the timeline of rulemaking generally, the ARC should take steps now to pave the runway for BVLOS flight in controlled and complex airspaces.

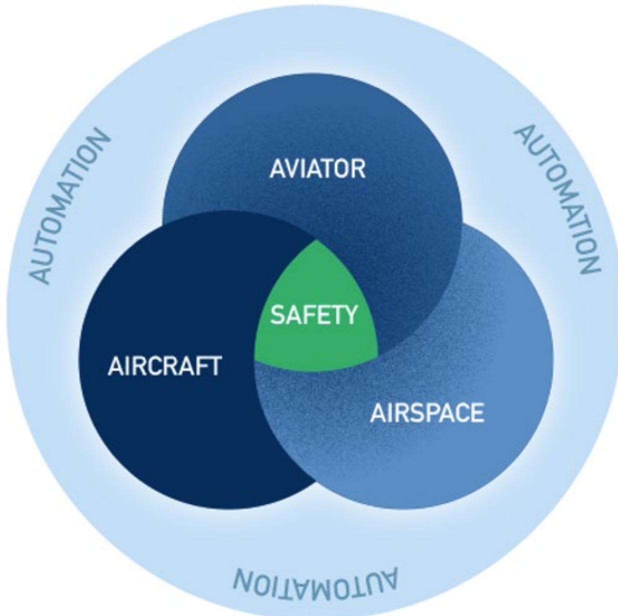
Automation in Airspace Access

Objective: Establish the role of automation in flying drones, including and especially BVLOS.

Automation is already a significant factor for safe and compliant flight across all aircraft, from auto-landings of jumbo jets to pilot-less space flight. The same is true with drones for programmatic and autonomous flight that exist today, but existing approaches to regulation do not support the use of automation at scale.

For example, LAANC is a UAS service with some automated features (e.g., automated approval for low-risk authorization requests). However, LAANC does not support the ingestion of automated flight plans. Instead, pilots must physically input and manage their airspace authorizations.

The potential role of automation for UAS is not limited to airspace but includes and supports all pillars of aviation. Across the entire workflow of an operation, automation can play a role in airspace management and deconfliction, assisting the pilot in command, and improving the flight and safety of the aircraft.



Recommendation: The FAA must account for and enable automation across drone flight, including UTM services, to optimize for both safety and scale of operations. This includes UAS and system platform requirements—potentially including design assurance levels related to hardware and software implementing the automation.

Drones require a different approach to balancing the traditional roles of the person, aircraft, and environment. The critical role of the pilot in command is transitioning to new paradigms that include high levels of automation.

Performance-based rulemaking, both for UTM services and those operators that will utilize UTM for safe BVLOS flight, can create a clear path for the role of automation.

Traffic Management for the Airspace

The Subgroup recognized that integration of BVLOS operations at scale—except, perhaps, for certain operations such as those at very low altitudes masked by infrastructure—will depend on a framework for sharing information between airspace users for purposes such as strategic deconfliction.

UTM Recommendations:

Recommendation: Establish rules and validation processes for USS that offer strategic deconfliction services to operators. These rules should be performance-based, non-prescriptive, and build on existing standards, such as the ASTM standards on Remote Identification and UTM. Through trials such as TCL and UPP, industry demonstrated that multiple operators can reliably detect conflict in congested airspace, ranging from VLOS operations with manually piloted aircraft to BVLOS operations with highly automated aircraft.

Recommendation: Recognize standards-based frameworks for USS interoperability. Examples of safe, secure, and scalable frameworks for interoperability include the Discovery and Synchronization framework described in the ASTM standards, which has been successfully applied to a range of UTM trials and implementations worldwide.

Recommendation: Establish airspace integration policies to promote cooperation in high-demand VLL airspace. Cooperation between UAS BVLOS via UTM will help to ensure that all operators can safely share the airspace.

Automating UAS Zone Activities

Related to embracing automation, BVLOS rulemaking should consider other manual processes that UAS pilots and companies need to follow for compliance. UTM services have the potential to reduce the operational load for operators and the FAA by opening systems like UAS or pilot registrations to APIs versus manual management on the FAA UAS Zone website.

Focusing on enabling scale and enabling automation, it is notable that thousands of remote pilots and aircraft operate under Part 107 today. The FAA would not only enable scale but also foster improved rates of compliance and currency by enabling UTM services and approved USSs to help companies maintain compliance by automating how aircraft and pilots are securely registered and updated. This would improve efficiencies today, but it will be required longer-term to enable compliance at scale BVLOS.

Authoritative

Objective: Create a path by which UTM services become a recognized and authoritative means for multiple BVLOS operations to safely share low-altitude airspace at scale.

There are three primary steps to implement UTM services across regulators and industry, including 1) approval, 2) operations and infrastructure, and 3) onboarding and auditing. Whereas the FAA manages all three roles in early UTM services like LAANC for airspace authorizations, the role of the FAA and industry should evolve with UTM, focusing more on the approved UAS Service Suppliers (USS) and the overall UTM system.

Taking LAANC as an example, the FAA is central at every step, including:

- Approval
    - Defining and implementing operating rules
    - Vetting potential companies
    - Signing MOAs that detail provider requirements
- Identifying supplemental sources of authoritative data
- Operations
    - Monitoring the deployment of approved technology
    - Creating and managing some authoritative data sets (e.g., airspace constraints)
- Onboarding and auditing
    - Technical onboarding with testing of user interfaces
        - New USS providers
        - Recurrent USS providers
    - Tracking performance and statistics

- Engaging in USS audits for MOA conformance

In considering the role of the FAA with regards to UTM, we can learn a lot from experiences associated with LAANC. Ultimately UTM needs to operate differently, however. As Administrator Dickson recently stated, “We’re also continuing to work with our global partners to develop a UTM architecture. But we ultimately want YOU, industry, to take ownership.”[166]

Recommendation: The FAA’s regulatory role should focus on defining UTM and approving USSs and the UTM system, leaving the operation of the federated system to industry.

There is consensus across Subgroup C that the role of the FAA for vetting and validating providers continues within a UTM construct. The manual and intensive role of testing user interfaces is not relevant when looking at a federated UTM system and can be done in an automated and ongoing manner in a UTM staging environment. ASTM interoperability standards in progress address this area.

Supplemental Data

Supplemental Data Service Providers (SDSP) as described in UTM CONOPS 2.0[167] will play a critical role in augmenting UTM services with useful data relevant to the airspace and operations. The Subgroup recommends that SDSP should provide data in accordance with performance-based rules for data quality, but not go through an intensive regulatory approval process.

Rather, as with LAANC where a USS has the ability and responsibility to choose a weather provider or “employ a reasonable algorithm for periods of nighttime,”[168] Subgroup C recommends that approved USSs for UTM services use performance-based processes to incorporate SDSP data as needed. This approach will also enable UTM services and ultimately the operators able to decide -- on a risk-based basis -- which, if any, SDSP data is useful in their operations.

For example, an operation could determine whether detailed terrain or population density data are relevant to their flight or not, or an operation could find a UTM provider with the kinds of weather requirements and detail needed for their CONOPS.

Performance & Risk-Based Approach

Whereas many early BVLOS demonstrations devised flight rules to optimize for factors such as ground-risk it is important to note that the utility, scale, and full benefit of UAS BVLOS flight may not be achievable without a more holistic accounting for risk decisions regarding airspace access. Ground-based risk needs to be accounted for, but ideally as a function of defined population densities and sensitivity of the specific structures or populations.

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[166] FAA Administrator Steve Dickson: Episode III Keynote, June 9, 2021, https://www.faa.gov/news/speeches/news_story.cfm?newsId=26180.
[167] UAS Traffic Management 2.0, https://www.faa.gov/uas/research_development/traffic_management/media/UTM_CONOPS_v2.pdf.
[168] FAA LAANC USS Performance Rules v5.0, https://www.faa.gov/uas/programs_partnerships/data_exchange/laanc_for_industry/media/LAANC_USS_Performance_Rules.pdf.

By creating a full scope of risk and performance, operators—with the aid of UTM services—can create flight plans that optimize for the totality of safety and performance considerations.

Recommendation: The FAA must implement a performance and risk-based approach that enables the industry to operate safely based on the totality of the circumstances, not one factor.

Global Considerations

As many UTM providers and UAS operators will operate globally, the ARC should consider regulations that will help facilitate global interoperability. Just as there are US data requirements with LAANC, for example, the ARC should consider what requirements for UTM services from a US-perspective complement UAS integration efforts around the world. The use of international standards can help to promote harmonization across different jurisdictions, such as the ASTM International standards for remote identification and tracking, and UTM.

Counter UAS

Among use cases for UTM and consumers of UTM services, Subgroup C wanted to mention the counter drone use case. Drone security firms can leverage UTM for improved situational awareness in the airspace and even get more detailed information about the operator, operation, and compliance of flight activities. Both counter drone companies and government agencies utilizing counter-UAS technologies will benefit from a fully functioning UTM system.

C. Cybersecurity

The ARC addressed cybersecurity concerns, gaps and associated needs and recommendations for broadly scaled BVLOS operations. Cybersecurity addresses the cyber risks to specific assets and communications for BVLOS as well as the industry's capabilities and needs for protecting UAS and associated systems from the environment in order to promote public safety. If aircraft systems, networks and services are compromised, the public, other aircraft (crewed and uncrewed) and broader environment are subject to heightened safety and security risks, especially if BVLOS operations are occurring at scale.

As is the case across all technology platforms, a highly scaled UAS BVLOS industry is not — and will not be — immune to cyberattacks. All critical infrastructure, industries (such as utilities, transportation/automotive and more) and the government are vulnerable to cyber-attack. Cyber-criminals, state actors and other entities may target the UAS industry with cyber and cyber-physical ransomware, denial of service and other attacks that can threaten the BVLOS value chain.

The universe of beneficial BVLOS use cases (as described by Subgroup A) is large and diverse. We note that while cybersecurity is a need that cuts across all BVLOS use cases, except in cases where 'security interoperability' is needed (e.g., certain communications protocols that all UAS or operators need to leverage) we do not believe there is (or ought to be) a "one size fits all" approach for cybersecurity. As with other regulatory areas, the Subgroup supports a tailored, performance-based, and risk-based approach to regulatory compliance and specificity only where needed.

Approximately one third of the ARC responded to a cybersecurity survey with questions regarding the industry's overall maturity and attention to cybersecurity. The full survey results are located in the appendices. Key takeaways from this survey were:

Industry has overall concern about its maturity regarding C2 link security and radio communications security (e.g., DAA, V2V), supply chain vulnerability management and risk, and workforce cybersecurity awareness. Industry was generally less concerned about its maturity regarding network communications security, presumably because it can leverage much of the technology sector's capabilities in that regard. Industry strongly emphasized the need for highly available and protected C2 links and connectivity to UTM systems as well as DAA (e.g., V2V) broadcast communications.
Industry considers public perception regarding its (and regulators') attention to cybersecurity to be very important.

Based on survey and ARC cybersecurity discussions, the Subgroup provides the following cybersecurity observations and recommendations for highly scaled BVLOS operations.

C2 Communications Security: For some BVLOS operations, C2 communications may be critical for enhanced operator situational awareness, tactical decision-making, and flight control. Degradation and loss of this link may have varying implications depending on the risk and automation of the operation.

Recommendation: In Phase 2 of this ARC, the industry and regulators should establish high-level risk- and performance-based rules for the security of C2 communications that can be addressed by standards bodies. Standards should address access control needs for both single UAS and multi-UAS C2 connectivity.

Accommodation of Security Overhead in Radio Frequency Spectrum: Cybersecurity controls (e.g., cryptographic signing, message authentication, encryption) in radio communications require bandwidth.

Recommendation: The FAA needs to consider security overhead in designating communications in protected UAS spectrum (e.g., for Detect and Avoid).

Detect and Avoid (DAA) Security: In operations where DAA is safety-critical (e.g., specific corridors), unauthenticated and unauthorized DAA information flows (e.g., by unauthorized entities) have the potential to interfere with and potentially redirect UAS in an unsafe manner. Both broadcast and network DAA communications are vulnerable to cyberattacks such as spoofing, replay and false data injection.

Recommendation: Ensure that performance-based and interoperable security controls are prioritized for safety-relevant DAA broadcast communications, not just network-enabled DAA services.

Secure Access to Authoritative FAA ATM Data: Highly scaled BVLOS operations would gain substantial safety benefits if UTM services were able to access authoritative ATM data. Access to authoritative FAA data would require UTM providers to have secure interfaces to securely access and limit exposure of ATM systems to cyber threats.

Recommendation: The ARC should recommend standardizing and enabling security certification for UTM providers to gain access and interface with FAA ATM data sources.

Security Assurance for Sensor Data Feeds: Some BVLOS operations will make use of external sensors to facilitate DAA and other safety-related applications. When sensor data is from a remote source and is critical to the safety of the operation, then baseline security protections may need to be afforded to the source and communications of such data.

Recommendation: Phase 2 of the ARC should examine high level security performance needs that can be addressed by standards bodies for highly automated systems in which the integrity and availability of automated reasoning and control features are more critical.

Security of Data Access and Services at the Network Edge: Many types of BVLOS operations will impose enormous data management and data access demands - including needs to collect or offload real-time data - in the field. Some services such as hyper-local weather data reporting require source authentication and integrity controls. The security of these local network service or point-to-point service links - if they impact the safety of the BVLOS operation - needs to be ensured.

Recommendation: Phase 2 should ensure that regulations address performance-based security requirements (authentication, integrity) for network edge UTM or proprietary services that impact the safety of the operation. Some of these services may be assisting the UAS in a decision-support capacity.

Identity Management and Trust and Authorization: The UAS industry is in its infancy regarding standardizing a trusted identity management infrastructure. Communications assurance is vital to UAS operations, and most communications rely on trusted identities such as digital certificates for security. While the International Aviation Trust Framework (IATF) in ICAO has made progress in maturing a governance model (and initial certificate policy) for aviation, it is currently technology specific. The UAS industry is not yet able to rely on this framework and additional identity types may need attention. Trust also needs to address authorization, for example if law enforcement or a regulator needed to issue a request (e.g., via some digital connection) for a UAS to land or perform some other sensitive function, these requests need to be authorized such that individuals lacking appropriate permissions cannot issue them. For example, if a regulator or law enforcement entity needs to request or command a UAS land or divert, the requesting entity needs to have the appropriate, known, authenticated authorizations.

Recommendation: For all communications requiring system-wide interoperability, Phase 2 should recommend regulations for an interoperable identity and access management framework and policy that recognizes and securely manages controlled roots of trust (e.g., root certificate authorities). Note that this is not needed for all UTM services or UAS communications, just those in which broad interoperability is needed. ID Management and Trust also needs to address entity authorizations (permissions).

Platform and Software Security: Platform and software security standards for aircraft are heavily safety focused. Not all safety controls address security vulnerabilities; safety addresses failure modes while security addresses attack modalities from the environment, including insider attacks. The ARC noted that while ICAO IATF are addressing governance and certificate policies with defined assurance levels, security assurance levels for UAS have not yet been defined such that they can be allocated to specific operational risk parameters.

Recommendation: The ARC ought to evaluate existing industry standards for adequacy to ensure risk-based controls for secure platforms. Example areas of platform security are physical security, protection and access to cryptographic key material and roots of trust, application software/firmware integrity protections and auditability.

D. Workforce Development

Implementation of BVLOS flights into national airspace and commercial workflows are critical to the continuing growth and development of the industry and in realizing the many benefits described elsewhere. As BVLOS operations increase, so will the demand for highly trained, professional, and responsible personnel in every part of the industry: UAS designers, manufacturers, operators, USS, and ancillary service providers.

Notably, the role of personnel will change over time. Pilots, for example, may transition to fleet managers of highly automated UAS. Requirements for flight crew need to account for these changes with risk-based and performance-based requirements for personnel competency.

Workforce needs and associated recommendations include the following:

Clarity on definitions: The FAA needs to clarify terms such as 'aviator', 'operator', 'technician', 'pilot', and 'dispatcher' such that future permitting, training and associated regulations are unambiguous. Autonomous operations may indicate the requirement for a technician or software expert rather than pilot. Legislation may be required to enable this. Note that some roles require the controlling operator to be 'in the loop' of the aircraft's control system vs. 'on the loop' as a supervisory role might be. In some cases, operators may transition from supervisory to real-time control roles. The training and certification for each may be distinct.

Recommendation: Clarify responsibility types and roles for terms used to regulate workforce entities.

Consider risk-based and performance-based approaches to personnel: Highly autonomous flight (e.g., programmed flight plans used in infrastructure) with automatic failsafes built into the UAS platforms may require less 'hands-on' real-time control than direct-control BVLOS operations with manually piloted aircraft. Indeed, a variety of drone companies--including those in the delivery and infrastructure inspection space--are already conducting highly automated operations under human oversight.

Recommendation: In Phase 2, the ARC should consider how operational complexity and risk (e.g., technology level of automation and back-ups to automation, environment, and other risk factors) relate to potential workforce requirements

Aircraft, operations, and locality-specific training: Demonstrated proficiency and currency are for specific aircraft and equipment types used in specific operations.

Recommendation: Beyond basic aircraft operation, performance-based training requirements should include consideration of contingency and emergency planning, real-time adaptable flight planning, UTM interaction and lost link procedures for the specific aircraft type(s) in the operation. Furthermore, other relevant considerations include understanding of airspace classification/identification, local regulations, use of standardized communications protocols, crew resource management, aeronautical decision making, weather forecasting in flight planning and effects of weather.

Establish a Known Operators Program: ARC participants noted that BVLOS scaling with UTM support will require a *known operators* program not unlike TSA Pre or Global Entry. With such a program, additional vetting of personnel and organizations would allow expanded operations based on levels of trust. Additional authentication and security for remote identification would be needed in support of such a program.

Recommendation: The federal government should explore creation of a known operators program that - leveraging increased authentication and secure identification - allows for expanded operations for approved entities.

Workforce Cybersecurity Awareness: Initial Working Group 1.2 Subgroup discussions identified the various types of workforce participants from software and platform developers, acquisition and operations individuals, technicians/maintainers, UAS operators/pilots and field entities interacting with the UAS. It has long been noted that the weakest security link in any system or operation is the people involved, and the industry is aware that regulatory attention regarding cyber workforce training and awareness is a critical need.

Recommendation: Address in standards bodies the cybersecurity maturity model requirements for development, maintenance and operational aviation organizations involved in BVLOS flight. A cyber-aware workforce is needed throughout the supply chain and operations lifecycle.

E. Laws/Rules Outside of Immediate FAA Rulemaking

In considering industry needs, the Subgroup documented laws, rules, and/or policy issues outside the domain of the instant FAA BVLOS rulemaking effort which, without clarification, could inhibit or delay the scaling of the UAS BVLOS industry. The Subgroup developed the following list of issues, all of which necessitate congressional, federal executive branch, and/or state or local government attention.

FAA Reauthorization

To the extent the ARC determines that the FAA does not possess the appropriate or necessary statutory authority to implement this ARC's recommendations, it may be necessary for Congress to revise the law in the next FAA Reauthorization legislation, which is due for revisions in 2023.

Recommendation: Working Group 1.2 recommends this ARC capture in its final report where legislative changes may be necessary, based on ARC recommendations.

Economic Authority

Laws defining aviation citizenship were defined for a different industry and different era. Due to how aviation citizenship laws are currently drafted, certain BVLOS operators (air carriers) will require "economic" authority (or registration) from the USDOT to operate. This includes the requirement that the operator be a "citizen of the United States" as defined in 49 USC 40102. Foreign civil aircraft operators conducting operations other than air carrier operations in the U.S. will also need DOT authorization. One or both could have implications for a variety of UAS BVLOS use cases. The application of the aviation citizenship laws to the UAS industry often leads to absurd results where American companies are not able to prove citizenship. If not addressed, a UAS operator subject to these requirements may not be able to legally operate. The "citizen of the United States" requirement for UAS operators therefore has many implications for UAS operator ownership and can significantly restrict ownership and investment. Further, citizenship requirements imposed for economic or competitive reasons are an unjustifiable barrier to entry for global operators and providers. These entities can help to stimulate competition and innovation in the U.S. market. U.S. companies are permitted to operate in a range of jurisdictions abroad, and the same privileges should be extended to global companies in the U.S.

Recommendation: Working Group 1.2 recommends that Congress and the Department of Transportation consider economic authority issues and how they impact this emerging industry in a new era.

Spectrum-Related Issues

Given UAS reliance on RF communications, the FCC has played and will continue to play an important role in enabling growth of the UAS industry. Reliable and continuous access to spectrum is essential to the continued growth of the UAS industry. There is no one-size-fits-all approach to spectrum suitable for UAS, and so it is critical that the FCC and NTIA enable all available communications technology for the industry, including consideration of regulatory restrictions on using certain spectrum bands for airborne operations, such as the restrictions set forth in 47 CFR 22.925, as well as the "mobile except aeronautical mobile" designation set forth in the FCC's Table of Allocations (47 CFR 2.106) that applies to many spectrum bands. BVLOS operations will require that spectrum bands with appropriate characteristics are sufficiently available to meet the needs of numerous users operating in a variety of operating environments. Without appropriate access to adequate spectrum, it will be difficult to scale UAS BVLOS operations.[169]

Recommendation: Working Group 1.2 recommends that FCC and NTIA enable all available communications technology for the industry in a timely way.[170]

Ambiguity Around Intergovernmental Jurisdictional Roles

The legal authorities of the FAA intersect with tribal, state and local government roles. Advancing UAS BVLOS operations would be expedited by operators/UTMs having access to all appropriate regulations related to a flight plan through a collaborative standard data exchange like FAA's LAANC, and the FAA could advance a clearinghouse of available information from certified tribal, state and local government entities.

Recommendation: Working Group 1.2 looks forward to learning about the work of Working Group 1.1 on community interest in UAS BVLOS and recommends that the ARC continue this open dialogue with all interested stakeholders. Further, we recommend the FAA explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.

Counter-UAS Issues

While the use of UAS for good must be enabled, there must also be a means to detect and mitigate unauthorized, criminal, or rogue drones that may cause harm. In 2016, federal national security agencies prevented expanded UAS operations from moving forward through the interagency process until UAS security was properly regulated. This is because under Title 18 of the United States Code, the deployment of many forms of counter-UAS technology is illegal. The Preventing Emerging Threats Act of 2018 was therefore passed by Congress to authorize relevant national security agencies to deploy counter-UAS technology to mitigate UAS threats to select U.S. facilities or assets.[171] The Preventing Emerging Threats Act is scheduled to expire in October 2022. To scale BVLOS operations in the U.S., federal national security agencies must continue to have the legal authority to protect against potential public safety and homeland security threats posed by rogue UAS. If Congress does not take action to

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[169] CDA Letter to FCC — Commercial Drone Alliance

[170] The FCC should work together with industry to move on rulemakings that will enable access to RF communications, such as AIA's petition for rulemaking on C2 Link.

[171] Preventing Emerging Threats Act of 2018; 6 U.S.C. § 124n - Protection of certain facilities and assets from unmanned aircraft.

extend the Preventing Emerging Threats Act, industry worries that security concerns will continue to handicap further integration of UAS into the NAS, including the ability to scale BVLOS operations.

Working Group 1.2 recommends that the legislative and executive branches work together to consider counter-UAS issues and extend the Preventing Emerging Threats Act.

International Harmonization

Integrating scalable BVLOS operations into the NAS will require new and novel ways of approaching regulatory approvals on issues relating to airworthiness, operator certification, licensing of remote pilots and operational requirements. Standards and regulations relating to BVLOS operations that are harmonized around the world may streamline compliance for UAS operators and manufacturers and help drive further innovation in the development of UAS technology and their commercial applications. If the FAA, EASA and other civil aviation authorities around the world adopt different standards or approaches relating to UAS airworthiness, operator/pilot certification and/or operational requirements for BVLOS operations, UAS operators and manufacturers will face barriers to operating abroad and marketing products in foreign markets. A lack of uniformity will create uncertainty and impede the development of new and innovative UAS technologies and commercial use-cases. As one example, the ARC should advise the FAA to coordinate with other civil aviation authorities on processes related to design and operational approval. Amongst other benefits, international harmonization enables commerce, including by facilitating easier import and export of hardware, and enables regulators to draw on a shared pool of expertise and experience in safe, secure, and responsible UAS integration.

Recommendation: To the extent possible, Working Group 1.2 therefore recommends the FAA work closely with international partners to streamline regulatory processes.

Executive Branch Leadership on UAS Issues

The countless public benefits of commercial UAS operations are in jeopardy of not being realized on a broad scale, as is America's leadership in aviation and innovation if the U.S. does not move forward quickly with the safe and secure integration of UAS into the NAS. High-level executive branch leadership is necessary for UAS integration to move forward in a timely way. The White House must exercise leadership on the issues and challenges facing UAS integration, including expanded UAS operations and UTM. These topics require input from and coordination among various federal agencies, including national security and law enforcement agencies. The White House is best positioned to convene key federal decision makers and drive a constructive conversation with industry stakeholders, tribal, state and local regulators, the security industry and other relevant stakeholders.[172]

Recommendation: Working Group 1.2 therefore urges the White House and Department of Transportation to play a leadership role in UAS BVLOS integration.

Section 2209

Section 2209 of the 2016 FAA Extension Act mandated that the FAA implement a process by which critical infrastructure facilities and other “fixed sites” may limit UAS use over private property. The

[172] https://www.commercialdronealliance.org/letters-comments/cda-wh-summit-request.

national security agencies, as well as all security stakeholders, are following this rulemaking closely. Working Group 1.2 supports the spirit of Section 2209 and views the upcoming rulemaking as a critical aspect of UAS integration. Working Group 1.2 also believes that it is important to enable authorized commercial operators to fly over these fixed sites in certain situations.

Recommendation: Working Group 1.2 therefore urges the ARC to recommend a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.

Operations Over People

Working Group 1.2 Subgroup B recognizes that the broader ARC will consider operations over people within the scope of this rulemaking, and so this topic falls slightly outside the scope of this section. However, the topic was critically important to the group, and we believed it important to state that. UAS BVLOS operations will not succeed without the ability to fly over people and moving vehicles. The FAA's OOP rule finalized earlier this year codified an extremely conservative OOP approach which does not recognize the full range of available mitigations for safety to nonparticipants on the ground. The rule incentivizes the marketplace to operate very small UAS which can meet the kinetic energy impact injury thresholds and does not account for heavier UAS that have highly effective mitigations for safe BVLOS operations. Working Group 1.2, therefore, sees tension between the OOP rule and what the ARC is going to recommend for BVLOS.

Recommendation: Working Group 1.2 urges the ARC to keep this in mind in Phase 2 and recommend a safe and reasonable path forward for BVLOS operations over people.

Network Remote ID Implementation

To appropriately and securely scale UAS BVLOS operations, law enforcement and security agency buy-in is needed for implementing network Remote ID as a pathway toward UTM. Obtaining the support of DHS and DOJ for a workable network Remote ID solution from a security perspective while maintaining appropriate privacy safeguards for UAS operators and customers is critical to advancing the industry.[173]

Recommendation: Working Group 1.2 urges the national security agencies and the FAA to engage in an open dialogue with industry to find solutions that enable us to enable network remote identification solutions.

Public Perception

As noted in the Phase 1.1 report, all stakeholders can agree that public perception and acceptance – in terms of how the public responds to UAS in their communities – is of utmost importance to the long-term success of the industry.[174] This includes around privacy, noise, and other relevant factors. The industry recognizes this, and has worked with other stakeholders to develop Voluntary Privacy Best Practices on UAS use.[175] The industry has worked with all stakeholders on community outreach through the IPP and other similar programs. The industry will need to continue to work with all governments –

[173] https://www.commercialdronealliance.org/letters-comments/cda-rid-letter

[174] Perspectives-on-drone-delivery.pdf (vt.edu)

[175] https://www.ntia.doc.gov/files/ntia/publications/uas_privacy_best_practices_6-21-16.pdf.

including federal, tribal, state, and local – as well as directly with communities to address this ongoing challenge.

F. Other

As the Industry Needs Subgroup considered what industry needs to be able to scale BVLOS, a few additional topics made the list.

For example, stakeholders mentioned the importance of **clarity** and **certainty** as their own industry needs, for funding reasons and so that companies can understand what is necessary to comply with regulatory frameworks. Because we discussed those needs throughout the document, we do not spend more time on them here.

Finally, the Subgroup recognized that industry needs vary from one vertical market sector to the next. This list is preliminary, and certainly not all-inclusive. As is true for the rest of the information documented in this report, as the industry evolves, needs will evolve as well. We urge the ARC to recommend that the FAA work closely with the industry beyond the timeline of this immediate ARC to ensure the collaboration continues.

G. Recommendations

Infrastructure Needs:

The following are the sub-group's recommendations addressing industry needs for physical and digital infrastructure.

Recommendation #1: Locations for Takeoff and Landing: As necessary, ensure appropriate information is available for zoning of takeoff and landing locations commensurate with operational risk that would mitigate local concerns.

Recommendation #2: Communications Infrastructure: Industry would benefit from clear performance requirements for conditions that mandate connectivity, in a way that enables flexibility and promotes scalability.

Recommendation #3: Communications Infrastructure: Industry service providers need help to understand eligibility and process to apply for a spectrum license based on ability to meet and performance requirements.

Recommendation #4: Location and Other Sensor Services: Define approaches to the operational approval process that account for the UAS characteristics, environment, flight profile(s) and associated risks in requirements, if any, for required sensor capabilities, redundancy and assurances.

Recommendation #5: Digital Infrastructure: In cases where real-time data is required, define SLA requirements for SDSPs.

Recommendation #6: Digital Infrastructure: In cases where UTM services need authoritative data from the FAA, then the requisite interface, access and potentially certification requirements for UTM to access these sources should be provided.

Recommendation #7: Risk Mitigation/Conflict Management Needs - New or enhanced data sources on microclimates: Support microclimate monitoring in circumstances where the operational, location, UAS type/capabilities and atmospheric norms necessitate greater consideration of the microclimate.

Recommendation #8: Risk Mitigation/Conflict Management Needs - Standardized Population Density Definitions: Provide definitions for population density such that regulations and/or operational constraints can be associated with them where needed in order to promote wider understanding and delineation of risk.

Recommendation #9: Risk Mitigation/Conflict Management Needs - Standardized Airspace Density Definitions: Promote wider understanding, delineation, and definitions for airspace density such that regulations and/or operational constraints can be associated with them where needed. Perhaps industry consensus bodies could address ways of defining airspace density beyond just airspace type.

Recommendation #10: Night Operations Specific Equipment: Enable BVLOS at night and develop performance-based rules for BVLOS flight at night.

Recommendation #11: Automation: In Phase 2 of the ARC, collaborate with industry to identify examples of automation approaches that support defined target levels of safety for the UAS industry.

Uncrewed Traffic Management (UTM)

The following are the sub-group's recommendations, addressing industry needs for Uncrewed Traffic Management (UTM)

Recommendation #12: For operations under 400 feet in uncontrolled airspace, UAS will be operating alongside other UAS, e-VTOL aircraft, and potentially others. The ARC should recommend the FAA promote cooperation between crewed and uncrewed operations, including potentially altering right-of-way requirements and promoting interoperable communication.

Recommendation #13: Automation in Airspace Access: The FAA must account for and enable automation across drone flight, including UTM services, to optimize for both safety and scale of operations. This includes UAS and system platform requirements—potentially including design assurance levels related to hardware and software implementing the automation.

Recommendation #14: Establish rules and validation processes for USS that offer strategic deconfliction services to operators. These rules should be performance-based, non-prescriptive, and build on existing standards, such as the ASTM standards on Remote Identification and UTM. Through trials such as TCL and UPP, industry demonstrated that multiple operators can reliably detect conflict in congested airspace, ranging from VLOS operations with manually piloted aircraft to BVLOS operations with highly automated aircraft.

Recommendation #15: Recognize standards-based frameworks for USS interoperability. Examples of safe, secure, and scalable frameworks for interoperability include the Discovery and Synchronization framework described in the ASTM standards, which has been successfully applied to a range of UTM trials and implementations worldwide.

Recommendation #16: Establish airspace integration policies to promote cooperation in high-demand VLL airspace. Cooperation between UAS BVLOS via UTM will help to ensure that all operators can safely share the airspace.

Recommendation #17: The FAA's regulatory role should focus on approving USSs and approving the UTM system, leaving the operation of the federated system to industry.

Recommendation #18: Performance and Risk-Based Approach: The FAA must implement a performance and risk-based approach that enables the industry to operate safely based on the totality of the circumstances, not one factor.

Cybersecurity

The following are the sub-group's recommendations to address industry needs for cybersecurity in UAS BVLOS operations.

Recommendation #19: C2 Communications Security: In Phase 2 of this ARC, the industry and regulators should establish high-level risk- and performance-based rules for the security of C2 communications that can be addressed by standards bodies. Standards should address access control needs for both single UAS and multi-UAS C2 connectivity.

Recommendation #20: Accommodation of Security Overhead in Radio Frequency Spectrum: The FAA needs to consider security overhead in designating communications in protected UAS spectrum (e.g., for Detect and Avoid).

Recommendation #21: Detect and Avoid (DAA) Security: Ensure that performance-based and interoperable security controls are prioritized for safety-relevant DAA broadcast communications, not just network-enabled DAA services.

Recommendation #22: Secure Access to Authoritative FAA ATM Data: The ARC should recommend standardizing and enabling security certification for UTM providers to gain access and interface with FAA ATM data sources.

Recommendation #23: Security Assurance for Sensor Data Feeds: Phase 2 of the ARC should examine high level security performance needs that can be addressed by standards bodies for highly automated systems in which the integrity and availability of automated reasoning and control features are more critical.

Recommendation #24: Security of Data Access and Services at the Network Edge: Phase 2 should ensure that regulations address performance-based security requirements (authentication, integrity) for network edge UTM or proprietary services that impact the safety of the operation. Some of these services may be assisting the UAS in a decision-support capacity.

Recommendation #25: Identity Management and Trust and Authorization: For all communications requiring system-wide interoperability, Phase 2 should recommend regulations for an interoperable identity and access management framework and policy that recognizes and securely manages controlled roots of trust (e.g., root certificate authorities). Note that this is not needed for all UTM services or UAS communications, just those in which broad interoperability is needed. ID Management and Trust also needs to address entity authorizations (permissions).

Recommendation #26: Platform and Software Security: The ARC ought to evaluate existing industry standards for adequacy to ensure risk-based controls for secure platforms. Example areas of platform security are physical security, protection and access to cryptographic key material and roots of trust, application software/firmware integrity protections and auditability.

Workforce Development

The following were recommendations the sub-group identified to address industry needs in workforce development.

Recommendation #27: Clarity on definitions: Clarify responsibility types and roles for terms used to regulate workforce entities.

Recommendation #28: Consider risk-based and performance-based approaches to personnel: In Phase 2, the ARC should consider how operational complexity and risk (e.g., technology level of automation and back-ups to automation, environment, and other risk factors) relate to potential workforce requirements

Recommendation #29: Aircraft, operations, and locality-specific training: Beyond basic aircraft operation, performance-based training requirements should include consideration of contingency and emergency planning, real-time adaptable flight planning, UTM interaction and lost link procedures for the specific aircraft type(s) in the operation. Furthermore, other relevant considerations include understanding of airspace classification/identification, local regulations, use of standardized communications protocols, crew resource management, aeronautical decision making, weather forecasting in flight planning, and effects of weather.

Recommendation #30: Establish a Known Operators Program: The Federal Government should explore creation of a known operators program that - leveraging increased authentication and secure identification - allows for expanded operations for approved entities.

Recommendation #31: Workforce Cybersecurity Awareness: Address in standards bodies the cybersecurity maturity model requirements for development, maintenance and operational aviation organizations involved in BVLOS flight. A cyber-aware workforce is needed throughout the supply chain and operations lifecycle.

Laws/Rules Outside of FAA Rulemaking

The following recommendations are those that the sub-group identified to address industry needs that, although fall outside of the laws/rules of FAA rulemaking, are important to highlight when considering changes needed for enabling successively scalable BVLOS operations in the NAS.

Recommendation #32: FAA Reauthorization: Working Group 1.2 recommends this ARC capture in its final report where legislative changes may be necessary, based on ARC recommendations.

Recommendation #33: Economic Authority: Working Group 1.2 recommends that Congress and the Department of Transportation consider economic authority issues and how they impact this emerging industry in a new era.

Recommendation #34: Spectrum-related Issues: Working Group 1.2 recommends that FCC and NTIA enable all available communications technology for the industry in a timely way.

Recommendation #35: Ambiguity Around Intergovernmental Jurisdictional Roles: Working Group 1.2 looks forward to learning about the work of Working Group 1.1 on community interest in UAS BVLOS and recommends that the ARC continue this open dialogue with all interested stakeholders. Further, we recommend the FAA explore a clearinghouse for relevant inputs from certified entities, especially local governments, to advance the industry integration.

Recommendation #36: Counter-UAS Issues: Working Group 1.2 recommends that the legislative and executive branches work together to consider counter-UAS issues and extend the Preventing Emerging Threats Act.

Recommendation #37: International Harmonization: To the extent possible, Working Group 1.2 therefore recommends the FAA work closely with international partners to streamline regulatory processes.

Recommendation #38: Executive Branch Leadership on UAS Issues: Working Group 1.2 therefore urges the White House and Department of Transportation to play a leadership role in UAS BVLOS integration.

Recommendation #39: Section 2209: Working Group 1.2 therefore urges the ARC to recommend a process by which trusted operators, including those operating BVLOS, can receive FAA approval to traverse FAA-designated fixed sites.

Recommendation #40: Operations Over People: Working Group 1.2 urges the ARC to keep this in mind in Phase 2 and recommend a safe and reasonable path forward for BVLOS operations over people.

Recommendation #41: Network Remote ID Implementation: Working Group 1.2 urges the national security agencies and the FAA to engage in an open dialogue with industry to find solutions that enable us to enable network remote identification solutions.

Other

Recommendation #42: We urge the ARC to recommend that the FAA work closely with the industry beyond the timeline of this immediate ARC to ensure the collaboration continues.

IX. Conclusion: Market Drivers (Working Group 1.2)

This report describes why, given how the UAS industry is funded and organized, the significant benefits of commercial BVLOS operations, and the broad array of industry needs to scale, it is critical that the FAA implement a risk-based, performance-based rule that provides certainty and streamlined approval processes in a timely way.

As ARC conversations have evolved, so has the content of these sections. This report represents the best efforts of Working Group 1.2 to gather and organize a large amount of information in a very short period of time. We anticipate, as the ARC continues to produce helpful education and learning opportunities, and the needs of the group become clearer, the content of this section may evolve as well. We also anticipate an opportunity to reconcile this report with the ARC’s findings and recommendations of Phase 2.

The industry remains willing to assist the FAA throughout this process, and beyond the scope of this ARC, including with forming a cost-benefit analysis. We appreciate this and other opportunities for collaboration with the FAA and other relevant stakeholders.

X. Regulatory Challenges (Working Group 1.3)

A. Overview

This draft report on the efforts of Working Group 1.3 of the BVLOS ARC represents just one portion of the early efforts that were done to support the Working Groups ultimately tasked with creating the recommendations for the FAA. In the following pages we will identify the scope of work assigned to Working Group 1.3 and tie that back to how it supports the overall objective of the ARC. We will describe the difference between the identification of issues and the drafting of recommendations, as they pertain to the phases of the ARC and the Working Group tasking.

This document will describe the formulation of the Working Groups, their relative roles, and how that relates to the ARC Charter. The specific organizations represented on Working Group 1.3 will be identified. The need to break down the work of 1.3 into more specific and manageable elements and the success and struggles of that effort will also be covered. We will address the use of a broad issues Working Group questionnaire compared to its further developed and more specific TG companion.

The concept and methodology applied with Working Group 1.3 to effectively address the tasks identified by either the ARC Charter or the ARC leadership will be addressed. The intent is to provide perspective on why the Working Group was broken down into the specific Task Groups, and how that was intended to support the efforts of Phase 2. The details of methodology will incorporate how Challenge Questions were utilized in various portions of the project to aid with scope and focus. A direct comparison of Working Group 1.3 to the planned Phase 2 Working Groups will be addressed.

Most of the work produced by Working Group 1.3 is intended to provide scope and focus to the Working Groups in phase 2. Necessarily, the Working Group 1.3 work is a base layer for the Phase 2 teams to take and build from. With that perspective in mind, view the Working Group 1.3 reports as the “problem statement” for what the individual Working Groups in Phase 2 will address. It was a struggle at times, but the team was tasked with identifying issues, not solutions.

Following the high-level descriptions of the form and function of the Working Group, the individual task group reports can be found. These TG reports are focused on their respective area of concentration and conform to the Working Groups of Phase 2. The only exception to this construct is the Regulatory Considerations TG whose findings likely bridge across all the phase 2 Working Groups.

B. Tasking

The UAS Beyond Visual Line-of-Sight Operations Aviation Rulemaking Committee (ARC) Charter established that "When necessary, the ARC may set up specialized and temporary Working Groups that include at least one ARC member and invited subject matter experts from industry and government." Working Group 1.3 was established as part of the ARC construct based on a division into 2 phases with Working Groups being identified specific to each phase. Working Group 1.3 is one of three Working Groups created for the work in Phase 1 of the ARC.

While the objective of the ARC is to "… provide recommendations to the FAA for performance-based regulatory requirements to normalize safe, scalable, economically viable, and environmentally advantageous UAS BVLOS operations…", Working Group 1.3's tasking was the development of a work product that would provide the Phase 2 effort with a clearly defined scope from which to develop these recommendations. Specifically, Working Group 1.3 focused on identifying the Regulatory Challenges that should be addressed by the Phase 2 Working Groups and what Regulatory Considerations could support the ARC recommendations.

The phase 2 Working Group structure was created to address key areas that were identified as Tasks of the ARC, or anticipated areas of focus from Working Group 1.3. Phase 2 is expected to consist of 5 Working Groups:

Working Group 2.1 – Air and Ground Risk
Working Group 2.2 – Aircraft and Systems
Working Group 2.3 – Third Party Services
Working Group 2.4 – Operator Qualifications
Working Group 2.5 – Flight Rules

The primary focus of the Regulatory Challenges portion of Working Group 1.3 was to identify regulatory "issues" that fell within the scope of the ARC's Charter, and that would aid in focusing the efforts of the phase 2 Working Groups. This tasking clearly stopped short of making any specific recommendations by focusing on the identification of issues but left that work to phase 2. However, the Regulatory Considerations portion of Working Group 1.3 was tasked with developing specific findings/recommendations for the phase 2 Working Groups that should be considered and are intended to assist in deriving the ARC recommendations. We will discuss how Working Group 1.3 approached these tasks later in the document.

To summarize the tasking of Working Group 1.3; the majority of our focus was on identifying specific issues that need to be addressed in phase 2 to safely enable BVLOS operations while a smaller, but no less important segment, identified key considerations for the framing of recommendations.

Challenge Questions

To assist in understanding the scope for Working Group 1.3 several challenge questions were developed. These were intended to serve multiple purposes. The questions could help ARC members gain perspective on the scope and focus of a particular Working Group, and thus inform their participation requests. The question and subsequent scope and focus would also serve to keep the Working Group targeted on the desired results during the detailed Working Group tasks. Challenge questions were useful at the Working Group level and at the task group level within the Working Group.

The 2 main Challenge Questions posed for Working Group 1.3 were:

What regulatory issues should the ARC address?
What guidance should the ARC consider in developing Phase 2 recommendations?

The first question helped to define the scope of much of Working Group 1.3's attention on identifying the issue. Not focusing on the solution/recommendation yet but allowing phase 2 to apply its efforts there. One lesson learned through this process is that most of us are not satisfied with just identifying the problem, we also want to find or suggest a solution. We will discuss some additional strategies used to aid with this focus on the issue, and not the solution.

The second Challenge Question is of a broader perspective and potentially applies across all of the phase 2 Working Groups. This emphasized the considerations that should be taken into account when formulating recommendations for the FAA. Whereas the bulk of Working Group 1.3's efforts were centered on identifying "issues", providing answers to this 2nd question would more appropriately carry recommendations. The report from the task group responsible for this area of focus is necessarily different from the other wok done in Working Group 1.3.

In the next section of the report we will bring together the challenge question concept and a more finely parsed Working Group structure to accomplish the tasks assigned to Working Group 1.3.

Construct of Working Group 1.3

ARC members were given the opportunity to voice their preferences for Working Group participation. The list of Working Group 1.3 members and observers is included in the appendix.

The FAA provided this ARC with a very robust support structure comprised of personnel from varying lines of business. The commitment displayed by the Organization, and especially by the individuals involved, is indicative of the unified recognition of the significance that this effort will impart on the UAS industry.

It quickly became apparent that Working Group 1.3 would need to separate into smaller Task Groups (TG), each with a specific area of concentration, to effectively manage the scope of the Working Group tasks. We adopted an approach where our TGs mirrored the planned Working Groups of Phase 2 plus a sixth task group to focus on the Regulatory Considerations question.

As a tool to help the TGs with the focus of their individual roles and to provide for a relatively standardized output, a template was created. The template's basic structure required that some core questions be addressed:

What is the issue?
Why is it important?
What is the scope for the Phase 2 Working Group?

In some instances, a task group added additional questions specific to their area of focus when soliciting input from members of the ARC outside the Working Group. The reports from the task groups attached to this document generally follow this format.

While the size of Working Group 1.3 was relatively small at about 20 members, we were fortunate to have all of the planned Working Group Leads for Phase 2 in our ranks. This afforded us a unique opportunity for these individuals to lead the phase 1 task group that would be identifying the issues their Working Groups would be writing recommendations for in Phase 2. An additional industry member volunteered to lead the TG on Regulatory Considerations.

Task Groups met independently to complete their research throughout the weeks. Task Group Leads and our FAA team members met once a week to discuss progress, identify issues, and share lessons being learned in the process.

The entire Working Group 1.3 team met weekly. Individual Task Group progress was discussed and an opportunity to ask questions and provide feedback across groups was provided.

C. Research and Key Takeaways

Task Groups utilized the Issue template described above as a basis to solicit input from members of the ARC. Each TG typically added questions specific to their topic area in an effort to garner as much detailed perspective as possible. In addition to the solicited input, the entire Working Group was asked to provide feedback on the drafts of each TG. Specific takeaways can be found in the individual TG reports.

Several TGs conducted interviews with Industry to inform their reports. Additionally, Subject Matter Experts (SMEs) were identified, approved, and utilized to bring perspective and specific detail to several task groups.

There were several elements that were clearly identified and found to be recurring across task groups:

- It was a challenge to limit the focus of work in Phase 1 to identifying the issues and not move into solving them, and formulating recommendations.
- It is challenging to de-couple our expectations from existing constructs and processes. The Working Groups in Phase 2 will have many opportunities to make recommendations where a paradigm shift will be critical to a successful outcome for the ARC.
- Multiple areas of overlapping subjects were identified, both within the Working Group and across Working Groups in Phase 1. It was necessary to work out a path to identify primary ownership assigned to a Working Group in Phase 2 and recognize the sub elements of that topic which will flow to other Working Groups.

Following are the reports from the individual Task Groups in Phase 1 for Working Group 1.3. The goal for TGs 1 – 5 was to identify the issues that should be addressed in Phase 2. TG 6 was focused on identifying overarching elements that should be considered when the Phase 2 Working Groups develop their recommendations.

Working Group 1.3 Task Group 1.3.1 Issues

Task Group: Task Group 1.3.1 Air/Ground Risk

What is the issue?

- Lack of definitions for current air and ground risks that are quantitative and objective (sparsely populated, densely populated, congested, etc.)

- Quantitative analysis of risk is challenging in a dynamic, highly complex environment (100 ppl/sq mile per the D&R process)
- Current methodology for classifying air and ground risk are not representative of actual risk
- Current regulation does not appropriately consider air risk around vertical infrastructure (shielded operations)
- Current regulation does not appropriately consider ground risk of sheltered persons
- Current regulation does not appropriately consider time bound population variances (stadiums, schools, industrial parks)
- We do not have air risk classifications (example: ASTM Standard F3442 Detect and Avoid Performance, SORA) and strategic deconfliction is not given appropriate consideration for air risk.
- There is no shared responsibility for deconfliction for air risk in a practical way.
- Only limited VLOS (Part 107.37 and 91.113&91.115) shared responsibility for deconfliction for air risk.
- There are no performance-based requirements for "see and avoid."

Why is it important?

- A process should be in place that leads to the appropriate requirement for the actual risk and that is scalable, repeatable, and predictable.
- Ambiguity in applying ground and air risk standards
  - Leads to overly conservative safety mitigation or lengthy approval processes
  - Not repeatable or scalable
- Doing a quantitative analysis of air and ground risk prior to flight is too dynamic and complex.
  - Analysis is cumbersome and not repeatable
- Reasonable assumptions that lead to simplification of the process are needed to make them scalable and avoid lengthy back and forth that are open to interpretation
- Currently for UAS, ground risk is directly correlated to the airworthiness or safety equipment installed on the UAS. But these mitigations are all for well-defined quantitative environments that are not represented in current regulation.
- Ground risk cannot be analyzed purely on population density as much of the population is sheltered for sUAS
- The use of the industry standards requires that you know the classification of the air and ground risk, which have not been defined.
- Sharing responsibility for avoiding a MAC would reduce the burden on UAS for DAA without reducing safety (Current burden is disproportionate to the risk, cannot be implemented feasibly, equipment that disproportionately increases UAS weight and ground risk without a commensurate reduction in air risk)

What is the scope for the Phase 2 Working Group 2.1 Air/Ground Risk? *(Frame up considerations for the solution: "think about…", "don't limit the recommendation to rules for only UAS….")*

- Matrix approach to allow flexibility (trade-space) to meet appropriate risk based on operator, UAS, operating environment.
  - Objective is to lead to an approval process that is consistent, scalable, and predicable.

    - Higher risk operations require more safety mitigations. (higher density population-urban vs. low population density-rural)
- List of references that were used to come to conclusions that can be included in the preamble.
- Determine a target level of safety to be included into the final rule, or have a final rule where the regulator has established the mitigations to meet the target level or safety.
- Creation of a rule that is simple enough for an average operator that does not require equipment testing, validation and determination of risk involved in an area prior to each operation.
- Creation of a rule with a burden of compliance that is proportional to the operational risk.
- Creation of a rule that does not require the operator to establish their own risk mitigations, but allows the operator to use risk mitigations (non-prescriptive) that have been determined to be appropriate for the contemplated operation.
- Identify a target level of safety for ground and air risk that is consistent with public acceptance and feasible and allows operators to achieve it via different means (strategic or tactical, operational or technical, etc.).
- Amend existing regulations that are relevant to UAS to make them less prescriptive and instead performance based, accounting for the appropriate target level of safety.

What relevant information do I have for the Phase 2 Working Group 2.1?

References used
"Safety Performance Objectives: Acceptable Level of Risk for Unmanned Aircraft Operations", draft white paper prepared for the DAC. Available in Working Group 1.3 > Technical Reference Documents
Weinert's Air Traffic density Database: https://zenodo.org/record/4317967#.YQ2n_IhKj-g
Weinert's air traffic density slides: https://zenodo.org/record/4310364#.YQ2oLYhKj-i
Weinert's air risk class page: https://github.com/mit-ll/air-risk-class
The National Human Activity Pattern Survey (NHAPS): https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf

SME Support
Andrew Weinert – Homeland Protection and Air Traffic Control Division at MIT Lincoln Lab. Andy provided very helpful data on air traffic density around the US, and has access to huge amounts of ATC RADAR and ADS-B data. One idea was to use that data to produce a 4-color map of the US that depicts Air Risk Class derived from actual air traffic density, instead of inferring ARC from indirect factors like airspace class or population density.

Andy Thurling – CTO at NUAIR, active in ASTM/DAA, RTCA, and JARUS/SORA. Great level of knowledge of air risk and standards work.

FAA BVLOS ARC Phase 1 Working Group 1.3.2

Aircraft and Systems

Phase 1 Task:

FAA BVLOS ARC Working Group 1.3.2 was tasked with identifying regulatory issues associated with aircraft and systems.

The group developed a survey and solicited SMEs and members of the ARC for feedback and comments. The survey asked participants the following questions:

What are the issues related to aircraft and systems?,
Why are these issues important and why must they be resolved?, and finally,
What should the scope of work be for Phase 2?

This report organizes and summarizes the survey responses.

Background:

The *potential* benefits of smaller uncrewed aircraft systems (UAS) are safer operations, leveraging rapid innovation, at lower cost, without risk to onboard occupants and often with lower risk to infrastructure and less impact on the environment. To harness these benefits, smaller uncrewed aircraft (UA) differ from traditional crewed aircraft in many significant ways. The list below highlights some of these differences.

Software/Firmware: With a focus on continuous improvement, software and firmware updates, both critical and non-critical, are more frequent.

Avionics: To leverage unconventional configurations, enable precision flight, and implement safe contingency behaviors, many UAs feature stability augmentation, an autopilot, and a flight management system. Many will incorporate autonomy to provide enhanced safety through capabilities such as collision avoidance, robust containment to the flight path or operating area, and selection of safe emergency landing areas.

Systems: The UA is typically one part of an overall system often having ground elements such as launch and recovery equipment and command and control infrastructure. Some elements, such as surveillance data from a network of ground-based sensors, may be provided by third parties.

Commercial Parts: Many UAs are designed using comparatively inexpensive commercial parts. Examples include servo actuators and brushless electric motors.

Modular Design: Many UAs are designed to be modular, with interchangeable parts that are simple to replace with simple tools or even without tools, and can only be assembled or installed in one way. Changing parts, such as wings or tail assemblies, may not impact the weight and balance or otherwise impact the airworthiness of the design.

Fueling: Some UA have batteries designed to be replaced during routine operation. This is analogous to re-fueling a traditional crewed aircraft.

Health and Safety Monitoring: In many cases, by design, the incorrect installation of parts or batteries prevents operation. Health monitoring of onboard systems are able to detect anomalies and predict failures.

Relevant Regulations - Part 21, Part 65, Part 43, Part 91, 107, Part 135 & A008 OpsSpec, Part 137, Part 139

Detail Level Issues

The background information above highlights the rationale behind many of the core issues. The following detail level issues were identified:

Lack of certification framework and specifications/requirements proportional to risk - Airworthiness, along with operating limitations, are important mitigations measures for ground risk in BVLOS operations. Yet, there is a 'missing middle' between P107, which does not specifically address airworthiness, and the current certification basis and process for Type Certification under 21.17b.

Lack of accepted industry consensus standards - Without technical standards, engineers cannot quickly and efficiently design aircraft and systems to meet safety objectives. Regulators must work with industry to develop and then accept standards in a timely manner.

Traditional definition of 'Major/Minor Change' does not align with UAS design principles and practices - A better way of managing updates and changes for certification/approvals is needed. It should be evaluated whether software and certain hardware should go through an additional configuration process, or some other process that is more time efficient.

Traditional view of 'Maintenance, Repair, and Major Alterations' does not align with UAS principles and practices - The level of oversight to achieve an adequate level of safety with UAS is not the same as with traditional aviation. In many cases, due to the low cost of commercial parts and module design, parts or components are simply replaced rather than repaired. Simple repairs and replacement of parts can be accomplished with basic tools and without a high degree of skill.

High-Level Issues

Several higher-level issues were identified:

Proportionality - The safety objectives and technical requirements imposed on aircraft and systems associated with smaller UAS BVLOS operations, as well as the level of oversight by the regulator, should be tailored to the risk of those operations. (Air and ground Risk was explored by Working Group 1.3.1)

Uncertainty - Evolving policies, processes, and guidance as well as delay in accepting consensus standards and issuing guidance results in uncertainties which impact all aspects of the UAS industry. (Market drivers was explored by Working Group 1.2)

Timeliness - Approval processes must align with aircraft and systems development cycles, and importantly, life cycles. The life cycle of UAS is in years, not decades.

Importance

Resolving these issues is important for the UAS industry for the following reasons:

Business Impacts - Long approval times, shifting guidance, and a high degree of regulatory uncertainty each drive up costs and are barriers to investment, both new or continued. Cost-prohibitive processes and high-fidelity test requirements that may not be appropriate for smaller UAS are barriers to entry, particularly to small businesses and new entrants.

Safety - Long regulatory lead times and uncertainty of outcomes may incentivize the design of systems that are easier to certify rather than those that enhance safety or lessen the impact on the environment.

Innovation - Many efficiency and safety improvements are achieved through rapid innovation cycles. These can be on the order of weeks and months, not years or decades - as has been the case in traditional aviation. Companies may forgo the pursuit of such improvements simply to expedite the approval process.

Societal Impacts - As a new technology interacts with society in new ways, the feedback and interactions with society are dynamic. Current processes do not accommodate quick responses to these demands. As such, the UAS industry may miss opportunities to optimize through continuous improvement cycles to align with public demand and expectations.

Scope of Work for Phase 2

The following challenge questions were developed to assist in formulating the initial work under Phase 2.

'Challenge' questions:

For the UAS BVLOS operations envisioned under the Charter for this ARC:

Recognizing the differences between UAS and traditional crewed aircraft, what new regulatory frameworks and/or changes to existing regulations governing aircraft and systems provide the best balance between safety/risk mitigation, economic drivers (and timelines), and societal benefits?

How much oversight should the FAA provide in ensuring airworthiness of the design of aircraft and systems?

How much oversight should the FAA provide in ensuring continued airworthiness through regulation of maintenance and repair of aircraft and systems?

How should the FAA view 'operational control' for autonomous UAS?

What, if any, changes or new regulations should be adopted/implemented to ensure the safety of 'autonomous' and 1:many operations?

How should industry consensus standards be leveraged in determining airworthiness of aircraft and systems, including systems which utilize a range of operational elements?

Potential Tasking:

In Phase 2, Working Group 2.2 will form task groups to develop recommendations for a progressive, risk-based, performance-based regulatory frameworks and policies related to:

Airworthiness and Production Certification: Similar to that for light-sport aircraft, this could take the form of an Industry-led, self-declarative compliance and audit system to the applicable regulations and industry-developed and maintained consensus standards for smaller UAS to achieve safety objectives consistent with societal expectations without FAA type design certification or direct FAA production oversight. A range of categories could be implemented, tied to consensus standards, which are proportional to risk. Many applicable consensus standards already exist.

Other CAAs have implemented 'standard scenarios' which define levels of risk and connect airworthiness to operational approval through self-compliance and design validation frameworks.

Type Certification: Driven by risk and societal expectation. Explore the level of oversight by the regulator. Explore the interactions between airworthiness and the operational approval of associate elements and third party services.

Continued Airworthiness: Develop and recommend regulatory frameworks for maintenance and repair that are not prescriptive and do not require the same level of certification as traditional crewed aviation.

Approval Delegation: Develop and recommend a path for delegation of certain approvals to companies and/or individuals within companies. Recommend creation of a streamlined path for delegation to existing FAA designees for new applicants.

Automation and Autonomy: Recommend frameworks that are not overly prescriptive and are appropriate and proportional to risk. The same level of certification and design assurance appropriate for traditional crewed aviation is not appropriate for smaller UAS.

Noise: Explore aircraft noise requirements for the range of aircraft and operations under this ARC.

Overlap Issues

The following issues were identified as having overlap with other Working Group topics:

14 CFR 91.113 Reform: For decades, overly literal interpretations of the antiquated language of this rule have been cited as the primary obstruction to UAS operations in all classes of airspace--yet to date no serious efforts have been made at either amending or augmenting the to allow for vast improvements in technology (across all forms of aircraft) that would support more capable and safer methods of vigilance and avoidance. Amending (or providing alternate compliance language for) this rule is the bedrock of enabling sustained BVLOS or any other broad-based integration of UAS into the NAS. (Working Group 1.3.4 Flight Rules)

Role of the Pilot and Operator: With increasing levels of automation and autonomy, the pilot is no longer the manager of the energy and trajectory of the aircraft and the owner/operator may no longer be the manager of the continued airworthiness of the aircraft. (Working Group 1.3.5 Flight Rules & Operator Qualifications)

Associated Elements & Third Party Services: New policy defines associated elements of a UAS that are not entirely contained onboard the aircraft. Many architectures can be envisioned. Details of the approval process could be explored to ensure that implementation of associated elements does not result in changes to aircraft requirements during the certification process. (Working Group 1.3.3 Third Party Services)

Parking Lot Issues

The following issues were identified as out of scope for this Working Group:

Spectrum allocation for Radio Navigation: Frequency allocations were made long before the small UAS industry was born, and these allocations do not offer industry sufficient options to meet potential standards being considered in RTCA (SC-228, WG-2), EUROCAE (WG-105, SG-2), or ASTM (F38). Not allocating sufficient spectrum in frequency ranges that enable radionavigation effectively cripples industry and stifles innovation.

Waivers/44807: Industry has experienced issues which may be due to internal coordination and process issues at the FAA. The FAA method of 'bring me a rock' approval process and timeline for aircraft, operations, and sub-systems is capricious and arbitrary. Previous Part 107 Waivers (2017-2020) were capricious and arbitrary, and lacked consistency and repeatability.

Airport Operations: There is a common industry misconception that UAS activity does not involve airport operations (as imposed by Part 107). Fixed facilities, such as those proposed by Amazon or Walmart, are not adequately being addressed. (Could be an overlap issue with Flight Rules)

Working Group 1.3.3 Task Group Report

This template is intended to be a guide to aid in meeting the objective of the Phase 1 group, and to provide a consistent scope of content for the Phase 2 Working Groups

Task Group:

Third-Party Service Providers

Third-Party is "a person (as defined by 14 CFR 1.1) that is not an applicant (as defined by the *FAA and Industry Guide to Product Certification*")

What is the issue?

Bottom Line Up Front (BLUF): Two major issues:

1) no specific methodology for the inclusion of third-party services for an Applicant seeking airworthiness certification (SAC, 44807 or type); and

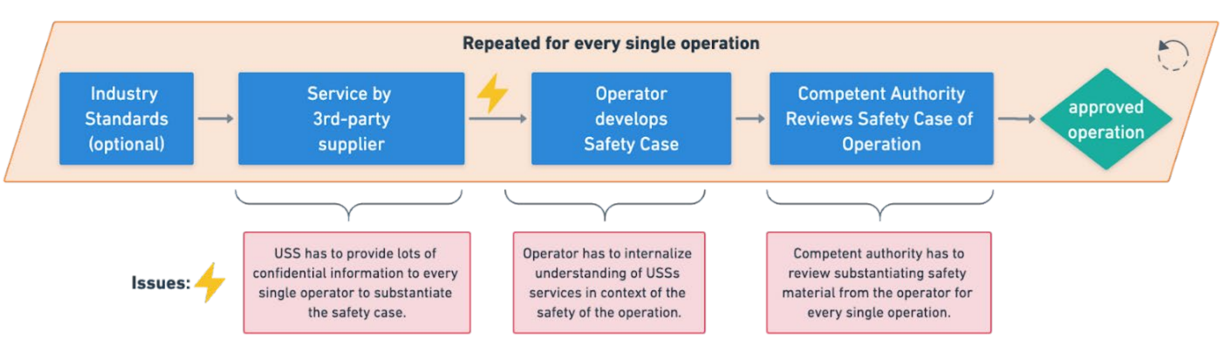
2) no specific methodology for the pre-approval of third-party services for operational approval

The existing regulatory structure has no specific methodology to approve third-party service providers required to meet the safety requirements for a UAS operator. Currently, air carrier (e.g., Part 135) and crop application operator (i.e., Part 137) certificates can be used to approve third-party services but there are no FAA accepted industry consensus standards to establish required performance for the different services. The FAA published clarifying instructions on how they will perform approvals against the current regulations in their memo "FAA Approval of Unmanned Aircraft Systems (UAS) Special Class UA Projects and their Associated Elements". However, this document does not resolve the question on how to approve a third-party service independent of an individual Type Certification and associated Operational Approval.

In federated Unmanned Aircraft System Traffic Management (UTM), third-party service providers, including Supplemental Data Service Providers (SDSPs), are expected to provide diverse services to users, (e.g., operators, pilots, and UAS Service Suppliers (USSs). SDSP services may include surveillance, weather, terrain/obstacles, CNPC/C2 coverage/status, path planning/optimization, and noise/environmental monitoring. Interoperability and coordination among UTM participants underlie federated UTM.

There are no specific requirements for safety services and no regulations or policy to rely on. For example, there is a lack of FAA accepted performance specifications for Control and Non-Payload Communications (CNPC) and Command and Control (C2) links. What availability, continuity and integrity are required? What are the required update rates for key information from the UA? Are multiple links required for certain operations? What are the spectrum requirements? Etc. Additionally, there are no FAA accepted specifications for UTM approval or any set process to obtain approval. Which means there is no clear way to determine operational safety of UTM services without understanding the division of responsibility between operator and service provider.

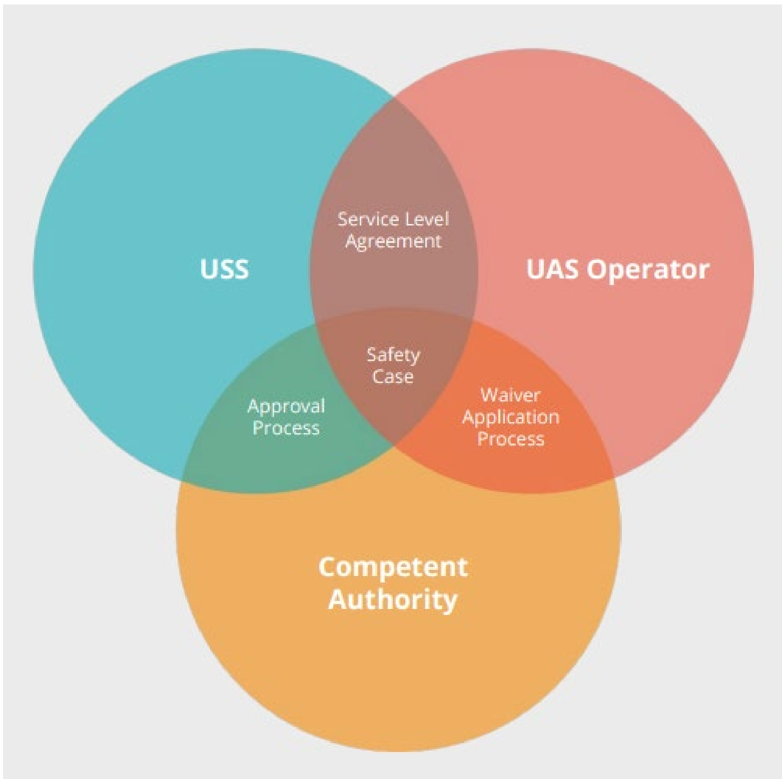
UTM Service Suppliers are typically not able to provide risk-mitigating services to UAS operators in a scalable way. Operators need to be able to own the justification for the utilized risk mitigating measures in their operations. They need to be able to substantiate a safety case for each waiver application. This suggests that service providers can only offer services to operators by divulging copious amounts of the implementation details. This process is repeated for every operator and each individual application rather than being a repeatable model.



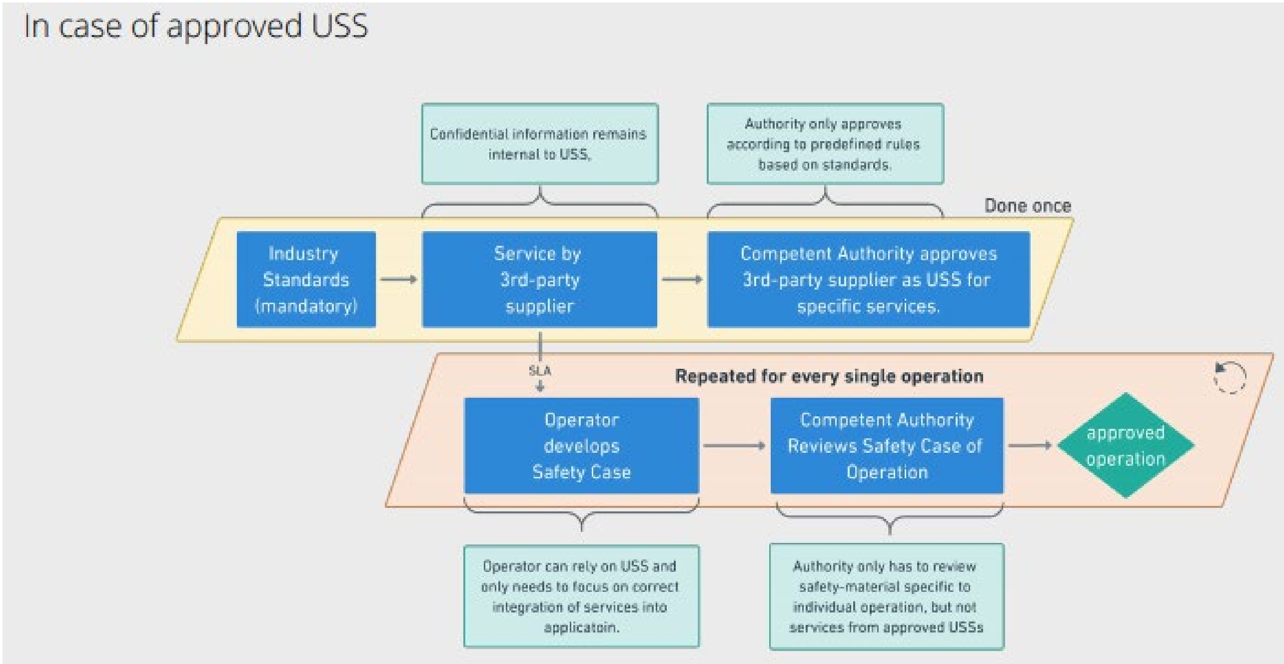
Service Providers (or USSs) providing services in today's regulatory environment
SOURCE: AIRMAP's presentation at ICAO DRONE ENABLE 3 (link)

This is hurting business objectives of service providers and operators while creating a greater workload for the competent authority. (FAA).

By introducing the concept of a Service Provider as an additional entity (*see picture below*), regulatory concepts like UTM or Risk Service certification could be introduced. This may potentially work the way type-certified parts are used in traditional aircraft.



Division of responsibility between UAS Operator, Service Provider and Competent Authority (FAA)
Source : JARUS SORA Annex H (draft)



Service Providers (or USSs) providing services in a possible future regulatory environment
SOURCE: AIRMAP's presentation at ICAO DRONE ENABLE 3 (link)

The initial need for services is likely in the ability to effectively conduct operations planning by determining air and ground risk, applying safety buffers, performing the conformance monitoring during the flight as well as some method of conflict detection and resolution during the flight.

Refer to the draft version of ANNEX H to the JARUS SORA package, which provides recommendations to regulators, service providers and operators, to see how this mechanism could function.

A clear path to certification and approval of third-party service providers to UAS operators is necessary. Moreover, a similar framework is needed for services that are to be provided to all other involved stakeholders (aside from operators), specifically: security and law-enforcement agencies, state, and local governments, etc.

Why is it important?

Without regulations or accepted means of compliance for each type of service, every operator is expected to provide justification for the use of a third-party service provider to meet their safety requirements. This adds administrative burden on both the FAA and the operator to collect and submit data even if the service has already been evaluated for previous approvals. Regulatory changes that enable independent approval for a third-party service in such a way that complies with an industry consensus-based standard will reduce FAA workload, cost, and schedule risk for applicants. Service provider approval and oversight against a standard will also lower risk by standardizing services.

UTM provides predictive analytical services for risk assessment and offers collision avoidance services (rules, strategic planning, tactical avoidance). They cannot protect from other UAS without 100% cooperation and cannot protect from crewed aircraft without data sharing from the FAA. These are just some of the reasons why a mandate for UTM is necessary. SBS data is needed or need to use ADS-B out to obtain TIS-B or need to understand what an acceptable solution for third-party surveillance should entail.

UTM is envisioned to be an essential element for safe integration of BVLOS operations and without a clear path for UTM implementation, complex UAS operations will be limited to exemptions and waivers. For USSs to offer services involved in mitigating risk for BVLOS operations, some sort of certification or approval-process would need to be established to create a scalable market for those services. The rules for this approval process would need to be purely performance-based, thus allowing for innovative ways to implement solutions in each safety-framework.

What is the scope for the Phase 2 Working Group? *(Frame up considerations for the solution: "think about…", "don't limit the recommendation to rules for only UAS….")*

Prepare proposed regulatory text to create certificates for third-party services. This text should consider all types of current and future third-party services that provide UAS related resources which have an impact on the safe operation of a UAS in uncontrolled airspace. The regulatory text should be performance based and take advantage of industry consensus-based standards. The intent would be to model the approach on the sUAS Remote ID regulations.

Services to be considered but not limited to:
Ground Based Detect and Avoid

Includes Surveillance UTM Supplemental Data Service Provider (SDSP) Performance

Minimum performance standards for Surveillance Supplemental Data Service Providers (SDSP) equipment and services to UAS Service Suppliers/Providers (USS/USP). These surveillance services will provide aircraft track information to Detect and Avoid (DAA) systems to enable BLVOS UAS operations and support spectrum radio-navigation equipment and installation approvals.

Control & Non-Payload Communication (CNPC) and Command and Control Link Systems:

- Lack a risk-based national regulatory framework for fully integrating UAS into the NAS
- Require fully functioning UTM system or systems that third-party service providers can support and feed into
- Need explicit agency support for LTE/5G commercial networks as infrastructure to aid the UAS ecosystem.
- Necessitate full and effective collaboration between FAA and FCC on issues relating use of commercial cellular networks for UAS support
- Have minimum performance requirements for CNPC and C2 links and DAA, including security, latency, and reliability requirements
- Issue explicit acceptance, preferably by advisory circular or notice of availability, by FAA of cellular to provide third-party, network-based services

Spectrum for non-network-based cellular services - what services will be used in what spectrum? (e.g., detect and avoid capability being developed in 3GPP using cellular communication outside network coverage like a non-network "Sidelink" (SL) mode used in Cellular Vehicle-to-Everything, CV2X).

There are existing methods that could be applied to “common” or “Commercial-off-the-shelf” (COTS) components to ease certification burden.

FAA could recognize references within waivers and exemptions to previously approved applications or Special Airworthiness Certificates in new applications. The Part 107 Waiver Team used to brag about specifically denying any application that looked identical to a previously approved application as a method of ensuring “credible operators”.

For non-critical COTS elements, the FAA could use either the TSO process or the NORSEE process. Example: PS-AIR-21.8-1602, Approval of Non-Required Safety Enhancing Equipment (NORSEE) currently specifically excludes all UAS but represents a good method for certifying AE.

These AE items (including third party services) could be considered “commercial parts” as defined by 14 CFR §21.1 and included in documents prescribed by 14 CFR §21.50.

Uncrewed Traffic Management Service Suppliers and other UTM components

- Introducing the concept of a Service Provider for UAS into the regulatory concept
- FAA identify long lead UTM requirements (e.g., ISO 27001) that will impact UTM certification process
- FAA commence conversations about requirements and process for UTM certification.
- Require recognized standards for UTM
- Recognized Conformity Assessment Bodies (CABs) for UTM Service Providers
- UTM mandate (need to start incorporating tracking data for uncrewed aircraft)
- Consider Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability
    - Performance and interoperability requirements, including associated APIs, for a set of Uncrewed Aircraft Systems (UAS) Traffic Management (UTM) roles performed by UAS Service Suppliers (USSs) in support of UAS operators. Roles are groupings of one or more USS services that a competent authority may choose to use in establishing the granularity of authorizations granted to a USS.
- Weather Supplemental Data Service Provider (SDSP) Performance
    - Minimum performance-based standards for Weather Supplemental Data Service Provider (SDSP) data and services to UAS Service Suppliers/Providers (USS/USP) and Operators in a UAS Traffic Management (UTM) ecosystem. These services will provide present and forecast weather information and products to enable VLOS and UAS BVLOS operations.

- Vertiport Automation Supplemental Data Service Provider (SDSP)
    - Performance-based standards for Vertiport Automation Supplemental Data Service Provider (SDSP) data and services to UAS Service Suppliers/Providers (USS/USP), Operators in a UAS Traffic Management (UTM) and Provider of Services for UAM (PSU) ecosystem. Provide present and forecast facility information and products to enable VLOS and UAS BVLOS operations, support other USS/PSU capabilities, such as geofencing and flight planning for applications involving Uncrewed Aircraft systems and Urban Air Mobility (Advanced Aerial Mobility), support spectrum radionavigation equipment and installation approvals.

Approval on a per-service level, like how USSs are approved to provide LAANC under a MOU and USS Performance Rules. Prepare preamble text that explains the need and benefits of the new regulations. This material should outline the shortfall (e.g., lack of regulatory structure) and explain the significance of the issues.

What relevant information do I have for the Phase 2 Working Group?

The FAA exemptions and waivers which are publicly available
The industry consensus standards (draft or published): Regulators and industry stakeholders alike are committed to appropriate industry standards' performance requirements as acceptable means of compliance (AMCs) to approve UTM services. While such AMCs should expedite the provisioning of SDSP services, there are additional issues that need facilitation. For example, business issues, including liability and remedies provisions for SDSP services require commercial contracts or service level agreements (SLAs) between providers and consumers. Contracting "overhead" must not impede service availability—the interplay of the contractual and regulatory approaches may deserve further harmonization.

F3411-19 Remote ID (WK76077 -revision to comply with Rule and MOC)
WK 63418 UTM USS Interoperability (Draft under Ballot)
WK62669 DAA Test Methods (Draft)
F3442 Standard Specification for Detect and Avoid System Performance Requirements
WK75923 New Specification for Positioning Assurance, Navigation, and Time
Synchronization for Unmanned Aircraft Systems
F3389/F3389M-20 Standard Test Method for Assessing the Safety of Small Unmanned Aircraft Impacts
(WK76302-revision to accommodate FAA MOC)

Other published material identified by members that is relevant and readily available

- ASTM TR1-EB: *Autonomy Design and Operations in Aviation Terminology and Requirements Framework*, 2019
- ASTM TR2-EB: *Developmental Pillars of Increased Autonomy for Aircraft Systems*, 2020
- ASTM AC377 TR3: *Regulatory Barriers to Autonomy in Aviation*: Draft v2.1 Jun 8, 2021
- ASTM Working Document: *AC377 Task Group Terms of Reference: Regulatory Barriers to Autonomy in Aviation*

- ASTM Working Document: *Part 91 Review*, Jan 28, 2021

Member company materials cleared for release to the group
List of potential third-party services that could support safety needs for UAS operations.

- ATM Coordination/Traffic Information
- Terrain Services
- Flight Planning Services/Low Level Route Design
- Network R-ID Services
- Geo-Awareness
- Conflict advisory and alerts
- Weather
- Aeronautical Information Management
- Control & Non-Payload Communications and Command and Control Links
- Ground based sensors used for DAA
- Remote Pilot Stations, including automatic takeoff and landing systems.

UTM has a standard and operational uses, plus several tests to show effectiveness (as demonstrated by NASA Technical Capability Level or the UTM Pilot Program (TCL/UPP).
Communications, Navigation and Surveillance (CNS) models are available, but largely untested by the regulator to ensure accuracy.
Setting a threshold could drive the demand for models and help with testing.
This is a good discussion regarding V2V, as GAMA has proposed UAT2 (1104 MHz) as an option.
Concepts described in ANNEX H to the JARUS SORA for determining air and ground risk as well as applying safety mitigating services with minimum levels for assurance and integrity and defined safety gain.
Adopting this to a standard rule where the involved parties declare compliance with predefined operating scenarios, and the regulatory body being primarily involved in approving and auditing service providers.
EASA's U-space regulation has similar concepts for U-space service providers.

Industry Concerns:
Overall AFR concepts… separation strategy
CNS prediction / performance thresholds (MASPS?... RTCA?)
Who is responsible for understanding if CNS is available?
How is a CNS service certified, authorized, and accepted by the FAA?
How does CNS service translate into risk (navigation risk, 4D volume sizing, ability to fly the new AFR flight rules)?
UTM testing or authorization to supply services
DSS service at the FAA? FIMS?
Will a third-party service be mandated? Or can an operator use internal means (like existing flight following procedures)
LAANC was implemented under the current regulatory environment. Similarly, the FAA can collaborate with industry to develop preliminary steps for certification of incremental UTM capabilities.

Challenge here is that LAANC provides a free service for completing the Airspace Authorization requirements of 14 CFR Part 107.41. There is no regulatory requirement that a USS alleviates, authorizes, or waives. Industry is concerned with de facto privatization of low-level ATC through UTM mandate by the FAA.
FAA commence conversations now with industry for decisions that impact long lead requirements such as demonstrating ISMS (e.g., ISO 27001).

Parking Lot issues

Industry Concerns
State Preemption – absent clear direction from the FAA regarding interstate commerce, states have been regulating or attempting to regulate UAS, including imposing flight restrictions. This is within their rights as a state to regulate intrastate commerce. OUT OF SCOPE

Section 2209 – This overdue requirement is creating uncertainty in the marketplace and holding back innovation. OUT OF SCOPE (Note, Working Group 1.2 discussed this issue as a relevant issue outside of the FAA's BVLOS rulemaking authority).

Workgroup 1.3.4 Issue Paper

Regulatory Construct

What is the issue?

Current FAA aviation operations regulations are largely based upon the assumption that a human pilot is 1) on board the aircraft; and 2) responsible for the operation of that aircraft. Scattered throughout the FARs are responsibilities that are assigned to the Pilot in Command, and in select cases those responsibilities are predicated on the presence of the pilot in the aircraft. For example, rules such as *14 CFR 91.113: Right of Way Rules* place the responsibility upon "each person operating an aircraft" to maintain vigilance so as to "see" and avoid other aircraft. However, under the FAA's narrow interpretation of "see" to mean direct observation by the human eye, UAS cannot comply with this regulation as they have no on-board person operating the aircraft.

In the case of UAS, roles and responsibilities that were previously accomplished by on-board pilots have been transferred elsewhere. In some cases, a remote human pilot maintains control of the aircraft, flying much as an on-board pilot would. In more common cases, various levels of automation have begun to perform key tasks that are still assigned to the pilot's responsibilities in regulation, ranging from pre-flight planning and weather checks to managing the aircraft in contingency situations. Other UAS crew positions, such as visual observers or maintenance personnel, are affected by an inapplicability of (and in some cases a lack of) regulations that govern their specific functions clearly and adequately.

The issue of human pilot responsibilities is just one example of how the existing regulatory system has not kept pace with the introduction of new technologies and new entrants (such as UAS) into the National Airspace System. Other regulatory parts, such as 14 CFR Parts 61 and 135, do not adequately account for nor fully accommodate UAS. The FAA, in some cases at Congressional direction, has attempted to address these regulatory gaps and conflicts through an increasingly complex and unwieldy system of waivers and exemptions (such as Section 44807 exemptions or Certificates of Waiver or Authorization) and a series of limited rulemakings (e.g., Remote ID and the upcoming Operations Over People rule). The resulting Byzantine structure has not only made it difficult for UAS proponents to understand and maintain compliance, but has generated substantial confusion in the larger aviation community as to what UAS are expected to do. All of these factors combine to create a current regulatory construct that:

Lacks clear understanding of key roles and responsibilities for many UAS operations, particularly those operations that incorporate a significant degree of automation;
In the absence of a traditional pilot, lacks the ability to adequately trace many key responsibilities to the person or other entity that is actually responsible;
Incorrectly assigns operational control and ultimate responsibility to persons that may not hold either; and

Has created a system of waivers and exemptions that are temporal, highly subjective, subject to substantial delays and are ultimately rooted in the same traditional regulatory shortcomings that caused the problem in the first place.

To address these shortcomings there is a need to modify the current regulatory construct, including the potential to create new regulatory Parts that:

Closes the existing gaps in regulatory coverage, such as providing appropriate and sufficient means of compliance to perform key aviation functions essential to the safety of the NAS (e.g., avoiding other aircraft).
Provides clear guidance on functional and operational responsibilities for UAS that accommodates varied levels of automation (from "pilot on the sticks" to fully-automated, system-controlled operations);
Correctly assigns operational control and ultimate responsibility for the operation of the UA system to the entity(ies) that exercise them.

Why is it important?

UAS are purposefully designed to address specific opportunities and shortcomings in the aviation market. They can deliver packages to homes that no traditional aircraft can access, inspect long-haul infrastructure at close range with no risk to human life, closely surveil hazardous spill and leak areas without exposing a human to toxicity, and deliver life-saving food and medications to people in need in the aftermath of a disaster. Many of these operations, by their very nature, violate existing FAA rules on aircraft operations, such as minimum safe altitudes and proximity to people and structures on the ground. The regulatory construct should not treat these as liabilities, but instead as features that must be supported to realize the benefits that UAS bring to aviation and to the world. Furthermore, the delays caused by the lack of clear regulatory guidance have imperiled the U.S.'s leadership position in technology and severely negatively impacted a projected multi-billion dollar industry whose only significant remaining impediment is regulatory approval.

What is the scope for the Phase 2 Working Group?

(Frame up considerations for the solution: "think about…", "don't limit the recommendation to rules for only UAS….")

In Phase 2, the Working Group will:

Survey the landscape of potential UAS operations across the spectrum of use cases, automation levels, intended airspace and other characteristics to determine what current and future UAS BVLOS operations may require to achieve normalized and routine access to the NAS.
Assess the regulatory gaps, conflicts and other impediments to routine BVLOS operations in the NAS, including the applicable provisions of 14 CFR Parts 91, 107, 135 and others as applicable. The assessment will include recommendations for operating Rules that will enable BVLOS operations (e.g., right of way, minimum safe altitudes, priority).

Work with Working Group 2.4 - Operator Qualifications to incorporate their regulatory change/creation recommendations for UAS crew training and qualification, and Working Group 2.2 to incorporate recommendations for aircraft equipage and ultimate certification.

Monitor the progress of the other ARC Working Groups to ensure our regulatory analyses and recommendations capture and support the intent and overall direction of the ARC.
Develop recommendations for a regulatory construct and operating rules that will support the broad range of intended UAS BVLOS operations and that supports novel/non-traditional roles and responsibilities unique to UAS. The recommendations will include the appropriate assignment of responsibilities for compliance with the rules (e.g., assumption of risk for both crewed and uncrewed aircraft for violations).

Working Group 1.3 Task Group Issues

This template is intended to be a guide to aid in meeting the objective of the Phase 1 group, and to provide a consistent scope of content for the Phase 2 Working Groups

Task Group: 1.3.5: Pilot/Operator Qualifications

What is the issue?

14 CFR § 91.3: Responsibility and authority of the pilot in command.

(a) The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

Over the past century, the history of aviation has proven that the introduction of automation into the cockpit has vastly improved aviation safety, saving countless lives and billions in crash damage through the reduction and/or correction of human error. Sophisticated flight management systems and coupled autopilots have demonstrated that even the most complex aircraft in the world are consistently being operated safely without the intervention of a human pilot. Through the use of advanced automation technologies, today's UAS have grown to incorporate the same level of capability into much smaller and lighter aircraft—aircraft that incur only an infinitesimal risk of severely damaging other aircraft or property, or of harming a human being. Appropriately measuring and assigning that risk is a key component of determining the types and levels of training and qualification needed for UAS crew operating highly automated systems for both present and future UAS BVLOS operations.

As UAS begin to scale toward nationwide operations, the need for increased automation becomes essential. Thousands of concurrent flights occurring across the country (or in some cases, the world) require a high degree of automation to ensure safe and efficient operations. Traditional PIC functions such as flight/route planning, weather, pre-flight checks, takeoff, cruise, hover, landing and even contingency management can be (and often are) accomplished by automated systems, often under the span of control of the system's Operator or Original Equipment Manufacturer (OEM), not the pilot. Current regulatory guidance, however, specifically assigns many of these responsibilities to the PIC, which creates a mismatch and incorrectly assigns responsibility (and potentially liability) to the UAS pilot, when in fact that pilot is not in control of these functions, and in some cases cannot intervene. At higher levels of automation the operator may be monitoring the health of the overall system vs. a pilot overseeing individual flights. In addition, new roles are emerging that exercise ultimate control over UAS operations that do not fit into currently defined (and regulated) roles.

This creates a need to re-provision, and in some cases redefine, the roles and responsibilities currently assigned to UAS Pilots (particularly the PIC), UAS Operators, and potentially OEMs that identifies and considers the broad array of traditional functions that may be accomplished via other methods and systems in the UAS operating environment. Ultimately, these actions could obviate the functions required to be performed by a human pilot/operator altogether, and vastly change the numbers of aircraft that are operationally controlled by a given system.

Why is it important?

Current FAA guidance assigns responsibility (and ultimately liability) to the UAS Pilot/Operator, the aircraft Operator, and the aircraft system OEM for specific roles and functions. Until regulatory guidance reflects the current and future roles and functions of automated systems in UAS operations, it is likely that a PIC or other crewmember could be issued a violation, or even prosecuted, for a function that is outside of their direct control as well as operational control. Changes should accurately trace responsibilities from regulation to application. There should be specific emphasis on the issue of ultimate operational control which may not lie with a human pilot at all but instead with the Operator, OEM or other entity. Without such regulatory changes, the safety benefits of automation cannot be used. In addition, large-scale and -volume UAS operations will not be economically viable in the United States and the many benefits of these operations will be lost.

Regulatory guidance must also clearly accurately align functional responsibilities to inform the evolving context of civil enforcement actions and civil/criminal proceedings related to UAS activity. Current regulations place the FAA certificates and ratings of crewmembers at risk for a UAS incident that may occur under automated control and could not have been influenced by their action. Correctly aligning functional responsibilities ensures that the person or entity that exercises operational control bears appropriate responsibility.

As responsibilities are correctly aligned, it is important that crew training and qualification programs reflect these changes, so that UAS crews are fully and appropriately trained on the responsibilities and tasks that are within their control.

Of note is this is not only a “tomorrow” problem. Highly automated systems are in use today that perform the lion’s share of legacy pilot functions *without direct input from the pilot*. Such operations that incorporate highly automated pilot functions, or that shift responsibilities to the Operator or OEM are difficult to approve because current rules don't accommodate these shifts. Allowances are only made after a lengthy and subjective exemption process that does not have clear guidance on how to demonstrate that automation can complete pilot tasks.

What is the scope for the Phase 2 Working Group? *(Frame up considerations for the solution: “think about…”, “don’t limit the recommendation to rules for only UAS….”)*

Identify roles and responsibilities of the Pilot, Operator, OEM and other existing positions relevant to BVLOS operations.

Assess future functional responsibilities and 1) assess whether they fit into existing roles/responsibilities; or 2) identify where new roles and/or responsibilities are necessary to reflect how UAS systems operate at various levels of automation.

Discuss with the ARC membership SMEs to identify any specific challenges that they may see in the operator qualification and training arena.

Recommend high-level regulatory changes to enable appropriate assignments of responsibility and level of operational control that supports the range of UAS operations. **In this paradigm, are human pilots or other crew even necessary at certain levels of automation?**

Assess and determine how these shifts impact UAS crew[176] training:

For which remaining functions must UAS crews be trained in order to accomplish their primary duties at various levels of automation?

What other functions (not performed by UAS crews) must the crewmembers fully understand how they are performed in order to make good decisions and execute their responsibilities safely and effectively?

What limitations, if any, are these functions constrained to by the ratio of aircraft to pilot and/or system? How can they be expanded to support 1:n operations?

Who should be responsible for determining the type and level of training/qualification required to perform these functions?

Develop, validate and submit recommendations for changes that address the gaps between current and desired regulatory guidance. The path of the recommended changes should be considered by the workgroup, i.e., whether modifying current guidance or creating new, UAS specific guidance.

Note: Check with Flight Rules TG to see if airspace should be considered as a factor that affects responsibilities and qualifications.

What relevant information do I have for the Phase 2 Working Group?

14 CFR Parts 1, 61, 91, 107 and 135

Inputs from ARC/SME surveys on core functions and what entity should perform them

Inputs from ARC/SME surveys on future states of UAS automation and impacts upon responsibility assignments

ASTM International, *Developmental Pillars of Increased Autonomy for Aircraft Systems* (West Conshohocken, PA: ASTM International, 2020), https://doi.org/10.1520/TR2-EB

ASTM International, *Autonomy Design and Operations in Aviation: Terminology and Requirements Framework* (West Conshohocken, PA: ASTM International, 2019), https://doi.org/10.1520/TR1-EB

2021 DRAFT ASTM AC377 TR3: *Regulatory Barriers to Autonomy in Aviation*

2021 DRAFT AC377 Task *Terms of Reference: Regulatory Barriers to Autonomy in Aviation*

2021 14 CFR Part 91 UAS-Applicable Sections Crosswalk

Foundation Questions

These questions are intended to help us challenge our thought processes and meet the goals of the work product for Phase 2 (in no particular order…).

What problem are you solving?

Current aviation regulations assign responsibilities and training/qualification standards for key flight-related duties and functions based upon legacy crewed aviation roles. These assignments are often

[176] In this context, "crew" is intended to refer to a variety of positions and functions. The term as used in this document does not necessarily imply certificated crew as seen from a regulatory perspective.

incompatible with UAS operations, particularly those that rely upon higher degrees of automation to accomplish operations at scale.

Is there a better way?
Changes are needed in regulatory guidance and training standards to accurately and appropriately assign responsibilities for key functions, and to set acceptable training/qualification standards that accurately reflect the duties and responsibilities of UAS crewmembers in their respective environments.

Are we sticking to defining the issue and not trying to solve it?
Yes.

Is this issue within the scope of the ARC Charter?
Yes.

Do we need it at all? (Where it can be a regulation, rule, concept, definition, pre-conceived box, etc…)

This is definitely needed. Existing regulatory guidance does not appropriately and specifically accommodate UAS BVLOS operations at scale, with some limited exceptions. The existing practice of "translating" existing Part 91/135 guidance at times results in varied interpretation and inconsistent application, making approvals highly subjective and subject to constant review.

Are we thinking outside the box with this issue, and not being constrained by prior concepts?

We are mindful of prior concepts and existing regulations, and will leverage those that fit into this effort. We are not, however, treating them as constraints.

Have we offered appropriate Scope Considerations with our issue?

Yes.

Should the ARC consider a path based on current regulation, or start completely fresh? Or Both?

Start fresh. Amending all of the potentially applicable portions of Part 61, 91, 107 and 135 is unwieldy and impractical within the scope of an FAA rulemaking effort. A clean-sheet approach is necessary, similar to the creation of Part 107, in order to enact the needed changes in time for them to be relevant and effective.

Should this issue be in the Parking Lot?

No.

Working Group 1.3

Task Group 6 (Regulatory Considerations)

Scope: Issues for ARC Phase 2 Working Groups to consider regarding: (1) how the FAA should think about its approach to BVLOS regulations; and (2) the considerations the FAA needs to balance in promulgating BVLOS regulations (e.g., safety, innovation, security, timeliness).

This document provides a narrative on specific issue sets followed by a list of issues/questions to be considered by the ARC as members work to develop specific recommendations for the FAA to achieve a regulatory framework that will normalize scalable, economically viable BVLOS operations for, at minimum, the specified use cases.

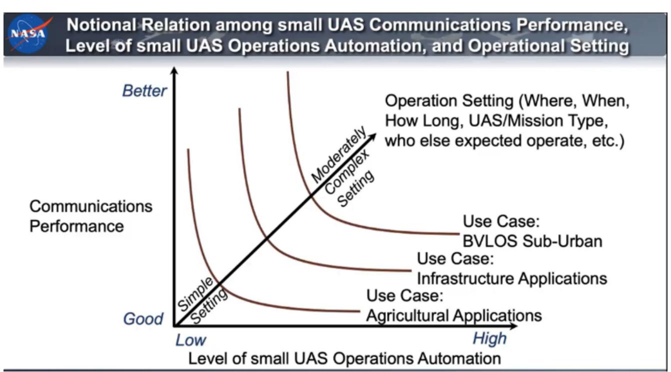
Issue Group 1: PRESCRIPTIVE OR FLEXIBLE REGULATORY APPROACHES, DIVISION OF RESPONSIBILITY

<u>OVERVIEW</u>: PRESCRIPTIVE OR FLEXIBLE REGULATORY APPROACHES

The FAA has expressed its desire to have a reasonable regulatory approach to BVLOS that ensures an “acceptable level of safety without imposing an undue burden on market participants.” A key consideration for the ARC will be how to balance regulatory flexibility with the preference for repeatable, predictable regulations that can be applied in most scenarios. While a more prescriptive approach would potentially facilitate predictability, it would likely discourage the broader UAS market by restricting who can conduct BVLOS operations and what satisfies operational requirements.

In addition, various factors may affect the safety risk presented by a BVLOS operation. It is worth considering an acceptable level of safety risk related to various use cases, and how certain factors (whether individually or in concert) change the level of risk. For example, an operation in a less populated area would seem to reduce the possible risk from heavier aircraft/payload. Similarly, an operation that flies a short distance BVLOS would also reduce the possible risk from aircraft weight. Operations in controlled airspace would have the benefit of greater Remote Pilot awareness of uncrewed traffic, given transponder and ADS-B requirements.

Safety should be considered on a continuum that is a function of elements such as aircraft weight, geographic location, length of flight, level of autonomy, predictability of communications links, and other risk mitigations built into the aircraft. The chart below from a NASA presentation provides a graphical representation of this kind of continuum analysis.



<u>QUESTIONS:</u>

Should the FAA approach to BVLOS regulations be prescriptive for all use cases and associated aircraft? Is this even possible? Alternatively, should the FAA approach to BVLOS regulations be flexible/performance-based and able to take into consideration multiple factors on the ground and in the air to determine risk and the relevant safety requirements?

How will the regulations address BVLOS operations with different levels of risk, including risks based on the weight of the aircraft, autonomy and mitigations on the aircraft, length in flight, geographic area for flight, on-aircraft systems, systems on the ground, proximity to terrain and structures, etc.?

The types of BVLOS operations and associated aircraft are varied. How will BVLOS regulations address each of these?

What precautions should be required for uncrewed aircraft in emergency scenarios (e.g., UAS malfunctions, variations from preplanned route)? Does this need be managed by a regulation?

Can BVLOS risks/vulnerabilities be solved with technology (performance/technical standards), or with infrastructure (airspace or air traffic changes), or both? How will the regulation reflect this?

OVERVIEW: DIVISION OF RESPONSIBILITY

The aircraft is the main element in any UA flight operation. Therefore, in a BVLOS scenario, aircraft designers and manufacturers will continue to have a key responsibility in the safety equation. Depending on the design of the aircraft and the operational plan, other equipment or component part providers also may have increased responsibility for achieving mission safety. The FAA may want to consider a scale that balances the interests of the relevant marketplace stakeholders, which may vary based on the use case and risk profile of the operation. Furthermore, the question of responsibility must account for the parties in the airspace that need to co-exist. To ensure safe operations in the NAS, consideration needs to be given to the level of situational awareness both traditional aviation and UAS operators need to have of each other's activities. BVLOS regulatory framework recommendations may want to include thoughts on the appropriate balance of responsibility among these entities and how acceptable safety can be achieved (or how that assessment changes across use cases). Furthermore, attention should be given to whether an iterative approach that begins with operations limited to under 400ft initially would yield the most suitable, timely outcome.

QUESTIONS:

Do BVLOS operations change the dynamic related to risk and responsibility such that any stakeholder has greater or lesser responsibility compared to the expectations for current VLOS stakeholders? How should the regulations account for that?

Who is the burden on? Consider the appropriate division of responsibility between expected UAS industry participants including aircraft manufacturer, technology/service provider, and aircraft operator. Should certain operators or operations have priority in the airspace? What factors would go into defining the scope of such a system?

Issue Group 2: FUTURE-PROOFING

OVERVIEW: The rapidly developing nature of technology makes it difficult for any regulatory authority to keep up with changes and delays the realization of economic and social benefits. While creating BVLOS rules, the FAA needs to be intentional in how they accommodate unknown future technological and societal developments. The FAA should also weigh the benefits of developing "future-proof" rules that may take longer to develop against the benefits of quickly issuing regulations based on what we know today. Alternatively, consideration should be given to a regulatory approach that can allow for better future-proofing such as the use of safe harbors. A safe harbor rule would potentially allow the agency to specify a particular technology or standard that is automatically deemed compliant (unless proven otherwise) while still allowing for alternative compliances now (and in the future).

QUESTIONS:

How can the FAA best future proof its BVLOS regulations?
Can BVLOS operations be executed with the equipment and infrastructure that exists today? Should there be an incremental (crawl, walk, then run) approach to the regulations?
What does the future of the airspace look like and do these BVLOS regulations need to take that into account?

Issue Group 3: NEW OR EVOLVING REGULATIONS

OVERVIEW:

Phase 2 should consider the full spectrum of regulatory options to enable BVLOS operations. Specifically, Phase 2 should identify regulatory provisions that are an impediment to BVLOS operations and recommend the ways those could be changed to enable a framework that allows various types of BVLOS operations, over time. The ARC should consider how textual changes to existing regulations, or simplified additions to them, could enable lower-risk BVLOS operations that make use of technologies that exist today, or that can be deployed in the near future. Options include tweaking or adopting existing rules, using current rules as a counterpoint, or completely writing new rules. Additionally, Phase 2 should consider adjusting crewed aviation rules where required if it creates an easier/better/safer solution.

QUESTIONS:

What textual changes to existing regulations would enable lower risk BVLOS operations in the near future?
Should the current definition of VLOS serve as a counterpoint to the definition of BVLOS operations?
Does the current definition of VLOS have the appropriate flexibility to be applied in BVLOS scenarios?
Does the FAA need to rethink its definitions of PIC, pilot and remote pilot in the context of BVLOS?
Do current FAA regulations sufficiently consider situational awareness in the air for BVLOS when the airspace is shared?
Will BVLOS regulations need to incorporate some awareness of ATC or ADS-B?
What existing FAA regulations for VLOS and crewed operations could apply to BVLOS operations? Which existing FAA regulations are an impediment to BVLOS operations? Are there any existing rules that could be modified to accomplish the goals of BVLOS?
Are there existing regulations/requirements for third party services from other agencies (privacy, spectrum, cybersecurity) that could help serve as performance baselines rather than reinventing the wheel specific to BVLOS?
Could current remote ID regulations be used or applied to support low risk BVLOS operations? What better standard is needed for non-low risk BVLOS operations?

Is the existing FAA aircraft certification framework flexible enough to keep up with UAS innovation?
Does the FAA process consider the lifecycle for UA market vs. crewed aviation?

Issue Group 4: STANDARDS-SETTING BODIES

<u>OVERVIEW</u>:

To support the goal of weighing the full spectrum of regulatory options to enable BVLOS operations, Phase 2 should also review the work and composition of standards bodies to ensure that any organizations that are recommended for potential FAA use or reference to their standards are structured with a mission and the right experts to provide recommendations that will support the creation of a flexible BVLOS operational framework over time.

<u>QUESTIONS</u>:

Should BVLOS regulations incorporate strictly defined standards, perhaps from standards-setting bodies, for all components, or should the regulations be open to innovation and incorporating components that can meet certain minimum performance criteria?
Is the work of recognized standards bodies in designing accepted standards critical to achieving scalable BVLOS? What functionalities necessitate a standards-based approach or interoperability between operators? How much should the FAA rely on the work of standards-bodies and what criteria should the FAA impose on these standards-bodies in order to ensure their work supports the FAA mission?

Issue Group 5: INTERAGENCY COORDINATION

<u>OVERVIEW</u>:

To set forth BVLOS operations, the FAA will need to coordinate with interagency partners to address security, environmental, economic, privacy, spectrum use and other issues that fall outside of the agency's jurisdiction and impact society at large (per the ARC charter). The FAA should attempt to pre-emptively consider the concerns of other agencies around safe, scalable, economically viable, and environmentally advantageous BVLOS operations and begin to educate interagency partners on the text of the initial rulemaking. This will help to insulate the FAA from delays caused by unforeseen concerns by interagency partners when they circulate the draft text for review. In addition, the FAA should consider jurisdictional and regulatory responsibilities in setting forth BVLOS flight that should be led by DOT or other departments and agencies.

<u>QUESTIONS</u>:

What pieces of BVLOS regulations should be undertaken by agencies other than the FAA? Are there aspects that could be moved up to DOT for economic decisions, or to other agencies (e.g., DHS for security, FCC for drone spectrum issues, DOJ/FTC for privacy, Commerce Dept)?
What are the jurisdictional concerns that need to be addressed?
What components of the BVLOS ecosystem will be under the FAA's direct oversight? Which components should be indirectly overseen by the FAA?
To the extent the FAA has indirect oversight over certain BVLOS components, and relies on industry-consensus standards, what are the repercussions for violating those standards?

Issue Group 6: UTM AND REMOTE ID

OVERVIEW:

The UAS traffic management (UTM) system is expected to serve as a flight management ecosystem for the controlled and uncontrolled portions of the NAS. UTM would ideally serve a key role in managing things like the division of responsibilities among various UAS marketplace participants and the FAA, and enable more scalable operations. The FAA has allowed BVLOS operations by waiver without an operational UTM. Consideration should be given to how larger scale, routine UAS BVLOS deployment changes the calculus around the necessity of UTM. It will be important to get more clarity from the FAA and NASA about the state and timing of UTM deployment, whether UTM should be undertaken by one federal contractor or a federation of UAS service suppliers, if UTM duties will be undertaken according to a set of common minimum standards, and whether UTM will be directly or indirectly overseen by the FAA.

The ARC and the FAA should consider the appropriate balance between a flexible, technology-neutral federated UTM architecture that is operated according to common minimum standards, or a UTM system that is operated by a government contractor or under delegated authority. The former would support broader market participation, hasten time to market by sharing responsibility among UTM providers, and allow various industry technologies and services to support the space and innovate low altitude traffic management. The latter would provide more government control. Similarly, there are currently rules around remote ID, but the FAA's final rule for Remote ID indicated that remote ID rules and standards may evolve as the industry moves to BVLOS operations managed by a UTM.[177] In the Remote ID final rule, the FAA indicated that a networked Remote ID solution might be most appropriate when the FAA adopts a UTM framework for UAS.[178]

Other factors to consider are possible cybersecurity and privacy questions presented by internet-connected UTM, the data that would be generated by UTM, and who can access the data and under what circumstances. In general, in developing regulatory recommendations, the ARC will need to assess whether UTM issues are necessary to address in the context of BVLOS operations, and whether a UTM framework needs to be addressed now or at a later time.

QUESTIONS:

Should BVLOS flight be allowed on a routine basis before there is a functioning UTM? Under what circumstances? Are there BVLOS operational cases that necessitate a functioning UTM? Do UTM standards or regulations need to be incorporated in BVLOS regulations?

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[177] The Remote ID final rule suggested the use of a broadcast only approach "for the time being," as an "initial" framework for remote ID, because it is a sufficient solution for limited UAS operations within the visual line of sight. The current Remote ID rule sets "the foundation for future regulatory actions." The current Remote ID rule sets "the foundation for future regulatory actions." *See* Remote Identification of Unmanned Aircraft, Final Rule, Docket No. FAA-2019-1100, RIN 2120-AL31 ("Remote ID Rule") at 63.

[178] "[T]he FAA has determined that a broadcast-based remote identification system that provides for immediate awareness of unmanned aircraft in the widest variety of settings will be adequate to support the phased, incremental approach, while allowing the UAS industry additional time to continue developing the network-based UTM ecosystem." Remote ID Rule at 73.

What changes to remote ID will be necessary in a BVLOS environment, and will BVLOS operations require a move to a more networked solutions for remote ID that will function in BVLOS environments?
Do the standards for Remote ID need to be reconsidered?
Who will have domain over the UTM data? Federal entities? Private sector? Where will these regulations fit?

Issue Group 7: GLOBAL HARMONIZATION

OVERVIEW:

To create effective rules, Phase 2 should consider other perspectives including those of other countries that are developing or have developed rules to manage BVLOS operations. Managing fully scaled BVLOS operations will be beyond the scope of what the FAA is used to overseeing, and the input of other stakeholders or delegated authority could relieve the burden. Additionally, ensuring our rules are coordinated with international trends could reduce some burden on operators.

QUESTIONS:

To what extent should the BVLOS regulations be harmonized with the approaches of other countries or regions? How can the FAA stay in the lead globally, as it has with Remote ID, to develop BVLOS frameworks that set the global standard?
Are there external market participants (e.g., crewed aircraft operators) that have some responsibility in BVLOS operations that the ARC should include in overarching regulatory considerations?

Parking Lot Issues

Do state or local governments have any responsibility with respect to oversight or management of BVLOS operations?
The argument was made that state and local needs a voice in UAS BVLOS operations. States are not necessarily interested in who specifically owns the airspace but being able to control where there are barriers. UAS operations occupy airspace that is very personal and historically has been used very little. Alternatively, there is a concern that state/local involvement may have other unintended effects on the process and ability to achieve the goal. The involvement of states would likely be outside FAA's authority and require federal legislation. In addition, there is concern that fragmentation of authority over flight paths, rules, equipage and other aspects of BVLOS operations would create a less safe operating environment, due to conflict and confusion.

WG 1.3 Summary

The reports produced by the Task Groups of Working Group 1.3 are indicative of the significant level of engagement in this process by members of the ARC. The FAA clearly defined "Tasks of the ARC" in its Charter. The focus of Working Group 1.3 on Regulatory Challenges and Considerations in this phase one effort is a necessary first step in achieving those milestones. The issues identified by members and captured here will provide the phase two Working Groups with a foundation to complete the recommendations required to "normalize safe, scalable, economically viable, and environmentally advantageous UAS BVLOS operations".

XI. Phase I Appendices

ARC Members by Phase I Working Groups

1. Community Interest: Safety, Environment and Security (Working Group 1.1)

Aerovironment	Chaim Kaltgrad
African American Mayors Association	Steven Reed
AriAscend/DSPA	Kenji Sugahara
Airbus	Scot Campbell
Aircraft Owners and Pilots Association (AOPA)	Chris Cooper
Airports Council International-North America (ACI-NA)	Chris Oswald
American Civil Liberties Union (ACLU)	Jay Stanley
American Petroleum Institute (API)	Suzanne Lemieux
ANRA Technologies	Amit Ganjoo
ASSURE UAS Center of Excellence	Stephen "Lux" Luxion
AT&T	Peter Musgrove
Cherokee Nation	JC Coffey
Consumer Technology Association (CTA)	Doug Johnson
DroneResponders	Charles Werner
Electronic Frontier Foundation (EFF)	Andres Arrieta
Electronic Privacy Information Center (EPIC)	Jeramie Scott
First Person View Freedom Coalition	David Messina
Florida Power and Light	Eric Schwarz
General Aviation Manufacturers Association (GAMA)	Jens Hennig
Helicopter Association International (HAI)	Chris Martino
Indianapolis Airport Authority	Mario Rodriguez
Insitu	Jeff Decker
Iris Automation	Jon Damush
Latino Pilots Association	Chad Lipsky
L3 Harris	Robert Gettler
Missouri University of Science and Technology	Chen Genda
National Conference of State Legislatures (NCSL)	Ben Husch
National Forum for Black Public Administrators	Marshall Taggart
National Governors Association (NGA)	Chris Kelenske
News Media Coalition	Chuck Tobin
Organization of Black Aerospace Professionals (OBAP)	Cpt. Albert Glenn
SAE International	Judith Ritchie
The Nature Conservancy	Gustavo Lozada
Virginia Tech UAS Test Site	Tombo Jones
Women and Drones	Sharon Rossmark
Verizon/Skyward	Melissa Tye

2. Market Drivers (Working Group 1.2)

Aerospace Industries Association (AIA)	Karina Perez
AirMap	Andreas Lamprecht
Airobotics	Niv Russo
AgEagle	Brandon Torres Declet
Aloft Technologies Inc.	Jon Hegranes
American Association of Airport Executives (AAAE)	Justin Barkowski
Association of Fuel and Petrochemical Manufacturers (AFPM)	Michael Burnside
Association for Unmanned Vehicle Systems International (AUVSI)	Brian Wynne
Choctaw Nation	James Grimsley
City of Reno	Calli Wilsey
CNN	Greg Agvent
Commercial Drone Alliance	Lisa Ellman
Conference of Minority Transportation Officials	Terrence Hicks
Dominion Energy	Nate Robie
DroneUP	John Vernon
Echodyne	Mo Hartney
Edison Electric Institute	Emily Fisher
FedEx	Anne Bechdolt
National Association of Counties (NACo)	Jessica Jennings
National Association of Tower Erectors (NATE)	Bryan Mckernan
National League of Cities (NLC)	Brittney Kohler
NUAIR Test Site	Ken Stewart
Percepto	Neta Gliksman
Phoenix Air	William Lovett
Qualcomm	Drew Van Duren
T-Mobile	Sean Murphy
Woman in Aviation International (WAI)	Allison McKay

3. Regulatory Concerns (Working Group 1.3)

Air Line Pilots Association	Vas Patterson
Alliance for Drone Innovation (ADI)	Jenny Rosenberg
American Association of State Highway and Transportation Officials (AASHTO)	Bob Brock
American Robotics	Vijay Somandepalli
ASTM International	Philip Kenul
Aura Network	Jim Williams
BNSF Railway	Todd Graetz
CTIA	Avonne Bell
Flight Safety Foundation	Deborah Kirkman
Matternet	Jim O'Sullivan
National Air Traffic Controllers Association (NATCA)	Jimmy Smith
National Association of State Aviation Officials (NASAO)	Ben Spain
Northern Plains UAS Test Site	Nick Flom
One Sky	Chris Kucera
Praxis Aerospace Concepts	Jonathan Daniels
Skydio	Jenn Player
State Farm	Todd Binion
University of Alaska Test Site	Cathy Cahill
Vigilant Aerospace	Kraettli Epperson
Wing	Margaret Nagle

Phase I Acronyms

AAM	Advanced Air Mobility
AC	Advisory Circular
AGL	Above Ground Level
ARC	Aviation Rulemaking Committee
B4UFLY	Before you fly
BVLOS	Beyond Visual Line of Sight
CBO	Community Based Organization
CFR	Code of Federal Regulations
CNS	Communications, Navigation and Surveillance
COA	Certificate of Waiver or Authorization
C-UAS	Counter UAS
DOC	Declaration of Compliance
EVLOS	Extended Visual Line of Sight
FIMS	Flight Information Management System
FPV	First Person View
GUTMA	Global UTM Association
IFR	Instrument Flight Rules
LAANC	Low Altitude Authorization and Notification Capability
MNO	Mobile Network Operator
MOC	Means of Compliance
MOSAIC	Modernization of Special Airworthiness Certificates
NAS	National Airspace System
NPRM	Notice of Proposed Rulemaking
OOP	Operations Over People
OST	Office of the Secretary of Transportation
PSP	Partnership for Safety Plan
RID	Remote Identification
RPAS	Remotely Piloted Aircraft System
RPIC	Remote Pilot in Command
SARPs	Standard and Recommended Practices
SDSP	Supplemental Data Service Provider (within a UTM system)
SFRA	Special Flight Rules Area
SGI	Special Government Interest
SMS	Safety Management System
SORA	Specific Operational Risk Assessment
UAM	UAS Air Mobility
UASFM	UAS Facility Map
UPP	UTM Pilot Program
USC	United States Code
U-Space	Uncrewed Space
USS	UAS Service Supplier

UTM	UAS Traffic Management
UVR	UAS Volume Reservation
VFR	Visual Flight Rules
VLOS	Visual Line of Sight