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UAS Air Carrier Operations Survey: Crew and Staffing Requirements

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16. Abstract

There is an increasing demand to utilize unmanned aircraft systems (UAS) for an array of new applications currently outside the scope of written regulation, including taxi services, package delivery, crop dusting, and more. Current regulations (i.e., 14 C.F.R. § 107) are restrictive to air carrier applications for UAS. In particular, small UAS (sUAS) regulations (14 C.F.R. § 107) do not explicitly address air carrier operations (codified under 14 C.F.R. § 121 and § 135). Crew and staffing requirements have not been researched extensively in unmanned operations, but recent and continuing developments in UAS applications and UAS automation have resulted in changing roles and responsibilities for crewmembers. The efforts of this survey will help inform future regulations from last-mile to high-altitude-long-endurance operations so that these novel applications of UAS can be integrated safely into the National Airspace System (NAS). An annotated bibliography was performed to synthesize crew and staffing literature and a survey of experts in industry and academia was conducted to gather insights about current and future policies from their companies. Findings will inform future regulations concerning UAS operators in air carrier operations. Standardizing UAS operator crew and staffing requirements will support the safe and efficient integration of UAS into the NAS, and this remains an important initiative for the FAA and industry stakeholders.

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List of Abbreviations

ARC	Aviation Rulemaking Committee
BVLOS	Beyond Visual Line of Sight
CAMI	Civil Aerospace Medical Institute
C.F.R.	Code of Federal Regulations
CS	Control Station
FAA	Federal Aviation Administration
IRB	Institutional Review Board
KSAs	Knowledge, Skills, and Abilities
NAS	National Airspace System
OMB	Office of Management and Budget
PIC	Pilot-in-Command
PSU	Provider of Services for UAS
RPA	Remotely Piloted Aircraft
RPIC	Remote Pilot-in-Command
SME	Subject Matter Expert
sUAS	Small Unmanned Aircraft System
UAS	Unmanned Aircraft System
USS	UAS Service Supplier
VO	Visual Observer

Abstract

There is an increasing demand to utilize unmanned aircraft systems (UAS) for an array of new applications currently outside the scope of written regulation, including taxi services, package delivery, crop dusting, and more. Current regulations (i.e., 14 C.F.R. § 107) are restrictive to air carrier applications for UAS. In particular, small UAS (sUAS) regulations (14 C.F.R. § 107) do not explicitly address air carrier operations (codified under 14 C.F.R. § 121 and § 135). Crew and staffing requirements have not been researched extensively in unmanned operations, but recent and continuing developments in UAS applications and UAS automation have resulted in changing roles and responsibilities for crewmembers. The efforts of this survey will help inform future regulations from last-mile to high-altitude-long-endurance operations so that these novel applications of UAS can be integrated safely into the National Airspace System (NAS). An annotated bibliography was performed to synthesize crew and staffing literature and a survey of experts in industry and academia was conducted to gather insights about current and future policies from their companies. Findings will inform future regulations concerning UAS operators in air carrier operations. Standardizing UAS operator crew and staffing requirements will support the safe and efficient integration of UAS into the NAS, and this remains an important initiative for the FAA and industry stakeholders.

Keywords: unmanned aircraft systems, crew requirements, air carrier operations, duty and rest requirements, training, testing, knowledge

Introduction

As the use of Unmanned Aircraft Systems (UAS) continues to expand, the complexity of flight operations is approaching those that are now performed only with onboard-personnel aircraft operations. These operations, which involve the transportation of cargo and people within the National Airspace System (NAS) are referred to by the Federal Aviation Administration (FAA) as Air Carrier Operations. The FAA is working to standardize UAS regulations for air carrier operations.

Currently, neither air carrier (14 C.F.R. § 121) nor commuter air (14 C.F.R. § 135) regulations adequately address remotely-piloted aircraft (RPA) flight operations. Crew and staffing requirements are affected by control station and operational requirements that differ from onboard aircraft flight deck operations. These differences lead potentially to differences in requirements regarding knowledge, skills, and abilities for RPA operations, which affects training requirements for crew and staff positions. In addition, changes in operational tempo, and differences in the accessibility and locations of ground-based control systems potentially leads to different requirements regarding duty time and other fatigue-related questions. Although the establishment of 14 C.F.R. § 107 provides regulations for small commercial RPA operations, the regulations do not address systems that weigh over 55 pounds, and they do not address the more complex types of operations expected for air carrier activities.

To begin addressing the expected need to establish new sets of standards for safe RPA air carrier-like operations, a research program was initiated that began with conducting four separate research literature reviews organized by topic:

- Knowledge, skills and abilities (KSAs; Torrence et al., 2020).
- Crew and staffing options (Hu et al., 2022).
- Duty time, shiftwork, and fatigue (Durham et al., 2021; Nesthus et al., 2021).

For the second phase of this research program, a survey based on some of the findings from the literature reviews was created to gather information from subject matter experts (SMEs) who were involved in either the manufacture and/or operation of remotely piloted aircraft, or were involved in educating personnel for participation in the manufacture and/or operation of remotely piloted aircraft. This report is a summary of findings from the survey relevant to crew and staffing criteria. Separate reports summarizing other findings from the survey not covered in this report are in development.

UAS Air Carrier-like Operations Crew and Staffing Issues

There is little distinction between “crew” and “staffing” requirements in the literature. For the purpose of this report, crew requirements refer to individual roles necessary for a successful UAS operation (e.g., pilot-in-command, launch and recovery specialist, sensor operator). Staffing requirements refer to the total number of personnel used during an operation,

including potentially multiple personnel at particular crew positions. Because the literature does not clearly delineate between crew and staffing, among other reasons, we find widely variable estimates for crew/staffing requirements. For example, Matos et al. (2015) suggest that most UAS operations require a crew of 7; however, Norton (2016) states that UAS operations crew size can range from 14 to over 30 members, depending on the UAS and the mission. Other reasons for widely variable estimates of crew/staffing requirements include large differences in the types of operations being performed, the number and type of aircraft involved in the operations, the level of automation present within the system, and the length and/or tempo of the operations. In the review of crew and staffing research by Hu et al. (2022), a number of crew positions were identified, as shown in Table 1.

Table 1

Potential UAS Crew Positions

Crew Position	Notes
Remote Pilot in Command (RPIC)	
Remote Pilot	Pilot position that potentially does not require the same level of certification as RPIC.
Mission Commander	Could be similar to RPIC or Remote Flight Operations Supervisor.[1]
Flight Director	Responsible for overall safety and airspace regulations.
Visual Observer (VO)	
Maintenance Technician	
Airframe and Powerplant Technician	
Ground Control Station Operator/Control Station Technician	This position is similar to Flight Engineer in manned flight decks.
Command and Control Operator	
Mission Planner	For Global Hawk or other highly automated systems.
Communications Operator	Responsible for maintaining satellite communications link during the flight.
UAS Service Supplier (USS)	Traffic deconfliction for cargo operations.
Provider of Services for UAS (PSU)	Advanced Air Mobility deconfliction.
Launch/Recovery Specialist	
Client Operator	
Software Specialist	
Sensor/Payload Operator	
Sensor/Payload Reporter	

[1] As defined in Beyond Visual Line of Sight (BVLOS) Aviation Rulemaking Committee (ARC; 2022).

Crew Position	Notes
Imagery Analyst	
Intelligence Analyst	
Flight Dispatcher	
Driver	For mobile ground control station
Lead Meteorologist	This is a position unique to a particular operation, which in this case is storm chasing. It would be similar to Intelligence Analyst in a military operation
Artificial Intelligence	

Note. *Table is reproduced from Hu et al. (2022).*

Several observations can be made from the entries in this table.

1. Several of these positions are likely different names for the same position. For example, maintenance technician and airframe/powerplant technician probably refers to the same activity, although it is possible they could be nuanced differently given sufficient time.

2. Some of these positions are transient. A launch/recovery specialist for example would likely perform other activities as well, given their availability during the rest of the operation.

3. While most of the positions are relevant during the flight, a few of them (Airframe and Powerplant Technician, Mission Planner) would only be required before or after the actual flight, except perhaps for operations involving multiple aircraft.

4. There is an interesting parallel between some of these positions and flight crews in older model airline aircraft. For these older aircraft, international flights could involve up to 5 crew positions. These were pilot, copilot, flight engineer, navigator, and radio operator. Three of these positions, pilot, flight engineer, and radio operator, have strong parallels to UAS crew positions found in the literature. In particular, the pilot-in-command (PIC), control station (CS) operator/technician, and communications operator are aligned closely with these positions. However, while current airline operations do not use a flight engineer or radio operator on their flight decks anymore, there is still a need in many UAS operations for the ground station operator/technician and communications operator. It seems probable that advancements in automation will remove the need for a communications operator for those systems using one currently.

5. One rarely considered aspect of the control station technician position is that having the control station accessible to maintenance personnel during the flight provides the potential opportunity to perform maintenance on the control station during a flight. This is much different from maintenance work conducted on manned aircraft, which would be conducted only when the aircraft is not currently being flown. Consideration should be

given as to how such maintenance would be conducted and certified. One possibility is that only specific types of maintenance would be allowed and that the maintenance would require more than one person to perform and oversee to ensure effectiveness of the maintenance.

6. The remote pilot position does not necessarily require the same level of training and certification as an RPIC. This possibility exists because of the potential for a level of automation in the system that renders most of the piloting responsibilities to the automation, without the need (or perhaps ability) for human intervention.
7. Several of the crew positions are unique to a particular operation. Lead meteorologist, for example, applies only to a storm chasing operation, and Intelligence Analyst applies to military operations. Having crew positions unique to specific types of operations speaks to the fact that most remotely piloted aircraft are created with specific operations in mind. One question that arises from these types of crew positions is whether or not there should be training and/or certification requirements for these positions.
8. Thinking ahead to air carrier-like operations, there are some obvious crew positions missing from the literature at this point. Examples of two of these are Load Master for cargo operations and Flight Attendant for passenger operations. The Flight Attendant position for these operations would be focused almost solely on ensuring the safety of the passengers, not serving drinks and snacks.
9. The last entry in the table is an acknowledgment of research being conducted into having an artificial intelligence acting as a crewmember (e.g., Swieringa et al., 2019). Swieringa et al. incorporated a voice recognition system that could alert air traffic controllers of maneuvers and be able to respond to aircraft traffic controller commands during lost link events. It is expected that certification of such systems would be required before they would be allowed to operate in the NAS.

Purpose

We gathered information regarding the current state of UAS operations considered relevant to air carrier flight activities. Specifically, we wanted to poll a variety of people involved in either commercial UAS activities or instructors focusing on training personnel for careers in commercial UAS activities. We were interested in gathering information from people engaged in different aspects of commercial UAS activities across a spectrum of responsibilities, from frontline workers to high-level managers to educators.

Methods

Stratification and Sample Selection

Because the questions in the survey asked about UAS air carrier operations that are still new, the strategy employed here was to cast a "wide net" of individual experience/knowledge and to probe as many variable viewpoints regarding UAS operations (including UAS air carrier operations) as possible. All participants were required to meet three eligibility questions before providing survey responses: 1) Must be affiliated with an operation that operates or plans to operate commercial UAS operations *OR* be affiliated with a UAS training or educational institution, 2) Must be affiliated with an organization that has established qualification requirements *OR* an affiliation with an organization that develops training requirements/provides training, 3) For those affiliated with an organization that operates or plans to operate commercial UAS operation, the organization must employ two or more UAS operators/pilots.

Potential participant names and email addresses were gathered from a variety of sources. The sample consisted of names compiled from publicly available dockets on the Federal Register (which identifies corporations who received blanket waivers from 14 C.F.R. § 107), the FAA's publicly-available *Part 107 Waivers Issued* website[2] (which identifies individuals who have been granted waivers from 14 C.F.R. § 107, thus known to be involved in commercial UAS activities), Google searches, and names provided by the research sponsors and contractors. To accommodate electronic distribution, only those individuals with email addresses on file were included in the initial sample list. Participants were also encouraged to share the survey link with their colleagues who were not included on the initial sample list (i.e., snowball sampling). Table 2 presents the different types of participants that were targeted for the survey along with our original goal for the number of participants of each type.

Table 2

Participant Recruitment Targets

Participant Category	Target
Small UAS (sUAS) Pilot/Operator (<55 lbs.)	40
Large UAS Pilot/Operator (≥55 lbs.)	40
UAS Cargo/Sensor Operator	40
Supervisor/Manager	40
UAS Instructor	40
Engineer	10
Other Crewmembers	10
Total	***220***

[2] https://www.faa.gov/uas/commercial_operators/part_107_waivers/waivers_issued/

For the purposes of estimation, a statistical power analysis suggested that 40 participants per group would result in a power of 0.8,[3] providing a statistically representative sample of the population.[4] The additional groups of engineers and other crewmembers were included to provide additional assurance of generalizability. These included primarily the list of certified remote pilots operating under 14 C.F.R. § 107 rules for small commercial UAS, as well as specific companies and educational institutions that were known to be involved in commercial UAS activities whose contact information was either available on the internet or through FAA contacts.[5]

Survey Items

Development of the survey questions began by identifying critical areas that needed to be covered by the questions. Besides demographic information, the literature review identified a need to cover several factors related to both current and future UAS operations that could be related to air carrier-like activities. These factors include crew and staffing requirements, knowledge, skills, and abilities requirements, duty and shift requirements, and training and certification requirements. Table 3 provides a listing of the sections included in the survey that concern crew and staffing.

Table 3

Main Survey Sections

Air Cargo	Instructor, Training
Air Carrier/Unmanned	Abilities
Crew & Staffing	Skills
Crew & Staffing, Fatigue	Organization
Crew & Staffing, Fatigue, Scheduling	Respondent Population
Crew & Staffing, Selection	Training
Crew & Staffing, Workload	Training, Certification
Fatigue & Fitness For Duty	Training, Not Required
Fatigue & Fitness For Duty, Reporting	Training, Required
Fatigue, Naps & Breaks	Training, Required, Recurrent
Instructor, Qualifications	UAS Equipment

The survey was constructed so that not every participant received the same set of questions. Because the survey was administered electronically, branching points were incorporated that would route the participant to the set of questions appropriate for their

[3] G*Power software, http://www.gpower.hhu.de/

[4] The recruitment targets were reviewed and approved by the Bureau of Transportation Statistics (BTS) as part of the Office of Management and Budget's (OMB) approval process.

[5] The recruitment targets were reviewed and approved by the Bureau of Transportation Statistics (BTS) as part of the Office of Management and Budget's (OMB) approval process.

particular areas of expertise, meaning the number of respondents per question may vary. Appendix A contains a listing of the questions relevant to the crew and staffing portion of the survey.

The survey was reviewed by a group of experienced FAA researchers and sponsors for clarity of instructions and technical details. Further, the Civil Aerospace Medical Institute's (CAMI) Institutional Review Board (IRB) and the OMB (Control No. 2120-0803) reviewed and approved the survey and methodology. In addition, beta testing was conducted within the research team and with SMEs to evaluate the quality of the survey. Feedback from the beta testing was discussed, incorporated, and approved by all vested parties.

Survey Administration

Upon clicking on the Qualtrics link, participants received the informed consent notice[6], which provided an overview of the study, its voluntary nature and ability to opt-out, informs them about the purposes of the study, and how FAA would use the results. All participants received the informed consent, and were required to provide their consent before continuing with the survey.

The survey consisted of approximately 147 questions; the exact number of questions varied because question items were customized to the participant's job role and experience (asked at the beginning of the survey). Survey respondents were compensated via a $50 mailed check for their time spent in participation.

Results

The survey was active for 90 days, at which time recruitment did not reach the 220-respondent target limit. Table 4 provides the final participant counts.

Table 4

Final Participant Recruitment

Participant Category	Target Recruitment	Final Recruitment	Job Role (%)
Small UAS Pilot/Operator (<55 lbs.)	40	51	29.5
Large UAS Pilot/Operator (≥55 lbs.)	40	14	8.1
UAS Cargo/Sensor Operator	40	4	2.3
Supervisor/Manager	40	45	26.0
UAS Instructor	40	41	23.7
Engineer	10	5	2.9

[6] An Informed Consent notice is a legal and ethical requirement for research involving human participants.

Other Crewmembers	10	13	7.5
Total	***220***	***173***	***100.0***

Eligibility

Survey respondents who met the eligibility requirements (n = 173) included 131 (75.7%) who reported being affiliated with an organization that operates or plans to operate commercial UAS operations with 42 (24.3 %) of those reporting being affiliated with a training or educational organization (Figure 1). Of the 173 total respondents, 107 (61.8%) reported working with an organization with established qualification requirements, while 66 (38.2 %) reported being affiliated with an organization that develops pilot requirements or provide training (Figure 1). Participants who responded they work with an organization who operates or plans to operate commercial UAS operations, to be considered as a respondent the organization had to employ two or more operators; Figure 2 provides the number of operators employed by each organization.

Figure 1

Respondents Who Work with an Organization that Operates/Plans to Operate UAS; Organizations that Have Established Pilot Qualifications (n = 173)

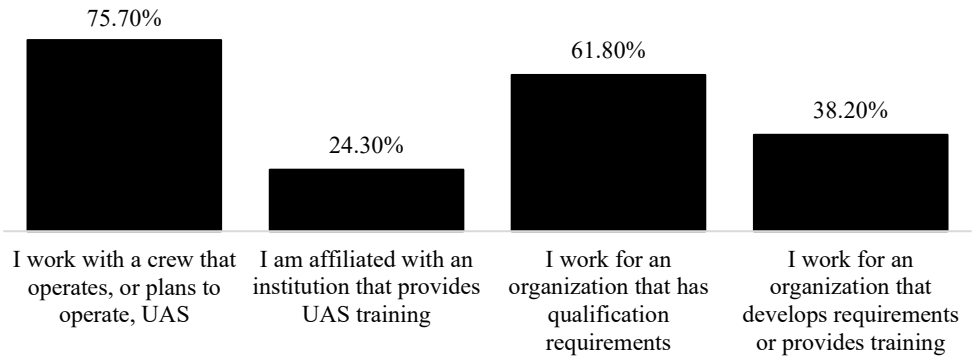
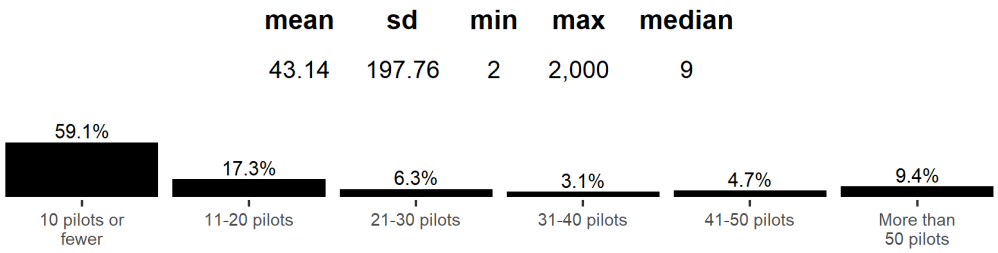


Figure 2

Number of Pilots Employed by Each Organization (n = 127)



Demographics

Survey respondents were sampled from various job roles (Figure 3) and reported an average of 7.01 (*SD* = 5.58) years of experience in their current job role (Figure 4). Table 4 and Table 5 shows the respondents' operational sector (i.e., drone service operator, school/training program, other work with drones, manufacturer. Respondents were asked to mark all that apply and those who indicated that they worked with drones but not within one of the listed sector types were asked to describe in what capacity their organization worked with drones. Text responses to that question are available in Appendix B (Table 14). Ninety-four percent of respondents held a current license or certification to fly a UAS, Table 7 provides a list of the license or certifications held by respondents. In addition to responding to the question regarding their current job role, participants also were asked to describe their role. Of the 173 survey participants, 166 provided a description of their job responsibilities; see Appendix B, Table 11.

Figure 3

Respondents' Current Primary Job Role (n = 173)[7]

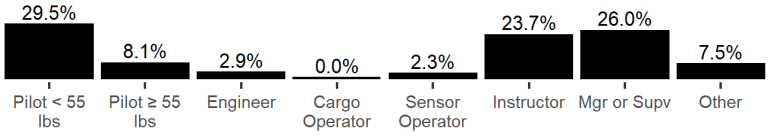
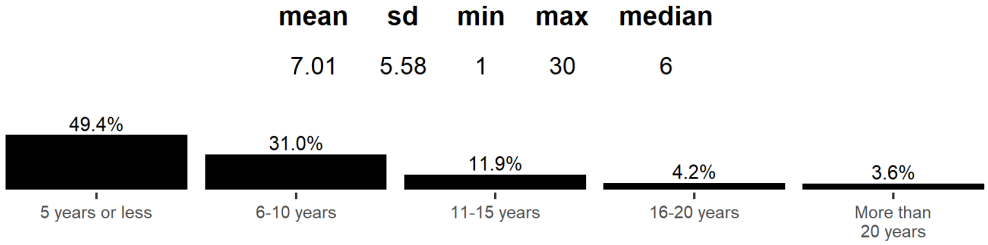


Figure 4

Years of Experience in Current Job Role (n = 168)



[7] Results include only respondents who indicated 'I work with an organization that operates or plans to operate UAS' or are 'affiliated with an educational institution' (See Appendix A, Section A: Demographics); for written responses for those who indicated 'Other', see Appendix B, Section A: Demographics (Item A1a).

Table 5

Commercial UAS Sector that Best Describes Respondents' Current or Planned Operations (n = 168)

	Respondents	
Sector Type	**Count (n*)**	**Percent (%*)**
Drone Service Operator (Uses drones to make money)	95	56.5
School or Training Program (Teaches students about drones)	76	45.2
Manufacturer of Drones (e.g., drone hardware, control station equipment, software)	28	16.7
Works with drones but none of the above	38	22.6

Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Table 6

Commercial UAS industry that Best Describes Respondents' Current or Planned Operations (n = 168)

	Respondents	
Industry Type	**Count (n*)**	**Percent (%*)**
Military or Military Contractor	41	24.4
Infrastructure (e.g., energy, roads, construction)	61	36.3
Agriculture	39	23.2
Shipping Package Delivery	23	13.7
Passenger Transportation (Air Taxi)	3	1.8
Emergency Response (e.g., law enforcement, search and rescue)	54	32.1
Entertainment and Media (e.g., news, film-making)	40	23.8
Real Estate	24	14.3
Academic/Scientific Research	47	28.0
Education	59	35.1
Other[8]	13	7.7

Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

[8] For written responses for those who indicated 'Other' as the industry they work see Appendix B, Section A: Demographics (Item A5, Table B4).

Table 7

Certifications Held by Respondents Who Currently Have a License or Certification to Fly a UAS (n = 158)[9]

	Respondents	
License or Certification Type	**Count (n*)**	**Percent (%*)**
14 C.F.R. § 107 certificate (e.g., remote pilot certificate)	143	90.5
14 C.F.R. § 61 certificate (e.g., manned pilot certificate)	50	31.6
Non-certificate: Fly Drones under hobbyist exemption (I fly drones as a hobby)	43	27.2
Instrument Rating	40	25.3
Military-qualified (RPA) pilot	22	13.9
Other[10]	14	8.9
I do not hold a certificate	3	1.9
Non U.S. (foreign) license	1	0.6

Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Respondents specified the certifications required to perform their job. Table 8 lists those certifications and the number of respondents selecting each type of certification. As expected, the largest category was for a Part 107 remote pilot certificate, with 87.4% of respondents stating this certificate as a requirement. Approximately 12% of the respondents needed a Part 61, manned pilot certificate, and 8.6% of respondents stated that they required either an instrument rating, or military UAS pilot training. Respondents also indicated whether they were required to have other types of certification to perform their jobs as shown in Table B5 of Appendix B. The responses found in Table B5 varied widely, with some respondents stating that no certification was required, only training provided by the employer, while others listed a commercial manned pilot certification, a Class II medical certificate, or piloting experience as adequate to qualify for their role. Some of the responses are believed to be in addition to the Part 107 certificate while others (e.g., on-the-job training) stand on their own.

[9] Results for 'Which Certifications do you hold' includes only respondents who indicated they hold a certification see Appendix A, Section A: Demographics.

[10] For a full list of written responses for those who indicated 'other' to the certifications they hold see Appendix B, Section A: Demographics (Table B5).

Table 8

Certifications Required for Respondents' Current Position (n = 151)[11]

	Respondents	
License or Certification Type	**Count (n*)**	**Percent (%*)**
14 C.F.R. § 107 certificate (i.e., remote pilot certificate)	132	87.4
14 C.F.R. § 61 certificate (i.e., manned pilot certificate)	18	11.9
Instrument Rating	13	8.6
Military-qualified (RPA) pilot	13	8.6
Non U.S. (foreign) license	0	0.0
Other[12]	12	7.9

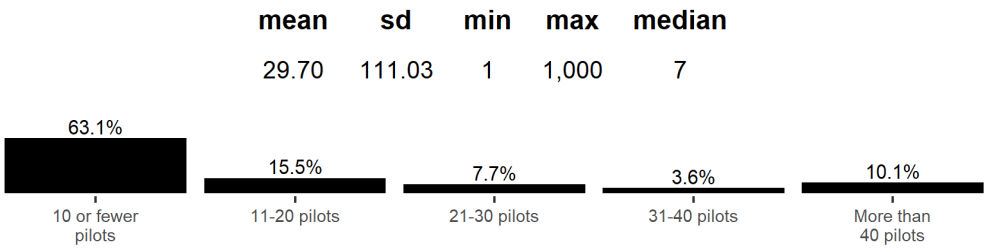
Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Organization Characteristics

Organizational information from respondents indicated the number of certified pilots employed by their organization (Figure 5). Figure 6 and Figure 7 provide the number of UAS/Drones operated on an average day, with the most common response indicating one to five flights with one to three different systems. The maximum number of UAS/drones operated at the same time given organization resources is five or fewer (Figure 8), with the most common response to the maximum number of systems operated by a single pilot was one (Figure 9).

Figure 5

Number of Certified UAS/Drone pilots Employed by Each Organization (n = 168)



[11] Results for 'Which certification(s) are required for your current position' includes only respondents who indicated they are certified a trained to Operate a UAS. See Appendix A, Section A: Demographics (Item A8).

[12]For a full list of written responses for those who indicated 'other', see Appendix B, Section A: Demographics (Table B6).

Figure 6

Average Number of UAS/Drone Flights (Operations) Conducted by each Organization (n = 167)

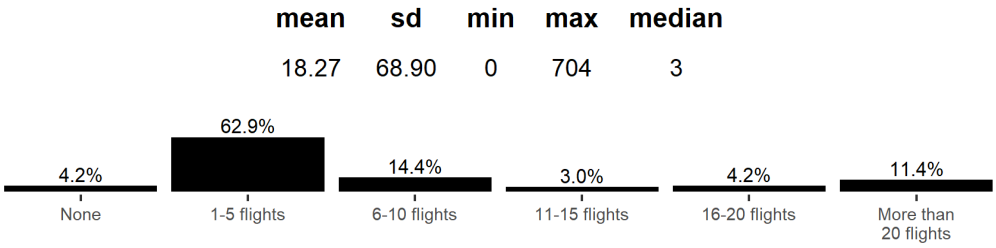


Figure 7

Average Number of UAS/Drones Operated at the Same Time (Across All Locations) by Organization (n = 161)

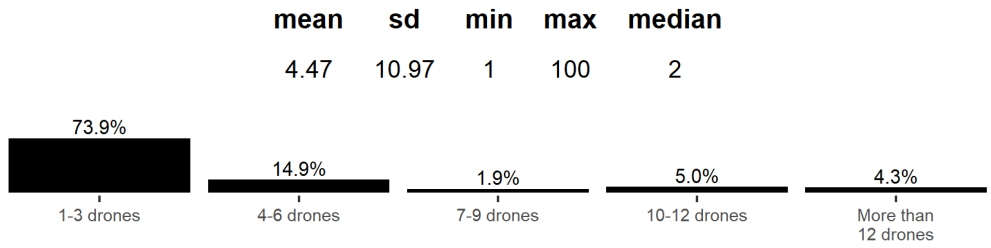


Figure 8

Maximum Number of UAS/Drones Operated at the Same Time Given Current resources by Organization (n = 167)

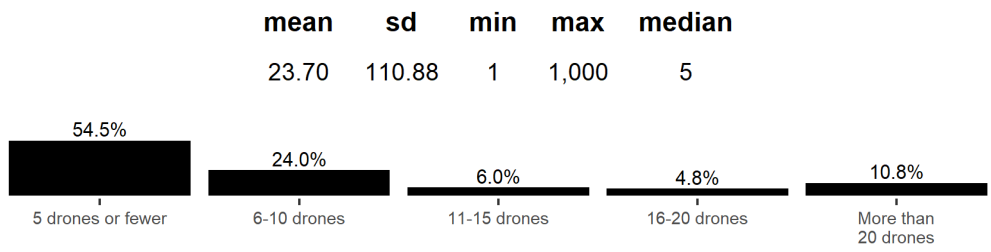
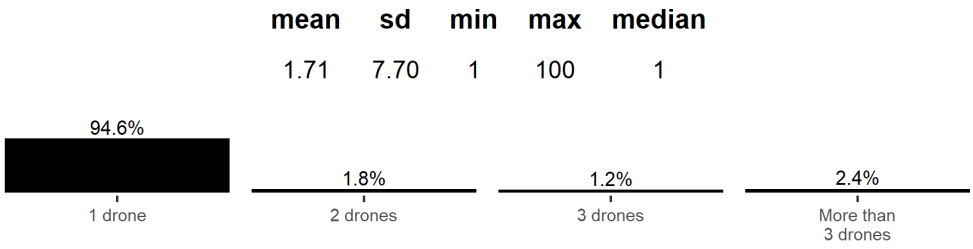


Figure 9

Maximum Number of UAS/Drones Operated by a Single Pilot at the Same Time by Organization (n = 166)

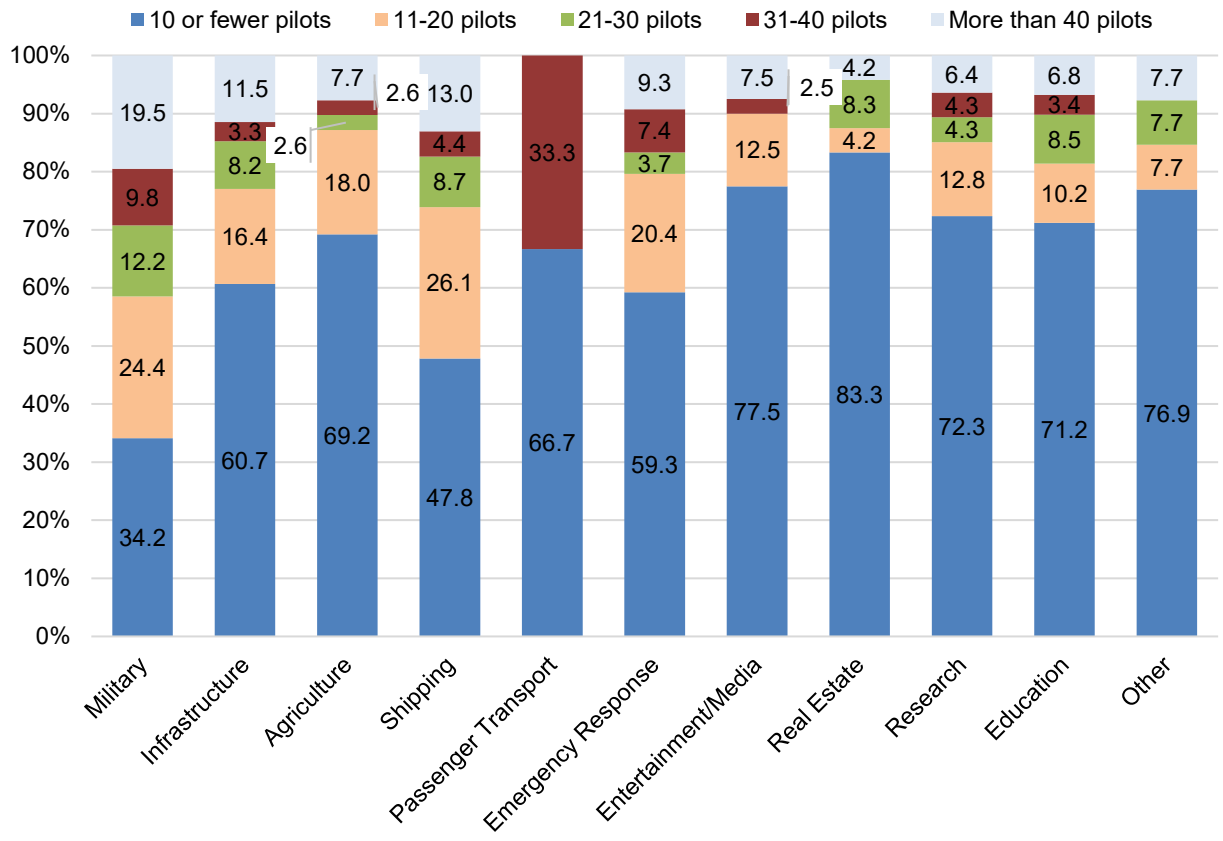


Crew and Staffing Characteristics

The majority of participants in the survey were employed in organizations with 10 or fewer pilots, a finding that holds true across each industry. The military and shipping industries appear to have the largest percentages of organizations employing more than 40 pilots (see Figure 10). Note, the bar indicating that 33% of the UAS passenger transport sector reporting employs 31 – 40 pilots may be inflated because it reflects the responses of only three participants.

Figure 10

Number of Pilots Employed in the Respondents' Organization, by Industry Sector (n = 127)



Question B1 asked about the minimum number of crewmembers needed for a flight operation. Figure 11 shows that the majority of operations (approx. 85%) required only 1 or 2 crewmembers. The highest response (50.4%) indicated the number of crewmember directly involved with a normal operation is two (Figure 12). A follow-on question asked the respondents to list the crewmembers that were needed for a flight operation. Table 19 in Appendix B provides that list. While "pilot" or an equivalent designation (e.g., operator) was always listed, operations needing two crewmembers varied regarding the second crewmember. This second crewmember was usually a visual observer ($n = 41$), but could also be a payload/sensor operator ($n = 8$) or a maintenance technician ($n = 4$). One respondent listing two crew positions simply said "Jack and Bubba".[13] Other crewmembers that participants listed for larger crew sizes included crew chief, data specialist, equipment manager, standby pilot, operations supervisor, and mission commander. It is likely that some of these positions (e.g., crew chief, operations supervisor, mission commander) are operationally equivalent.

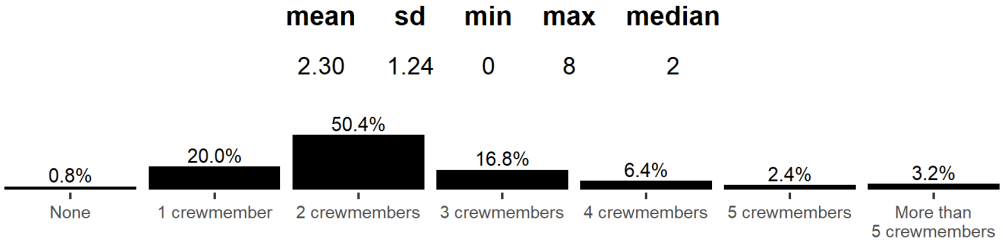
[13] Proper names have been changed to maintain anonymity and prevent disclosure.

Figure 11

Minimum Number of Crewmembers required for a Flight Operations According to Organizational policies (n = 126)[14]

Figure 12

Number of Crewmembers directly involved during a normal UAS/Drone Operation (n = 125)[15]



Crew and Staffing Characteristics of Air Carrier Delivery or Air Taxi Services

Respondents answering questions regarding crew and staffing characteristics must have responded that their organization currently, or has plans to, conduct UAS air carrier delivery operations or UAS air taxi services. The anticipated number of crewmember required for air carrier operations is two (Figure 13). Anticipated flight plans for air carrier operations will typically follow established flight routes (Figure 14).

[14] Results include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role (See Appendix A, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems; Item B1).

[15] Results include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role (See Appendix A, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems; Item B2).

Figure 13

Number of Anticipated Crewmembers required for Air Carrier Operations (n = 108)[16]

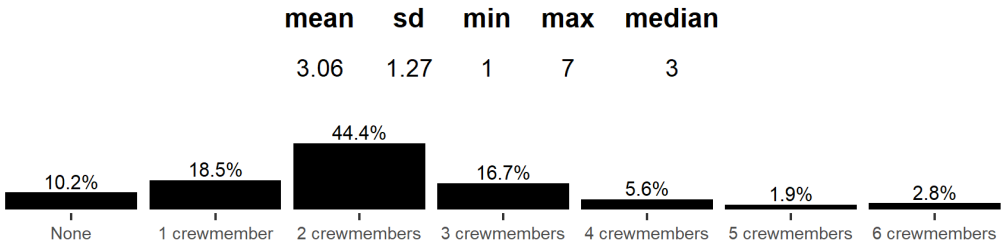
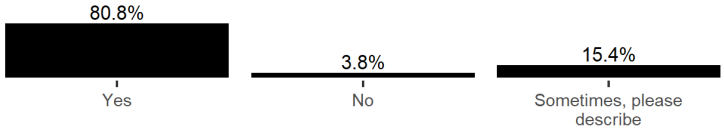


Figure 14

Anticipated Flight Plans Follow Established Flight Plans (e.g., Published Routes and Procedures, Company-Derived Flight Plans; n = 26)[17]



Aircraft Characteristics

When asked about the aircraft they operate, the majority of participants indicated that they were operating four-rotor-wing aircraft (i.e., quadcopters), but a notable minority of participants indicated that they operated fixed-wing aircraft (Table 9 and Table 10). A plurality participants indicated that their total takeoff weight did not exceed 20 pounds, but a sizeable minority indicated weights in excess of 40 pounds (with 15.2% of participants reporting takeoff weights in excess of 100 pounds; Figure 15).

[16] Results include respondents who indicated their job role as 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role and indicated their organization currently or plans to conduct 'Passenger Transport (Air Taxi)' or 'Shipping or Package Delivery' (see Appendix A, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems). No respondents provided a written response to this question.

[17] Results include respondents who indicated their job role as 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role and indicated their organization currently or plans to conduct 'Passenger Transport (Air Taxi)' or 'Shipping or Package Delivery' (see Appendix A, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems). See Appendix B, Section B, and Table B13 for a list of written responses.

Table 9

UAS/Drone Types Most Commonly Operated within the Commercial Sectors (n = 125)[18]

	Respondents	
Kind of Drone	**Count (n*)**	**Percent (%*)**
Fixed wing	50	40.0%
Single rotor wing	10	8.0%
Multi-rotor wing	102	81.6%
Transition (vertical to horizontal)	25	20.0%
Other[19]	7	5.6%

Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Table 10

Number of Rotors for Commonly Operated for Each Multi-Rotor Wing UAS/Drone (n = 101)[20]

	Respondents	
Number of Rotors	**Count (n*)**	**Percent (%*)**
1 Rotor	10	9.9%
2 Rotors	7	6.9%
3 Rotors	3	3.0%
4 Rotors	90	89.1%
5 Rotors	1	1.0%
6 Rotors	26	25.7%
7 Rotors	0	0.0%
8 Rotors	28	27.7%
9 Rotors	0	0.0%
10 Rotors	1	1.0%
11 Rotors	0	0.0%
12 Rotors	2	2.0%

Note. *n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

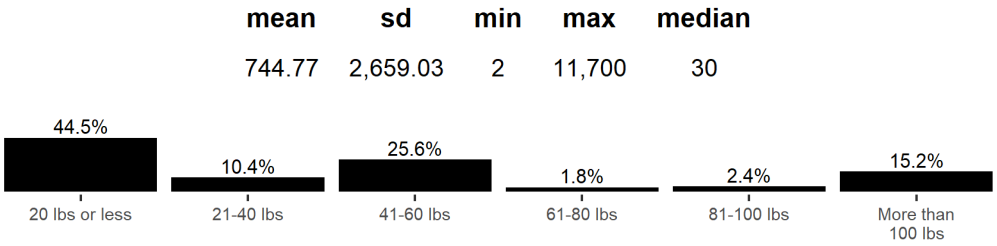
[18] Results include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role (Table 4).

[19] See Appendix B, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems (Table B9) for a list of written responses.

[20] Results include only respondent who indicated they operator 'multi-rotor wing' UAS (see Appendix A, Section B; Item B4).

Figure 15

Maximum Takeoff Weight of UAS/Drone Commonly Operated (n = 164)



Automated Functions

As identified by Hu et al. (2022), the literature has suggested that operations are moving toward higher automation and lower staffing (e.g., Swieringa et al., 2019). From the survey, Figure 16 shows that some level of automation is used for a majority of the systems being flown. Figure 17 shows that, even if systems are flown manually, there are several automated functions available for more than 90% of the systems being flown. Only the automatic obstruction avoidance and automatic traffic avoidance functions showed less availability (see Figure 17).

Figure 16

Autonomous Functionality of UAS/Drones Commonly Operated (n = 165)

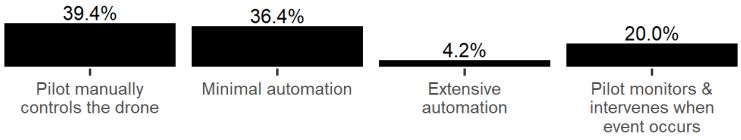


Figure 17

Automatic Functions Available or Required for UAS/Drones Commonly Operated in Commercial Operations (n = Available/ n = Required)

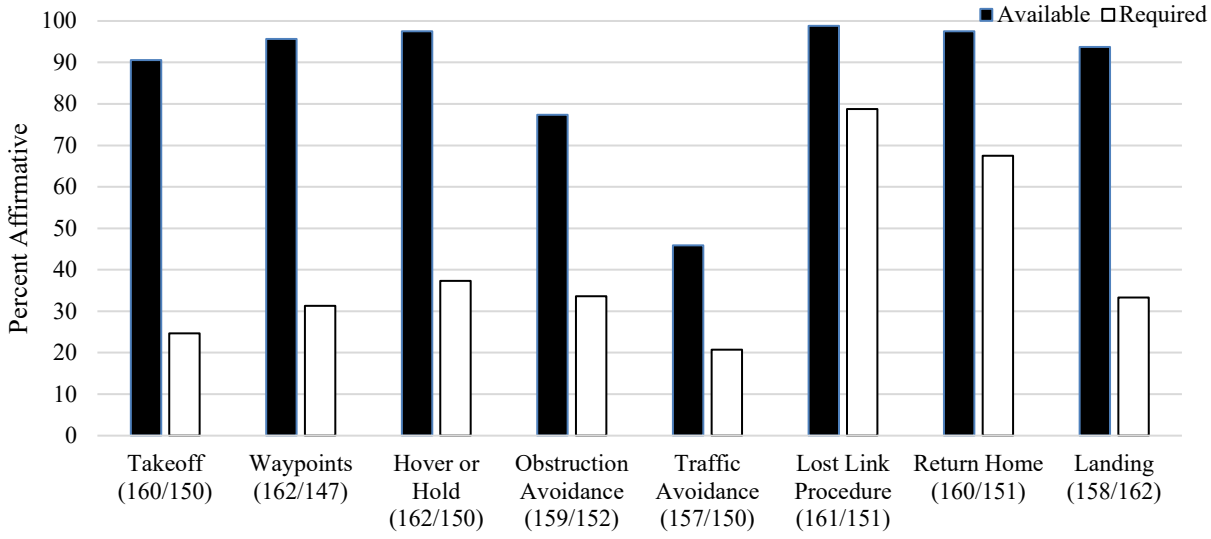


Figure 18 show that there were other available or required automated functions that were not listed in Figure 19. Appendix B, Table 21 and Table 22, list full responses. Looking at those tables, some of the automated functions listed do not have an impact on crew requirements (e.g., remote ID). However, the majority of the functions could affect crew requirements as they automate responsibilities performed either by the pilot (e.g., geo-fencing, parachute emergency landing) or by a sensor operator (e.g., pre-defined photographic and video scanning procedures).

Figure 18

Other Autonomous Functionality Available for UAS/Drones Not Previously Listed (n = 162)[21]

Figure 19

According to Organizational Policy, Transfer of Controls from One Pilot to Another While UAS/Drone is in Flight Permissible (n = 111)[22]

Air Delivery Operations

Participants reported that the majority of organizations do not currently, or have plans to, conduct UAS air carrier delivery operations (Figure 20) with only 27 respondents indicating that their organization either currently, or plans to conduct, air carrier delivery operations.

[21] See Appendix B, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems (Table B10) for a list of written responses.

[22] Results include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role (see Appendix A, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems). See Appendix B, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems for a list of written responses.

Figure 20

Organizational Current or Plan to Conduct UAS Air Carrier Operations (n = 115)[23]

Cargo Characteristics

Participants reported that the majority of cargo carried on a flight averaged 5 pounds or less (Figure 21). However, participants reported that their maximum weights exceeded 5 pounds, with nearly a quarter of respondents reporting a maximum weight over 20 pounds (Figure 22).

Figure 21

Average Cargo Weight for UAS Carrier Operations in Pounds (n = 21)[24]

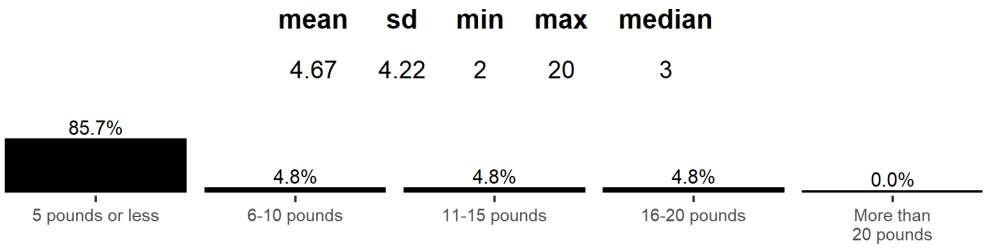
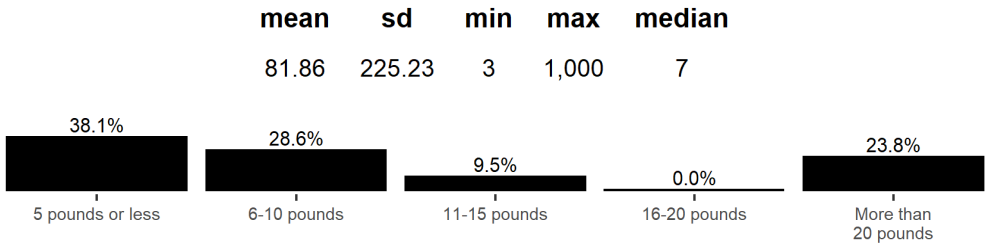


Figure 22

Maximum Cargo Weight for UAS Carrier Operations in Pounds (n = 21)[25]



Although some participants reported that they anticipated carrying heavier cargo, the majority (59.1%) reported an anticipated average cargo weight of 5 pounds or less (Figure 23

[23] Results include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' as their job role.

[24] Results include only respondents who indicated their organization currently or plans to conduct UAS air carrier delivery Operations

[25] Results include only respondents who indicated their organization currently or plans to conduct UAS air carrier delivery Operations

and Figure 24). It is expected that this approximately 5 pound cargo weight will not increase until either more large UAS (> 55 pounds) are certified for these operations or Part 107 operations allow waivers exceeding the 55 pound boundary level.

Figure 23

Anticipated Average Weight of the Cargo for Future UAS Air Carrier Operations in Pounds" (n = 22)[26]

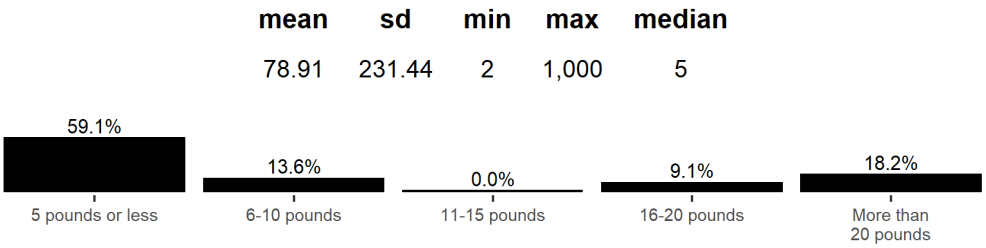
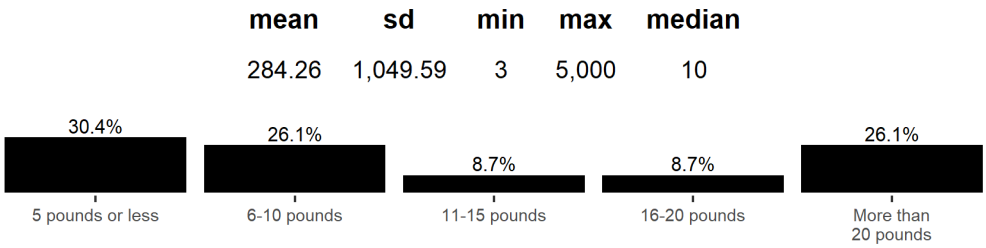


Figure 24

Anticipated Maximum Weight of the Cargo for Future UAS Air Carrier Operations in Pounds (n = 23)[27]



Air Taxi Operations

The questions included in this section were intended to provide clarity regarding expected design standards and implementations for air taxi operations. Unfortunately, only 8 respondents noted an intention by their organization to conduct UAS air taxi operations (see Figure 25). This number of respondents is too low to reliably represent the potential population of personnel or organizations expected to be involved in such operations. However, for the sake of completeness, the questions and responses received for this section are reported below (Figure 26 through Figure 37, and Table 11).

[26] Results include only respondents who indicated their organization currently or plans to conduct UAS air carrier delivery Operations.

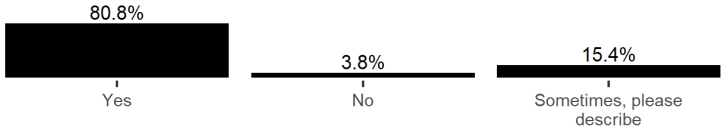
[27] Results include only respondents who indicated their organization currently or plans to conduct UAS air carrier delivery Operations.

Figure 25

Organizational Plan to Operate UAS Air Taxi Services (n = 119)[28]

Figure 26

Anticipated Flight Plans for UAS Taxi Services Follow Established Flight Plans (e.g., Published Routes and Procedures, Company-Derived Flight Plans (n = 26)[29]



Aircraft Characteristics

Figure 27

Maximum Number of Passengers per Trip (n = 6)[30]

[28] Results include only respondents who indicated 'Pilot/Operator with systems less than 55 pounds ,' 'Pilot/Operator of systems equal to/greater than 55 pounds' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on Item A1 and work with an organization who currently or plans to conduct Passenger Transport (Air Taxi) Services.

[29] Results include only respondents who indicated the work with an organization who currently or plans to conduct Passenger Transport (Air Taxi) Services.

[30] Results include only respondents who indicated the work with an organization who currently or plans to conduct Passenger Transport (Air Taxi) Services.

Figure 28

Passenger Baggage Allowed for UAS Taxi Services Flights (n = 6)[31]

Table 11

Items Available to the Passenger(s) During the Flight (n = 2)[32]

	Respondents	
Item Available to the Passengers	**Count (n)**	**Percent (%)**
Emergency call button	2	100.0%
Sick bags	2	100.0%
Fire extinguisher	2	100.0%
Oxygen masks (protection against smoke or odors in cabin)	1	50.0%
Air bags	2	100.0%
Passenger-initiated land immediately button or switch	2	100.0%

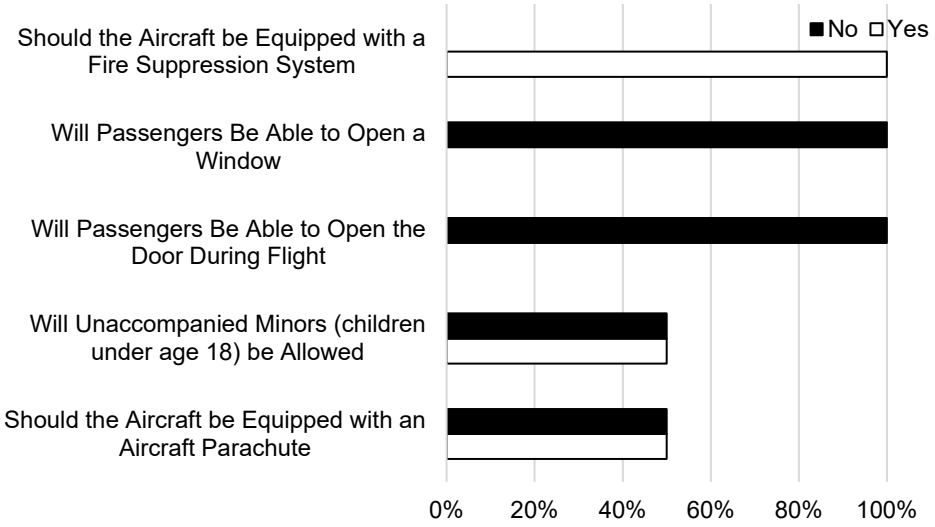
Note. n* may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).

[31] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.

[32] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.

Figure 29

Additional Aircraft Safety Characteristics" (n = 2)[33]



Automated Functions

Figure 30

Future Level of Automation that should be Allowed Over the Next few Years (Between Now and the Year 2025) for UAS Taxi Operations (n = 2)[34]

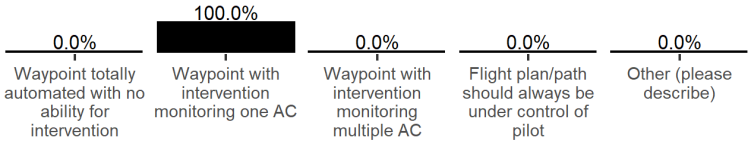
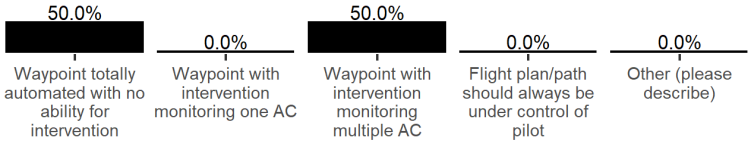


Figure 31

Future Level of Automation that should be Allowed Beyond the Next few Years (After the Year 2025) for UAS Taxi Operations (n = 2)[35]



[33] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.

[34] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services No respondents indicated "Other" and provided a written response.

[35] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services No respondents indicated "Other" and provided a written response.

Figure 32

Lowest Level of Automation that should be available for UAS Taxi Services (n = 2)[36]

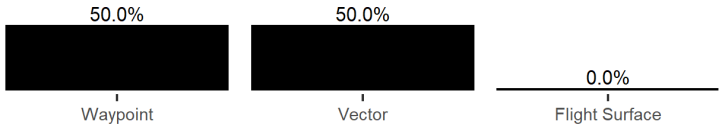
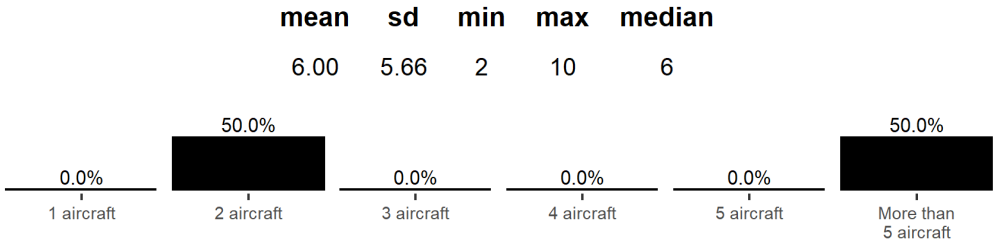


Figure 33

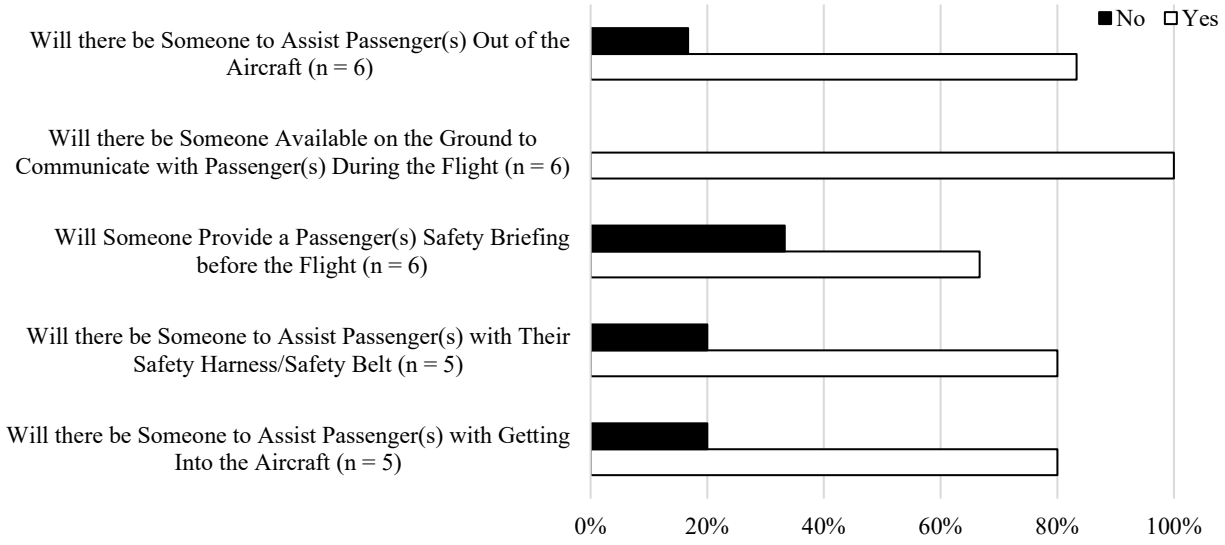
Maximum Number of Aircraft should be Allowed for Monitoring by a Single Pilot/Operator (n = 2)[37]



Passenger Assistance

Figure 34

Passenger Assistance Features and Functions (n = 5)[38]



[36] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.
[37] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.
[38] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.

Passenger Communication

Figure 35

Methods of Communication, Possibly Available to Passengers during UAS Taxi Service Flights (n = 2)[39]

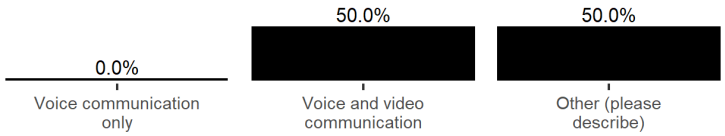


Figure 36

Communication Initiation Methods by Passenger during UAS Taxi Service Flights (n = 2)[40]

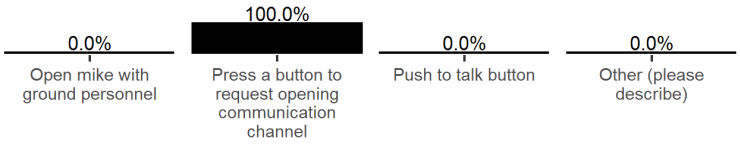


Figure 37

Flight Progress Available to Passenger (n = 2)[41]

Discussion

Although one of the primary reasons for conducting this survey was to provide insight into potential requirements for conducting UAS air carrier-like operations, responses showed that the majority of respondents' organizations neither conduct nor plan to conduct either UAS air carrier delivery operations or UAS air taxi services. This unfortunately greatly limits the usefulness of the responses in this survey as far as air taxi services are concerned. The majority of UAS pilot responses were from pilots of small UAS who were operating under Part 107, which currently allows neither large cargo operations nor air taxi services. However, more importantly, most Part 107 operations are likely either commercial endeavors that do not need to expand into cargo or air taxi businesses in order to make reasonable profits, or they are civil

[39] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services. See Appendix B, Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems (Table B14).

[40] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services. No respondents indicated "Other" and provided a written response.

[41] Results in the table include only respondents who indicated they work with an organization that currently or plans to conduct Passenger Transport (Air Taxi) Services.

service operations (e.g., search and rescue, police support) that are able to fulfill their roles without the need to consider air carrier requirements.

Despite these limitations, there are novel and interesting findings from the survey in regard to crew and staffing issues. As identified in the results section, Table B2 in Appendix B provides a listing of job responsibilities provided by the respondents. This list contains a wide variety of job responsibilities across a wide range of operations. While many of the descriptions suggest similar crew positions (e.g., pilot), the variety of operations might require different types and levels of training for those positions. For example, a pilot training program for an armed military system might differ a great deal from a pilot training program designed to assist in movie production. These potentially large differences in training suggests different certification requirements for the pilots of these operations. Even when operations are commercial in nature (e.g., crop dusting, radio tower inspection), differences in how these operations are performed might require different certification requirements.

When asked about minimum crew size requirements, the majority of respondents estimated their current requirements to be one or two crewmembers. As most of the respondents were conducting operations with small UAS, this smaller number of crewmembers would be expected. In addition, when asked how many crewmembers would they anticipate for air carrier-like flight operations the responses varied from 1-6 crewmembers, with the majority of responses ranging from 1-3 crewmembers. Unfortunately, we did not ask the respondents to provide a listing of required crewmembers to clarify who they had in mind. Further research will be needed to clarify how those in the UAS industry envision crew positions and responsibilities in such operations.

The listing of crew positions in the survey did not provide any roles that were not included as a result of the literature review. From a staffing point of view, the listing of crew positions did include standby pilots who could replace the controlling pilot - whether as planned or as necessary.

The survey results revealed a high degree of availability of automation. Many of the available automated functions focused on making control of the aircraft easier for the pilot, which would reduce training requirements for the pilot position. Interestingly, two automated functions that were not as available as other functions were automated object avoidance and automated traffic avoidance, which would seem to be more critical than some of the other functions available. However, current avoidance requirements still mostly involve human intervention at this time so the technology for automated avoidance maneuvers might not be mature enough to be operationally useful. Also, the sensors required to perform these automated functions might be too bulky for smaller UAS. This may be particularly true for Part 107 operations, which might limit the number and type of systems where the functions can be implemented.

Current and expected cargo loads were relatively small in this survey, but this appears reasonable because of the large percentage of respondents operating under Part 107 rules. Whether air carrier-like cargo operations can occur under Part 107 waivers or whether other certifications (e.g., Part 135) are needed has not yet been decided. Either way, there is still an expectation that new certifications will be created to allow for new crew positions (e.g., load master) for these operations. One aspect of cargo operations that was not covered extensively in this survey was in regard to single pilot control of multiple aircraft. Although the majority of our respondents (95%) indicated a one-to-one ratio between pilot and aircraft, there are current package delivery flight operations where single-pilot control of multiple aircraft is already happening, with ratios as high as 1:24 being reported (personal communication, Julianna Martorella, Zipline). These types of operations are expected to continue.

There are a number of UAS air taxi operational requirements and standards that will need to be addressed before such operations are allowed. Some of these requirements and standards can be established using lessons learned from manned air taxi operations. However, UAS air taxi operations present unique questions for policy makers. Many of these questions were asked in this survey, specifically about how passengers would be assisted, whether and how communication with passengers would be handled, what emergency procedures and equipment would be available, and several other issues.

As was discussed earlier, the small number of respondents of these questions limits the generalizability of the data. One result of interest is that many of the respondents were not in agreement with each other, which suggests that there will likely be much debate on how to proceed with certain issues. Additionally, inconsistencies in the survey results may be due to shortcomings of the survey itself and should be acknowledged. The primary shortcoming of this survey pertains to a variety of job roles that were underrepresented by few respondents (e.g., UAS pilots > 55 lbs and sensor operators) while some job roles were over-represented such as supervisors and UAS instructors making up approximately half of all respondents sampled. Further, a portion of the total respondents belong to an undefined ‘other crewmember’ job role which could have skewed results related to perceptions about crew and staffing needs, or may have created other inconsistencies. In addition to issues with representative sample sizes across job roles, it is important to recognize that the majority of respondents have no more than 10 years of experience in their current job role, which would be expected of the newness of UAS operations, and which could have skewed results in the current and associated reports.

Conclusions

In many ways, commercial UAS operations are still very much in their infancy from the point of view of policy makers. One difficulty is that the types and number of commercial UAS operations is always changing. The general direction regarding the number of operations is increasing but some operations are disappearing while others are being added. At this time, it is difficult to determine which operations will fail commercially and which ones will succeed.

From a crew and staffing point of view, there are many questions that need to be addressed before requirements can be established for many of these operations, especially regarding the transportation of passengers. While many current Part 135 operations are performed without the use of a crewmember devoted specifically to the safety of passengers, letting the pilot handle safety briefings, loading and unloading of passengers, and monitoring passenger safety and comfort during the flight, it seems likely that will not be sufficient for UAS passenger operations. Because of the separation of the pilot from the aircraft, the pilot may not be able to interact with the passengers at all, leaving it necessary for a separate crewmember to handle these tasks. During passenger flights, communications with the passengers will be a crucial issue to solve because of the separation of the crew from the passengers. The experience of the remote crewmembers will not match the experience of on-board passengers, which might lead to confusion regarding the passenger's state of mind and their emotional state.

Other unresolved crew and staffing issues noted in the introduction include (a) the role of maintenance technicians during the flight given their access to the control station, (b) potentially different training and certification requirements for the remote pilot position as compared to the remote pilot in command, (c) how to handle crewmember positions that are unique to a particular operation (e.g., lead meteorologist), and (d) the role of automation/autonomy as a crew position. Clearly, more research and operational experience is required before air carrier-like remotely piloted operations can be conducted in the NAS.

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Appendix A.
Market Survey Questions for UAS Crew and Staffing

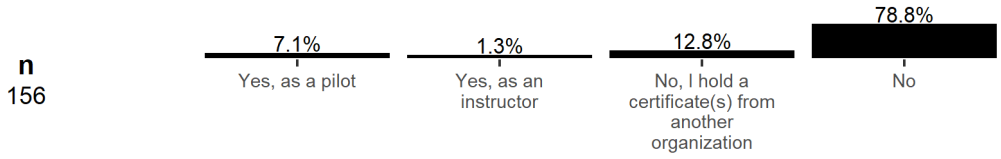
The Federal Aviation Administration's (FAA) Civil Aerospace Medical Institute (CAMI) constructed a survey to gather information about the current state of Unmanned Aircraft Systems (UAS) operations considered relevant to air carrier flight activities. The survey polled a variety of people involved in commercial UAS activities from frontline workers to high-level managers to educators. The survey examined areas related to UAS operations such as crew and staffing, operator knowledge and skills, duty/rest, and training requirements.

An open invitation to complete the online survey was distributed via email to a sample of potential participants with UAS industry, training, or crew experience (N=2,524). Of those, 97 invitations were returned undeliverable resulting in 2,427 invitations delivered directly to potential participants. Invitees were encouraged to share the open invitation with other UAS professionals who met eligibility requirements. Invitees were informed that survey completion was voluntary and that a third-party contractor would compensate participants for completing the survey.

Overall, 173 participants met the requirements for inclusion: 1) work as crew that operates/plans to operate UAS, or provides UAS training; or 2) work for an organization with UAS pilot qualification requirements; and 3) the organization had more than 1 employee. This report summarizes the survey results for the crew and staffing items.

Example of Report Format

A9. Do you hold a Trusted Operator certificate from the Association for Unmanned Vehicle Systems International (AUVSI)?



Definitions of Descriptive Statistics

Number of Respondents (n): The number of respondents who provided a valid response for an item.

Mean: The arithmetic average, calculated as the sum of response values for an item divided by the number of respondents (n) who answered that item. *Not applicable (N/A), Don't know,* and *No experience to say* responses are excluded from calculations and reporting.

Standard Deviation (sd): The measure of dispersion, or spread of values around the mean. Smaller standard deviation values indicate higher levels of agreement among respondents. *Not*

applicable (N/A), Don't know, and *No experience to say* responses are excluded from calculations and reporting.

Response Distribution (%): The proportion, or percentage, of respondents that selected a given response across item response options. *Not applicable (N/A), Don't know,* and *No experience to say* responses are excluded from calculations and reporting.

Frequency Count (n*): The number of times a response option is selected. A frequency count for 'mark all that apply' items may sum to greater than the number of respondents (n).

Percent (%) of Respondents: The percent is calculated by dividing the frequency count by the number of respondents and multiplying by 100.

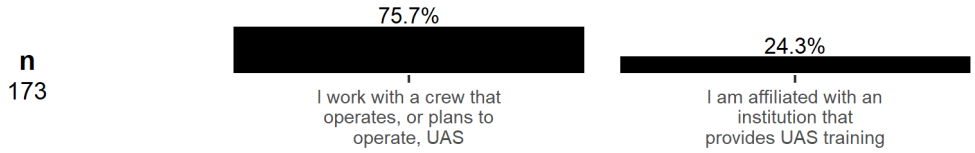
Median (med): The exact middle data point calculated in a set of rank-ordered values. It is less affected by extreme values in comparison to the mean, and thus, is relied upon when extreme values are present in a data set (e.g., total flight hours flown).

Minimum (min): The lowest, or minimum, value provided.

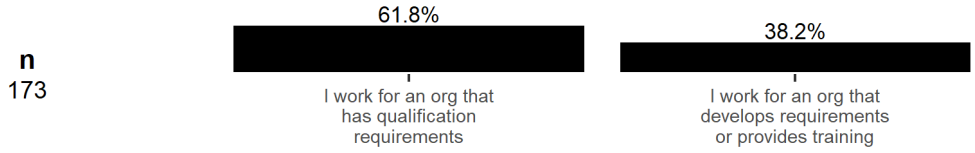
Maximum (max): The highest, or maximum, value provided.

Participant Eligibility

1. Which of these statements best applies to you?



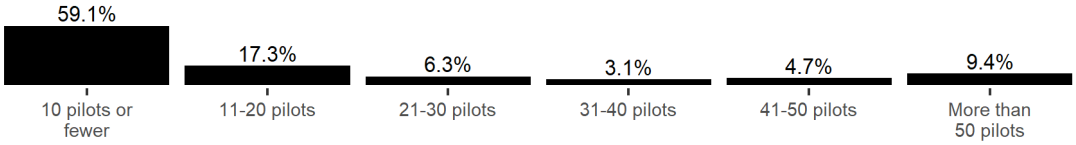
2. Do you work for an organization with established UAS pilot qualification requirements?



Results for *Item 3* include only respondents who indicated 'I work with an organization or crew that operates, or plans to operate, unmanned aircraft systems (UAS)/drones)' on *Item 1*.

3. How many drone operators/pilots does your organization currently employ? (provide estimate if unsure)

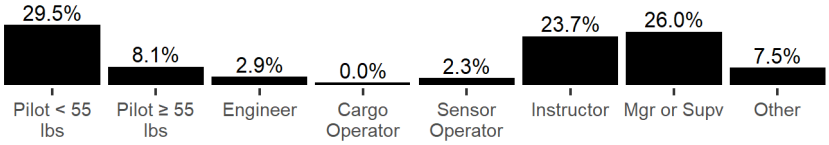
n	mean	sd	min	max	median
127	43.14	197.76	2	2,000	9



Section A: Demographics

A1. Currently, what is your primary job role? (required)

n
173



Results for *Item A1a* include only respondents who indicated 'Other' on *Item A1* and provided a written response.

A1a. In brief, please describe your job role: (See Appendix B for a list of responses)

	n
2022	13

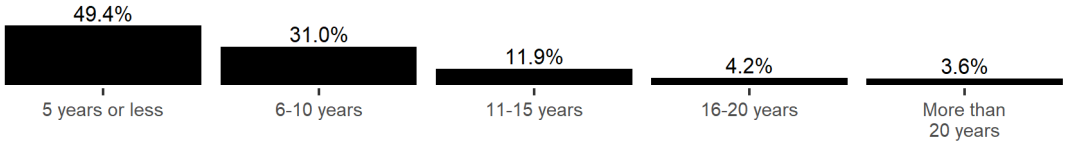
Results for *Item A1b* include only respondents who provided a written response.

A1b. In brief, please describe the main responsibilities of your job: (See Appendix B for a list of responses)

	n
2022	166

A2. How many years of experience do you have with your current role(s)?

n	mean	sd	min	max	median
168	7.01	5.58	1	30	6



A3. The organization that I work for is, or plans to be, a: *[mark all that apply]* (required)

	n
2022	168

2022 n*		2022 %*
95	Drone service operator (uses drones to make money)	56.5
76	School or training program (teaches students about drones)	45.2
28	Manufacturer of drones (e.g., drone hardware, control station equipment, software)	16.7
38	Works with drones, but none of the above (please describe)	22.6

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Results for *Item A4* include only respondents who indicated 'Works with drones, but none of the above' on *Item A3* and provided a written response.

A4. In what capacity does your organization work with drones? (See Appendix B for a list of responses)

	n
2022	38

A5. Please select the industry or sector that best describes the current or planned drone operations of your organization: *[mark all that apply]* (required)

	n
2022	168

2022 n*		2022 %*
41	Military or Military Contractor	24.4
61	Infrastructure (e.g., energy, roads, oil and gas, and construction)	36.3
39	Agriculture	23.2
23	Shipping or Package Delivery	13.7
3	Passenger Transport (Air Taxi)	1.8
54	Emergency Response (e.g., local law enforcement, disaster and accident)	32.1
40	Entertainment and Media (e.g., film-making, pictures)	23.8
24	Real Estate	14.3
47	Academic/Scientific Research	28.0
59	Education	35.1
13	Other (please describe)	7.7

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Results for *Item A5a* include only respondents who indicated 'Other' on *Item A5* and provided a written response.

A5a. Other industry or sector, please describe: (See Appendix B for a list of responses)

	n
2022	13

A6. Are you currently trained, licensed, or certified to fly a drone?

Results for *Item A7* through *Item A8* include only respondents who indicated 'Yes' on *Item A6*.

A7. Which of these certificates do you hold? *[mark all that apply]*

	n
2022	158

2022 n*		2022 %*
143	14 CFR Part 107 certificate (i.e., remote pilot certificate)	90.5
50	14 CFR Part 61 certificate (i.e., manned pilot certificate)	31.6
40	Instrument rating	25.3
22	Military-qualified (RPA) pilot	13.9
1	Non U.S. (foreign) license	0.6
43	I fly drones as a hobby	27.2
14	Other (please describe)	8.9
3	I do not hold a certificate	1.9

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Results for *Item A7a* include only respondents who indicated 'Other' on *Item A7* and provided a written response.

A7a. Other certificate(s), please describe: (See Appendix B for a list of responses)

	n
2022	14

A8. Which of these certificates are required for your job? *[mark all that apply]*

	n
2022	151

2022 n*		2022 %*
132	14 CFR Part 107 certificate (i.e., remote pilot certificate)	87.4
18	14 CFR Part 61 certificate (i.e., manned pilot certificate)	11.9
13	Instrument rating	8.6
13	Military-qualified (RPA) pilot	8.6
0	Non U.S. (foreign) license	0.0
12	Other (please describe)	7.9

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

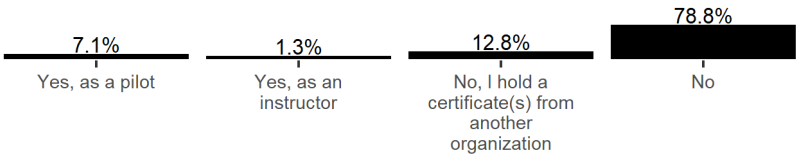
Results for *Item A8a* include only respondents who indicated 'Other' on *Item A8* and provided a written response.

A8a. Other certificate(s), please describe: (See Appendix B for a list of responses)

	n
2022	12

A9. Do you hold a Trusted Operator certificate from the Association for Unmanned Vehicle Systems International (AUVSI)?

n
156



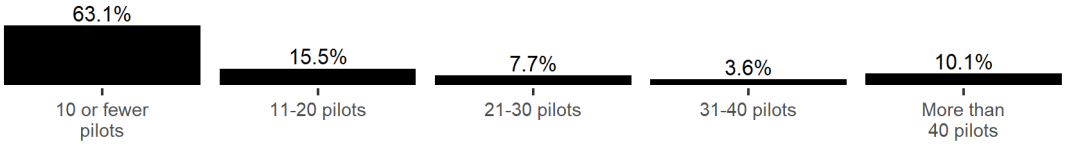
Results for *Item A9a* include only respondents who indicated 'No, I hold a certificate(s) from another organization' on *Item A9* and provided a written response.

A9a. What certificate(s) do you hold from another organization? Please describe. (See Appendix B for a list of responses)

	n
2022	18

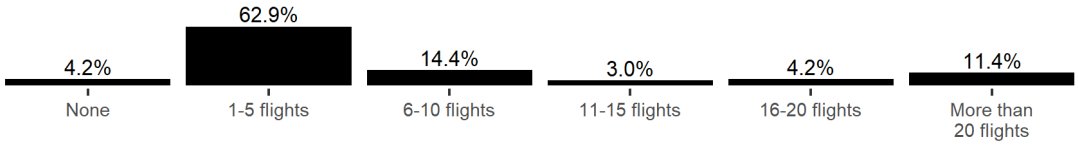
A10. What is your estimate of the number of certified UAS/drone pilots employed by the organization where you work?

n	mean	sd	min	max	median
168	29.70	111.03	1	1,000	7



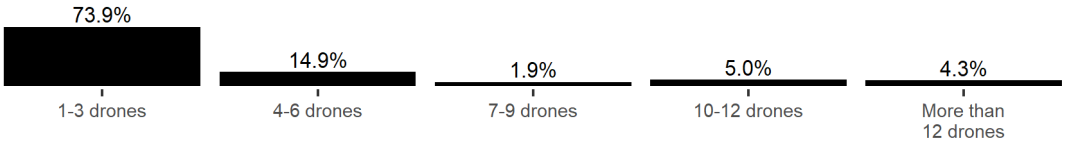
A11. On an <u>average day</u>, how many UAS/drone flights (operations) does your organization fly?

n	mean	sd	min	max	median
167	18.27	68.90	0	704	3



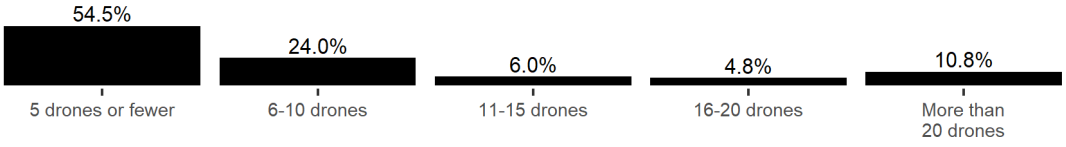
A12. On an average day, how many drones does your organization fly at the same time (across all locations where your organization flies)?

n	mean	sd	min	max	median
161	4.47	10.97	1	100	2



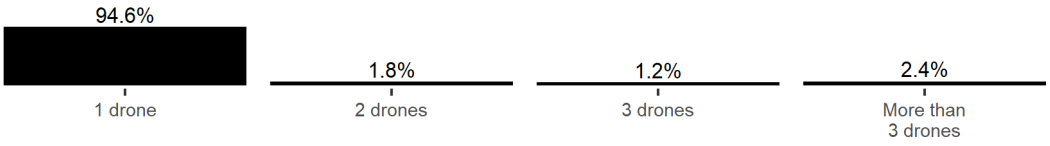
A13. Given current resources, what is the maximum number of drones your organization can fly at the same time?

n	mean	sd	min	max	median
167	23.70	110.88	1	1,000	5



A14. For the typical operation at your organization, what is the maximum number of drones a single pilot flies at the same time?

n	mean	sd	min	max	median
166	1.71	7.70	1	100	1

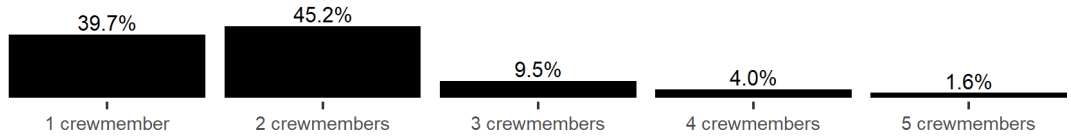


Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems

Results for *Item B1* through *Item B2* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1*.

B1. What is the minimum number of crewmembers needed for a flight operation according to your organization's policies?

n	mean	sd	min	max	median
126	1.83	0.88	1	5	2



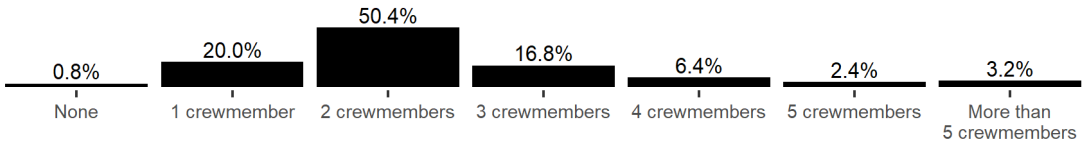
Results for *Item B1a* include respondents who indicated more than one crewmember on *Item B1* and provided a written response.

B1a. Please list the crewmembers needed for a flight operation according to your organization's policy (See Appendix B for a list of responses)

	n
2022	73

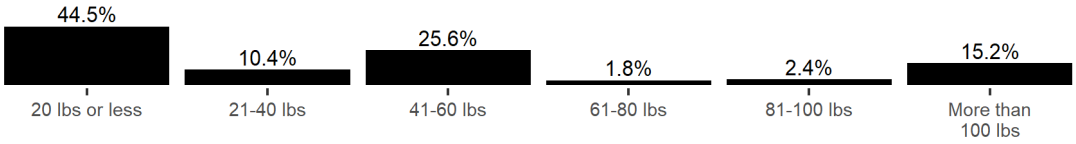
B2. How many total crewmembers are directly involved during a normal drone operation?

n	mean	sd	min	max	median
125	2.30	1.24	0	8	2



B3. What is the maximum takeoff weight of the drones you are involved with ***in pounds***?

n	mean	sd	min	max	median
164	744.77	2,659.03	2	11,700	30



Results for *Item B4* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1*.

B4. What kind of drones are you operating? *[mark all that apply]*

	n
2022	125

2022 n*		**2022 %***
50	Fixed wing	40.0
10	Single rotor wing	8.0
102	Multi-rotor wing	81.6
25	Transition (vertical to horizontal)	20.0
7	Other (please describe)	5.6

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

Results for *Item B4a* include only respondents who indicated 'Other' on *Item B4* and provided a written response.

B4a. Other, please describe: (See Appendix B for a list of responses)

	n
2022	7

Results for *Item B4b* include only respondents who indicated 'Multi-rotor wing' on *Item B4*.

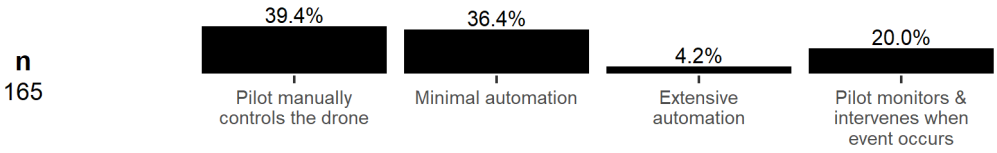
B4b. Please enter the number of rotors for each multi-rotor wing drone you operate *(enter only one number per box)*

	n
2022	101

2022 n*		2022 %*
10	1 rotor	9.9
7	2 rotors	6.9
3	3 rotors	3.0
90	4 rotors	89.1
1	5 rotors	1.0
26	6 rotors	25.7
0	7 rotors	0.0
28	8 rotors	27.7
0	9 rotors	0.0
1	10 rotors	1.0
0	11 rotors	0.0
2	12 rotors	2.0

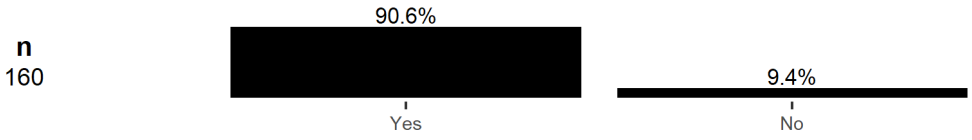
n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

B5. What level of automation most accurately describes the autonomous nature of the drones you operate?



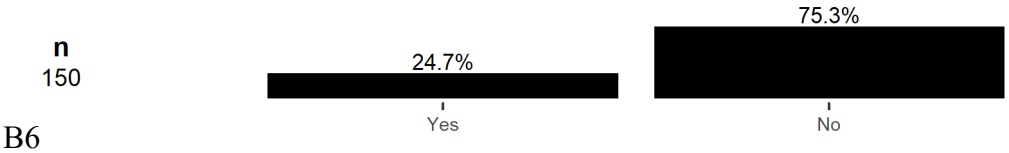
B6. What automated functions are available and required on your aircraft?

Takeoff <u>available</u>



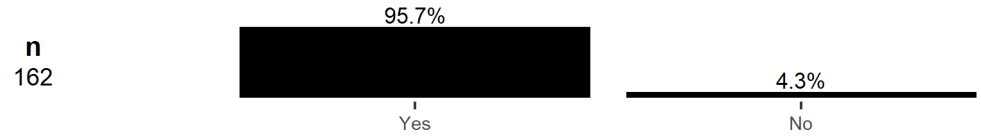
B6. What automated functions are available and required on your aircraft?

Takeoff <u>required</u>

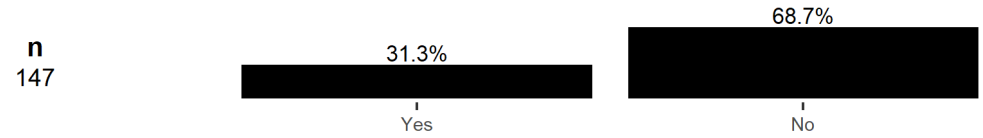


B6

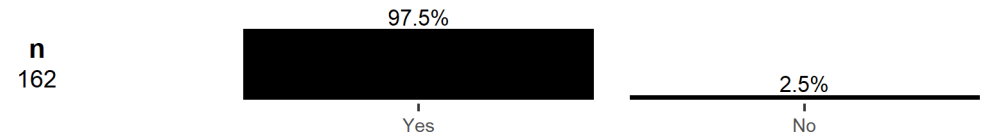
Flight Path (waypoints) <u>available</u>



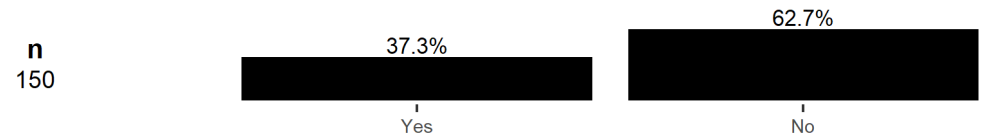
Flight Path (waypoints) <u>required</u>



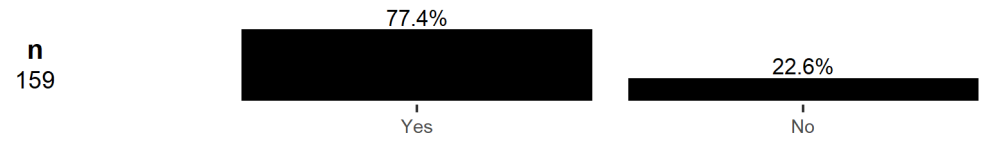
Hover or Holding Pattern <u>available</u>



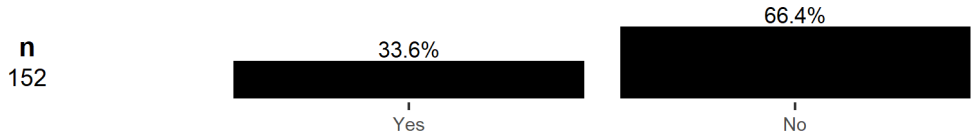
Hover or Holding Pattern <u>required</u>



Obstruction Avoidance <u>available</u>

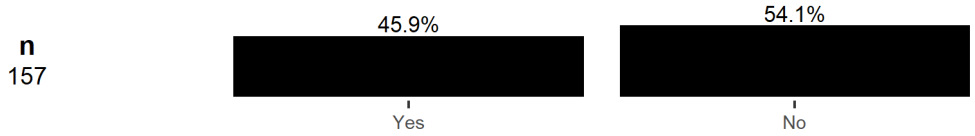


Obstruction Avoidance <u>required</u>

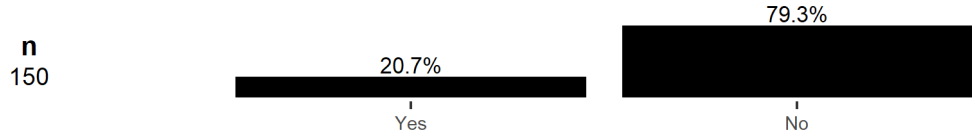


B6. What automated functions are available and required on your aircraft?

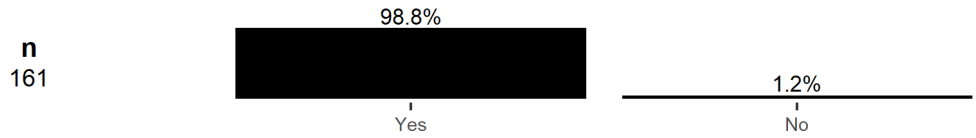
Traffic Collision Avoidance available



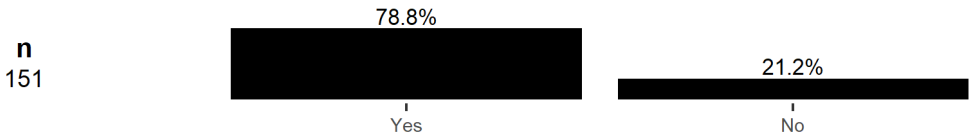
Traffic Collision Avoidance required



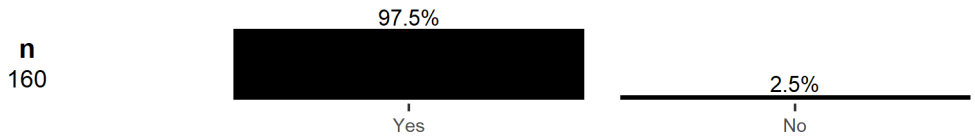
Lost Link Procedure available



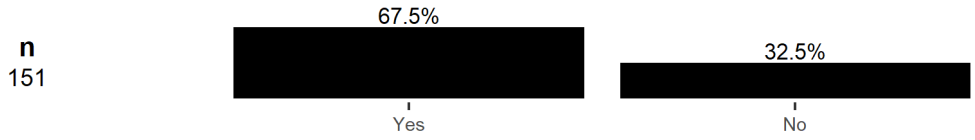
Lost Link Procedure required



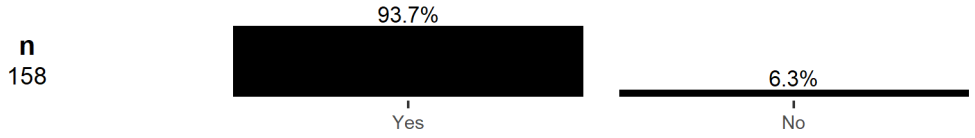
Return Home available



Return Home required

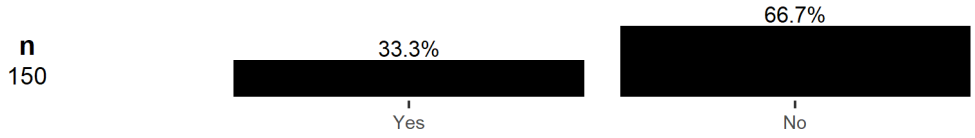


Landing available

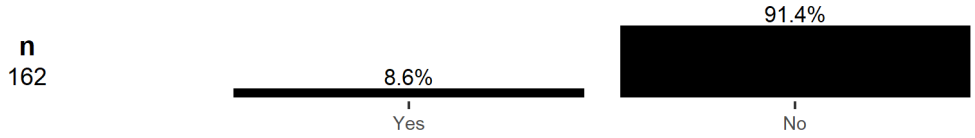


B6. What automated functions are available and required on your aircraft?

Landing required



B7. Are there other functions not listed in the previous question that are available or required for your aircraft?



Results for *Item B7a* through *Item B7b* include only respondents who indicated 'Yes' on *Item B7* and provided a written response.

B7a. Other available automation please describe: (See Appendix B for a list of responses)

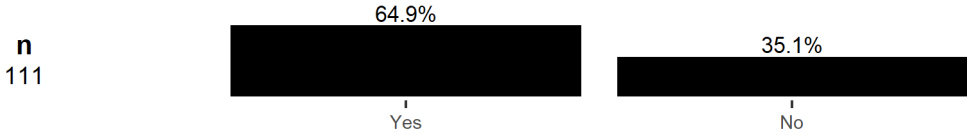
	n
2022	14

B7b. Other required automation please describe: (See Appendix B for a list of responses)

	n
2022	4

Results for *Item B8* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1*.

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight?



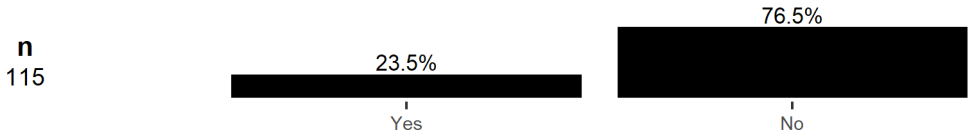
Results for *Item B8a* include only respondents who indicated 'Yes' on *Item B8* and provided a written response.

B8a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.) (See Appendix B for a list of responses)

	n
2022	70

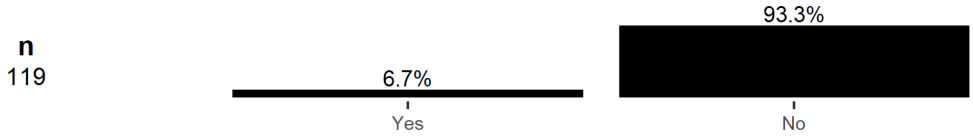
Results for *Item B9* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1*.

B9. Does your organization currently, or have plans to, conduct UAS air carrier delivery operations? (required)



Results for *Item B10* include only respondents who indicated 'Pilot/Operator with systems less than 55 pounds ,' 'Pilot/Operator of systems equal to/greater than 55 pounds' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1* and 'Passenger Transport (Air Taxi)' on *Item A5*.

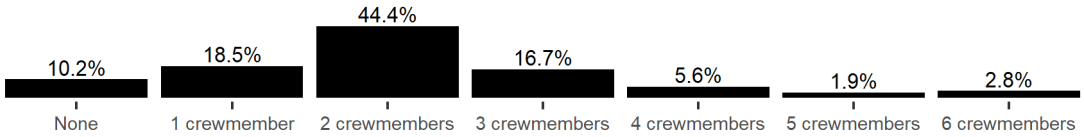
B10. Does your organization have plans to conduct UAS air taxi services (carriage of people for hire)? (required)



Results for *Item B11* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1* and 'Passenger Transport (Air Taxi)' or 'Shipping or Package Delivery' on *Item A5* and 'Yes' on *Item B9* and 'Yes' on *Item B10*.

B11. What do you anticipate to be the <u>minimum</u> number of crewmembers needed for air carrier flight operation according to your organization's policies?

n	mean	sd	min	max	median
108	3.06	1.27	1	7	3



Results for *Item B11a* include respondents who indicated at least one crewmember is needed for air carrier flight operations on *Item B11* and provided a written response.

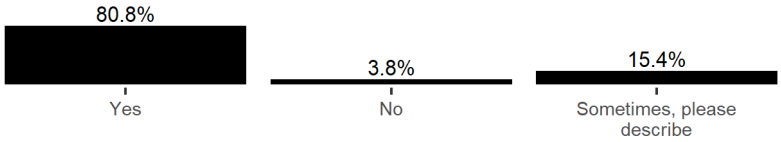
B11a. Please provide the job title of each crewmember position in the air carrier operation. (See Appendix B for a list of responses)

	n
2022	0

Results for *Item B12* include only respondents who indicated 'Yes' on *Item B9* and 'Yes' on *Item B10*.

B12. <u>Will anticipated flight plans</u> follow established and mapped flight plans (e.g., published routes and procedures, company-derived flight plans)

n
26



Results for *Item B12a* include only respondents who indicated 'Sometimes' on *Item B12* and provided a written response.

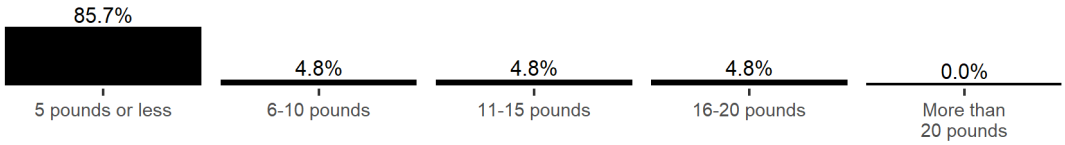
B12a. Sometimes, please describe if anticipated flight plans will follow established and mapped flight plans. (See Appendix B for a list of responses)

	n
2022	4

Results for *Item B13* through *Item B16* include only respondents who indicated 'Yes' on *Item B9*.

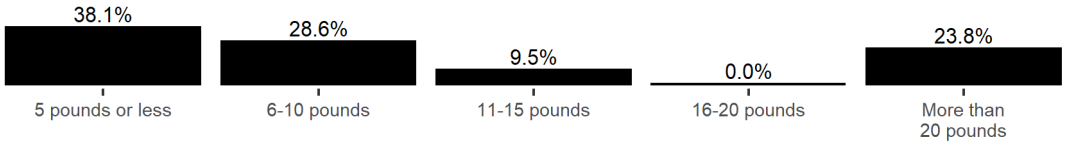
B13. What is the <u>average</u> weight of the cargo you carry on a flight ***in pounds***?

n	mean	sd	min	max	median
21	4.67	4.22	2	20	3



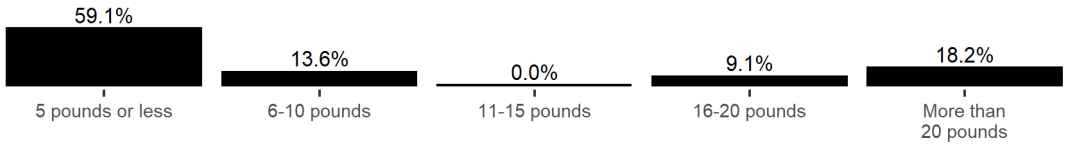
B14. What is the <u>maximum</u> weight of the cargo you carry on a flight ***in pounds***?

n	mean	sd	min	max	median
21	81.86	225.23	3	1,000	7



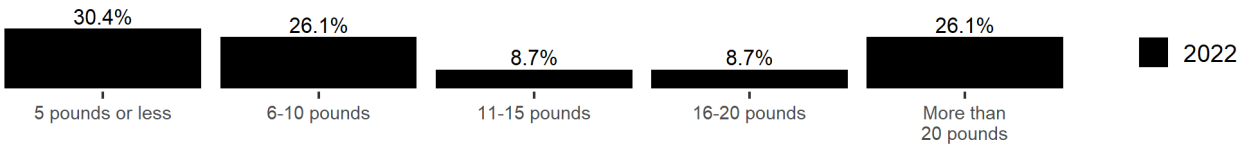
B15. What is the <u>anticipated average</u> weight of the cargo you carry on a flight ***in pounds***?

n	mean	sd	min	max	median
22	78.91	231.44	2	1,000	5



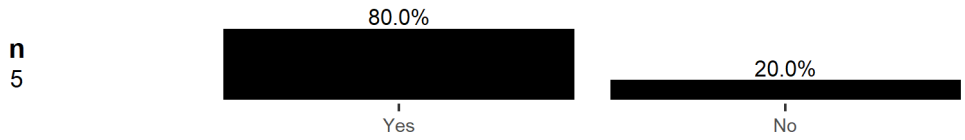
B16. What is the <u>anticipated maximum</u> weight of the cargo you carry on a flight ***in pounds***?

n	mean	sd	min	max	median
23	284.26	1,049.59	3	5,000	10



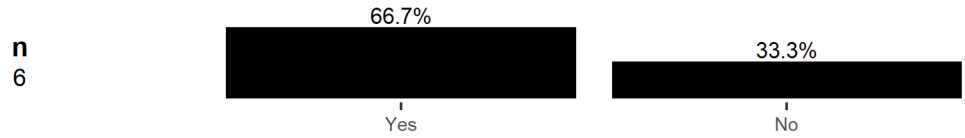
Results for *Item B17* through *Item B23* include only respondents who indicated 'Yes' on *Item B10*.

B17. Will there be someone to assist passenger(s) with getting into the aircraft?



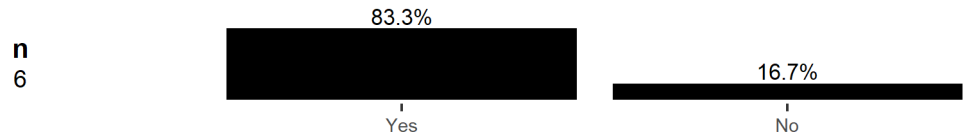
B18. Will there be someone to assist passenger(s) with their safety harness/seat belt?

B19. Will someone provide a passenger(s) safety briefing before the flight?



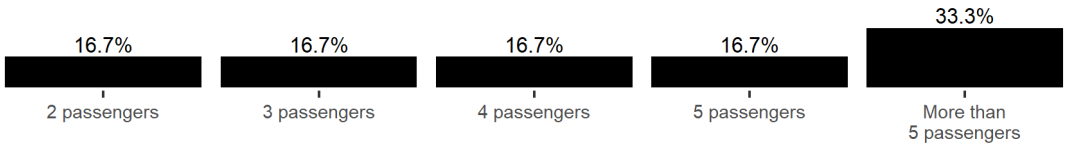
B20. Will there be someone available on the ground to communicate with passenger(s) during the flight?

B21. Will there be someone to assist passenger(s) out of the aircraft?



B22. What will be the maximum number of passengers per trip?

n	mean	sd	min	max	median
6	5.83	4.71	2	15	4.5



B23. Will passengers be able to bring baggage?

n
6

Results for *Item B24* through *Item B36* include only respondents who indicated 'Passenger Transport (Air Taxi)' on *Item A5*.

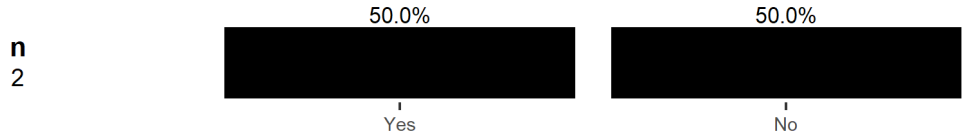
B24. Which of the following items will be available to the passenger(s) during the flight? *[mark all that apply]*

	n
2022	2

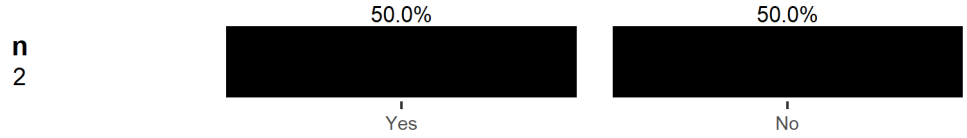
2022 n*		2022 %*
2	Emergency call button	100.0
2	Sick bags	100.0
2	Fire extinguisher	100.0
1	Oxygen masks (protection against smoke or odors in cabin)	50.0
2	Air bags	100.0
2	Passenger-initiated land immediately button or switch	100.0
0	None of the above	0.0

n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

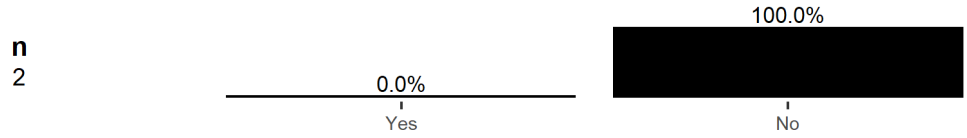
B25. Should the aircraft be equipped with an aircraft parachute?



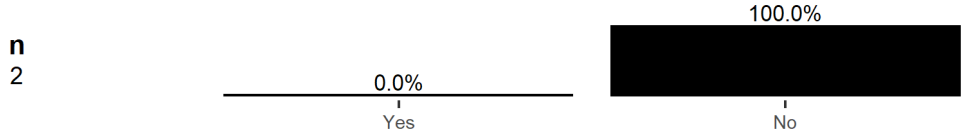
B26. Will unaccompanied minors (children under age 18) be allowed?



B27. Will passengers be able to open the door during flight?



B28. Will passengers be able to open a window?



B29. If someone will be available to communicate with during the flight, would that communication be:

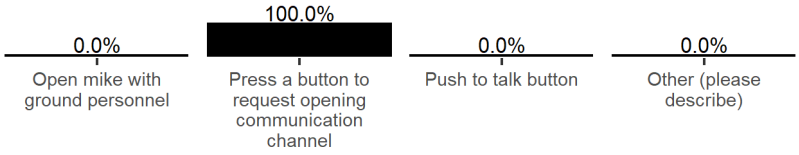
Results for *Item B29a* include only respondents who indicated 'Other' on *Item B29* and provided a written response.

B29a. Other, please describe: (See Appendix B for a list of responses)

	n
2022	1

B30. If communication is available, how will that communication be initiated?

n
2



Results for *Item B30a* include only respondents who indicated 'Other' on *Item B30* and provided a written response.

B30a. Other, please describe: (See Appendix B for a list of responses)

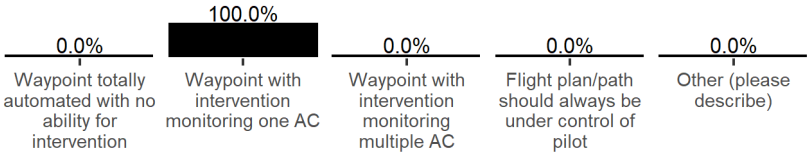
	n
2022	0

B31. Will there be an indication of flight progress available to the passenger?

n
2

B32. Within the next few years (between now and the year 2025), what level of automation should be allowed for these types of flight operations?

n
2



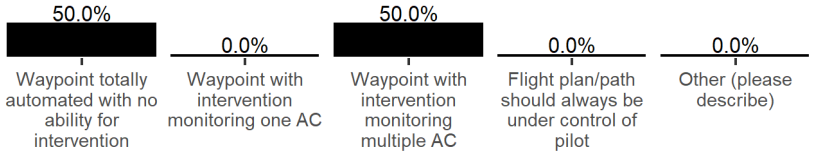
Results for *Item B32a* include only respondents who indicated 'Other' on *Item B32* and provided a written response.

B32a. Other, please describe: (See Appendix B for a list of responses)

	n
2022	0

B33. Beyond the next few years (after the year 2025), what level of automation should be allowed for these types of flight operations?

n
2



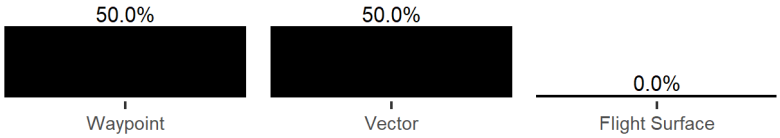
Results for *Item B33a* include only respondents who indicated 'Other' on *Item B33* and provided a written response.

B33a. Other, please describe: (See Appendix B for a list of responses)

	n
2022	0

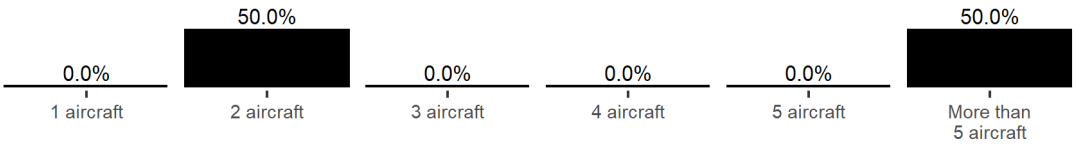
B34. If remote pilot control is possible, what should be the lowest level of flight control automation available to the remote pilot?

n
2



B35. If a remote pilot is monitoring multiple aircraft, how many aircraft should be monitored (maximum)?

n	mean	sd	min	max	median
2	6.00	5.66	2	10	6



B36. Should the aircraft be equipped with a fire suppression system?

n
2

Appendix B.
Responses to Text-entry Items

The FAA constructed a survey to gather information about the current state of Unmanned Aircraft Systems (UAS) operations considered relevant to air carrier flight activities. The survey examined four areas related to UAS operations: operator knowledge, skills, and tests; duty and rest; training requirements; and crew and staffing requirements.

The items addressing crew and staffing requirements included 18 open response items formatted for text entry. These items typically asked respondents to explain the job roles and crew and staffing requirements for UAS operators within their organization. Of those 18 open response items, four had no responses and are not presented in this report: B11a, B30a, B32a, and B33a. Item B7 assessed other automation functions not listed in item B6 that were available (B7a; Table B10) or required (B7b; Table B11) on the respondent's aircraft.

This appendix provides responses for the remaining 14 UAS crew and staffing open response items. These are verbatim responses with the exception of removing any personally identifying information and expletives, as needed.

A. Demographics

Item A1a, Table 12; *Item A1b,* Table 13; *Item A4*, Table 14; *Item A5a*, Table 15; *Item A7a*, Table 16; *Item A8a*, Table 17; *Item A9a*, Table 18.

B. Air Carrier Operational Considerations for Unmanned Aircraft Systems

Item B1a, Table B8; *Item B4a*, Table B9; *Item B7a*, Table B10; *Item B7b*, Table B11; *Item B8a*, Table B12; *Item B12a*, Table B13; *Item B29a*, Table B14.

For all tables, each new comment is denoted by an asterisk (*) in the far left column.

Section A: Demographics

Item A1 asked for the primary job role of the participant. Respondents who indicated 'Other' were asked to describe the job role (A1a) as well as the main responsibilities of the job (A1b), Table B1 and Table B2, respectively.

Table B1

Responses Provided by Participants Who Indicated 'Other' on Item A1, and Who Provided a Description of Their Job Role (n = 13)

A1. Currently, what is your <u>primary</u> job role? (required) *Other (please describe)*	
a. In brief, please describe your job role:	
*	Business Owner
*	CEO
*	Director, UAS Flight Operations
*	I am a Detective with the Sheriff's Office and also the lead UAS pilot/program coordinator
*	I am the VP of our company, and manage, operate and maintain UAS above and below 55 lbs
*	Marketing Manager
*	Operations and also Pilot
*	owner/exec
*	Part 141 assistant chief flight instructor, airplane
*	Pilot and Manager of pilots
*	Public Safety Representative
*	Research UAS applications, and in that also pilot, but also instruct
*	Supervisor and Pilot/Operator of systems equal to/less than 55 pounds.

Table B2

Descriptions of Job Responsibilities Provided by Respondents on Item A1b (n = 166)

	A1b. In brief, please describe the main responsibilities of your job:
*	• Working with engineers and former NASA astronauts by researching, preparing and producing media content (Videography, Photography, and/or Drone Content, etc.) for documentation, training, promotion, sales, and other communicative purposes for both internal and external audiences. • Monitor and track manufacturing schedule of important programs • Remote camera operations for static tests

A1b. In brief, please describe the main responsibilities of your job:	
*	As a professor of Aeronautical Science teaching our Bachelor of Science in Unmanned Systems Applications and our Master of Science in Unmanned Systems at [University], I teach the concepts about UAS operations and safety management. Later, in advanced classes, I lead students through applications of UAS-related student projects.
*	As CEO of our Part 107 test prep and drone flight instruction company, I manage each of our key team members and set strategy.
*	As operations manager, prepare estimates for clients to obtain traffic data for engineering companies.
*	AS President I run the business and co-manage field operations which I also participate in at times
*	Associate professor providing ground and flight instruction utilizing sUAS.
*	Build and fly drones for various government sponsors.
*	Camera operation and weapons guidance on the MQ-9
*	CEO/Owner [Company] an unmanned systems and services company
*	Chief pilot and instructor, also cfi/i/mei/agi for small growing company, I bring the mindset of GA part 61 aviation and apply to part 107
*	Chief Pilot, team management as well as current/qualified RPIC
*	Co-designee, develop, edit, and author Unmanned Aerial System (UAS) training programs. Ensure federal, state, and local law regulatory compliance for all administrative and operational documents. Ensure all Safety Management System (SMS) administrative and operational documents meet all regulatory guidance standards. Perform academic, hands-on system training, and various UAS simulation and flight operations instruction for civilian (foreign/domestics), military (foreign/domestics), and other governmental agencies.
*	Co-Founder of [Company]. I am responsible for business development and the managing member of the company. I join the crew on service jobs, provide instructional training and work with the Airborne Public Safety Association on the NIST sUAS Standard Test Methods program.
*	Conduct training and evaluations for a P135 UAS operation. I also participate in flight operations.
*	Contract MQ-9 Pilot/Instructor for the U.S. Air Force, [Address]
*	COO - Operations Management. Flight planning, drone operations and maintenance, planning and development, FAA and waiver management.

A1b. In brief, please describe the main responsibilities of your job:	
*	Coordinate Geospatial program at the college and other public safety programs.
*	Criminal Division Commander, UAS Program Commander
*	Curriculum development and instruction
*	Define operational requirements form local missions. Maintain your aircraft and log flights. Tran our group of volunteer spotters in operations and safety standards
*	Department Chair over the training for our UAS dept.
*	Deputy Director of Emergency Management for a County government
*	Develop and disseminate testing procedures and standards for response robotics.
*	Develop core competencies for UAS operators and sensor operators; help select equipment to meet mission requirements; train operators; obtain all necessary approvals; oversee safety; responsible for safe and effective execution of the mission.
*	Develop, maintain and teach and 1 year UAS certificate program at a community college
*	Direct a non-profit that facilitates the use of unmanned technologies for environmental research and monitoring.
*	Director of Operations
*	Director of UAS Operations and Safety - Review operational safety plans, set policies and procedures for drone use, provide flight instruction and analyze safety metrics.
*	Director of UAS Programs. EP for grp 1-3 UAS, Primary UAS Instructor
*	Drone & field operator flying under and above the canopy as well as conducting radio tower inspections
*	Drone Pilot for [University] Extension Communications Department for Photo and Video purposes
*	Emergency Management
*	Ensures that all flight operations are conducted safely and in compliance with all FAA regulations, OpSpecs and company policies. Coordinates with the POI on regulatory requirements and OpSpecs, to ensure the highest level of safety and regulatory compliance.
*	Executive Director, [Company], [Company], responsible for "all things uncrewed" for the [Company].
*	Filming and editing all videos for my organization
*	Flight and regulatory instructor for a UAS training company.

	A1b. In brief, please describe the main responsibilities of your job:
*	Flight instructor for public safety UAS
*	flight of uav in response to wildfires
*	Flight operations and mission planning
*	Flight Operations Manager: I manage upwards of 15 pilots currency and medical requirements, as well as a fleet of SUAS.
*	Flying for the film industry
*	Founder and President of [Company], a drone service company that specializes in provide aerial film to sports teams.
*	Geospatial Program Manager and sUAS Pilot and Data Specialist for Emergency Responses.
*	GIS Administrator for company. Gathering, managing data and imagery.
*	Help teach the teacher and kids in school about drones and the rules to govern them
*	I am a Director of the [University] Drone Center. A research based educational center that build, maintains, operates, educates, integrates, and provides training with UAS systems.
*	I am a drone operator and program administrator for the UAS program of the [Company].
*	I am a professor and department chair in the Department of Wildlife at [University] (aka [University]), as well as a Principal Investigator for projects run through [University] Sponsored Programs Foundation. For two of my projects, I serve as the primary UAS pilot for externally-funded research - it is this role that I am writing about in the survey.
*	I am a professor at a university. My primary responsibilities include developing course content, instructing in a lecture setting, instructing in a project setting, supervising a UAS instructor team, grading, advising, and mentorship.
*	I am a scientist that uses drones for animal surveys, we have agency oversight that liaises with the FAA and has established further protocols in addition to part 107
*	I am a software engineer. I develop web based applications and streaming systems to deliver content to paid students.
*	I am a Video Producer/Director at a local PBS affiliate TV station tasked with producing commercial/educational content for public broadcast.
*	I am primarily a civil engineer (previously engineer in training). I maintain a Remote Pilot Certification for the purpose of operating a small UAS for land surveying purposes. I develop plans for surveys including verifying airspace, altitudes, and planning ground control point locations. I often act as the person manipulating the controls for the small UAS as well.

A1b. In brief, please describe the main responsibilities of your job:	
*	I am responsible for building our drone fleet for last mile delivery and other applications
*	I am responsible for the operation of the UAS. I collect assets typically video footage used for marketing purposes. I then edit the footage into marketable deliverables and deliver them to the client. I also serve as my companys software engineer providing web development support as needed.
*	I am the aviation coordinator and UAS pilot for a large agency.
*	I am the Deputy Chief of Special Operations, Research and Training. I supervise our UAS Unit.
*	I am the Director of [Company] UAS Flight Operations. I am a SME for UAS Operations worldwide both Civil and Military. I design UAS flight operations Airspace, and the Documented Programs of record.
*	I am the drone RPIC that operates and performs various drone jobs.
*	I am the founder/CEO of [Company]. We are a Drone Technology company. I am an FAA Part 107 Pilot having flown 4,000 UAS missions
*	I am the Leadin Instructor for the [Company] Fire Academy UAS program
*	I am the Lieutenant and Program Manager of our Aviation Unit.
*	I am the owner of a Drone Service Provider company, [Company name].
*	I am the program coordinator, curriculum designer, and lead instructor at a university UAS degree program.
*	I am the UAS Program Manager and lead FAA Part 107 Pilot in our organization.
*	I am the UAS Program Manager for a collegiate UAS program. I develop and oversee the training for students and professionals
*	I am [Company] COO - responsible for national operations and flight management for our UAS systems.
*	I build, own, and operate 12 electric and gas powered RC aircraft and helicopters, some with FPV or HD recording cameras. I operate these under the FAA rules, and with AMA insurance as provided by my RC flying organization, of which I am the Vice President.
*	I co-coordinate the drone certificate and degree program at [Name] College. I teach students how to operate drones and process drone data for mapping and surveying applications.
*	I handle sensor integration as well as airframe design. Over the development of the platform I train and educate or internal personnel.

	A1b. In brief, please describe the main responsibilities of your job:
*	I lead the unmanned systems division within a large industrial services company. I oversee operations, sales, and the backend business in general.
*	I manage DOD programs and several are either UAS or C-UAS customers.
*	i manage FPL's drone organization that is responsible for the safety, training and integration of UAS into the company and also all FAA waivers and authorizations as well.
*	I manage our UAS program. I am responsible for developing new uses for drones in our organization and am generally responsible for managing our fleet.
*	I oversee advanced technology Initiatives within the [Company], including oversight and management of the [Company] and oversight of the [Company] participation in the FAA BEYOND program (the [Company] is the only tribal lead participant in the BEYOND program).
*	I provide private training for customers of small, medium, and large businesses to adopt drones, learn the Part 107 test, and develop workflows for UAS mapping, GIS analysis, data collection, and inspection.
*	I run the drone studies program at [Name] Junior College, including course development and delivery.
*	I teach young research students how to become FAA Part 107 certified and how to operate UAVs.
*	I train unmanned aircraft system pilots in Part 107 rules and regulations in order to get them ready for the written qualification test.
*	I work as a City emergency manager as well as a communications specialist.
*	I'm the Vice President of our company. I operate drones, operate payloads, maintain, and manage drones for inspection purposes. Above and below 55 lbs. I used to fly for government contracts overseas in the SUAS, and MEUAS fields
*	I'm a Land Surveyor and on some jobs we use a drone to capture imagery above the site. Sometimes we build an orthomosaic from the drone photos and sometimes we build a 3D model with the drone photos using Structure from Motion software to get X, Y and Z data of features on the site.
*	IN FIELD PIOT RESPOSIBLE FOR MULTISPECTRAL INSPECTION OF AGGRIGULTURE
*	Instruct
*	Instruct military/civilian personnel on the use of UAVs

	A1b. In brief, please describe the main responsibilities of your job:
*	Instructing UAS systems for military
*	Instructor & Evaluator. When new pilots join the team, I will assist in ground training, application training, drills, and on-the-job training. Once they have met the minimum requirements, I conduct checkrides which are oral and practical, as well as conducting annual line and competency checks.
*	Instructor MQ-9 Launch & Recovery Pilot, Instructor MQ-9 Mission Control Element Pilot, USAF
*	Instructor sensor operator operating and teaching camera manipulation, synthetic aperture radar use, and other equipment usage
*	Investigate felony level crimes UAS Program coordinator/lead UAS pilot
*	IT director for a construction company
*	Launch and recovery instructor for sensor operators. In an FTU school house
*	Lead a 4 man operations of a Group 3 UAS
*	Lead electrical and firmware engineer for avionics, chief UAS pilot, CEO.
*	Maintain automation for building and lighting energy consumption. Maintain HVAC equipment controls and I use the drone to do visual assessments on buildings faster and more economical for building sustainability
*	Maintain Clients Fly and Maintain Aircraft Compliance
*	manage a team of pilots worldwide with the largest number in the USA.
*	Manage global Company Unmanned Aerial System program consisting of over 100 drones of various types and more than 100 drone operators operating in four countries focused on supporting mining activities.
*	Manage group of pilots charged with selling, supporting sUAS.
*	Manage team of UAS pilots performing public safety and commercial UAS flights.
*	Manage the curriculum and resources for [Name] University's UAS, aviation maintenance, and aviation administration programs.
*	Managing Member/Chief Pilot of an Agricultural Aerial application Company
*	My company works with private corporations and government entities looking to establish drone programs. We write the SOP's, safety procedures, train the trainer programs, risk mitigation strategies, assist in identifying platforms that satisfy their use-cases and finally manage/oversee the programs (fleet, pilots, software, etc.).

A1b. In brief, please describe the main responsibilities of your job:	
*	Oil and Gas Training, including drone training.
*	Operate a commercial delivery drone
*	Operate an MQ-9 Reaper as pilot-in-command; conduct intelligence collection (ISR) and precision strike as required in pursuit of US interests and Joint Forces Air Component Commander objectives
*	Operate drones
*	Operate the gimbal and sensor on the aircraft. Assist pilot with checklists and scanning GCS instruments and warnings. Assist pilot in scanning for traffic during critical phases of flight. Fly the aircraft and operate the sensor payload when using aircraft that do not require a 2 person crew.
*	Operate UAS drone
*	Oversee the management of our UAS program
*	Owner of aerial imagery company using Mavik 2 and 3 drones
*	owner operator of commercial drone business oversee day to day operations and pilots I also am licensed and can do pilot work
*	owner/Executive: President, Flight Operations
*	P107 certified pilot for company Service jobs. VO for company Service jobs. Sales director for USA retail business. Sourcing and Supply chain manager. Office Administrator.
*	Part 107 pilot, cinematographer and photographer.
*	Part 141 Assistant Chief Flight Instructor, airplane
*	Pilot
*	Pilot drone for forest data collection. Chief pilot responsible for compliance with national airspace.
*	Pilot drone for land survey
*	Piloting RC helicopters, quadcopters, hexacopters, and fixed wing aircraft and full size fixed wing aircraft for aerial photography, videography and 3D modeling.
*	Plan and operate drone operations
*	plan, coordinate and supervise the completion of drone flight operations.
*	Police Supervisor over traffic Team. Team employs sUAS platforms for crash/crime scene documentation.

A1b. In brief, please describe the main responsibilities of your job:	
*	Primary Part 107 Certified pilot and trainer.
*	Professor and Director of Research Laboratory (teaching, research, and service)
*	Professor, Information Systems and Aviation Studies Department [Name] Community College
*	Provide leadership to a collegiate aviation program.
*	Provide Search and Rescue services to [County]
*	Provide UAS instruction relating to UAS Operations. Serve as the university UAS Operations program coordinator.
*	Provide uas training to disabled veterans for commercial operations and adaptive recreational therapy utilizing drones
*	Provide water rescue service to the town of [County]
*	Providing contract training and consulting to major UAS company.
*	Public Safety Agency UAS Representative
*	Rated aviator, RQ-7 Shadow operator. Engineer for design of survivability requirements for Army FUAS systems.
*	Regulatory compliance
*	Remote PIC of sUAS aircraft for residential survey work
*	Remote Sensing Lead at [Company], LLC and Manager, University of [Name] Drone Lab
*	Research scientist/professor
*	Research UAS applications, build and flight test instrumented UA, instruct students
*	Responsible for developing targeted strategies to promote [Company] and all its divisions including Charter, Production, Electronic News Gathering (ENG), Air Medical, Aircraft Management, and Technology Solutions for Law Enforcement Agencies.
*	Sales Manager/COO I take aerial photos for construction projects for both estimating and marketing.
*	Sensor Operator Evaluator and Instructor for MQ-9A. Performs, evaluates and instructs MQ-9A launch and recovery operations worldwide. Performs, evaluates and instructs mission support element IMINT, SIGINT and ELINT devices onboard MQ-9A.
*	Standardization Instructor Operator
*	SUAS instructor

	A1b. In brief, please describe the main responsibilities of your job:
*	sUAS Operations and maintenance Instructor/ Large UAS maintenance instructor
*	Submit Waivers and ATC Authorizations under FAR Part 107. Support staff with reviewing airspace and interpreting FARs. Review all incident and accident reports and council pilots as needed. Assist with staff hiring, write articles for the company email newsletter, and provide online training to pilots.
*	Supervise our UAV program and am a part 107 licensed pilot.
*	[Name] training specialist
*	Takeoff and landing copilot, checklist reading, data monitoring, camera manipulation. During flight- aircraft monitoring, communications and camera manipulation.
*	Teaching computer programming, manufacturing, and system integration
*	Technical Director Archaeology and Drone Pilot for research
*	The main responsibilities of my job are to oversee production of a local community access station and the department that runs the drone division.
*	The Owner and operator.
*	To test new configurations of a VTOL aircraft, and maintain proficiency in the event a contract requires deployment.
*	To train and educate potential drone pilots in the safe operation of sUAS.
*	Training public safety on drone use, regulation, and policy. Also curriculum development
*	UAS Coordinator and Remote Pilot
*	UAS Detail Coordinator for the [Company] State Police
*	UAS operations over agricultural land. We are a team of 15 operators.
*	UAS safety standards instructor and flight trainer for potential Part 107 pilots and Part 107 pilots.
*	UAS Standardization Pilot
*	UAV pilot / aerial videographer, photographer
*	UAV remote pilot in command for LLC. Research assistant professor.
*	We are a marketing firm that also specializes in content generation where we use drones to aide in the visuals for people to identify with local business.
*	Work with public safety agencies to start and expand UAS programs. COA writing, trainer, pilot.

A1b. In brief, please describe the main responsibilities of your job:	
*	[Company] is a drone delivery platform.

Table B3

Responses Provided by Participants who Indicated 'Works with drones, but none of the above' on Item A3, and Who Provided the Capacity in Which Their Organization Worked with Drones on Item A4 (n = 38)

A3. The organization that I work for is, or plans to be, a: *[mark all that apply]* (required) *Works with drones, but none of the above (please describe)*	
A4. In what capacity does your organization work with drones?	
*	Animal and environment surveying
*	capture college event images
*	Crime scene reconstruction, search and rescue
*	Develops the standards for drones and pilots to be evaluated in the us and abroad.
*	Drone service operator, but not for monetary compensation.
*	Emergency services
*	Federal Emergency Responses
*	Full spectrum of operations including public safety, agriculture operations, GIS, research and development, and marketing/communications.
*	Gathering updated aerial imagery and asset inspection.
*	In support of Military Operations
*	Land surveys
*	Law Enforcement/First Responder
*	less than 55 LBS
*	Local government use for public safety (not for-profit)
*	Military
*	national defense and security
*	Owner/Operator as a hobby.
*	Photo/Video/Agriculture and Natural Resources
*	Police drone operator.
*	Public Safety
*	Public Safety Agency
*	Public Safety Agency using Drones for law enforcement purposes

A3. The organization that I work for is, or plans to be, a: *[mark all that apply]* (required) *Works with drones, but none of the above (please describe)*	
A4. In what capacity does your organization work with drones?	
*	Research
*	search and recon
*	Supplies worldwide ready MQ-9A aircrew for DOD.
*	Supporting UAS Government Programs including the FAA.
*	survey jobsites, create 3d models from drone pictures
*	Use the camera and maneuverability to assess rooftops and maintenance
*	Uses drones as tools for scientific research
*	We are a public safety/law enforcement entity. We use drones for in-progress emergencies, planned large-scale events, and video/photos for evidence and promotional items.
*	We are a state agency that utilizes drones for environmental uses and also for search and rescue and documentation of different work activities.
*	We are an archaeological unit and use drones to look at the landscape
*	We use drone for search and rescue
*	We use drones for aerial footage to enhance our projects/videos for community based pieces.
*	We use drones for life safety missions.
*	We use drones to enhance operational efficiency and safety aspects of various mining operations.
*	We use drones to film.
*	We use them for searches, crime/accident scene photography/videography, and over watch

Table B4

Responses Provided by Participants who Indicated 'Other' on Item A5, and who Described Their Organization's Current or Planned Drone Operations (*n* = 13)

A5. Please select the industry or sector that best describes the current or planned drone operations of your organization: *[mark all that apply]* (required) *Other (please describe)*	
a. Other industry or sector, please describe:	
*	all public safety

A5. Please select the industry or sector that best describes the current or planned drone operations of your organization: *[mark all that apply]* (required) *Other (please describe)*	
a. Other industry or sector, please describe:	
*	Athletics
*	construction
*	Film
*	Imagery for large property management companies and building owners
*	Law enforcement
*	Natural Resources Monitoring
*	Providing adaptive recreational drone therapy for neurological disorders like TBI, and PTSD to name a few.
*	Residential Construction
*	Search and Rescue
*	Space Industry
*	Tribal Government
*	We fly for fun.

Table B5. *Responses Provided by Participants who Indicated 'Other' on Item A7, and who Described the Certificates They Hold* (n = 14)

A7. Which of these certificates do you hold? *[mark all that apply]* *Other (please describe)*	
a. Other certificate(s), please describe:	
*	ATP
*	ATP, commercial, single and multi-engine land.
*	CFI
*	CFI, CFII
*	Commercial Cert and CFI.
*	FAA Class II certification to perform MQ-9A senor operator LR and MCE duties.
*	Flight Instructor, Airplane Single Engine, Airplane Multi-Engine, Instrument Airplane
*	Former military officer/pilot

A7. Which of these certificates do you hold? ***[mark all that apply]*** *Other (please describe)*	
a. Other certificate(s), please describe:	
*	My 14 CFR Part 107 certificate expired in SEP 2018 and is not needed in my current position. I am trained, certified DCMA Military UAS Pilot (equivalent).
*	Part 137 Agricultural Operations for UAS Part 61 Student Pilot Certificate
*	Part 61 student pilot certificate
*	PPL, CPL, ATP
*	Technical training…aircrew fundamentals initial qualification training, launch and recovery training
*	[Company] Crew Member- Operator and Maintainer

Table B6

Responses Provided by Participants who Indicated 'Other' on Item A8, and who Described the Certificates Required for Their Job (*n* = 12)

A8. Which of these certificates are required for your job? ***[mark all that apply]*** *Other (please describe)*	
a. Other certificate(s), please describe:	
*	Basic Law Enforcement Academy certificate of completion.
*	Commercial
*	Experience satisfies the requirement for the company. Flown a variety of UAS for 10 years
*	FAA Class II certification.
*	I fly under the FAA rule 49 USC 44809
*	My 14 CFR Part 107 certificate expired in SEP 2018 and is not needed in my current position. I am trained, certified DCMA Military UAS Pilot (equivalent).
*	No certificate required, just training provided by employer.
*	None
*	OSHA 10, OSHA 10 Construction.
*	PPL, CPL
*	SUAS certification

A8. Which of these certificates are required for your job? ***[mark all that apply]*** *Other (please describe)*	
a. Other certificate(s), please describe:	
*	[Company] Crew Member- Operator and Maintainer

Table B7. *Responses Provided by Participants who Indicated 'No, I hold a certificate(s) from another organization' on Item A9, and who Listed the Certificates They Hold from Another Organization* (*n* = 18)

A9. Do you hold a Trusted Operator certificate from the Association for Unmanned Vehicle Systems International (AUVSI)? *No, I hold a certificate(s) from another organization (please describe)*	
a. What certificate(s) do you hold from another organization? Please describe.	
*	Advanced Safety Levels One and Two Certificates from the Unmanned Safety Institute.
*	advanced sUAS operator, payload operator, [Company] Drones, Inc. National Emergency Services Academy - advanced sUAS course graduate
*	Aerial Applicator [Company]
*	AMA pilot
*	AMA Pilot instructor
*	FAA Part 107
*	FAA UAS
*	I have FAA approval [Number] for aircraft less than 55 lbs. I am AMA Member # [Number]
*	I hold a Safety Certification from Unmanned Systems Institute
*	Military Form 8, MQ-9 Instructor Pilot
*	Multiple UAS platform certifications, Instructor certification, Standardization certification, multiple UAS autopilot certifications, safety certification, laser operation certification, crash investigation certification
*	NCDOT UAS Operator Permit
*	NIST sUAS Standard Test Methods (1) Basic Proficiency; (2) Advanced Proficiency; and (3) Instructor Certificate issued by the Airborne Public Safety Association
*	NIST sUAS Standard Test Methods BPERP and Instructor.

A9. Do you hold a Trusted Operator certificate from the Association for Unmanned Vehicle Systems International (AUVSI)? *No, I hold a certificate(s) from another organization (please describe)*	
a. What certificate(s) do you hold from another organization? Please describe.	
*	PRO Level 3 from Unmanned Safety Institute, OSHA 30, 50+ FEMA certifications, Master UAS Instructor from USI, Certified SAR Drone Pilot with the Civil Air Patrol
*	Qualifications through the military
*	Safety, VLOS, systems and BVLOS certificates from the Unmanned Safety Institute (USI)
*	Unmanned Safety Institute PRO Pilot/Instructor

Section B: Air Carrier Operational Considerations for Unmanned Aircraft Systems

Table B8

Responses Provided by Participants who Indicated on Item B1 that More Than One Crewmember was Needed for a Flight Operation, and who Listed the Crewmembers Needed for a Flight Operation Based on Their Organization's Policy (*n* = 73)

B1. What is the <u>minimum</u> number of crewmembers needed for a flight operation according to your organization's policies?	
a. Please list the crewmembers needed for a flight operation according to your organization's policy:	
*	1- Ground crew 1- Pilot
*	1. Remote Pilot 2. Observer
*	2
*	2 Operators, and 2 co-operators
*	3x Maintenance 1x pilot
*	For a more advanced soot, a Visual Observer (VO) and UAV Pilot are needed for a flight operation.
*	For LR operations we require 1 pilot, 1 sensor operator and 1 safety observer. For MCE operations we require 1 pilot and 1 sensor operator.
*	Ground Station tech. Pilot in command

B1. What is the <u>minimum</u> number of crewmembers needed for a flight operation according to your organization's policies?	
a. Please list the crewmembers needed for a flight operation according to your organization's policy:	
*	ground support x2, PIC/ OIC x1, Safety Officer x1, Operator x1
*	[Name], and [Name]
*	One Part 107 Pilot in Command and one Visual Observer
*	Operator and Visual Observer
*	Part 107 Certified Pilot Visual Observer
*	PIC & VO
*	PIC and observer
*	PIC, VO
*	Pilot Sensor Mission Commander/Coordinator Maintenance
*	Pilot VO
*	Pilot & VO but depends on the technical aspects of the shoot. this changes daily and by location.
*	Pilot , ground support and spotter
*	Pilot and additional observer
*	Pilot and Camera Operator or Instructor and Student Pilot
*	Pilot and Observer
*	Pilot and payload operator
*	Pilot and sensor
*	Pilot and sensor operator
*	Pilot and Sensor Operator
*	Pilot and sensor operator or dual pilot.
*	Pilot and sensor payload operator
*	Pilot and spotter
*	Pilot and spotter
*	Pilot and Spotter

B1. What is the <u>minimum</u> number of crewmembers needed for a flight operation according to your organization's policies?	
a. Please list the crewmembers needed for a flight operation according to your organization's policy:	
*	Pilot and Visual Observer
*	Pilot Camera Operator Ground Coordinator
*	Pilot in command and a visual observer
*	Pilot in Command and a Visual Observer
*	Pilot in Command, spotter
*	Pilot in Commander Visual Observer(s)
*	Pilot Manipulating the Controls Visual Observer to assist the pilot and provide additional safety
*	Pilot, flight engineer, standby
*	Pilot, Payload operator
*	Pilot, sensor operator, operations supervisor
*	Pilot, technician, camera operator
*	Pilot, Visual observer
*	Pilot, VO
*	Pilot, vo, cameraman
*	Pilot-in-charge Visual observer
*	Remote Pilot in Charge and Visual Observer
*	Remote Pilot in Command and Designated Observer
*	Remote pilot in command and visual observer.
*	Remote Pilot in Command Visual Observer
*	Remote Pilot in Command, Remote Sensor Operator
*	remote pilot in command, spotter observer, equipment manager
*	Remote pilot, visual observer
*	RPIC - VO
*	RPIC & VO

B1. What is the <u>minimum</u> number of crewmembers needed for a flight operation according to your organization's policies?	
a. Please list the crewmembers needed for a flight operation according to your organization's policy:	
*	RPIC (Remote Pilot In Command) VO (Visual Observer) PO (Payload Operator)
*	RPIC 1/VO 1, RPIC 2/VO 2
*	RPIC and Flight Operator (i.e., ground crew)
*	RPIC and RVO
*	RPIC and VO
*	RPIC VO *However, oftentimes, other roles present: PMC, crew chief, multiple VOs, etc. However, SOPs dictate 2 minimum.
*	RPIC, flight operator, maintenance technician
*	RPIC, Visual Observer
*	RPIC, VO
*	RPIC, VO
*	RPIC, VO, and Ground Technician
*	Student Instructor
*	Visual line of sight operator and drone operator
*	visual observer
*	Visual observer
*	Visual Observer, RPIIC
*	VO Data Specialist

Table B9

Responses Provided by Participants who Indicated 'Other' on Item B4, and who Described the Kind of Drones Being Operated (*n* = 7)

B4. What kind of drones are you operating? *[mark all that apply]* Other (please describe)	
a. Other, please describe:	
*	DJI Mavic 3

B4. What kind of drones are you operating? *[mark all that apply]* *Other (please describe)*	
a. Other, please describe:	
*	Mostly quadcopters
*	Multicopter
*	Quad
*	quad copter VTOL drones
*	quad rotor
*	Quadcopter - DJI Phantom

Item B6 assessed whether automated functions were required, and if they were available. These functions included Takeoff, Flight Path, Hover or Holding Pattern, Obstruction Avoidance, Traffic Collision, Lost Link, Return Home, and Landing. Item B7 asked if the respondent's aircraft had other automated functions (not listed in item B6) that were available or required. Those respondents who indicated 'Yes' were asked to describe the available (B7a) or required (B7b) automation, Table 21 and Table 22, respectively.

Table B10

Responses Provided by Participants who Indicated 'Yes' on Item B7, and who Listed Other Available Automation (n = 14)

B7. Are there other functions not listed in the previous question that are available or required for your aircraft? *Yes (please describe)*	
a. Other available automation:	
*	ADS-B receiver Redundant Flight Systems
*	Auto-Divert to closest practical field.
*	Autopilot altitude hold, airspeed hold, and heading hold
*	DJI Intelligent Flight Modes Skydio flight modes
*	Geo-Fencing, SATCOM, Cellular, Lost Comm,
*	hover, Return to Landing
*	Parachute emergency landing

B7. Are there other functions not listed in the previous question that are available or required for your aircraft? *Yes (please describe)*	
a. Other <u>available</u> automation:	
*	position hold from visual inertial odometry (VIO)
*	Remote ID
*	sensor operation
*	Swarm Mapping
*	Various pre-defined photographic and video flight regiments
*	Visible markers or lighting for waivered missions beyond the agency's max distance from ground control station
*	Your question only assumes one UA is flown at the organization. For training, we use UA that have no automation. Later, we use UA that have autonomous capabilities.

Table B11

Responses Provided by Participants who Indicated 'Yes' on Item B7, and who Listed Other <u>Required</u> Automation (n = 4)

B7. Are there other functions not listed in the previous question that are available or required for your aircraft? *Yes (please describe)*	
b. Other <u>required</u> automation:	
*	Ai Software packages
*	Auto-Divert to closest practical field.
*	Geo-Fencing, SATCOM, Cellular, Lost Comm,
*	sensor operation

Table B12

Responses Provided by Participants who Indicated 'Yes' on Item B8, and who Described the Procedure for Transfer of Controls (n = 70)

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight? *Yes*	
a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.)	
*	3-way positive transfer of controls. The PIC responsibility for the flight does not change.
*	Accomplished via IP address change to facilitate aircraft switching to the next ground control station.
*	After the situation (handover) brief, outgoing pilot gets up from pilot seat and relieving/incoming pilot sits in pilot seat with the same controls and displays available.
*	All crew members must attend appropriate mission brief and be signed off on go-no go procedures. Crew are verbally briefed before crew change out.
*	Both physical and electronic
*	Briefing and checklist turn-over.
*	Current rpic explains drone's current state, shows settings to on coming rpic, explains mission, and any out of the norm operations. On coming pilot repeats all of these things back, and fills out replacement checklist. Normal flight continues
*	Datalink passed to other crew in separate GCS
*	Direct communication between two pilots and physical handoff of controls during stationary flight of rotary-wing aircraft is permitted, but only when necessary.
*	Electronic Switch
*	Electronic switch via controllers.
*	Electronic, hub and spoke operations
*	Ground station (control station) connects via web service so any other ground station with proper network access can view the flight and or request command from another station
*	In-briefing for incoming RPIC, positive exchange of flight controls on one GCS unit
*	Linked transmitters for instructor / trainee may be used for flight monitoring and assistance, where the instructor may take over flight controls as needed or requested.
*	Most platforms it is positive transfer of control, physically handing the controller off to another RPIC. The other platform requires a switch transfer between two ground stations.
*	One crew member gets up and swaps seats at a time.

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight? *Yes*	
a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.)	
*	Our primary operation is Drone as First Responder pilots for multiple agencies. So, a tele operator is manipulating controls and RPIC can take over controls via electronic switch (and communication protocols.)
*	Outgoing pilot places aircraft on holding mission while briefing and changing seats with incoming pilot.
*	Passing of the controller to the other pilot
*	Physical exchange of controls
*	Physical change of controls
*	Physical change of controls with a challenge and response from both pilots.
*	Physical change of controls. Recovery pilot receives brief and assumes flight from adjacent seat to pilot.
*	physical control exchange
*	Physical exchange
*	Physical exchange
*	Physical exchange along with verbal confirmation of command.
*	Physical exchange of controller while the drone is hovering in GPS mode away from any obstacles.
*	physical exchange of controls
*	physical exchange of controls
*	physical exchange of controls
*	physical exchange of controls
*	Physical exchange of controls
*	Physical exchange of controls
*	Physical exchange of controls or a switch between two controllers, we have both.
*	Physical exchange of controls under special circumstances
*	Physical exchange of controls with both pilots acknowledging control (I.E. "I have control.....You have control".

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight? *Yes*	
a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.)	
*	Physical exchange of controls.
*	Physical exchange of controls. Typically does not occur; however, it is possible. Officers would speak with one another and explain the status and mission of the aircraft before handing it over.
*	Physical exchange of GCS
*	Physical exchange only if medically necessary to safely continue and land the UAS.
*	Physical exchange under static RPIC
*	Physical exchange with briefing
*	Physical exchange with positive confirmation of transfer
*	Physical exchange, challenge on response during transfer,
*	Physical relief after turnover
*	Physical Swap of Controls
*	Pilots can swap out mid-flight utilizing the same ground control station or the aircraft can be transferred to another geographically separated ground control station via line of sight or satellite link.
*	Pilots follow a detail checklist starting with a flight brief which covers all parameters to confirm both systems are reading the same data. All, link and signal strengths are covered as well as alternate recover plans before aircraft control is switched.
*	Positive exchange required with callout "I have the controls" Swap of controls or secondary controller may be used
*	Primary Pilot requests control exchange. Secondary pilot accepts or rejects the request. If accepted, primary pilot allows secondary pilot to take control of the aircraft.
*	Procedural handoff from one GCS to another via control link transfer. Fully documented via checklist procedure. Manual Controller has capability to transfer to automated GCS as well.
*	Procedure includes positive three-way transfer of controls from pilot on the controls to the other pilot with verbal acceptance of transitioned controls and acknowledgement of pilot relinquishing control.
*	Set the orbit pattern and release by change of frequency control.

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight? *Yes*	
a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.)	
*	Stop any progress and hover aircraft. Brief incoming pilot while maintaining visual LOS, Physical and verbal exchange of controls, shadow new pilot for initial actions to ensure orientation. Communicate switch to management.
*	Switch control from one controller to another controller
*	System will allow an RPIC to request to take flight. Request needs to be allowed by original RPIC
*	The controller may be occasionally held by another operator during operation. The controller is simply handed from one operator to another
*	The drone is tele operated by a sworn police officer through the CAPE Motorola system.
*	The primary pilot requests relief from PIC. Alternate (certified) pilot assumes PIC function by taking the GCS unit from the relieved pilot.
*	The RPIC will hand the controller physically exchanging control of the drone to the second pilot.
*	This is very rare, but we will conduct a physical exchange of controls
*	Typical 'I have the Controls - You have the Controls' method for verbal transfer of control. Control station physically transferred from one operator to the other.
*	Using a buddy-box trainer set-up, the instructor holds a momentary switch that enables the student's radio. Before the instructor hands over control to the student, he verbally says, "Are you ready for flight controls?" If the student responds with, "Yes, I'm ready for flight controls." Then the instructor activates the switch and says, "You have flight controls," If the student has flight controls, he confirms with, "I have flight controls."
*	verbal and physical exchange with acknowledgement
*	Verbal procedure between pilots.
*	Verbal queue that one pilot has control over the other, followed by physical exchange of controls.
*	Verbal transfer of control checklist accomplished before hand-off of aircraft. Can also transfer aircraft from one station to another using a frequency change

B8. Does your organization permit the transfer of controls or responsibilities from one pilot to another while a drone is in flight? *Yes*	
a. Please describe the procedure (e.g., physical exchange of controls, electronic switch to different set of controls, etc.)	
*	We are a training organization and regularly conduct 1:1 and small group training. Our flight instructors stand next to our students and hand the controls over during the course of training as part of our curriculum.

Table B13

Responses Provided by Participants who Indicated 'Sometimes' on Item B12, and who Described the Anticipated Flight Plans (*n* = 4)

B12. <u>Will anticipated flight plans</u> follow established and mapped flight plans (e.g., published routes and procedures, company-derived flight plans)? *Sometimes, please describe*	
a. Sometimes, please describe if anticipated flight plans will follow established and mapped flight plans:	
*	Flight plans will be dictated by Operating airspace and FAA rules and regulations. We anticipated flight plans will eventually follow established routes and procedures. During development of the US NAS for UAS Operations, we will anticipate higher levels of isolation in terms of airspace and routing, and then a gradual move towards full integration.
*	May need to deviate based on locating subject or identifying new hazard.
*	On automated flights
*	Our business model only has flight as one of three sectors: Training and Sales being the other two (from Services, where we fly). Plan is to move towards package delivery after we secure BVLOS waiver. For package delivery, flight plans will follow established and mapped flight plans.

Table B14

Responses Provided by Participants who Indicated 'Other' on Item B29, and who Provided a Description (*n* = 1)

B29. If someone will be available to communicate with during the flight, would that communication be: *Other (please describe)*	
a. Other, please describe:	
*	Voice is the threshold. Voice and video is the final objective.