NATIONAL AIR TRANSPORTATION ASSOCIATION

Urban Air Mobility: Considerations for Vertiport Operation

A Note from NATA President Gary Dempsey

As *the* trade association representing the general aviation industry's experts in aircraft ground support, NATA is pleased to chair the newly-formed Urban Air Mobility (UAM) Ground Handling Standards Review working group chartered by the International Business Aviation Council's IS-BAH Standards Board. This paper is merely the initial gap analysis and literature review of existing guidance. I'm excited about the possibility and promise of Urban Air Mobility. After having spent decades in the aviation industry, I believe this is a new frontier that will radically change business and operational models. We are at an interesting time in aviation; while the concept of UAM has been dreamed about since shortly after the Wright brothers first took flight, only now has the confluence of technology, operational expertise, and talent put the concept within reach of reality. It is also a unique opportunity for new companies to partner with legacy aviation service providers, and for both to learn from one another.

Aircraft ground service providers and air charter operators will provide the operations and support that will enable UAM's success. The National Air Transportation Association (NATA) is the singular voice of these companies, who, in turn, empower the Association to serve as the sole, national point of expertise in their core business competencies.

NATA looks forward to working with UAM companies to develop synergistic connections between them and our members.

National Air Transportation Association

NATA is the national association of general aviation service providers, representing over 2,600 businesses including Fixed Base Operators, Part 135 on-demand air charter operators, Part 145 repair stations, and training providers certificated under Parts 141 and 142. NATA's diverse membership serves all aspects of the nation's aviation industry. Since its inception, NATA has advocated on behalf of its members and played a pivotal role in developing and elevating safety standards, operational protocols, and fostering professionalism within the aviation industry. NATA provides training, services, and benefits to our members and represents the business interests of general aviation service companies before policymakers and stakeholders to ensure safety, efficiency, and economic viability of the industry.

NATA has spent years developing an operational culture based on proven safety and security methods to establish the industry standard. NATA's advocacy efforts are member-driven, and the structure of the Association is reflected by our technical committees, which are comprised of our core memberships' lines of business (e.g. aircraft ground services, air charter, aircraft maintenance) and ensures we remain a progressive and proactive association that is able to respond to a changing industry.

Problem Statement

As Urban Air Mobility (UAM) moves from concept to reality, topics such as propulsion, aircraft and operational certification, societal acceptance, noise, and local zoning regulations have dominated stakeholder conversations. Although these issues are indeed some of the most significant challenges, and thus have rightly garnered concomitant attention, other topics like passenger facilitation and aircraft ground support have largely been overlooked. But, as with conventional aviation, UAM will rely heavily on a broad ecosystem of passenger accommodation facilities, skilled personnel, and ground support equipment and services in order to create an efficient system able to realize the full potential of UAM.

UAM providers have correctly identified customer experience as a key spoke of the virtuous flywheel that UAM will require for commercial viability. Customer experience is the successful orchestration of a harmony between good customer service and efficient passenger facilitation that enables seamless arrivals, departures, and ground service connections, and keeps aircraft on schedule. While emerging UAM companies have core expertise in fleet operations and passenger aggregation, a natural synergy exists with legacy aviation service providers that operate brick-and-mortar infrastructure at airports and heliports across the United States.

This paper comprises a gap analysis and tailored literature review of the elements of UAM around which a more collaborative dialogue with UAM stakeholders will help to ensure the success of the emerging UAM industry. NATA stands ready to work with industry partners and UAM companies as the voice of our members, the aviation industry service providers with a history of successfully supporting the most advanced, safest aviation industry in the world.

Urban Air Mobility | *A new opportunity for legacy industry businesses*

DEFINING UAM

Urban Air Mobility (UAM) is an emerging concept that represents a significant paradigm shift for legacy aviation stakeholders. Simply put, UAM is envisioned as on-demand air transportation within core urban areas and residential suburban destinations outside city centers using new, electric-powered, vertical takeoff and landing (eVTOL) aircraft. UAM will also play an important role in rural connectivity. Illustrating the challenges associated with rural mobility, the US Department of Transportation's (DOT) Essential Air Service program (EAS) was established after the Airline Deregulation Act to guarantee small communities adequate access to transportation options by certificated air carriers. eVTOLs have the potential to provide rural-urban connectivity in a more efficient and cost effective way.

The UAM concept relies on the utilization of uncongested, low-altitude airspace, and at the center of UAM's value proposition is improved transportation efficiency (i.e. reduced commuting time and road congestion through a fully integrated shared transportation system that seamlessly integrates surface and air transportation).

While some forms of UAM exist today using conventional helicopters and limited existing heliport infrastructure, they are considerably narrower in scope than the concepts of operations (CONOPS) envisioned by UAM proponents and have historically been varied in their record of safety and economic success. The next generation of UAM will ultimately be an amalgamation of transformative technologies and operational models including various elements of electric propulsion, new and unique passenger aggregation and advertising channels, modification of existing infrastructure, and new aircraft that are already moving from concept to manufacturing. As a testament to the maturity of the technology and the market, many legacy aviation companies have joined well-funded start-ups that are making major investments and commitments to UAM development and deployment. Indeed, UAM

demonstration projects are already underway in Sao Paulo, Dubai, and New Zealand. The federal government has also recognized the potential value of an emerging UAM market and the challenges it may pose for existing regulatory regimes. After conducting two independent market analyses, NASA announced that in 2020 it will sponsor a UAM "grand challenge" to examine system level safety and integration scenarios within a robust and relevant environment.

Currently, most heliports in the U.S. are single-point designs allowing for only one aircraft to land or takeoff at a time without the provision for multiple or simultaneous operations, and that do not allow for parking, let alone providing any services to passengers. These shortcomings will more than likely limit the number of heliports that are available to be retrofitted for eVTOL operations considering the volume of traffic expected. For this reason, there are multiple possible business models that this new eVTOL market has the potential to create or expand upon.

As with other facets of UAM CONOPS, a UAM provider could elect any one of multiple business models for the provision of ground-based services. The UAM provider could itself be the facility owner, which would, if they so elected, provide for that company's exclusive use of the vertiport and thus potential competitive advantages by limiting traffic only to their customers. In another model, the UAM provider may own the facility but lease it to a firm that specializes in passenger facilitation and ground handling. Such an arrangement would enable the UAM provider to control the brand experience while alleviating the day-to-day administrative concerns with the facility's operation. In this kind of lease, the facility manager may seek to accommodate other UAM providers' passengers and aircraft especially in lower-demand markets, but that would, of course, be subject to their contractual arrangement with the facility owner. Possibly the most plausible arrangement would mirror existing airport FBOs, whereby a UAM provider would lease space from an existing infrastructure owner.

Due to the emerging nature of the UAM concept, there exists no single business model, but one could be loosely defined as:

- On-demand: Generally speaking, UAM CONOPS envision on-demand flights, similar to many of today's ridesharing companies. However, UAM providers may seek to explore scheduled Part 135 charter authority in early stages before full scale demand warrants a more fluid flight schedule.
- Vertical Takeoff and Landing: VTOL aircraft will operate in dense urban cores that require a high degree of maneuverability.
- Electric Propulsion: The current hypothesis is that the low noise profile of electric propulsion will promote societal acceptance.
- Value proposition: Ever year, commuters waste millions of hours of productivity stuck in chronic road congestion. Some commuters are likely to pay a premium for early UAM operations, ultimately providing a level of reduction in road congestion and thus serving as an incentive for local policymakers to work with UAM companies.
- Reduced seat-mile cost: Ultimately, the goal of UAM operators is to reduce ride-share air transportation costs to that of ride-share surface transportation costs and seamlessly integrate the two transportation modes.

Gap Analysis & Literature Review | *Reviewing Existing Standards and Regulations*

We premise this review on the assumption that the closest example of existing of infrastructure is that which supports helicopter operations, i.e. heliports and helistops. However, there are a number of obstacles associated with this classification when applied to the future of eVTOL infrastructure. As discussed in more detail in the following paragraphs, FAA's oversight and enforcement authority of private heliports is extremely limited. Thus, while ample guidance on technical subjects such as the engineering and design of a heliport or vertiport exist, that guidance is not compulsory in nature at private facilities. On the other hand, a discussion regarding what underwriters may require is certainly worthwhile and may indeed include adherence to existing federal guidance as a condition of coverage, but that is beyond the scope of this review.

Subject Area	Existing Regulations* / Policy Guidance	Best Practices / Industry Solutions
Passenger Facilitation	**N/A**	**NATA Safety 1ˢᵗ Training Program**
Ground Handling	**FAA Advisory Circulars 00-34A, 00-65A, 150/5210-5D, 150/5210-20A**	**Audit Standard: International Standard for Business Aircraft Handling (IBAC)** **NATA Safety 1ˢᵗ Training Program**
Security	**49 CFR 1550.7, as applicable**	**CrewID® (NATACS)**
Signage, Marking, Lighting	**Advisory Circular 150/5340-1M, 150/5340-30J, 150/5210-5D, 150/5345-53D, 150/5345-12F**	**N/A**
Design and Planning	**Advisory Circular 150/5390-2C**	**AAMS Heliport Risk Assessment Tool and**

		Liability Toolkit. NEMSPA Hospital Helipad Safety.
First Response	**Advisory Circular 150/5200-31C, 150/5210-17C, 150/5220-10E, 150/5210-14B, 150/5210-6D**	**NFPA 418 – Standard for Heliports. GAMA & FAA First Responder Safety at a Small Aircraft or Helicopter Accident**
*In general, FAA Advisory Circular guidance is only compulsory at public-use facilities		

EXISTING STANDARDS AND THE REGULATORY VOID

At present there is no comprehensive canon of policy guidance or regulatory mandates governing vertiport operations; this presents both opportunities and challenges. There are no mandatory design standards, fire codes, building codes or best practices that speak to eVTOL infrastructure and what will be required for a vertiport and its operations to be considered "safe" by an objective standard.

In some cases, this regulatory void may discourage early investment. In the absence of policy guidance, many localities are unwilling to issue the required permitting or licensing for the establishment of sites to support these aircraft.

One of the reasons for this void is the lack of a vehicle that has been flight tested and certified to provide the necessary performance data that the FAA can use as basis for regulatory proceedings or policy guidance. On April 3, 2019, the FAA issued a Request for Information (RFI) to the eVTOL industry to begin this process.[1] The sheer number of eVTOL aircraft currently under development will not only be a challenge for regulators, but also represents a tremendous opportunity to gather performance data. In 2017, the Vertical Flight Society (VFS) began tracking the claims of companies that purport to have eVTOL aircraft and, at last count, estimated a total of 169 different aircraft designs, according to publicly available information.[2]

The existing regulatory void can be beneficial. As discussed in the following section, the vast majority of recognized existing vertiports in the U.S. are privately owned. This allows owners considerable flexibility in their design and operation. Unfortunately, it also provides stakeholders with few options for remedy should oversight or enforcement challenges arise. A particular example of relevance to vertiports is the possibility of new building or tower

---

[1] FAA RFI "Vertical Takeoff and Landing Design", 04/03/2019, Solicitation Contract #33063
https://faaco.faa.gov/index.cfm/announcement/view/33063
[2] Vertical Flight Society eVTOL Aircraft Directory: http://evtol.news/aircraft/

construction in close proximity to a vertiport, or within its approach and departure path. The FAA's obstruction evaluation process will only make a determination whether a proposed structure would encroach onto a flight path, but the determination is not in any way enforceable. While this also applies to public use airports, the lack of any FAA oversight of vertiports leaves operators with no one "in their corner" should such a situation arise.

REVIEW OF U.S. FACILITIES AND TRAFFIC

An analysis of the existing facilities for "conventional" aircraft is in order. The following information is for the United States only. According to the Federal Aviation Administration (FAA) Airport Master Record data base, there are an estimated 19,629 "airports" currently in existence in the United States with the following breakdown by type.[3]

	Airports	Heliports	Seaplane Bases	Ultralight Parks	Gliderports	Balloonports
Publicly-Owned	4,067	664	132	1	2	0
Privately-Owned	8,818	5,112	370	111	33	14
Public-Use	4,811	60	211	3	5	1
Private-Use	8,286	5,809	291	109	30	13

The comparison of Public-Use vs. Private-Use is of particular importance to the discussion of UAM, given this paper's assumption that vertiports are more likely to be operated as private-use facilities.

---

[3] FAA Airport 5010 Data Base: https://www.faa.gov/airports/airport_safety/airportdata_5010/

According to the FAA Airport Master Record data base, the five busiest heliports currently accommodating revenue operations are:

Heliport	Location	Estimated Annual Operations
Downtown Manhattan/ Wall St.	New York, NY	26,807
East 34th St.	New York, NY	17,482
West 30th St.	New York, NY	12,310
Waikoloa	Waikoloa Village, HI	6,000
Ketchidan / Tempsco	Ketchikan, AK	4,500

It is conceivable that the public, acting through their policymakers and elected officials, will not continue to tolerate such a minimal oversight role by the FAA for eVTOL infrastructure when contemplating volumes potentially as great – or greater than – those illustrated above. This is especially true of the often-vocal groups who advocate for traveler safety and consumer protections, and the policymakers who are fond of introducing "passenger rights" legislation, which most commonly extends beyond accommodations at airports to apply to flight delays and cancellations. The applicability of DOT's "unfair and deceptive practices" rules, such as the tarmac delay rule and oversales compensation rule, are generally premised upon whether the operation constitutes a public charter. An examination of how those rules would apply in a UAM operation would be beneficial, but beyond the scope of this paper.

For this reason, there is more than likely justification for a rule change within the FAA to add an additional category to the current public and private standards currently being used. Such an addition may be the adoption of a requirement that a facility used in a "commercial" manner would become subject to the current standards published by either the FAA or International Civil Aviation Authority (ICAO) for public use facilities.[4] Such a policy change

---

[4] ICAO Working Paper STA/10-WP/7, 10th session of the Statistics Division Nov 27, 2009, Review of the Classification and definitions used for civil aviation activities.

would provide regulators with oversight and certification authority for eVTOL and heliport infrastructure, which does not exist for 99% of the heliports in operation today.

CURRENT FAA OVERSIGHT AUTHORITY

The major disparity between public and private-use heliports is due, at least in part, to the fact that the FAA does not and cannot regulate "private" facilities. The FAA makes this clear in its *Heliport Design Guide*, Advisory Circular AC-150/5390-2C on page one.[5]
The advisory circular goes on to say that "…use of this AC is mandatory for all projects funded with federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC)." According to FAA records, the total number of heliports in the U.S. that have received AIP funding between 1996 and 2017 is estimated to be 33. Of those 33 facilities, 32 are collocated on airports of appreciable size, leaving the Indianapolis Downtown Heliport (8A4) in Indianapolis, Indiana as the only standalone heliport in the U.S. to have ever applied for and received AIP funding.[6] Thus, the FAA has unequivocal oversight authority over only one heliport of the nearly 6,000 in existence in the U.S.

Many helicopter operators that conduct commercial flight operations in the U.S. do so under 14 CFR Part 135, Air Carrier and Operator Certification.[7] This is significant because, while the FAA may not prescribe heliport design standards, 14 CFR 135 provides some specifications for landing and takeoff sites. For certificate holders operating under 14 CFR Part 135, guidance is provided in 135.229(a) as to what constitutes proper infrastructure. This section states "no certificate holder may use any airport unless it is adequate for the proposed operation, considering such items as size, surface, obstructions, and lighting." By comparison, operations conducted under 14 CFR Part 121, must ensure that the intended for use are "certified" under 14 CFR Part 139 and that this certification is current.[8] [9] However, the FAA "has determined it is not in the public interest to certificate heliports at this time" and

[5] FAA Heliport Design Guide, Advisory Circular AC-150/5390-2C.
https://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5390_2c.pdf
[6] FAA Airport Improvement Program (AIP) Grant Histories. https://www.faa.gov/airports/aip/grant_histories/
[7] Title 14 CFR 135.299(a)
[8] Title 14 of the Code of Federal Regulations (14 CFR) part 121 air carriers
[9] Title 14, Code of Federal Regulations (CFR), Part 139 (14 CFR Part 139)

has exempted operators of heliports from complying with Part 139 requirements. Nonetheless, by choosing to use the phrase "such items as…" and the term "adequate" in the regulatory text of Part 135, the FAA has allowed for significant latitude to make a determination as to what constitutes safe and operationally compliant infrastructure. Thus, while a vertiport may be operated as a privately owned, private use facility, it is also possible that given a Part 135 UAM operation, the vertiport would be compelled to comply with certain federal standards or guidance that the FAA may use as a benchmark in evaluating the "adequacy" of the facility.

ADDITIONAL OVERSIGHT AND GUIDANCE

The FAA Heliport Design Guide does go on to say that "other federal agencies, states, or other authorities having jurisdiction over the construction of other heliports decide the extent to which these standards apply." Other agencies and jurisdictions, including local governments, can in fact require adherence to the FAA design guide to meet their compliance standards. In some cases, this makes non-mandatory policy guidance like the *Heliport Design Guide* "regulatory" by reference or incorporation.

Many states in the U.S., through legislation or regulation, have determined to what extent the FAA Heliport Design Guide applies and how the FAA guidelines are subsequently enforced in their jurisdiction, ranging from extremely minimal and permissive to highly integrated and restrictive. Having passed legislation on the matter, the Departments of Transportation for states such as Illinois and California are provided full oversight and authority when it comes to any airport within their geographical jurisdiction. The state of Illinois currently classifies heliports and vertiports and published standards that must be met before a mandatory "Certificate of Approval" may be issued to a heliport sponsor or operator in that state.[10] If a state or municipality requires an FAA airspace determination letter to be issued prior to moving forward with approvals for licensing or a conditional use permit, an investor may have to wait 12, 18, or even 24 months. The state of California has similar mandates incumbent on the sponsor of a heliport. Requirements include sound studies, land use compatibility studies, and environmental impact reports, which are all outlined in the

---

[10] State of Illinois, Title 92: Transportation, Chapter I, Department of Transportation, Subchapter b: Aeronautics, Part 14 Aviation Safety.

Caltrans Airport Land Use Planning Handbook.[11] In the state of New York, all sponsors must follow the guidance spelled out by the Department of Transportation but also the New York General Business Law Section 249.[12] This preparation of a request for authorization to the governing municipality includes a requirements to hold public hearings.[13]

One nongovernmental organization whose codes are often adopted by states and local municipalities, both in the U.S. and overseas, is the National Fire Protection Association (NFPA). NFPA-418, Standard for Heliports specifically states in Section 4.2.2 that "the design of the heliport, including all the aeronautical components, shall be in accordance with FAA AC 150/5390-2C, Heliport Design Advisory Circular."[14] Those municipalities who have since adopted these standards as their code have thus made the FAA Heliport Design Guide regulatory in nature and have given the "Authority Having Jurisdiction" (AHJ), in this case the Fire Marshall, full oversight and interpretation authority.

Additionally, other industry associations or independent organizations that must be considered as addressing potential oversight and jurisdiction are those that are affiliated with the International Code Council (e.g. the International Fire Code and the International Building Code). Depending on which codes a municipality has adopted, the interrelationship of some of these standards can be rather confusing, as illustrated here in the following excerpts.

International Fire Code:

- "Helistops and heliports on buildings shall be constructed in accordance with the International Building Code."[15]
- "Before operating helicopters from helistops and heliports, approval shall be obtained from the Federal Aviation Administration."[16]

International Building Code:

- "Rooftop heliports and helistops shall comply with NFPA 418."[17]

---

[11] California Airport Land Use Planning Handbook, State of California Department of Transportation (Caltrans), Division of Aeronautics
[12] New York General Business Law Section 249, Location of privately-owned airports.
[13] New York State Department of Transportation, 2011 Program Guidelines Aviation Capital Grant Program, Office of Integrated Modal Services, Aviation Bureau, August 2011.
[14] National Fire Protection Association (NFPA-418) Standard For Heliports.
[15] International Fire Code (2012) 2007.8
[16] International Fire Code (2012) 2007.8
[17] International Building Code (2012) [F] 412.7

UAM Considerations for the Passenger Interface | *Core competencies from legacy aviation*

STATE OF THE INDUSTRY

The airport Fixed Base Operator industry counts over 3,000 locations across the country's 5,000 general aviation airports. Slightly less than half of FBOs are owned by public entities such as the airport sponsor, local municipality, state, or county. Independent FBOs account for about 1,500 locations. And, there are a small number of "chain" or "network" FBOs that have multiple locations. FBOs offer a myriad of services beyond ground handling and fuel sales. Lines of revenue often include airport management duties, hangar rentals, leasing and sales, ground transportation, concierge services, and maintenance. Given the FBO industry's experience responding to the ebb and flow of general aviation activity (i.e. fuel and aircraft sales), it is highly adept at responding to changing customer preferences and providing excellent customer service with the goal of attracting and retaining repeat business.

PASSENGER FACILITATION

The average helipad in operation today consists of a single Final Approach and Takeoff (FATO) area and Safety Area. Managing passengers within this minimal infrastructure has routinely been accomplished by the pilots. At scale, eVTOL vertiports may consist of multiple landing and parking sites. Coupled with the expected traffic, the volume of expected passengers will require a dedicated and well-trained staff of ground personnel to maintain safety, security, and efficiency.

As envisioned by UAM operators, eVTOLs will use "vertiports" located at key origin and destination hubs. These vertiports may leverage existing infrastructure atop buildings and parking garages, or they may be new-build constructions. Today, a robust industry of airport Fixed Based Operators (FBOs) facilitate the movement of pilots and their passengers. FBOs are commonly fuel vendors, provide ground support for aircraft and crew, sell supplies and services, and, in many cases, serve as a "terminal" for general aviation passengers as they

arrive and wait to depart. There are some important differences between the nature of services today's FBOs provide and those that will be required to enable a functional UAM network.

Uber's seminal whitepaper, "Fast-Forwarding to a Future of On-Demand Urban Air Transportation," speaks to the fundamental business elements of NATA member FBOs:

"We will clearly direct passengers where to go and what to do to embark or disembark on their VTOL journey… On the way to that departure door, we imagine a rapid and seamless process whereby the rider's identity, security checks and even the weighing of the rider and their luggage (if necessary) can all be done… When the VTOL is ready at the takeoff/landing pad, the confirmed rider would be invited into the aircraft area by means of an automatic door, and she would walk the short distance on a marked pathway to the VTOL."

The following sections of this paper will expand upon a number of the elements of this vision that are complex procedural and ergonomic design considerations ripe for collaboration with experienced industry thought leaders:

- "clearly direct passengers"
- "rapid and seamless process"
- "invited into the aircraft area"
- "automatic door, and… marked pathway"

Today's FBOs are experts in facilitating passenger and aircraft movements. They have developed proven methods to safely and efficiently move passengers to and from aircraft in very active ramp environments. NATA member FBOs are uniquely poised to collaborate with UAM stakeholders in developing effective passenger facilitation procedures that will ensure a balance of safe and efficient operations while maximizing passenger throughput.

There are some fundamental differences in the nature of services that today's FBOs provide from those that will be required to enable a functional UAM network. NATA keenly understands that UAM terminals of the future are likely envisioned to be more akin to a

public transportation node than current FBO terminals. These new facilities must be designed to accommodate a greater throughput of passengers and aircraft.

A key source of this difference is because, at scale, a vertiport would likely operate at a higher tempo than most existing FBOs. A vertiport could potentially "turn" more aircraft in a single hour than many FBOs handle in a single day. This corresponds to a higher number of transient people – both crew and passengers – in the facility and demands proper staffing modeling and application to ensure both quality customer service and, more importantly, simple "crowd control." In addition, because of high facility utilization in what is likely to be a confined space, vertiport operators would benefit from ensuring that any wayfinding signage within the passenger facility is familiar and easily recognizable in order to avoid passenger confusion and to enable the organized processing of various passenger groups. The Transportation Research Board's Airport Coöperative Research Program Report (ACRP) number 52 provides wayfinding and signage guidelines for airside and landside airport operations. Additionally, though only mandatory at airports collecting a passenger facility charge or Airport Improvement Grant Recipients, the FAA has incorporated the ACRP's recommendations in its Advisory Circular 150/5360-12F.

Passengers and crew will spend less dwell time at vertiports due to expected optimization models. That means systems upon which flight crews rely (i.e.weather and briefing terminals, dispatch and operational control functions, briefing/debriefing facilities) will need to be automated or optimized for faster transfer of information without the interference of passenger handling. Facilities and operational procedures that effectively segregate crews from passengers will be imperative.

Many FBOs today routinely handle a certain number of "familiar" aircraft. These aircraft may be tenants, based at the airport, or frequent visitors. This provides a modest level of safety and security; the flight crews, and to some extent the passengers, know the details of the facility and the ground crews are familiar with the specifics of the aircraft. In a UAM operation, even in a potentially single-aircraft type operation, such familiarity is unlikely. Solutions such as CrewID® are an elegant and efficient way to validate the identity, training level, and qualifications of personnel. CrewID® also has the ability to act as an access

credential and can incorporate radio-frequency, machine-readable optical labels (QR codes) or magnetic-stripe components.

A simple automatic door and marked pathway may not be sufficient to ensure passenger compliance when they are on the ramp. This paper will discuss the suitability of existing signage, marking, and lighting conventions. However, ensuring effective communication with passengers in an elevated noise environment and, furthermore, ensuring passenger compliance with ground and aircrew instructions are challenges not likely to be solved by access control and visual indicators alone. If passengers are to move about the vertiport surface while aircraft are operating, vertiport operators should consider either intuitive visual or augmented audio communications to convey their instructions. A comparable operational environment was "Gate 35X" at Ronald Reagan Washington National Airport (DCA), which had a series of aircraft hardstands that were not equipped with jet bridge infrastructure. During enplaning and deplaning, the hardstands were adequately staffed to ensure passengers did not wander out of designated areas, and unique visuals, including color-coded footprints painted on the ramp properly grouped passengers moving from the aircraft, to the ramp, to ground transportation.

Vertiports will thus require staffing allocations similar to today's FBOs. Depending on the demand and level of service, some FBOs may cross train staff to perform both safety critical functions on the ramp and customer service duties. Other FBOs have dedicated customer service and concierge staff whose sole responsibility is to ensure a positive customer experience. Separate from the Safety 1st program, NATA has long provided Customer Service training and workshops, working to educate FBO professionals around the country on the expectations of aviation customers and how to attract new and retain repeat clientele.

A vertiport would ideally provide a seamless interface between ground and air transportation systems. Indeed, the cover of Uber's aforementioned whitepaper depicts a vertiport whose landside (where passengers enter and exit cars), and airside (where they enplane or deplane), are separated only by a narrow facility that presumably queues them for departure. These terminals will also provide arrival and departure points for the communities they serve and create a first and last impression of that location. They must

provide an attractive, safe, efficient, comfortable, and familiar transfer of passengers to and from UAM aircraft and various modes of ground transportation. To accomplish this, basic service functions will be required, as well as thoughtfully designed facilities that will assist the passenger to and from air/ground transportation systems. Proper signage, thoughtfully designed access roadways, adequate and convenient parking, safe drop-off and pick-up areas, lighting, walkways, and integrated security systems must all work together to facilitate the safe and orderly flow of passenger activity.

Terminal space and aircraft infrastructure requirements will, of course, vary based on anticipated passenger/aircraft activity and location. UAM terminals in dense urban environments will require more robust infrastructure and operational requirements then those located in suburban/rural environments. An entire FBO-specific industry exists that specializes in planning, programming, designing, and managing general aviation passenger terminals to meet unique location requirements, resulting in higher overall quality, lower life cycle costs, and increased sustainability.

GROUND HANDLING

There are no federal regulations directly related to ground handling procedures or training, and existing FAA guidance on ground handling is of limited utility. However, industry standards do exist. FAA Advisory Circular 00-34A, *Aircraft Ground Handling and Servicing*, provides some fundamental safety advice, but was published in 1974 and contains system specific guidance that will not apply to eVTOL (e.g. fuel system servicing).

The International Standard for Business Aircraft Handling (IS-BAH) is a set of global industry best practices for business aviation ground handlers, which features, at its core, a safety management system (SMS). IS-BAH follows the structure of the widely-implemented International Standard for Business Aircraft Operations (IS-BAO) Program and incorporates the NATA Safety 1st Ground Audit Program. IS-BAH is the global industry standard for handlers and operators around the world to meet the coming SMS requirements from the International Civil Aviation Organization (ICAO). IS-BAH offers Fixed Based Operators (FBOs) and Business Aircraft Handling Agents (BAHAs) a scalable, industry-developed code

of best practice centered around SMS principles adopted by ICAO and other operations-critical industries. These standards and recommended practices are voluntary and may be self-administered, although many of the largest FBO operators in the U.S. are conforming to IS-BAH. Those FBO/BAHAs that are seeking independent recognition of conformity to the IS-BAH can do so via a third-party auditing process, providing an effective way to exceed simple compliance and demonstrate to regulators, customers, and other stakeholders, that they are working actively to control and mitigate risk.

The ramp is a dynamic work environment. Aircraft are taxiing in and out, groups of passengers are often enplaning and deplaning at the same time, and ground service equipment like tugs, start carts, and fuel trucks are moving about. Aircraft are starting their engines or taking on fuel. Every day at FBOs around the country, trained ground handling personnel work in close proximity to aircraft. While aircraft moving about an FBOs ramp may be under their own power, or under tow, the nature of operations at a vertiport will be vastly different. At a vertiport, ground handling personnel will be working around multiple aircraft during various points of the takeoff and landing phase of flight. While many aircraft ground handling principles and ramp safety principles are directly transferrable, a vertiport may in some respects resemble the flight deck of an aircraft carrier.

An aircraft carrier's flight deck has been called "a million accidents waiting to happen."[18] However, for the nearly 1,000 personnel aboard an aircraft carrier that work on the flight deck, a comprehensive set of universal standard procedures and curriculum prescribe the training and behavior of flight deck personnel and mitigate the level of risk associated with such a complex environment.[19][20][21] The U.S. Navy's manuals are worthy of review by vertiport planners and operators during procedural engineering exercises. In addition, they discuss some commonalities in systems that eVTOLs may share with military aircraft: for example, ground handling personnel may need to actuate folding or tilting rotors during the

---

[18] *Supercarrier.* George C. Wilson. Berkley. 1988.
[19] *CV Flight/Hangar Deck NATOPS Manual.* NAVAIR 00-80T-120.
[20] *Aviation Boatswain's Mate H.* NAVEDTRA 14311.
[21] *Air Department Standard Operating Procedures (SOP).* COMNAVAIRFORINST3100.5.

course of securing or repositioning aircraft that are not either running or occupied by flight crew, should OEMs provide external controls for those aircraft functions?

It should also be noted that the FAA is currently in the process of revising AC 00-65A, which discusses the use of towbar and towbarless movement of aircraft. Based on the presumably limited size of vertiports, ground movement – either via taxiing or repositioning with ground service equipment (GSE) – may be necessary and will be contingent upon the eVTOL's landing gear configuration. eVTOL aircraft manufacturers should consult AC 00-65A and subsequent revisions.

SECURITY

At present, the federal agencies have been silent on the need for UAM-specific security regulations. Such a void provides a potential "first mover advantage" for early deployments, that can establish themselves as a benchmark to assist the federal government in developing what will likely become policy guidance of either a recommended or compulsory nature; thus, it is important that early UAM deployments examine how existing general aviation security solutions may best adapt to the UAM environment. Early and earnest commitments to robust security programs may serve as a model for future policy mandates, ultimately lowering potential future compliance costs.

Aviation security experts have long recognized that the most effective security programs are tailored to specific operations. Existing aviation security programs are, as a result, largely risk-based. Because the UAM value proposition depends on on a seamless experience that saves the commuter time, any security regime must be tailored to minimize pre-boarding hassle. As UAM moves from concept to deployment, objective third-party security risk analysis will be involved during design phases, rather than as an afterthought; while it will be possible to design a security framework with low impact to passengers, it is also possible that, if poorly executed, security could become one of the most acute obstacles to deployment. A number of established companies in the aviation sector are already providing assistance with security program design and deployment.

A number of security solutions providers already exist with dedicated resources and demonstrated expertise that are well positioned to adapt existing programs for charter and business operations to UAM operations. NATA Compliance Services assists the industry in administering pre-employment background checks, ID and Known Crewmember badging, TSA repair station and standard operator security programs, and DOT Anti-Drug and Alcohol Misuse Prevention Program management. NATA Compliance Services (NATACS) is the industry leader in aviation security program compliance, and currently offers security solutions for a number of Transportation Security Administration (TSA) programs to include the Twelve -Five Standard Security Program (TFSSP), Private Charter Standard Security Program (PCSSP) and DCA Access Standard Security Program (DASSP). Created in 2002, in part to help the general aviation industry comply with stringent new aircraft and air travel security requirements, NATACS is uniquely positioned to assist UAM operators in navigating a growing regulatory landscape.

Operations that can pose the greatest security risk (e.g. a terrorist attack using an airliner) are subject to the highest levels of security in the form of screening, vetting, passenger control, and operational oversight. To help identify lower risk travelers and therefore allow focused use of limited security resources, programs have evolved, geared toward regular travelers, that provide a means for people who must frequently undergo this high level of security screening to streamline the process. Typically, these fee-based programs like Global Entry and PreCheck involve voluntarily submitting to a government background check followed by an in-person interview to establish, on the part of the government, a level of trust beyond that of the average, largely unknown, traveler.

While such charges and procedures may be appropriately rigorous for scheduled air carriers, they are likely ill-suited for a typical UAM customer. Most smaller operations such as on-demand air charters present a lower risk and thus programs for those operations provide acceptable security with less stringent measures. Nevertheless, there are still requirements for identity verification and screening to ensure that even a few people on a smaller aircraft do not pose an unacceptable security risk. A fundamental tenet of effective security in charter and business aviation is that all occupants of the aircraft are known to the operator and, in fact, frequently have a personal vested interest in ensuring a safe and secure flight. Again,

this is a manifestation of effective risk analysis and developing security programs appropriate for a defined level of security risk. It is assumed that the tasks of identity verification and lower-level security vetting could be easily incorporated into an app-based user interface, possibly integrated with a non-invasive biometric component like an iris scan or facial recognition.

In UAM operations, particularly as envisioned at scale, a spectrum of potential risk exists. Passengers may be well known (for example, as long-term subscribers or frequent users of a service) or completely unknown. If a UAM provider seeks to accommodate both subscribers and "ad hoc" users, different security protocols may be appropriate, each of which could require differentiated passenger facilitation protocols at the vertiport. Existing security programs such as the Twelve-Five Standard Security Program (TFSSP) and the Private Charter Standard Security Program (PCSSP) are examples of tailoring a level of security screening and control to the perceived risk. The TFSSP requires operators to perform fingerprint-based criminal history records checks on crewmembers and to restrict access to the flight deck. Under the current regulations, the Twelve-Five Standard Security Program (TFSSP) would apply if the aircraft used exceed 12,500 pounds at Maximum Takeoff Weight (MTOW). Given the limited range, aircraft weight, and small payloads anticipated in UAM aircraft, the security risk is reduced. There is no mandatory security program required for aircraft below the TFSSP threshold.

The PCSSP adds requirements for passenger and baggage screening using x-ray and metal detectors. In the case of those programs, aircraft maximum gross weight and seating capacity is the discriminator. Larger aircraft with more seats ostensibly pose a greater threat should they be commandeered and used as a weapon and are more likely to be carrying passengers who are not well known. Thus, enhanced security requirements are in place for these aircraft in terms of passenger vetting, screening, and notification of the nature of the operations. Operators of aircraft that do not meet the applicability threshold for either program have only the generalized security requirements that must be maintained by every operator.

UAM security programs may need to consider not only the size of the aircraft but also the wide variety of possible geographic areas in which they operate. Some passenger vetting

might be accomplished as a function of a subscription to a UAM service, similar to the way surface ride-share programs today require a user to provide some level of biographical information as a condition of usership.

UAM Ground and Infrastructure Safety Considerations

SAFETY

Whether or not UAM operators fall under existing operational regulatory regimes, such as Part 135, or whether policymakers will need to create new regulations to govern the unique nature of UAM operations, oversight agencies such as the FAA and NTSB will need accurate data to inform future policymaking efforts. As one example, the Aviation Safety Reporting System (ASRS) already exists as a nonpunitive incident disclosure system that generates significant data that can be disaggregated and analyzed to identify trends. ASRS should be reviewed to ensure it will be able to adequately and accurately accommodate UAM-related reports and subsequently disaggregate the data with enough accuracy to be a useful policy tool.

Similarly, the NTSB has identified safety improvements in the Part 135 industry as a "Most Wanted" focus area. The NTSB's Most Wanted list identifies the top safety improvements that can be made across all modes of transportation to prevent accidents, minimize injuries, and save lives. While the NTSB does not have the authority to promulgate regulation, the Most Wanted List identifies relevant problems that policymakers and regulators need to address to effect key safety improvements.

A number of other considerations including signage, marking, lighting, emergency response, and vertiport design and planning are all topics of expertise among NATA's members. Selected consideration of each are included below.

SIGNAGE, MARKING, AND LIGHTING

FAA policy requires that visual aids associated with facilities in the National Airspace System (NAS) have a specific configuration for both primary and backup electrical power. The intended scope of flight operations, as it pertains to visual and/or instrument meteorological conditions and time of day, will largely guide certain decisions about signage, marking, and lighting. It will be incumbent on vertiport operators to determine, based on the type of approach and surface visual aids, whether alternate or emergency power units will be necessary, and more importantly, whether the vertiport will need a dedicated power unit for this purpose, or whether the vertiport's host infrastructure's (if not a stand-alone vertiport) power configuration is adequate.

As previously mentioned, it is possible that, at scale, the airside operation of a vertiport may more closely resemble the flight deck of an aircraft carrier. While the signage, marking, and lighting used at airports is designed primarily for use by operators of moving aircraft and ground vehicles, aircraft carriers have their own unique visual aids on the flight deck that are not only used by the pilots of aircraft, but also by the flight deck personnel as a reference for locating equipment, identifying areas for safety concerns, and indicating the status of operations.[22] Thus, a suggested topic of inquiry is whether or not vertiports will need a new marking and lighting convention that is of a hybrid-use for both ground personnel and landing and departing aircraft. Such a system could be dynamic in nature, that is to say similar to the runway status light system that the FAA began researching and deploying in the early 2000s. That system uses automated, surveillance-driven lights embedded in key pavement markings to indicate to pilots whether it is safe to cross hold short markings and whether the runway is clear of obstructions for takeoff. It is conceivable that the surveillance hardware and software that operate the lights could be adapted to vertiport configurations to advise both pilots and ground crews of the condition of the final approach and takeoff (FATO) area, and possibly to provide some degree of voiceless communication of clearances or instructions. This type of dynamic visual indicator could be operated by properly trained ground support personnel to convey takeoff or landing clearances and would enhance efficiency by reducing radio frequency congestion. It would, however, require specialized

---

[22] *Aviation Boatswain's Mate H.* NAVEDTRA 14311.

training separate and apart from ramp safety and aircraft service. Given a private use facility, manual operation of this type of dynamic visual indicator may not require full FAA-certification for air traffic controllers.

The existing airport signage, marking, and lighting convention is totally unfamiliar to passengers, and thus cannot be relied upon to ensure passenger compliance. In addition, in low light operations, lighted pathways intended to direct passengers to their aircraft may interfere with other safety-critical indications. In the case that vertiport designers explore the creation a hybrid-use signage, marking, and lighting convention, it is worth considering a fusion of the guidance of ACRP Report 52 and Advisory Circular 150/5360-12F, so that everyone moving about the vertiport surface – including passengers – can intuitively ascertain safe/unsafe areas, the status of landing or departing aircraft, and directional guidance.

An additional lighting-related consideration for vertiport operators and pilots, though not pertaining to physical vertiport design, is the recommended aircraft lighting configuration during takeoff and landing. 14 CFR 91.209 specifies the operation of an aircraft's lights, but due to a presumably small physical area at a vertiport and the potential of temporarily blinding ground crew and passengers, aircraft lights should be operated in a way that maximizes visibility of the FATO and enables safe enplaning/deplaning of passengers without dazzling or blinding persons on the vertiport surface.

Notably, the FAA's Airport Lighting Equipment Certification Program (ALECP), outlined in AC 150/5345-53, allows FAA-approved third-party certifiers to evaluate and certify airport lighting equipment and license suppliers to mark products that meet FAA specifications. Suppliers are not required to participate in this program. However, similar to this paper's earlier observations about the nature of FAA Advisory Circular guidance, in order to qualify for federal grant assistance, airport sponsors must purchase equipment certified under the ALECP. It is possible that this program could serve as a model for other vertiport infrastructure components as operators seek to pursue objective, third-party evaluations of the safety of their facility if it is not intended to be a public-use vertiport.

VERTIPORT DESIGN AND PLANNING

This paper assumes that vertiport operators are likely to, at least initially, elect to operate their vertiports as private facilities. It further assumes, based on Uber's CONOPS, that at scale, eVTOL journeys will more often originate from, and terminate at, vertiports rather than at airports. So, if vertiports are to be private facilities without extensive oversight authority, it is reasonable to assume that operators will seek some degree of objective, third-party evaluation of their vertiport design and operation.

Given the potential volume of operations in conjunction with the overall size, complexity, and number of vertiports envisioned, there is a sound business case for standardized design and construction, especially by firms already specializing in airport design and engineering. Using standardized designs and components will help reduce the time needed for construction, and could help streamline the permitting and application process by building out a set of precedent cases for other states and municipalities to reference when considering permitting requests.

Despite the lack of regulatory oversight authority, investors and underwriters of eVTOL infrastructure, as well as the government jurisdictions where vertiports are to be located, are likely to demand some type of standard be created and adhered to. This could come in the form of a third-party accreditation or audit program, of which there are a few already in existence, including the International Business Aviation Council, which **recently established a working group to review ground handling standards for Urban Air Mobility.**

Based in Montreal, IBAC is a non-profit organization that promotes and manages the industry-leading standards for safety and best practice, including: International Standard for Business Aircraft Operations (IS-BAO) and International Standard for Business Aviation Handling (IS-BAH). As the official observer organization for business aviation at the International Civil Aviation Organization (ICAO), IBAC is a highly influential force in all ICAO forums that affect business aviation.

Airports are already beginning to work on the charging equipment that eVTOLs will need. For example, Los Angeles County Public Works department recently added a Pipistrel SkyCharge station to the Compton/Woodley Airport.[23] While the *FAA Reauthorization Act of 2018* expanded eligibilities for the use of federal funding for certain electrical infrastructure including microgrids, the law limits applicability to only public-use airports, a designation that is not likely to include most UAM vertiports.

These charging systems, however, come with their own challenges. One of the most immediate challenges is the supporting electrical power grid. As the American Society of Civil Engineering observes, most electric transmission and distribution lines were constructed in the 1950s and 1960s with a 50-year life expectancy, and the more than 640,000 miles of high-voltage transmission lines in the lower 48 states' power grids are at full capacity.[24]

Another challenge will be the available parts for constructing sub stations around the country to support the added demand that eVTOL infrastructure will place on the already fragile electrical power grids. A planning concern for the electrical infrastructure necessary to support the eVTOL industry will be the availability and lead time for the components required to build electrical substations that will supply the electricity to the charging stations to support the electrical charging capabilities for landing and takeoff sites. The Electronic Components Industry Association (ECIA) has shown a steady increase in the lead time for components over the past three years.[25] If these various lead times continue to increase, it could cause those looking to invest in the development of eVTOL infrastructure to reconsider due to extended time delays.

In July of 2018, record heat pushed the power grid in California to the limit, with electrical distribution companies asking customers to help prevent an overload by using less electricity at peak times (i.e. 2pm to 9pm).[26] Compensating for this fluctuation in electricity availability

---

[23] Transport Up, The Latest News for Urban Aviation 15 May, 2019: https://transportup.com/headlines-breaking-news/la-county-airport-adds-an-electric-aircraft-charging-stations/

[24] 2017 Infrastructure Report Card. ASCE.

[25] ECIA: https://www.ecianow.org/wp-content/uploads/ECIA_LEAD_TIME_BREAKDOWN_March19.pdf

[26] LA Times: https://www.latimes.com/local/lanow/la-me-ln-heat-wave-southland-20180723-story.html

during the afternoon rush hour for those wanting to commute by eVTOL will impose a surge in demand and challenge to the grid. One feasible answer to this challenge is the integration of large-scale energy storage facilities to compensate for high demand peek draw times. This, however, comes with its own set of challenges, in that accomplishing such a task on a rooftop structure in a densely populated area would mean installing these systems on top of occupied structures, which will invoke numerous fire safety codes that will then need to be appropriately addressed.[27]

The U.S. energy storage market nearly doubled in 2018 and is expected to double again in 2019.[28] According to the National Fire Protraction Association (NFPA) the education and training of first responders on how to react to and effectively deal with these new energy storage systems during emergencies will need to be updated.[29]

EMERGENCY RESPONSE

Operators of Part 139 airports must provide aircraft rescue and firefighting (ARFF) services during air carrier operations that require a Part 139 certificate, although, as this paper has discussed, Part 139 certification is unlikely to be applicable to vertiports. However, whether or not vertiports are sited with existing infrastructure or if they are new construction, they will be subject to local fire codes, which will have significant impacts not only on the facility's design, but also on its fire mitigation equipment and procedures. In addition, existing fire and building codes for heliports do not address high voltage electrical charging systems, electrical storage systems (ESS), or large numbers of onboard aircraft batteries.

The General Aviation Manufacturers Association (GAMA) has worked closely with the FAA to produce a highly informative series of training modules for first responders. This training is intended for use by firefighters, emergency medical services, and police. As the FAA notes, "as small aircraft and helicopters have become more complex, technology has provided systems that have enhanced operational safety. In the event of an accident, many of these

---

[28] Utilitydive.com: https://www.utilitydive.com/news/aps-storage-facility-explosion-raises-questions-about-battery-safety/553540/
[29] Firerescue1.com: https://www.firerescue1.com/fire-products/education/articles/394009018-Eight-firefighters-injured-in-energy-storage-system-explosion-underscoring-the-need-for-ESS-responder-safety-training

systems have presented additional hazards to first responders or any potential rescuer at an aircraft accident scene."

Possibly the most relevant standard for vertiport first response planning is NFPA 418. The National Fire Protection Association (NFPA) is a global, self-funded, nonprofit organization, established in 1896, devoted to eliminating death, injury, and property and economic loss due to fire, electrical, and related hazards. NFPA is widely known as a standard setting body, with a committee-drive process accredited through American National Standards Institute. NFPA standard 418 specifies the minimum requirements for fire protection for heliports and rooftop hangars.

A number of FAA Advisory Circulars address topics are applicable to vertiport emergency response, but may not speak to certain unique elements of eVTOL operations. For example, AC 150/5210-6D, *Aircraft Fire Extinguishing Agents,* likely does not adequately address proper agents or procedures to be used in combatting an electric or hybrid VTOL motor or battery fire. NFPA has developed a course on electric/hybrid vehicle emergency response, but it was issued in 2013, and considerable progress has been made in battery technology, namely energy density, since that time. Likewise, while AC 150/5210-14B, *Aircraft Rescue and Fire Fighting Equipment, Tools, and Clothing,* incorporated an NFPA standard by reference, first responders may have limited options in terms of stand-off distances in the initial response stages, and it is unclear whether existing personal protective equipment is suited for first response to an eVTOL fire at a vertiport.

Additional Observations

AIRCRAFT MAINTENANCE, REPAIR, AND OVERHAUL

Under existing regulations, the operator is responsible for the airworthiness of the aircraft. Though the term "airworthy" is not defined explicitly in code or in statute, it generally means using properly trained and certificated technicians to maintain the aircraft in accordance with the manufacturer's maintenance program and on any applicable federally mandated inspection cycle. The FAA currently has no plans to address maintenance technician certification and training for the emerging eVTOL category and class of aircraft. However, Congress and the FAA have recently contemplated changes to the repairman certificate. One option the FAA is considering is the use of repairmen instead of Airframe and Powerplant (A&P) mechanics. Under part 135, a repairman can only work under §135.411(a)(2)[30], which requires a maintenance program and other processes and systems similar to those at a part 121 operator. That will mean a more onerous process, yet the FAA is also studying the possibility of exempting autonomous aircraft from some of the other requirements under §135.411(a)(2).

These proposals are well within the capability of traditional Maintenance, Repair, and Overhaul (MRO) facilities, which support both heavy and routine maintenance for conventional aircraft with trained and qualified personnel. Many sophisticated MROs provide a mobile maintenance service and are authorized by the FAA to perform maintenance away from a fixed location. UAM will need to leverage the work-away model, and depending on the size of the eVTOL, it may be that the aircraft will not always need to be in a hanger, the way maintenance is generally performed today. Aircraft with higher levels of autonomy may have the ability to perform continuous reliability analysis, track and schedule routine maintenance, as well as non-routine maintenance items with the remote assistance of the operator's maintenance technicians. This can optimize routine support activity and may increase the flexibility of maintenance worksites.

---

[30] Aircraft that are type-certificated for a passenger seating configuration, excluding any pilot seat, of ten seats or more, are maintained under a maintenance program in §§135.415, 135.417, 135.423 through 135.443.

Future vertiports may be unique in their limited accessibility. Major aircraft components are often cumbersome to transport. Thus, elevated vertiports may pose challenges for maintenance accessibility. There are certainly conceivable scenarios wherein repositioning a disabled aircraft may be impossible if the nature of the malfunctioning equipment either renders the aircraft incapable of flight, or ineligible for a ferry permit. As UAM providers and vertiport operators consider siting, they will want to carefully consider whether the host infrastructure will accommodate the movement of major components in and out of the structure.

PART 135 SAFETY DATA COLLECTION AND REPORTING

Due to the diversity of Part 135 aircraft and operations, regulatory mandates must be scale-able and provide appropriate flexibility. Airline safety programs, like Flight Operations Quality Assurance (FOQA), are dependent on large volumes of data generated by their hundreds of similar aircraft and thousands of pilots. The Part 135 industry is already leading efforts, like those detailed below, to realize the safety benefits of such programs, but that are scaled for this industry.

While scheduled airlines' mandatory FOQA programs are supported by onboard aircraft hardware and sophisticated modeling software, this is impractical for nearly all Part 135 operators. Their relatively small size – in terms of the number of aircraft and types - is one of the biggest hurdles to implementing safety programs that are successful at airlines. In addition, scheduled airlines own the aircraft they operate, while Part 135 operators may only manage and operate an aircraft for its owner. Therefore, the installation of additional hardware such as cockpit recorders is likely to represent a prohibitive cost of compliance leading owners to remove their aircraft from Part 135 service.

The Part 135 industry has undertaken several initiatives that go above and beyond current statutory safety mandates. First, any 135 operator conducting international operations in EASA territories is required to have a safety management system (SMS) program, and as a result, many in the industry have simply adopted it as a best practice. In addition, the Air

Carrier and Contract Training Workgroup under the Air Carrier Training Aviation Rulemaking Committee (ARC) recommended that the FAA implement a Standardized Curriculum concept where the initial training on each aircraft type would be approved at a national level. Pilots of participating carriers will receive standardized training providing a data feedback loop on the effectiveness of the training. NATA also formed the Air Charter Safety Foundation, which operates an Aviation Safety Action Program (ASAP) now used by over 130 operators. ASAP fosters a voluntary, cooperative, non-punitive environment for the open reporting of flight safety concerns. When an employee of a participating operator submits a report to ASAP, the report is processed and reviewed by an event review committee (ERC), which decides on the appropriate course of action in response to the event. The ERC is comprised of an FAA representative, a company management representative, and a representative from the participating employee group.

UNIQUE CONSIDERATIONS FOR UAM PART 135 CONSIDERATION

Given early modeling of aircraft and services, this paper assumes new entrants intend:

- Aircraft typically under a 12,500 lbs MTOW
- Capacities of 4-6 passengers
- Operated point-to-point

Compliant operation of the aircraft must be the top priority.

Engaging in a comprehensive rulemaking effort to establish a new regulatory "part" for UAM would likely be a years-long proceeding that is largely unnecessary, at least in the initial development of the industry. Given the general parameters of UAM CONOPS, Part 135 operational authority is the best fit. Bringing UAMs into the existing ecosystem, with appropriate exemptions/exceptions as needed, is a faster path. NATA's members have substantial expertise in each of these areas. Each option has pros and cons for the UAM provider and certificate holder that should be well understood prior to choosing a path. UAMs would have several options for Part 135 compliance:

- UAM provider obtains its own operational certificate from FAA
  - New certification
  - Obtain existing business holding certificate

- UAM provider obtains the aircraft and provides them to a certificate holder (i.e. traditional aircraft management and membership groups)
- UAM provider does not own or operate the aircraft but acts as a broker/aggregator connecting passengers with carriers. (This currently requires no certification from FAA/DOT)
- By using a Part 380 model, the UAM provider could contract for flights on a specific schedule and then resell them to the public. Flights could still be operated under Part 135.

However, there are limitations that must be observed to ensure operations remain "on-demand" and do not cross into prohibited scheduled operations which would require Part 135 commuter or Part 121 scheduled carrier authority. In some instances, if the aircraft are eligible[31], Part 135 commuter authority may be preferable as it permits operating an unlimited number of flights on a schedule.

Additional considerations pertaining to FAA oversight:

- Scheduled vs. on-demand. Operations must be structured to prevent unintentional scheduled service unless commuter authority is obtained. When pooling unrelated parties into a group for a shared flight, the sequence of events is essential to prevent a violation.
- Procedural issues
    - Adding aircraft, pilots to the certificate
    - Maintenance manuals and controls
    - Pilot training programs
- HAZMAT programs
- Drug/Alcohol Testing
    - DOT economic authority is required
    - Minimum insurance requirements
    - Public Charter and Broker Rules
    - Air Carrier Access Act

---

[31] To be eligible for Part 135 commuter authority, the aircraft may not be turbo-jet powered. All turbo-jet powered aircraft operated on a schedule must meet Part 121 requirements. See *14 CFR 110.2*

Thank You

NATA wishes to extend our gratitude to the following individuals and entities for their insight and contributions:

- Aviation Management Consulting Group
- Chris Baum – President (Charlie Bravo AeroSafety, LLC)
- Rex Alexander and Five-Alpha LLC
- Carol Giles – President (Giles Group)
- Jacqueline Rosser – Owner (Jacqueline Rosser Consulting)
- Mike France – Managing Director of Safety & Training (National Air Transportation Association)
- National Air Transportation Association Compliance Services
- Dr. Benjamin Goodheart and Magpie Human Safety Systems