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UAS Air Carrier Operations Survey: Fatigue

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Technical Report

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16. Abstract

There is an increasing demand to utilize unmanned aircraft systems (UAS) for new applications currently outside the scope of written regulation, such as taxi services, package delivery, and crop dusting. The Code of Federal Regulations on Aeronautics and Space (14 CFR) are restrictive to air carrier applications for UAS. In particular, small UAS (sUAS) regulations (14 CFR § 107 [Federal Regulation for Commercial sUAS]) do not explicitly address air carrier operations (codified under 14 CFR § 121 [Federal Regulation for Air Carriers and § 135 [Federal Regulation for Commuter Air Operations]). Duty time, shift work, and fatigue requirements have been extensively researched in manned operations, but recent and continuing developments in UAS applications and UAS automation have resulted in changes to work elements, and ultimately to operator fatigue. This Market Survey regarding UAS operator fatigue will help inform future policy and regulations associated with UAS operations so that novel applications of UAS can be integrated safely into the National Airspace System (NAS). Survey results found a majority of organizations have 10 or fewer drone operator pilots with an average of 7 years of experience. The majority of respondents indicated that the anticipated average in-flight time for air carrier delivery operations is 30 min or less and that for air taxi services the anticipated average in-flight time is higher, at 1 hour or less. A majority of respondents disagreed that fatigue represents a safety concern, but expressed some variation on how much time on duty is risky for operator fatigue. Respondents indicated that they work relatively regular weeks with 1-3 days off between shifts and routine breaks during shifts. A large proportion of respondent organizations provide fatigue awareness and fatigue management training, and also appear to provide mechanisms for reporting crewmember fatigue when it represents a safety concern. However, a majority of organizations do not maintain records about the prevalence of fatigue even though a majority of respondents reported experiencing fatigue themselves while on duty and that workload and work schedules might be factors contributing to fatigue while on duty. Recommendations for standardizing UAS duty time, shift work, fatigue awareness and educational requirements are suggested for supporting the safe and efficient integration of UAS into the NAS.

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List of Abbreviations

ATC	Air Traffic Controller
AUVSI	Association for Uncrewed Vehicle Systems International
BTS	Bureau of Transportation Statistics
FAA	Federal Aviation Administration
CAMI	Civil Aerospace Medical Institute
CFR	Code of Federal Regulations
14 CFR § 107	Title 14 CFR Part 107 (Federal Regulation for Commercial sUAS)
14 CFR § 121	Title 14 CFR Part 121 (Federal Regulation for Air Carriers)
14 CFR § 135	Title 14 CFR Part 135 (Federal Regulation for Commuter Air Operations)
FRMS	Fatigue Risk Management System
HSI	Human System Interaction
ICAO	International Civil Aviation Organization
NAS	National Airspace System
OMB	Office of Management and Budget
RPA	Remotely Piloted Aircraft
SME	Subject Matter Expert
sUAS	Small Unmanned Aircraft System
UAS	Unmanned Aircraft System

Abstract

There is an increasing demand to utilize unmanned aircraft systems (UAS) for new applications currently outside the scope of written regulation, such as taxi services, package delivery, and crop dusting. The Code of Federal Regulations on Aeronautics and Space (14 CFR) are restrictive to air carrier applications for UAS. In particular, small UAS (sUAS) regulations (14 CFR § 107 [Federal Regulation for Commercial sUAS]) do not explicitly address air carrier operations (codified under 14 CFR § 121 [Federal Regulation for Air Carriers and § 135 [Federal Regulation for Commuter Air Operations]). Duty time, shift work, and fatigue requirements have been extensively researched in manned operations, but recent and continuing developments in UAS applications and UAS automation have resulted in changes to work elements, and ultimately to operator fatigue. This Market Survey regarding UAS operator fatigue will help inform future policy and regulations associated with UAS operations so that novel applications of UAS can be integrated safely into the National Airspace System (NAS). Survey results found a majority of organizations have 10 or fewer drone operator pilots with an average of 7 years of experience. The majority of respondents indicated that the anticipated average in-flight time for air carrier delivery operations is 30 min or less and that for air taxi services the anticipated average in-flight time is higher, at 1 hour or less. A majority of respondents disagreed that fatigue represents a safety concern, but expressed some variation on how much time on duty is risky for operator fatigue. Respondents indicated that they work relatively regular weeks with 1-3 days off between shifts and routine breaks during shifts. A large proportion of respondent organizations provide fatigue awareness and fatigue management training, and also appear to provide mechanisms for reporting crewmember fatigue when it represents a safety concern. However, a majority of organizations do not maintain records about the prevalence of fatigue even though a majority of respondents reported experiencing fatigue themselves while on duty and that workload and work schedules might be factors contributing to fatigue while on duty. Recommendations for standardizing UAS duty time, shift work, fatigue awareness and educational requirements are suggested for supporting the safe and efficient integration of UAS into the NAS.

Keywords: unmanned aircraft systems, duty time, shift work, operator fatigue, air carrier operations, human factors, pilot flight duty

Introduction

As the use of Unmanned Aircraft Systems (UAS) continues to expand, so too does the complexity of UAS flight operations. The Federal Aviation Administration (FAA) refers to operations that involve the transportation of cargo and people within the National Airspace System (NAS) as Air Carrier Operations. Currently, neither air carrier (14 CFR § 121) nor commuter air (14 CFR § 135) regulations adequately address UAS flight operations. Specifically, 14 CFR § 107 provides regulations for small (commercial) UAS (sUAS) operations, but it address neither systems that weigh over 55 pounds nor the more complex types of operations expected for unmanned air carrier activities.

The FAA is working to standardize UAS regulations for air carrier operations. Current initiatives aim to standardize (a) the issuance of UAS air carrier operating certificates, (b) UAS remote pilot and crew requirements, (c) training and testing requirements, and (d) duty and rest requirements.

The increasing adoption and prevalence of UAS in air carrier and civil operations presents new human factors issues concerning duty time, shift work, and operator fatigue that could affect the performance of UAS operators and operational safety. Duty time and rest requirements in manned operations are standardized based on empirical evidence. However, duty time, shift work, and fatigue in UAS operations have not been extensively investigated and should be further examined to standardize pilot and crew training, testing, duty time, and rest requirements. Taking steps to standardize UAS operator requirements will improve overall safety in performance and further support the integration of UAS into air carrier operations and the NAS.

To help establish new sets of standards for safe UAS air carrier-like operations, a research program was initiated. In the first phase of this research program, literature were reviewed on the following topics:

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

In the second phase of this research program, a survey based on the main findings from the literature reviews gathered information from subject matter experts (SMEs). SMEs were involved either in the manufacturing and/or operation of UAS, or in the educating of personnel entering the UAS industry. This report summarizes the findings from the SME survey related to duty time, shift work, and operator fatigue. Other reports summarize aspects of the survey not covered in this report (Williams et al., Under Review-a, Under Review-b, Under Review-c).

Previous research has examined fatigue in aviation-specific and non-aviation manned operations (see Durham et al., 2021). However, the research suggests a need for standard

definitions and classification of UAS,[1] safety considerations for NAS operations,[2] and UAS regulation for integration into the NAS.[3] Achieving these needs requires a better understanding of how to maximize safety and minimize risk during actual UAS operations; it will also require an examination of fatigue factors associated with duty time, shift work schedules, and workload. For example, duty time, shift work and fatigue research in unmanned operations has been conducted primarily in military aviation operations[4] and maritime operations[5]. Other research in UAS operations take human-system interaction (HSI) and workload into consideration[6]. The needs identified in the literature cannot be met without a holistic approach that considers all of these areas including information regarding any requirements for operators (e.g., fatigue awareness education, duty scheduling, HSI training, mitigation strategies similar to what is required of manned flight operations).

To better understand how to maximize safety in UAS operations, a survey was developed to (a) gauge present and future thinking regarding operator fatigue preparedness and requirements for UAS operations and (b) gather information regarding the current state of UAS operations that were considered relevant to air carrier flight activities. The goal was to gather information from SMEs who are currently engaged in different aspects of commercial UAS activities across a spectrum of responsibilities, from frontline workers to high-level managers to educators who train personnel for careers in commercial UAS activities.

Methods

Stratification and Sample Selection

The strategy employed here was to assess a representative sample of individual experience/knowledge and viewpoints regarding UAS operations (including UAS air carrier operations) that could factor into fatigue. All respondents had to meet three eligibility requirements before providing survey responses: (a) 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, (b) must be affiliated with an organization that has established qualification requirements OR an affiliation with an organization that develops training requirements/provides training, and (c) if affiliated with an organization that operates or plans to operate commercial UAS operations, the organization must employ two or more UAS operators/pilots.

Participant names and email addresses were sourced from publicly available dockets including the Federal Register (which identifies corporations who received blanket waivers from

[1] See Clothier et al. (2011); Maddalon et al. (2013); Washington et al. (2017).
[2] See Cook et al. (2012).
[3] See Cork et al. (2007); Hayhurst et al. (2006).
[4] See Chappelle et al. (2011); Hardison et al. (2018); Thompson et al. (2006); Tvaryanas et al. (2008).
[5] See Hopcroft et al. (2006); Man et al. (2015).
[6] See Coppin et al. (2009); Crandall et al. (2008); Hoepf et al. (2015); Narayan et al. (2007).

14 CFR § 107), the FAA's 14 CFR § 107 waivers website (which identifies individuals who have been granted waivers from 14 CFR § 107, thus known to be involved in commercial UAS activities), and Google searches. Research sponsors and contractors also submitted some candidates for participation. Additionally, 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 were also included in the sample.

To accommodate electronic distribution, only those individuals with email addresses on file were included in the initial sample. Respondents were also encouraged to share the survey link with their colleagues who were not included on the initial sample list (i.e., snowball sampling). See Table 2 for the different types of respondents targeted for survey participation along with our original goal for the number of respondents for each type.

The additional groups of engineers and other crewmembers in Table 1 were included per SME recommendation to provide additional assurance of generalizability. A statistical power analysis[7] suggested that 40 respondents per group would result in a power of 0.8, providing a statistically representative sample of the population.[8]

Survey Items

Survey questions were developed to better understand UAS operations. Besides demographic information, several factors related to both current and future UAS operations that could be related to air carrier-like activities were included (e.g., crew and staffing requirements, knowledge, skills, and abilities requirements, duty and shift requirements, training and certification requirements). The sections included in the survey were:

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

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

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

All survey items were administered electronically via a Qualtrics link. The survey was constructed so that not every participant received the same set of questions; branching logic was incorporated to route respondents to the set of questions appropriate for their particular areas of expertise, based on their responses. Therefore, the number of respondents per question varied. Appendix A contains a list of the questions relevant to the operator fatigue portion of the survey.

FAA researchers and sponsors reviewed the survey to ensure clarity of instructions and technical details. In addition, beta testing was conducted within the research team and with SMEs in UAS operations to evaluate the quality of the survey. Feedback from the beta testing was approved and incorporated by all vested parties.

Survey Administration

Upon clicking on the Qualtrics link, respondents received the informed consent notice[9], that provided them with an overview of the study, including the purpose, and informed them about their rights as volunteer research participants (i.e., participation is optional, the FAA will de-identify their data before use). All were required to provide their consent before continuing with the survey.

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

Results

The survey was active for 90 days. Recruitment was below the 220-respondent target limit. Final respondent counts are provided in Table 1.

[9] An Informed Consent notice is a legal and ethical requirement for research involving human participants. This study was separately reviewed and approved by the Civil Aerospace Medical Institute (CAMI) Institutional Review Board and by the OMB (Control No. 2120-0803).

Table 1

Final Respondent Recruitment

Respondent Category	Target	Final Recruitment
Small UAS Pilot/Operator (<55 lbs.)	40	51
Large UAS Pilot/Operator (≥55 lbs.)	40	14
UAS Cargo/Sensor Operator	40	4
Supervisor/Manager	40	45
UAS Instructor	40	41
Engineer	10	5
Other Crewmembers	10	13
Total	*220*	*173*

Eligibility

One hundred and seventy three respondents met the eligibility requirements of the survey. Of these, 131 (75.7%) reported being affiliated with an organization that operates or plans to operate commercial UAS operations and 42 (24.3%) of those reported being affiliated with a training or educational organization (Figure 1). Of the 173 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 2). For respondents who indicated that they work with an organization that operates or plans to operate commercial UAS operations, respondents of the organization had to employ at least two or more operators. Figure 3 provides the percentage of organizations with the number of operators (i.e., pilots) employed per industry sector.

Figure 1

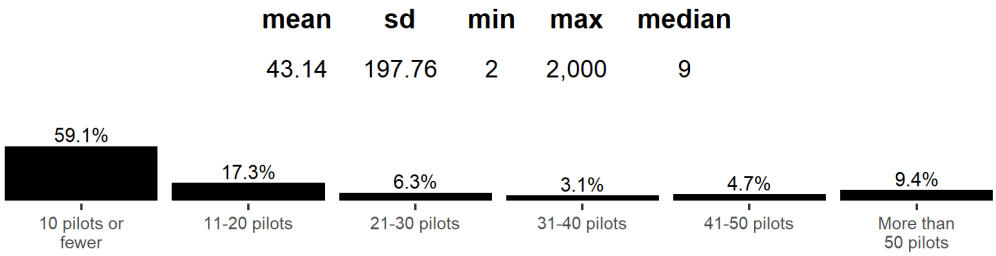
Respondents Who Work With an Organization that Operates UAS Versus Those Affiliated With an Educational Institution (n = 173)

Figure 2

Respondents Who Work With an Organization With Established Operator Requirements Versus Those Who Are Affiliated With an Organization Who Establishes Requirements or Provides Training (n = 173)

Figure 3

Pilots Employed by Each Organization (n = 127)



Demographics

Survey respondents reported an average of 7.01 (*SD* = 5.58) years of experience in their current job role (Figure 4). Table 2 and Figure 5 show the respondents' operational sector type (i.e., drone service operator, school/training program, other work with drones, and 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 7). Ninety-four percent of respondents reported holding a current license or certification to fly a UAS (see Table 3). For those who responded with other certifications, text comments are available in Table 9 of Appendix B.

Figure 4

Years in Current Job Role (n = 168)

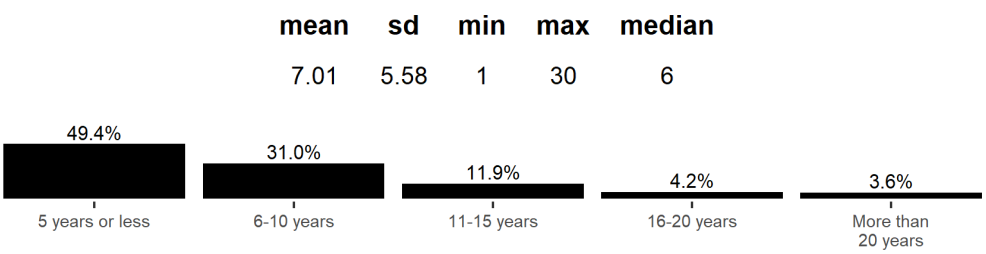


Table 2

Commercial UAS Sector Currently or Planned to Operate Within (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. May sum to greater than the number of respondents to the item as the response option was "select all that apply", providing an opportunity for respondents to select more than one option. The percentage of respondents (percent [%]) is based on the number of respondents to the item.

Respondents mainly worked in organizations with 10 or fewer pilots, a finding that held across each industry. The military and shipping industries appeared to have the largest percentages of organizations employing more than 40 pilots (see Figure 5). Furthermore, three respondents reported being associated with current or future UAS passenger transport; thus, the response of 33% of the UAS passenger transport sector reporting employing 31 – 40 pilots may be inflated.

Figure 5

Pilots Employed in Each Organization, by Industry Sector (n = 127)

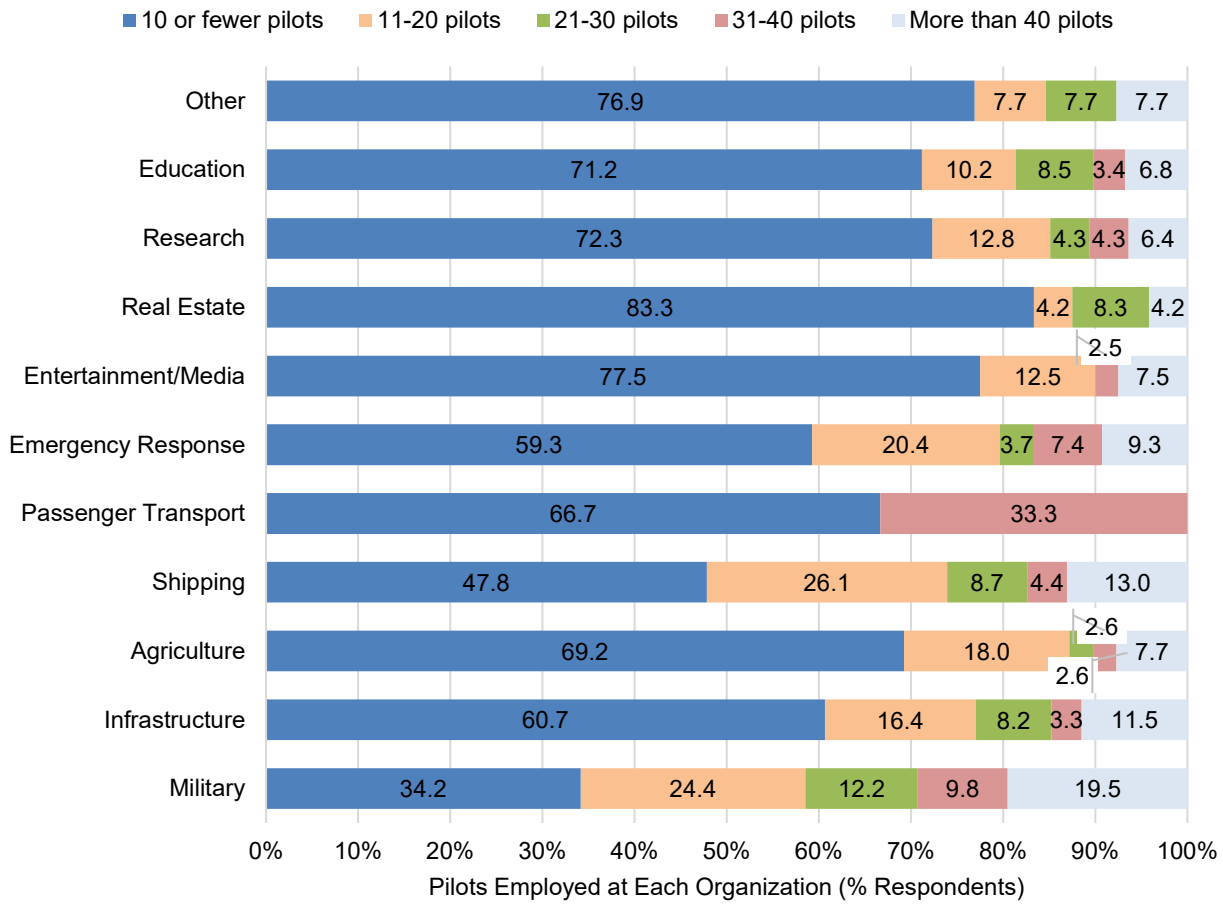


Table 3

Certificates Held by Respondents Who Currently Have a License or Certification to Fly a UAS (n = 158)[10]

License or Certification Type	Respondents	
	Count (*n*)	Percent (%)
14 CFR § 107 certificate (e.g., remote pilot certificate)	143	90.5
14 CFR § 61 certificate (e.g., manned pilot certificate)	50	31.6
Instrument Rating	40	25.3
Military-qualified (RPA)[11] pilot	22	13.9
Non U.S. (foreign) license	1	0.6
Fly Drones under hobbyist exemption (I fly drones as a hobby)	43	27.2
Other[12]	14	8.9
I do not hold a certificate	3	1.9

Operational Considerations

The majority of respondents indicated they work with a crew that operates or plans to operate UAS (75.7%; Figure 6), and the majority of organizations had 10 or fewer operators/pilots (59.1%; Figure 7).

Figure 6

Respondent Choice With Which Statements Best Applies (n = 173)

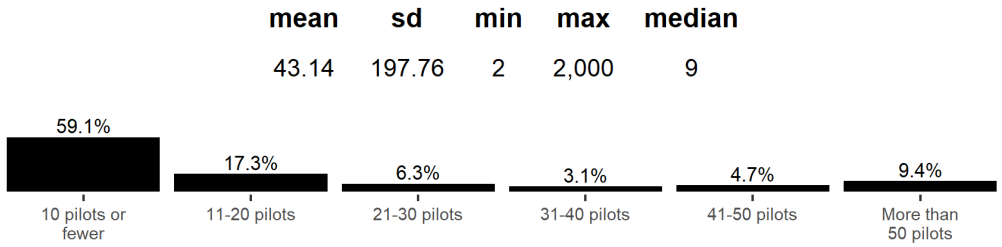
[10] Results for 'Which Certifications do you hold' includes only respondents who indicated they hold a certification to operate an aircraft see Appendix A, Section A. Demographics

[11] Remotely Piloted Aircraft.

[12] 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).

Figure 7

Number of Drone Operators/Pilots the Respondent's Organization Currently Employs (n = 127)



Note, participants were prompted to provide an estimate if unsure.

The majority of respondents reported having 10 or less years of experience in their current role (Figure 8). Most respondents reported that they do not hold a Trusted Operator certification from the Association for Un-crewed Vehicle Systems International (AUVSI; 78.8%; Figure 9).

Figure 8

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

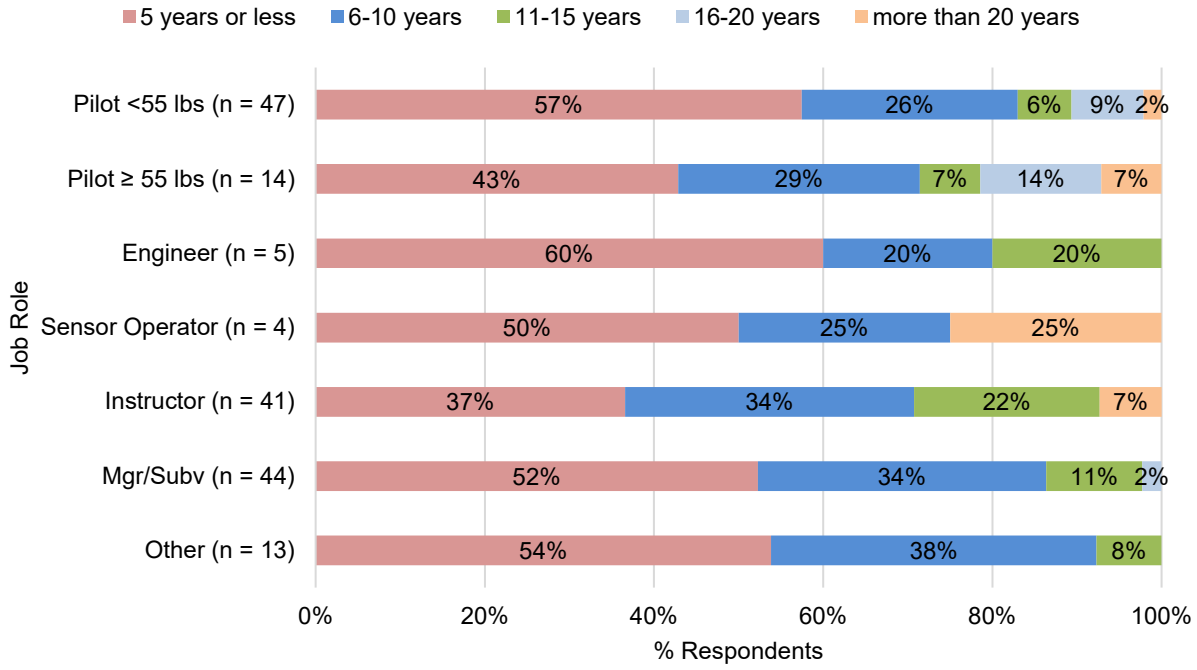
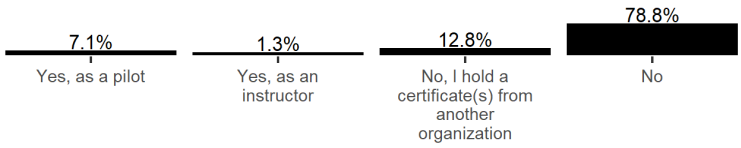


Figure 9

Respondents Holding a Trusted Operator Certificate From the Association for Unmanned Vehicle Systems International (AUVSI; n = 156)



The majority of respondents indicated that the anticipated average in-flight time for air carrier delivery operations was 30 minutes or less (66.7%; Figure 10). For air taxi services, the anticipated average in-flight time was higher, at 1 hour or less (Figure 11). Additionally, the majority of respondents indicated that they anticipate making one pickup and one delivery stop on a flight before returning to base (Figure 12; Figure 13).

Figure 10

Anticipated Average In-Flight Time in a Flight Plan for Air Carrier Delivery Operations (n = 24)

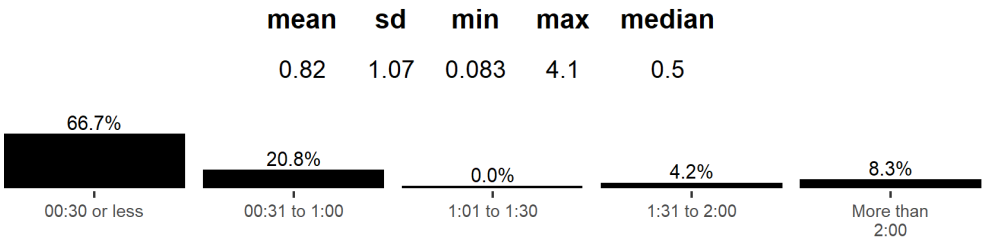


Figure 11

Anticipated Average In-Flight Time in a Flight Plan for Air Taxi Services (n = 5)

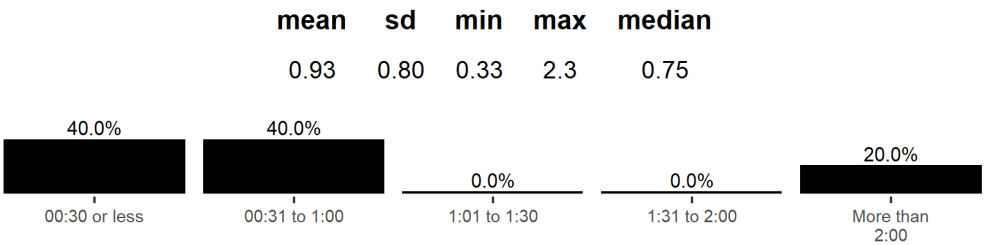


Figure 12

Anticipated Number of Pickup Stops on a Flight Before Returning Back to Base Location (n = 24)

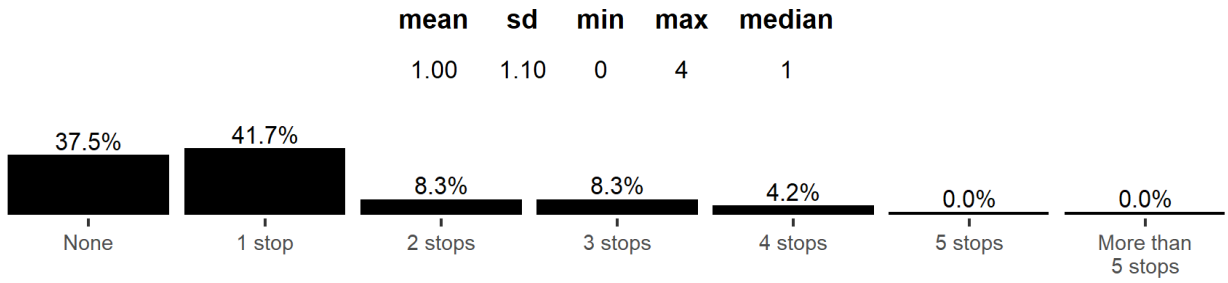
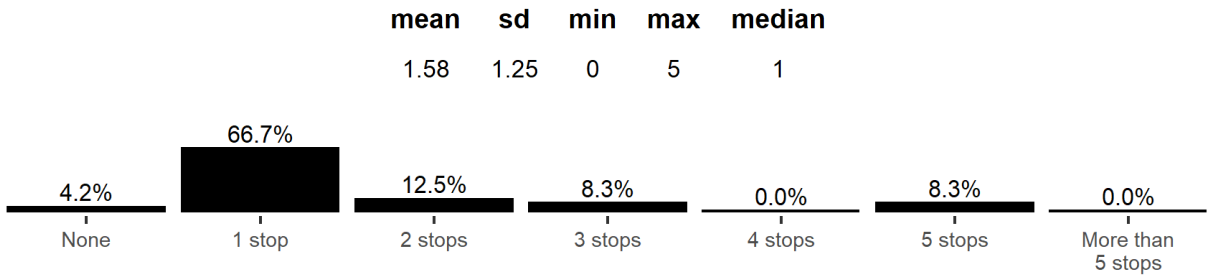


Figure 13

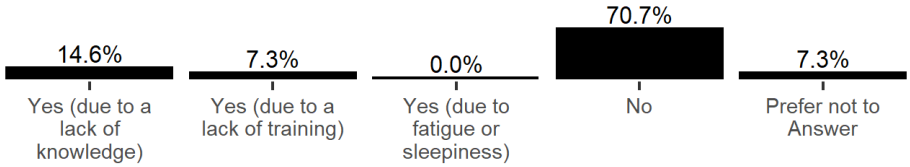
Anticipated Number of Delivery Stops on a Flight Before Returning Back to Base Location (n = 24)



The majority of respondents indicated that their employees have not had any operational deviations (70.7% as reported by Managers or Supervisors, and 90.4% as reported by Pilots/Operators, Engineers, Cargo Operators, Sensor Operators, or Other; Figure 14), and that they were responsible for one drone per operation (Figure 15).

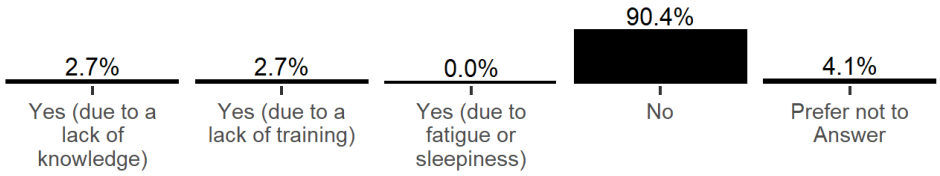
Figure 14

Operational Deviations[13] in the Last Year as Reported by Manager/Supervisors (n = 41)[14]



[13] Respondents were provided with a list of example operational deviations that included accidental rule violation, accidental crash, and flyaway situations.

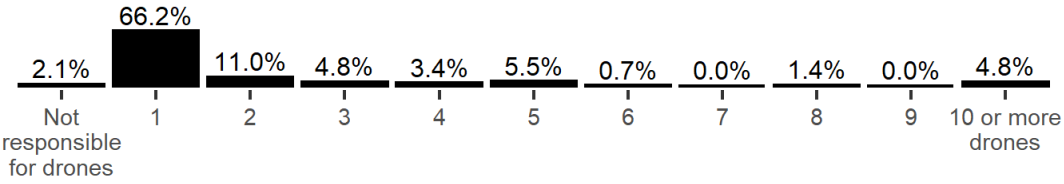
[14] Figure 14 include respondents who indicated their primary job role as 'Manager or Supervisor' (see Appendix A, Section A: Demographics).



Pilots/Operators, Engineer, Cargo Operator, Sensor Operator, or Other (*n* = 73)[15]

Figure 15

Number of Drones the Respondent is Responsible for per Each Operation (n = 145)

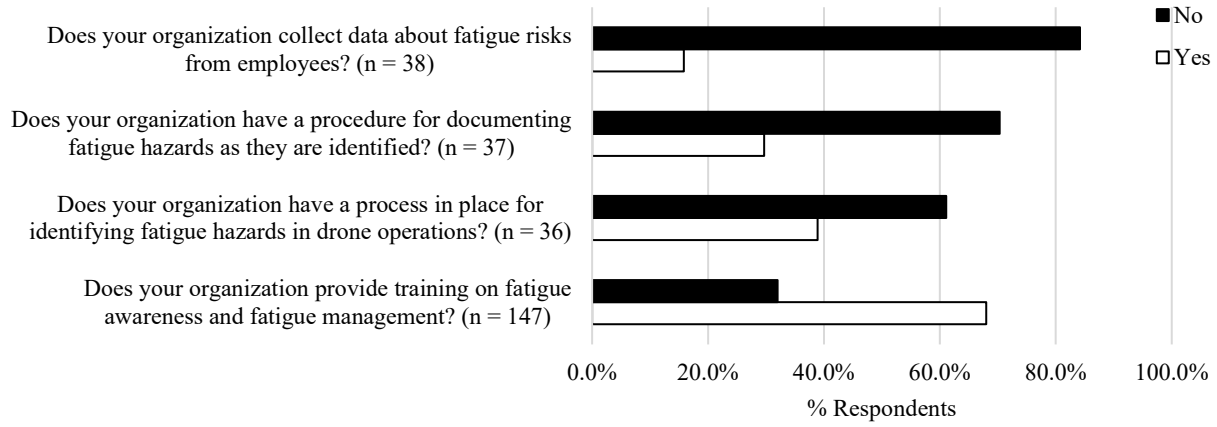


Fatigue Mitigation

The majority of respondents indicated that their organization provides training on fatigue awareness and fatigue management. Conversely, the majority of organizations do not collect data on fatigue risks from employees, do not have a procedure for documenting identified fatigue hazards, and do not have a process in place for identifying fatigue hazards in drone operations (Figure 16).

Figure 16

Organizational Fatigue Awareness and Management (n Provided by Topic)



[15] Figure include respondents who indicated their primary job role as 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator ,' 'Sensor Operator,' or 'Other' (see Appendix A, Section A: Demographics).

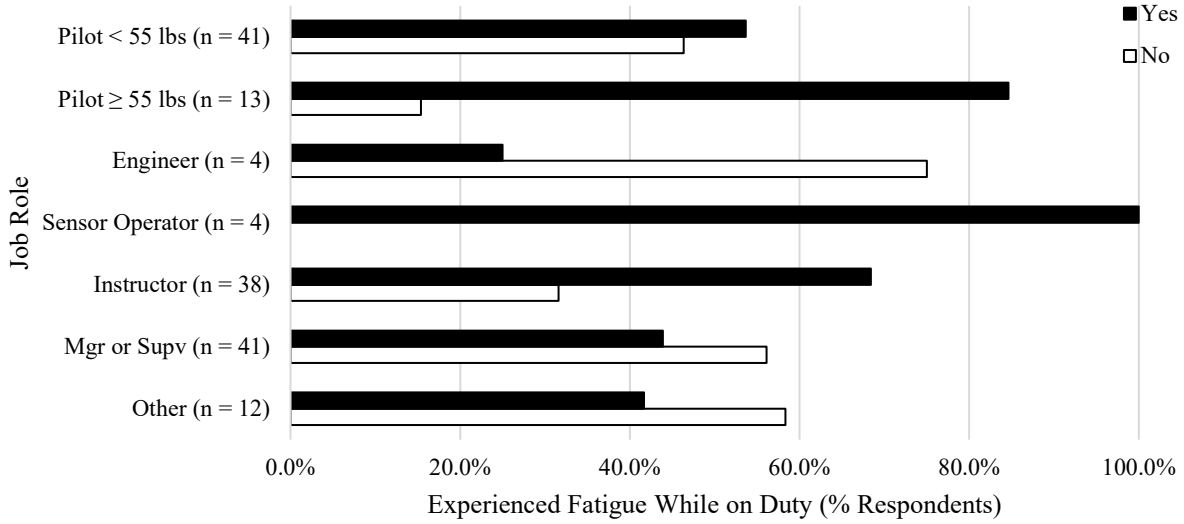
When asked about their personal experiences, the majority of respondents reported having experienced fatigue while on duty (Figure 17); the highest prevalence of reports of fatigue were found among Sensor Operators, Pilots operating UAS ≥ 55 pounds, and Instructors (Figure 18). The majority of respondents reported that workload and schedule were contributing factors to fatigue during duty periods. The same trends appeared between all respondents (left panel) and UAS pilots (<55 lbs. and >55 lbs.; right panel): Workload was rated as the top contributing factor to fatigue, followed by Work Schedule (Figure 19).

Figure 17

Respondent has Experienced Fatigue while On Duty (n = 153)

Figure *18*

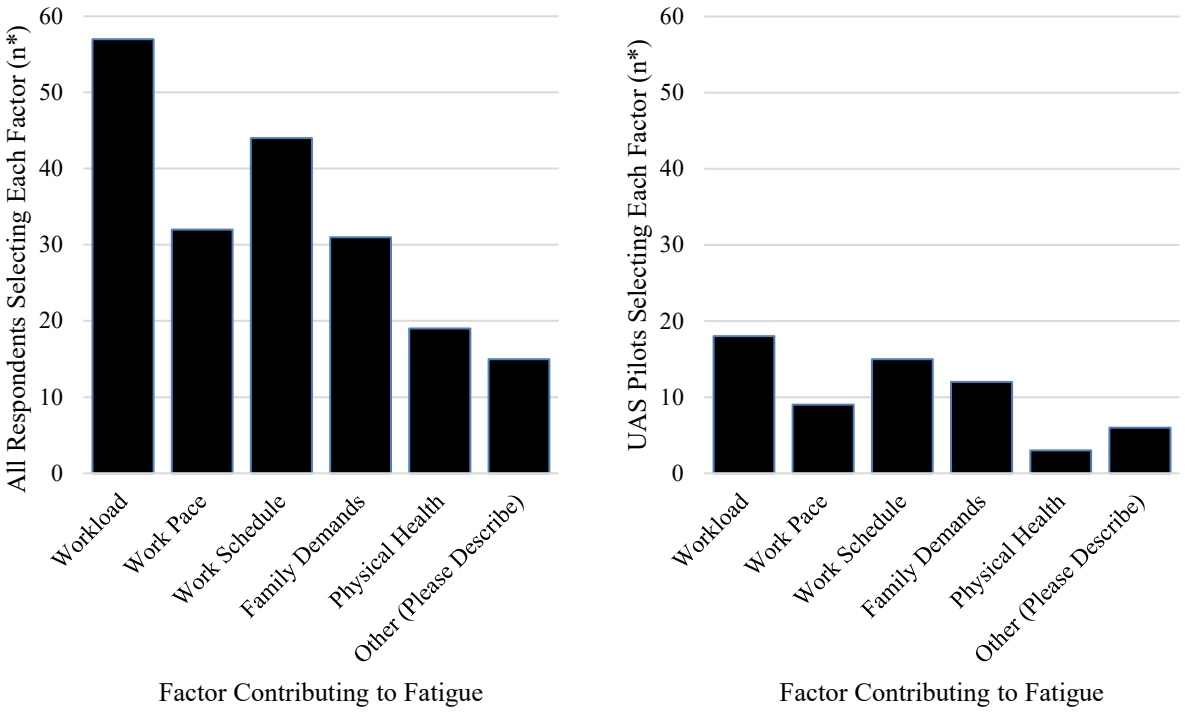
*Experienced Fatigue W*hile on Duty, by Job Role *(n Provided by Job Role)*[16]



[16] See Table 2 for Job Roles.

Figure 19

Factors Contributed to Respondent Fatigue While On Duty (all participants, n = 87, left panel; UAS pilots only, n = 33, right panel)



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

Most respondents disagreed that crewmember fatigue is a common occurrence (Figure 20). Notably, the highest agreement with the statement came from Pilots operating UAS ≥ 55 pounds (84.6%, *n* = 13) and Sensor Operators (75.0%, *n* = 4); the lowest agreement with the statement came from Pilots of UASs less than 55 pounds (61.0%, *n* = 41) and Managers or Supervisors (61.0%, *n* = 41; Figure 21).

Figure 20

Agreement With the Statement, "Crewmember fatigue is a common occurrence." (n = 154)

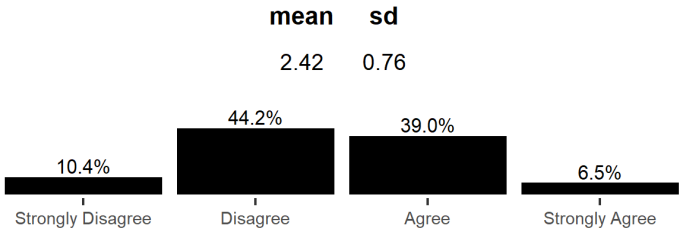
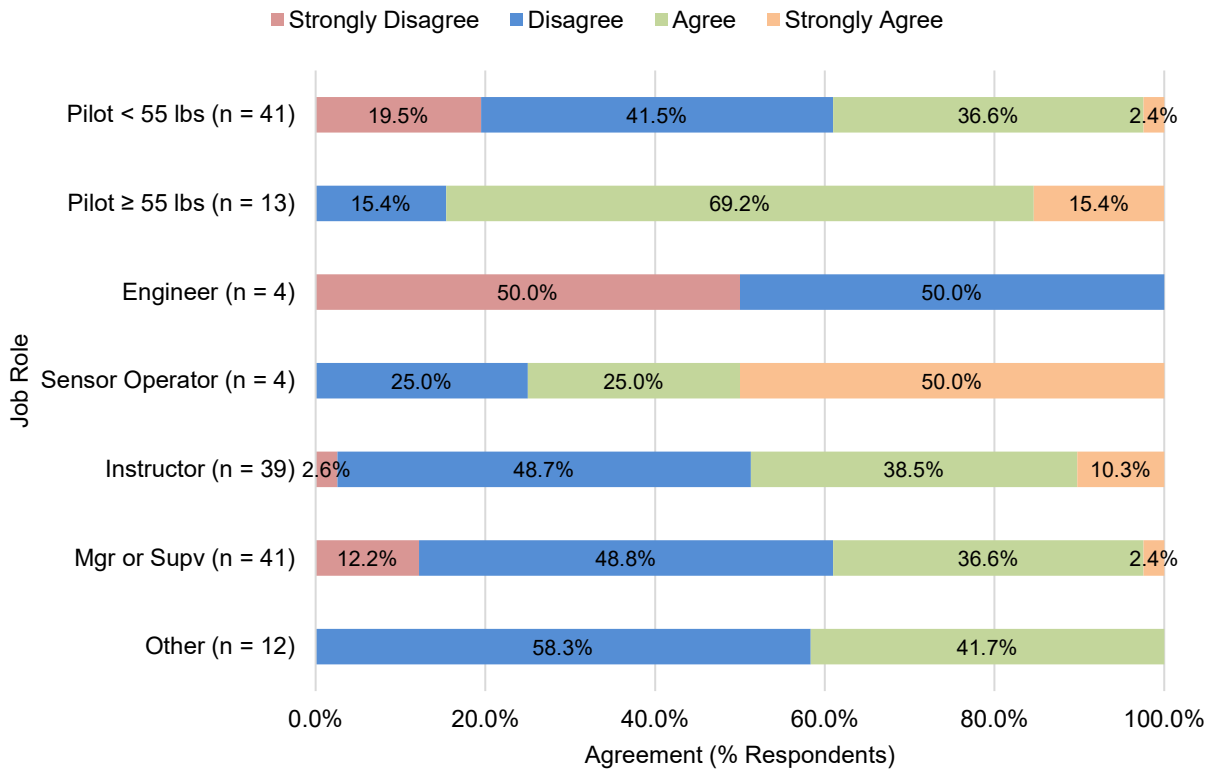


Figure 21

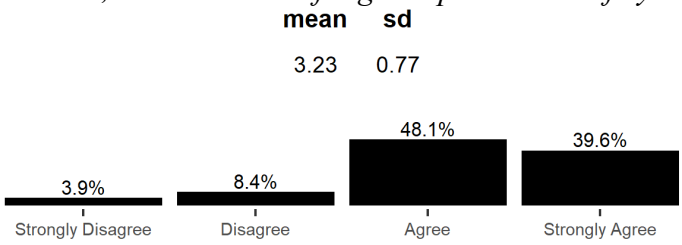
Agreement with the Statement, "Crewmember fatigue is a common occurrence," by Job Role



The majority of respondents agreed that fatigue represents a safety concern (Figure 22).

Figure 22

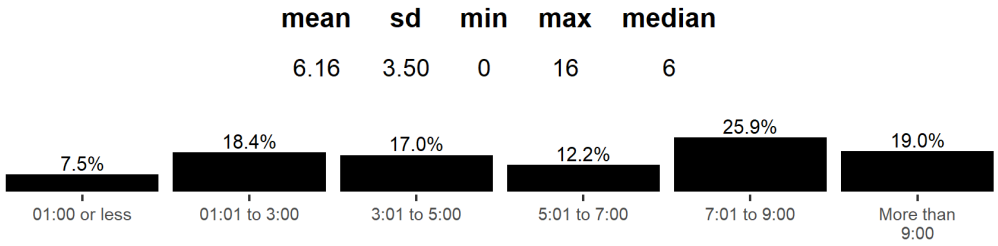
Agreement with the Statement, "Crewmember fatigue represents a safety concern." (n = 154)



Respondents expressed variability in how much time on duty makes operator fatigue become risky (Figure 23).

Figure 23

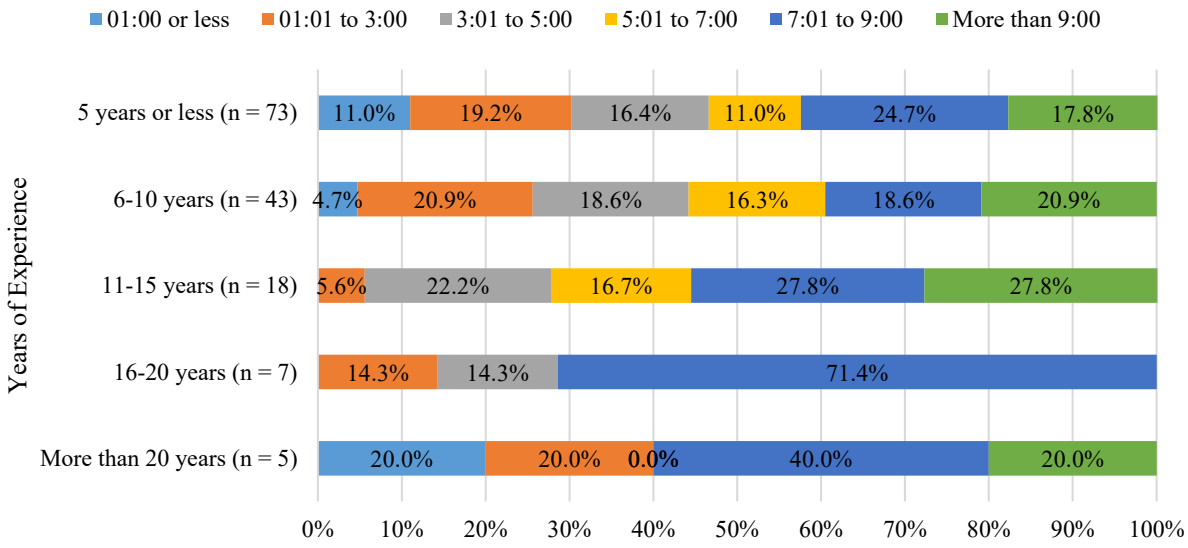
After How Much Time On Duty That Operator Fatigue Becomes Risky (n = 147)



The majority of respondents with greater than 10 years of experience rated that fatigue does not become risky until after 7 hours on duty (Figure 24).

Figure 24

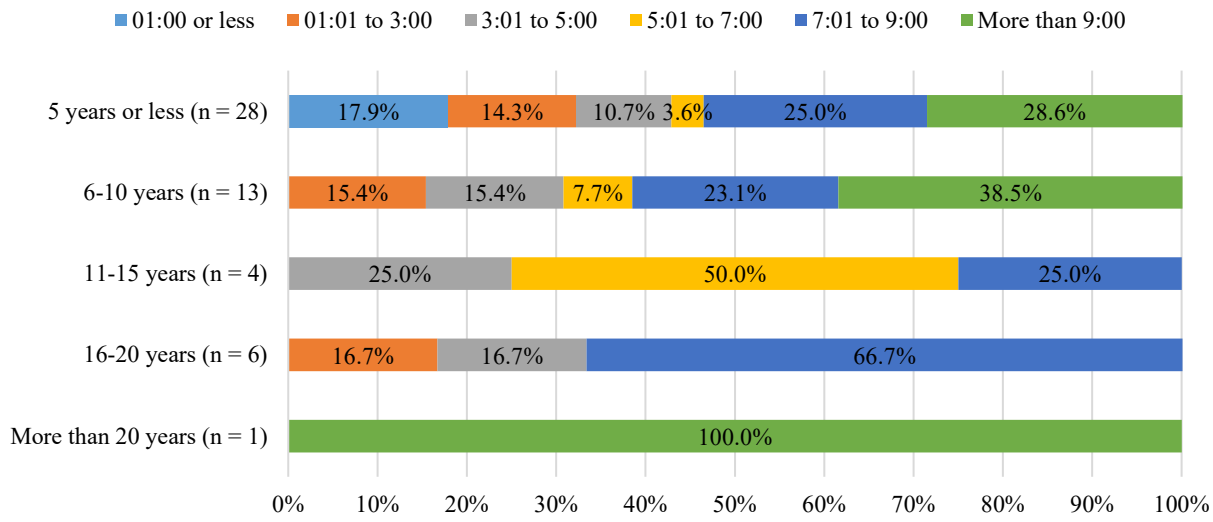
After how much Time On Duty (Hours) That Operator Fatigue Becomes Risky, by Experience Level (>10 years of experience, n = 30; <10 years of experience, n = 116)



When filtering the data to include only UAS pilots (both <55 lbs. and >55 lbs.), a similar trend was found in which respondents with more years of experience perceived fatigue as risky after more time on duty (Figure 25). Note that similar to Figure 24 (above), the majority of respondents had 10 or fewer years of experience.

Figure 25

After How Much Time On Duty that Operator Fatigue Becomes Risky, by Experience Level for Only UAS Pilots (<55 lbs. and >55 lbs.)

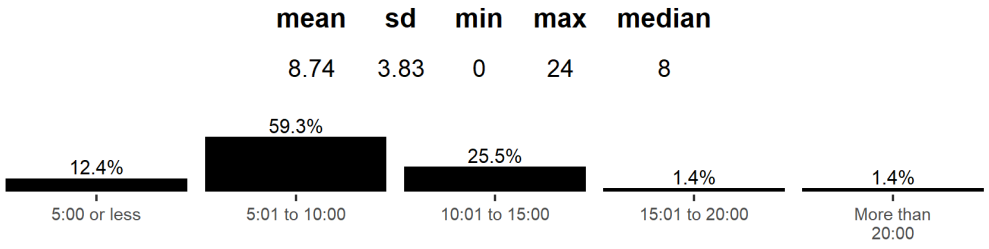


Duty Time and Shiftwork

The majority of respondents reported that their organizations considered 5 hours or less as normal minimum rest periods (Figure 26).

Figure 26

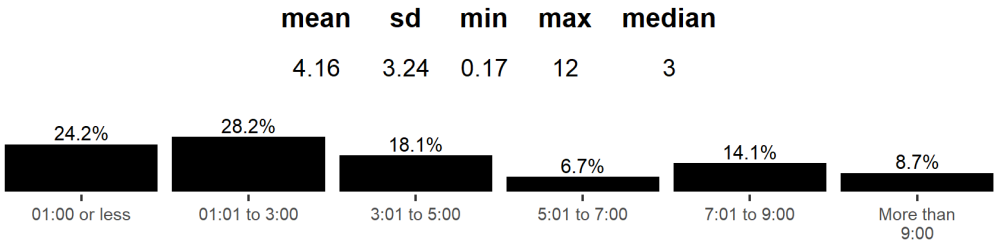
How Long the Respondent's Organization Considers to Be Normal Minimum Rest Periods (n = 145)



Respondents reported that on average over 50% of crew members stay on station for less than 3 hours during a single operation (Figure 27).

Figure 27

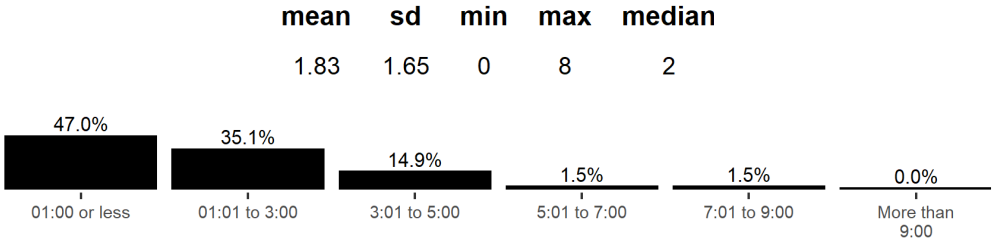
On Average, How Long a Crew Member Stays On Station During a Single Operation (n = 149)



Nearly half of respondents indicated that a crewmember is required to stay on station for an hour or less before taking a break (Figure 28).

Figure 28

How Long a Crewmember is Required to Stay On Station Before Taking a Break?" (*n* = 134)



Respondents indicated variability in what is the maximum length of time a crewmember should be required to stay on station (Figure 29). A similar pattern appeared when responses were examined by industry (Figure 30; note that the unusual pattern in the Passenger Transport industry may due to the small number of responses).

Figure 29

Maximum Length of Time a Crewmember Should Be Required to Stay On Station (n = 148)

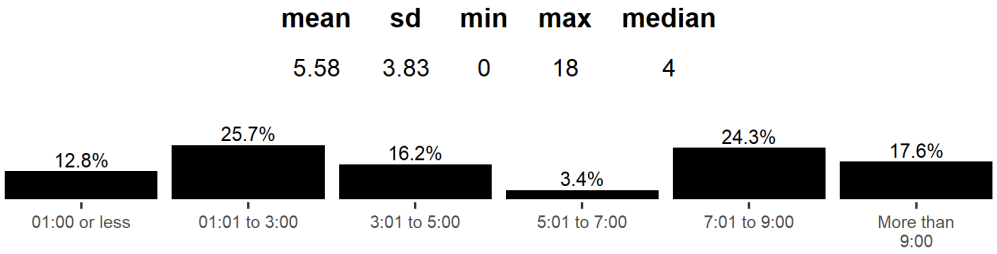
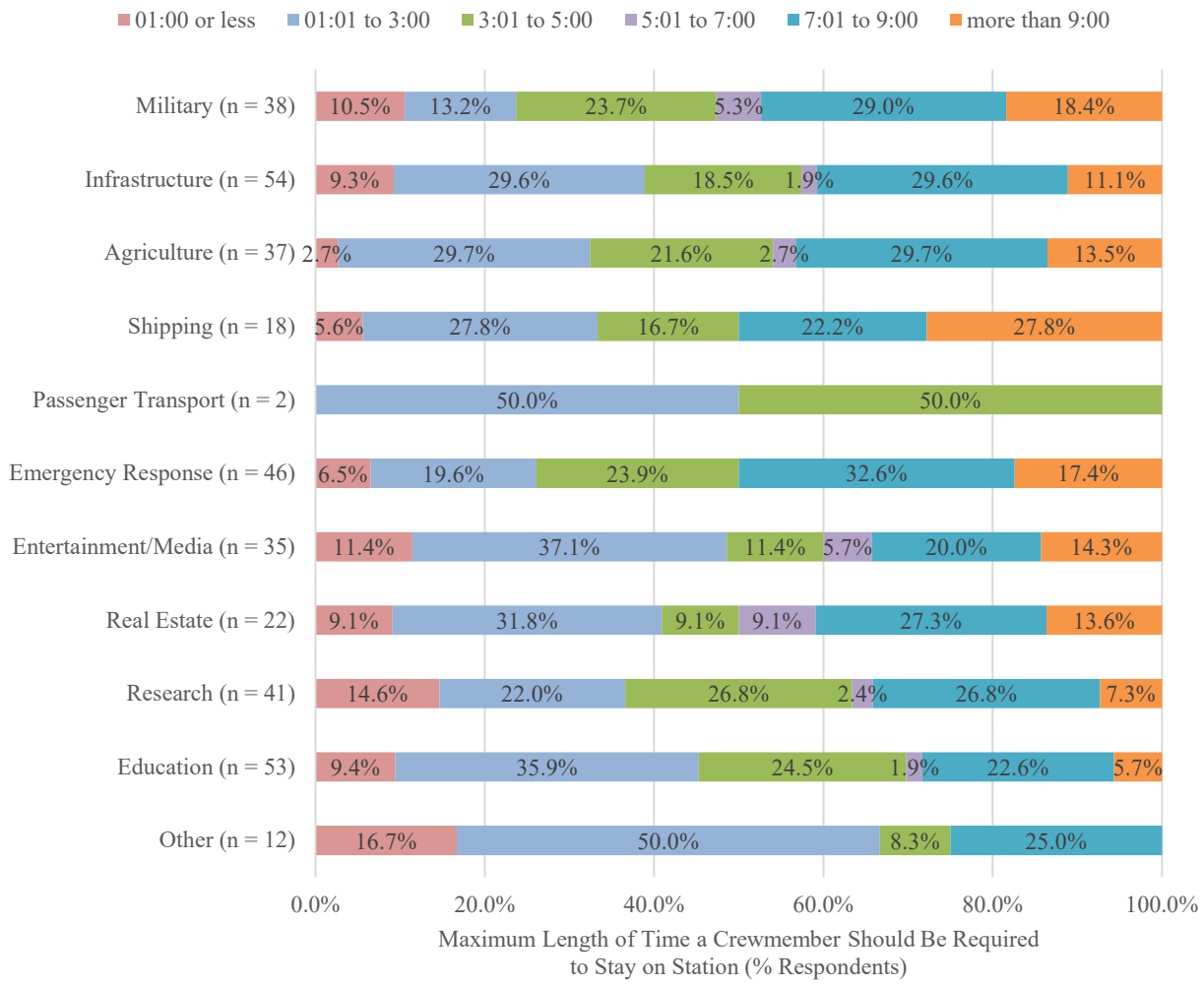


Figure 30

Maximum Length of Time a Crewmember Should Be Required to Stay on Station (Hours), By Industry



The majority of respondents reported working 1-5 consecutive shifts (i.e., without a day off) in the last month (Figure 31). A similar pattern appeared when responses were examined by industry (Figure 32).

Figure 31

Maximum Consecutive Number of Shifts of Any Kind Worked Without a Day Off (Within the Past Month; n = 108)[17]

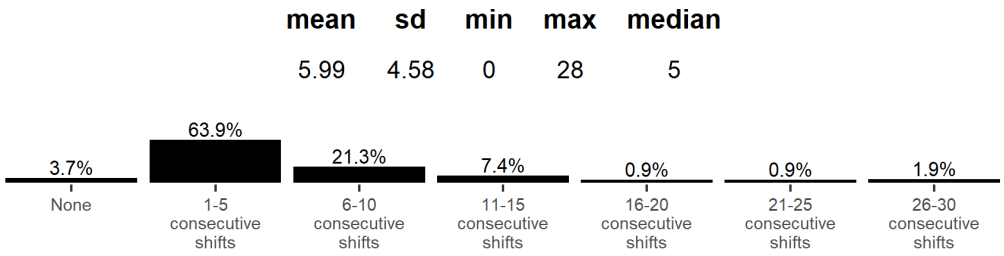
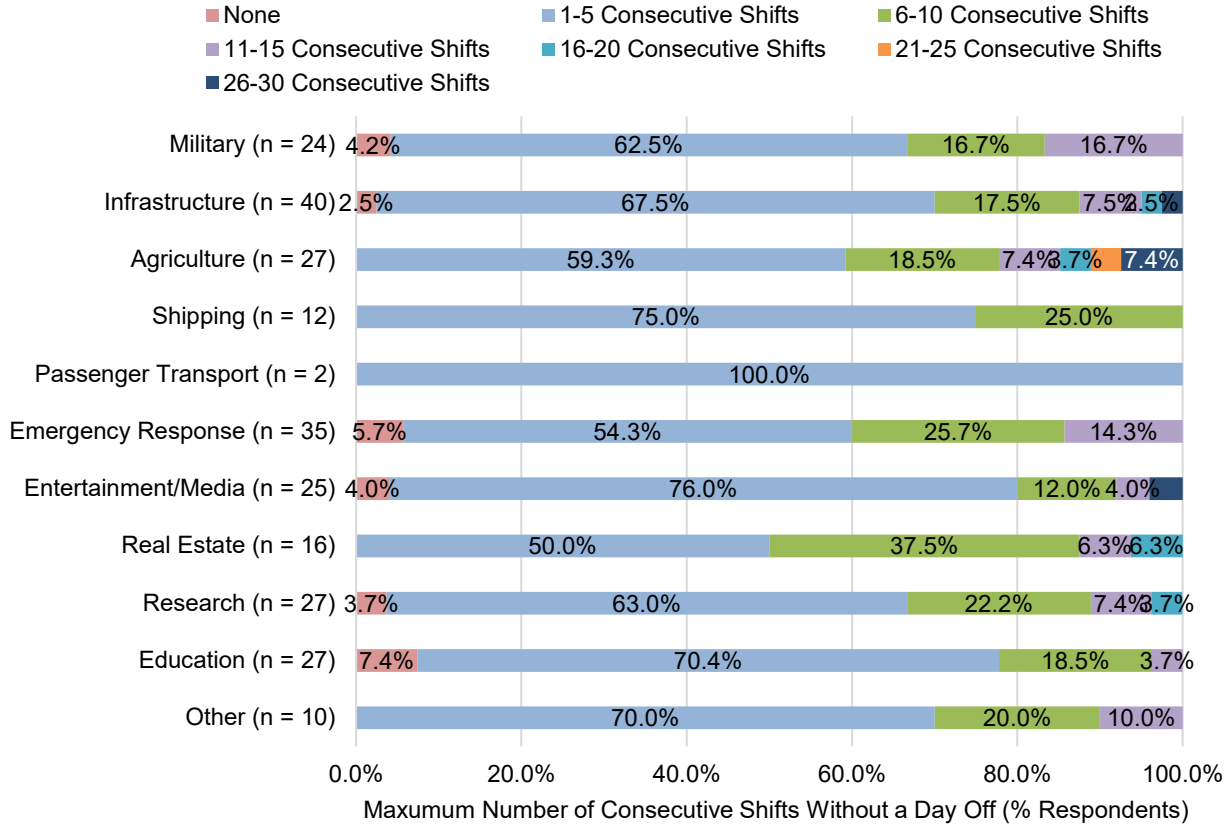


Figure 32

In the Last Month, Maximum Consecutive Number of Shifts Without a Day Off, by Industry[18]



[17] Item displayed to respondents with the following Job Roles only: Pilot, Cargo Operator, Sensor Operator, Manager, Engineer, or Other.

[18] Item displayed to respondents with the following Job Roles only: Pilot, Cargo Operator, Sensor Operator, Manager, Engineer, or Other.

The majority respondents reported having 1-3 successive days off (Figure 33) with permanent days off that are the same every week (Figure 34). The majority of respondents also reported feeling that the time on position between breaks is adequate (Figure 35).

Figure 33

Days Off in Succession the Respondent Normally Has (n = 147)

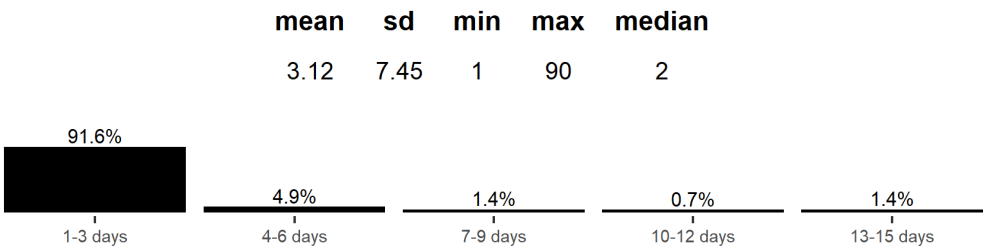


Figure 34

Current Organization of Respondent's Days Off (n = 147)

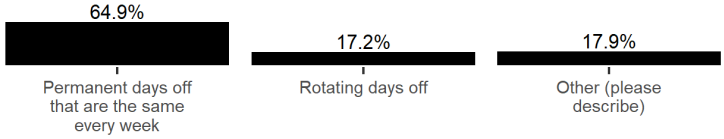
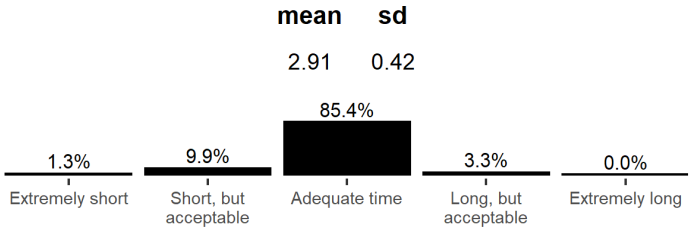


Figure 35

Respondent's Time on Position Between Breaks (n = 151)



Discussion

This Market Survey sought SME opinion related to duty time, shift time and operator fatigue to address issues therein and recommend a path forward. Specifically, UAS air carrier operating certificates, remote pilot and crew requirements, training and testing requirements, duty and rest requirements, and perceptions of fatigue risk were surveyed. Overall, the majority of organizations had 10 or fewer drone operator pilots with sufficient years of experience. Data collected on shift schedules in these operations also indicated that respondents work relatively

regular work weeks with 1-3 days off between shifts and regular breaks during shifts. This finding suggests that shift schedules may not be a major risk factor for fatigue among respondents. However, the conclusion may not be so simple, as further examination showed that the majority of respondents with 10 or more years of experience rated that fatigue does not become risky until after 7 hours on duty (Figure 24). This finding was more pronounced when the data was filtered to only include UAS pilots (Figure 25).

It is not entirely clear at this time whether the industry will move, as business needs change, toward a shift schedule structure that increases risk of fatigue. Previous research has indicated that multiple shifts or rotational shifts contribute to elevated risks of fatigue (Della Rocco & Nesthus, 2017; Orasanu, et al., 2012), but some shift schedule structures have been found to be better at fatigue risk management than others (McCallum et al., 2003; Miller, 2006). Regardless, the literature on shiftwork and fatigue research might offer guidance on the development of duty time, hours of service, and rest regulations for UAS air carrier operations. Regarding basic knowledge of fatigue, the results are promising and show that many organizations provide training on fatigue awareness and fatigue management; organizations also largely appear to provide mechanisms for reporting crewmember fatigue when it presents a safety concern (see Figure 16). However, the survey results also indicate that the majority of organizations are not identifying, collecting, nor documenting fatigue-related information among their employees (see Figure 16). Coupled with differences among respondents about the prevalence of fatigue, this finding is concerning.

Interestingly, most respondents disagreed with the statement that crewmember fatigue is a common occurrence (see Figure 20) or is a safety concern (Figure 22). The extent to which respondents disagreed with whether crewmember fatigue is a common occurrence depends on their job role (see Figure 21). Meanwhile, the majority of respondents reported experiencing fatigue themselves while on duty (see Figure 17). In particular, sensor operators and UAS pilots operating aircraft greater than 55 pounds reported the highest rates of fatigue (see Figure 18). This inconsistency in responses may be due to safety/reporting culture issues, a small sample size for some items, or the variation in respondents' job roles. Despite these inconsistencies, the majority of respondents reported workload and work schedule as contributing factors to fatigue while on duty (Figure 19). However, there is some variation in responses to the amount of time on duty before operator fatigue becomes risky (see Figure 23). Further research is needed to inform questions about whether UAS operator time on duty is equivalent to pilots in crewed operations. Overall, the survey's findings are consistent with trends identified in previous duty time, shiftwork, and fatigue research among flight attendants (Avers et al., 2009; Nesthus et al., 2007), air traffic controllers (ATCs; Della Rocco, 1999), flight crews (Gander et al., 2013), and aviation maintenance technicians (Hobbs et al., 2011).

Inconsistencies in the survey results may be related to survey limitations. The primary limitation of this survey is the variety of job roles that were underrepresented (e.g., UAS pilots > 55 lbs. and sensor operators), while some job roles were over-represented such as supervisors

and UAS instructors who made up approximately half of all respondents sampled. Further, a portion of the total respondents belongs to an undefined 'other crewmember' job role, which could have skewed results related to fatigue risk perceptions or created other inconsistencies. In addition, we also want to recognize that the majority of respondents have no more than 10 years of experience in their current job role, which may have skewed results in the current report and associated reports.

While we recognize that UAS air carrier operations are a growing industry, we examined respondents' responses to several items grouped by job role or years of experience in the current report. The increasing prevalence of current UAS air carrier operations provides regulatory agencies with the opportunity to monitor and work alongside UAS air carrier operators to develop fatigue prevention strategies. By doing so, better fatigue prevention strategies can be integrated into the NAS to maintain aviation safety, as well as, manage fatigue among employees within operators.

The authors recommend developing a set of standards or guidelines (e.g., Advisory Circular), based on the documented research literature on work and fatigue for these newly innovative and bourgeoning operations. To help mitigate risk of fatigue, the authors recommend guidance from some recent advances on the topic of Fatigue Risk Management Systems (FRMS). The FAA has operational experience with these concepts relative to 14 CFR § 117, Flightcrew Member Duty and Rest Requirements, and in particular § 117.7, Fatigue Risk Management System. The International Civil Aviation Organization (ICAO) has also published guidance material on FRMS; ICAO's Fatigue Management Guide for the Oversight of Fatigue Management Approaches (2016c) has been designed to be read in association with one or more of the relevant Implementation Manuals, depending on the professional group being regulated and monitored, including:

- Fatigue Management Guide for Operators (ICAO, 2015) within Annex 6 Part I.
- Fatigue Management Guide for General Aviation Operators of Large and Turbojet Aeroplanes (ICAO, 2016b) within Annex 6 Part II.
- Fatigue Management Guide for Air Traffic Service Providers (ICAO, 2016a) within Annex 11.

Given the increasing use and fast-changing pace of the unmanned air carrier industry, frequent and periodic review of both the guidance literature and re-assessment of industry stakeholders (e.g., with instruments such as surveys) will be needed to ensure that fatigue mitigation guidance remains up-to-date, applicable, and actionable.

Conclusions

UAS operations are relatively new and therefore subject to improvement. Regulatory agencies and industry should work together to develop guidance and regulations that can support these operations. This pursuit will present unique challenges given the type and number of commercial

UAS operations are frequently changing. The general direction regarding the number of operations is increasing but some operations are disappearing while others are being added. Because it is difficult to predict which operations will fail and which ones will succeed, vigilance will be needed to prevent fatigue from becoming a risk factor as industry needs change. To support both industry and safe operations in the NAS, new guidelines are warranted based on the fatigue research literature and the results of the Market Survey primarily related to UAS operator fatigue.

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Appendix A.
Survey Question Items for UAS Crew and Staffing

The Federal Aviation Administration's (FAA) 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.

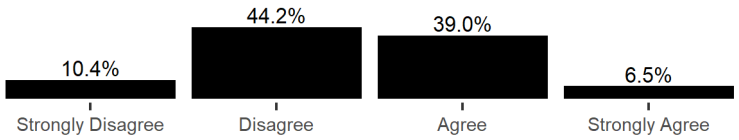
An open invitation to complete the online survey was distributed via email to a sample of potential respondents with UAS industry, training, or crew experience (N=2,524). Of those, 97 invitations were returned undeliverable resulting in 2,427 invitations delivered directly to potential respondents. Invitees 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 respondents for completing the survey.

Overall, 173 respondents 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 operator fatigue and duty/rest items.

Example of Report Format

C12. Indicate your level of agreement with the following statement: *Crewmember fatigue is a common occurrence*.

n	mean	sd
154	2.42	0.76



Definitions of Descriptive Statistics

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

Response values: Response options (labels) on response scales are assigned values for use in calculations. For example, values for an item answered on an agreement scale would be assigned 1 through 4 where 'Strongly disagree'=1 and 'Strongly agree'=4. *Not applicable (N/A), Don't know,* and *No experience to say* responses are excluded from calculations and reporting.

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.

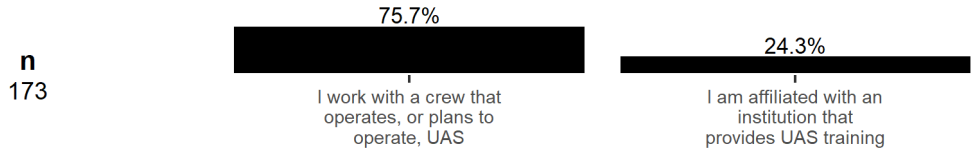
Median (med): The exact middle data point calculated in a set of rank-ordered values. It is less affected by extreme values in comparison to the mean, and thus, is relied upon when extreme values are present in a data set (e.g., total flight hours flown).

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

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

Respondent Eligibility

1. Which of these statements best applies to you?

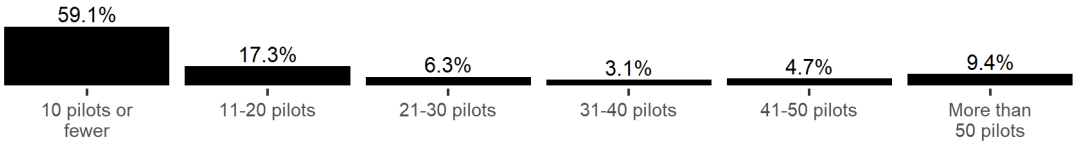


2. Do you work for an organization with established UAS pilot qualification requirements?

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*.

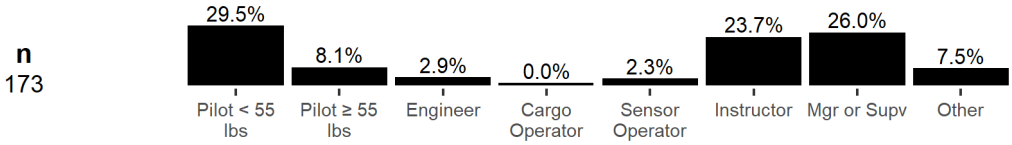
3. How many drone operators/pilots does your organization currently employ? (provide estimate if unsure)

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)



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 A for a list of responses)

	n
2022	13

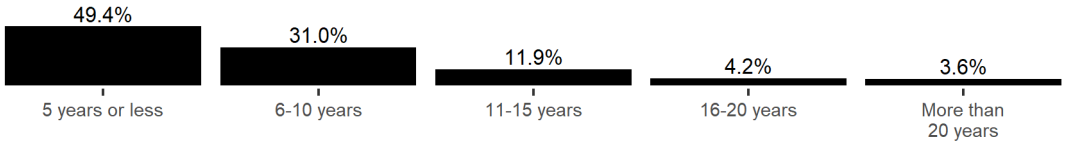
Results for *Item A1b* include only respondents who provided a written response.

A1b. In brief, please describe the main responsibilities of your job: (See Appendix A 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 A 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

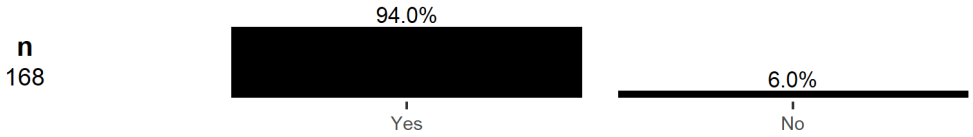
n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

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 A 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 A 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

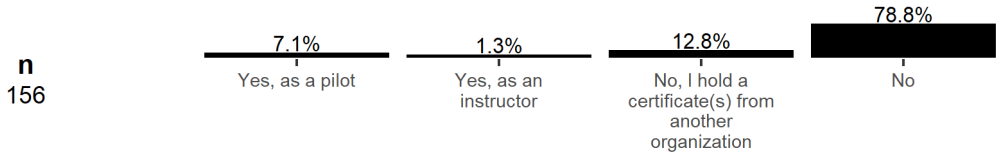
n may sum to greater than the number of respondents to the item (n) due to multiple responses. The %* of respondents is based on the number of respondents to the item (n).*

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 A 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)?



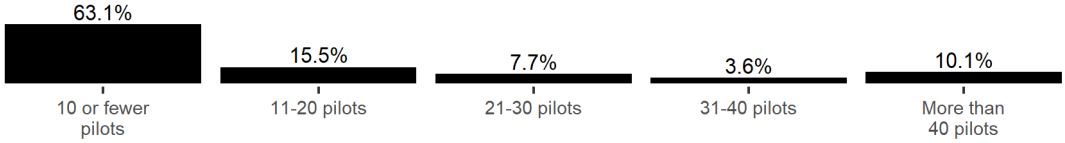
Results for *Item A9a* include only respondents who indicated 'No, I hold a certificate(s) from another organization' on *Item A9* and provided a written response.

A9a. What certificate(s) do you hold from another organization? Please describe. (See Appendix A 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?

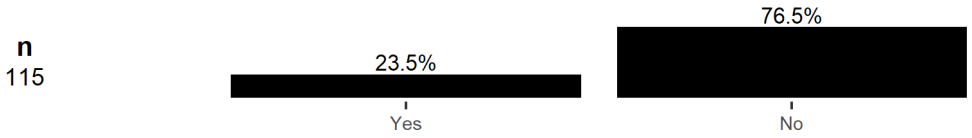
	n	mean	sd	min	max	median
2022	168	29.70	111.03	1	1,000	7



Section B. Air Carrier Operational Considerations for Unmanned Aircraft Systems

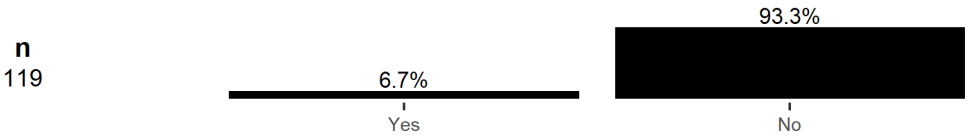
Results for *Item B1* include only respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator,' 'Sensor Operator,' 'Manager or Supervisor,' or 'Other' on *Item A1*.

B1. Does your organization currently, or have plans to, conduct UAS air carrier delivery operations? (required)



Results for *Item B2* include only 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* and 'Passenger Transport (Air Taxi)' on *Item A5*.

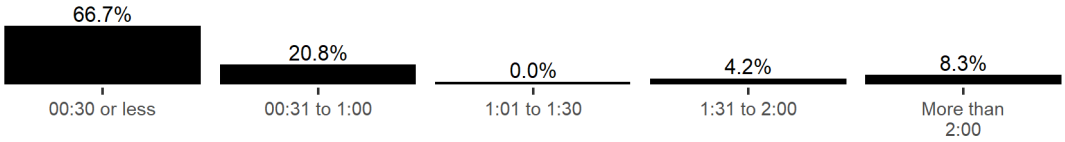
B2. Does your organization have plans to conduct UAS air taxi services (carriage of people for hire)? (required)



Results for *Item B3* through *Item B4* include only respondents who indicated 'Yes' on *Item B1*.

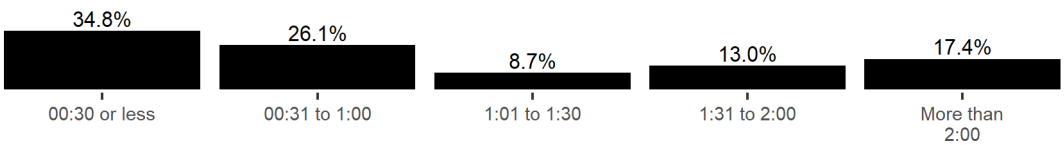
B3. What is the <u>anticipated average</u> in-flight time in a flight plan for your air carrier delivery operations?

n	mean	sd	min	max	median
24	0.82	1.07	0.083	4.1	0.5



B4. What is the <u>anticipated maximum</u> in-flight time in a flight plan for your air carrier delivery operations?

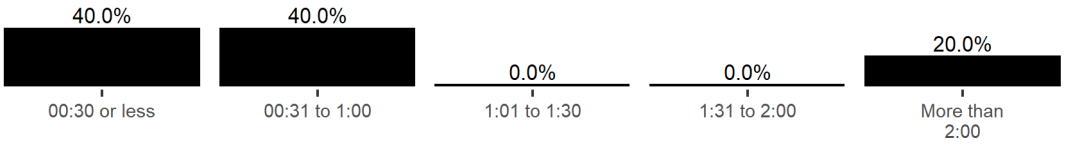
n	mean	sd	min	max	median
23	1.51	1.61	0.23	6.8	0.83



Results for *Item B5* through *Item B6* include only respondents who indicated 'Yes' on *Item B2*.

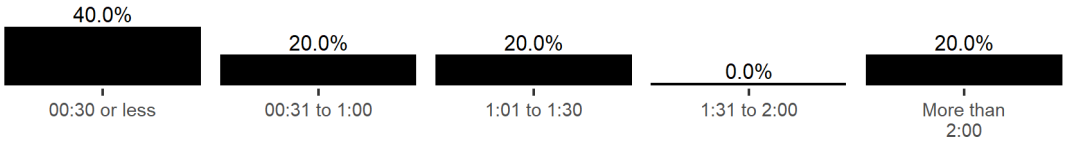
B5. What is the anticipated average in-flight time in a flight plan for your air taxi services?

n	mean	sd	min	max	median
5	0.93	0.80	0.33	2.3	0.75



B6. What is the anticipated maximum in-flight time in a flight plan for your air taxi services?

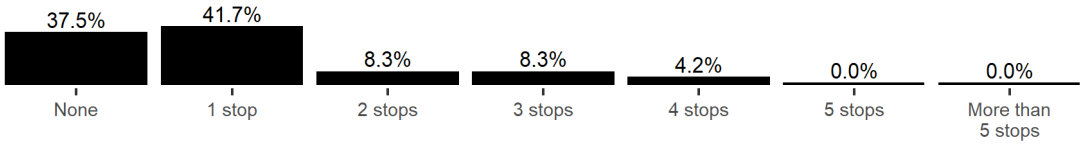
n	mean	sd	min	max	median
5	2.10	3.03	0.5	7.5	0.75



Results for *Item B7* through *Item B8* include only respondents who indicated 'Yes' on *Item B1* or respondents who indicated 'Yes' on *Item B2*.

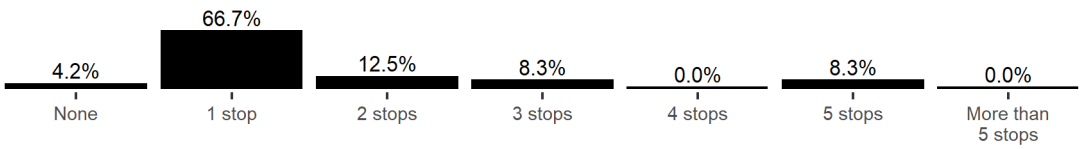
B7. How many pickup stops do you anticipate making on a flight before returning back to your base location?

n	mean	sd	min	max	median
24	1.00	1.10	0	4	1



B8. How many delivery stops do you anticipate making on a flight before returning back to your base location?

n	mean	sd	min	max	median
24	1.58	1.25	0	5	1



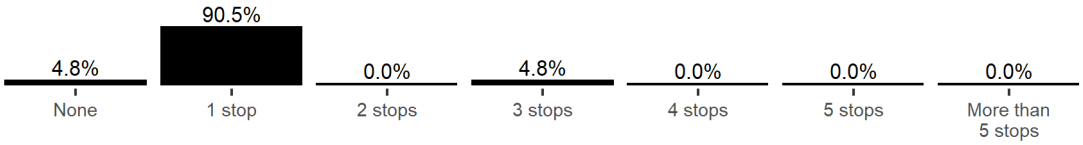
Results for *Item B9* through *Item B10* include only respondents who indicated 'Passenger Transport (Air Taxi)' or 'Shipping or Package Delivery' on *Item A5*.

B9. How many <u>pickup</u> stops do you <u>make</u> on a flight before returning back to your base location?

n	mean	sd	min	max	median
21	0.62	0.50	0	1	1

B10. How many <u>delivery</u> stops do you <u>make</u> on a flight before returning back to your base location?

n	mean	sd	min	max	median
21	1.05	0.50	0	3	1



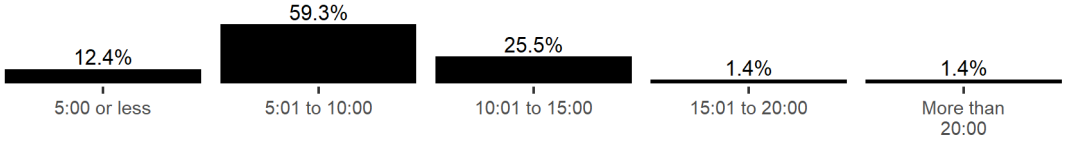
Section C. Fatigue and Fitness for Duty

C1. Did any crewmembers in your organization participate in any continuous operations overnight in the last year?

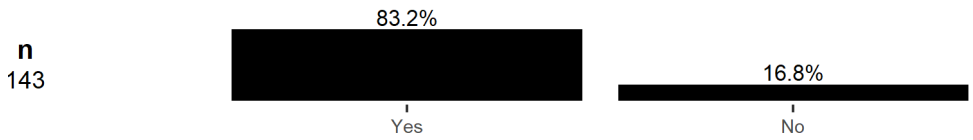
n
141

C2. How long does your organization consider to be normal minimum rest periods?

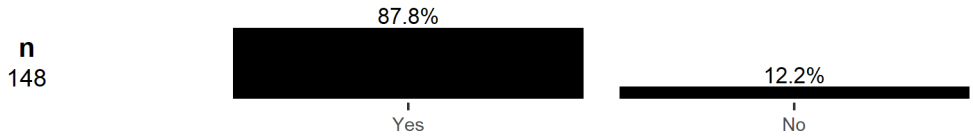
n	mean	sd	min	max	median
145	8.74	3.83	0	24	8



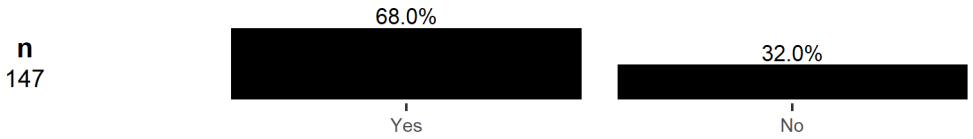
C3. Does your organization have a policy that workers must take responsibility for their own fitness of duty?



C4. Does your organization have a policy that workers are required to arrive for work sufficiently well-rested to be able to safely and reliably perform their work responsibilities throughout their scheduled duty period?



C5. Does your organization provide training on fatigue awareness and fatigue management?



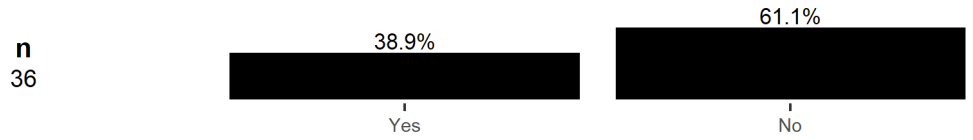
Results for *Item C6* include respondents who indicated 'Manager or Supervisor' on *Item A1* and provided a written response.

C6. Please describe what measures you use to assess fitness for duty for your employees. (See Appendix A for a list of responses)

	n
2022	32

Results for *Item C7* through *Item C9* include respondents who indicated 'Manager or Supervisor' on *Item A1*.

C7. Does your organization have a process in place for identifying fatigue hazards in drone operations?

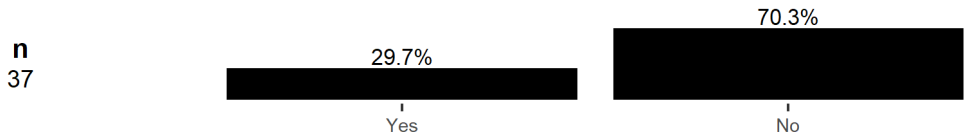


Results for *Item C7a* include respondents who indicated 'Yes' on *Item C7* and provided a written response.

C7a. If yes, please describe the process for identifying fatigue hazards. (See Appendix A for a list of responses)

	n
2022	14

C8. Does your organization have a procedure for documenting fatigue hazards as they are identified?

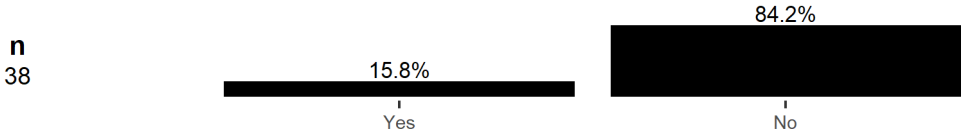


Results for *Item C8a* include respondents who indicated 'Yes' on *Item C8* and provided a written response.

C8a. If yes, please describe the process for documenting fatigue hazards. (See Appendix A for a list of responses)

	n
2022	11

C9. Does your organization collect data about fatigue risks from employees?

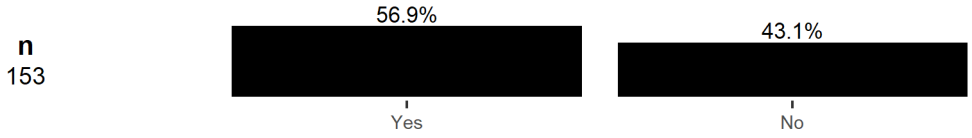


Results for *Item C9a* include respondents who indicated 'Yes' on *Item C9* and provided a written response.

C9a. If yes, please describe what data is collected from employees. (See Appendix A for a list of responses)

	n
2022	6

C10. Have you experienced fatigue while on duty?



Results for *Item C11* include respondents who indicated 'Yes' on *Item C10*.

C11. Which of the following factors do you think contributed to your fatigue while on duty? *[mark all that apply]*

	n
2022	87

2022 n*		2022 %*
57	Workload	65.5
32	Work pace	36.8
44	Work schedule	50.6
31	Family demands	35.6
19	Physical health	21.8
15	Other (please describe)	17.2

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).*

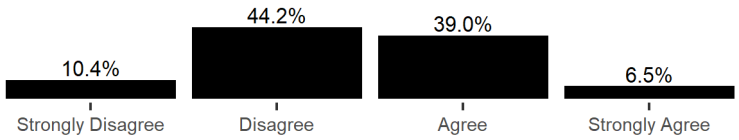
Results for *Item C11a* include respondents who indicated 'Other' on *Item C11* and provided a written response.

C11a. Other, please describe: (See Appendix A for a list of responses)

	n
2022	15

C12. Indicate your level of agreement with the following statement: *Crewmember fatigue is a common occurrence*.

n	mean	sd
154	2.42	0.76



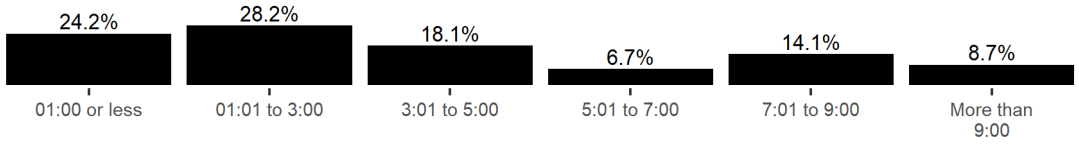
C13. Indicate your level of agreement with the following statement: *Crewmember fatigue represents a safety concern*.

n	mean	sd
154	3.23	0.77

Section D. Duty Periods

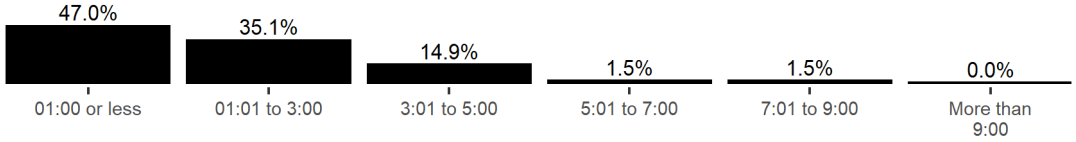
D1. On average, how long does a crew member stay on station during a single operation?

n	mean	sd	min	max	median
149	4.16	3.24	0.17	12	3



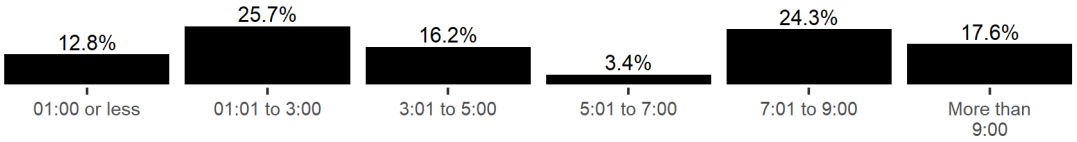
D2. How long is a crew member required to stay on station before taking a break?

n	mean	sd	min	max	median
134	1.83	1.65	0	8	2



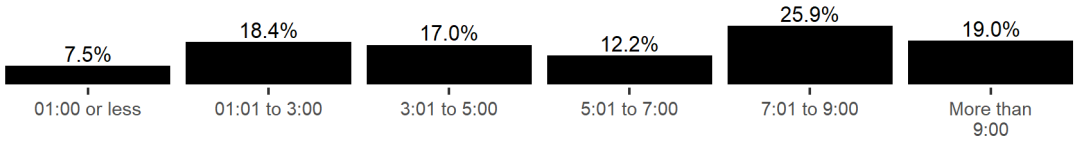
D3. What is the <u>maximum</u> length of time a crewmember should be required to stay on station?

n	mean	sd	min	max	median
148	5.58	3.83	0	18	4



D4. After how much time on duty does operator fatigue become risky?

n	mean	sd	min	max	median
147	6.16	3.50	0	16	6



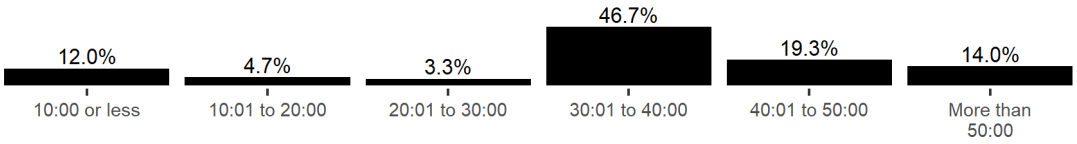
Results for *Item D4a* include only respondents who provided a written response.

D4a. Why do you believe operator fatigue becomes risky after this amount of time? (See Appendix A for a list of responses)

	n
2022	139

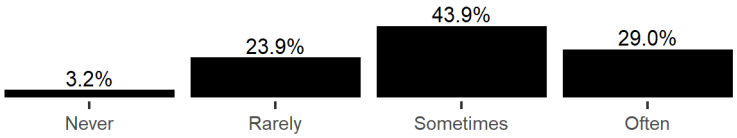
D5. On <u>average</u>, how long did you work each week excluding overtime in the <u>last 3 months</u>?

n	mean	sd	min	max	median
150	57.27	104.11	0	960	40



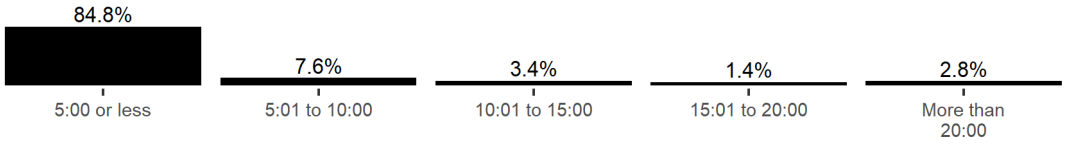
D6. How often do you travel for work?

n	mean	sd
155	2.99	0.81



D7. How much time do you typically spend traveling to flight/operation sites?

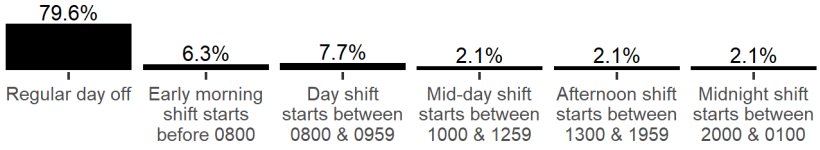
n	mean	sd	min	max	median
145	3.78	7.66	0	72	1



D8. Please indicate your typical shift schedule for a week period.

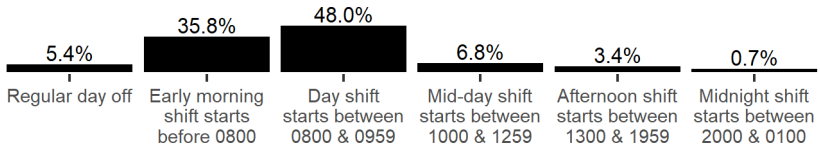
Sunday

n
142



Monday

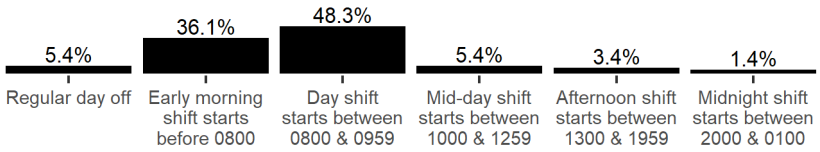
n
148



D8. Please indicate your typical shift schedule for a week period.

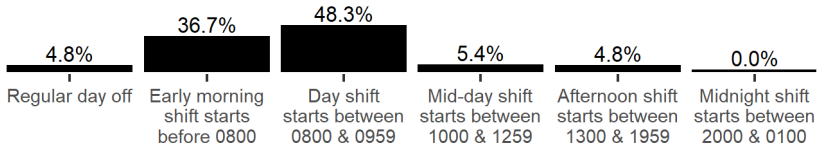
Tuesday

n
147



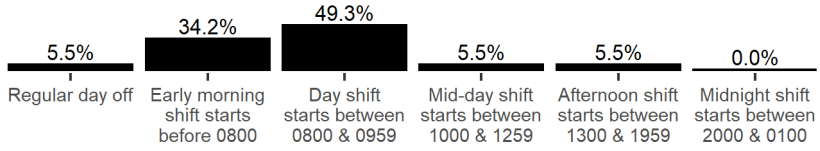
Wednesday

n
147



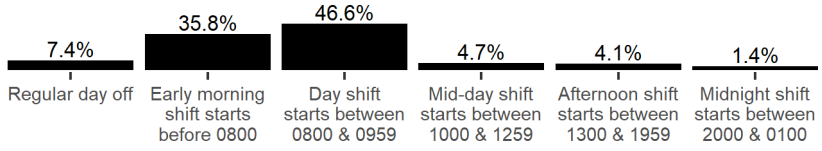
Thursday

n
146



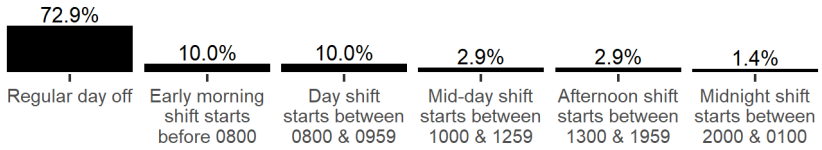
Friday

n
148



Saturday

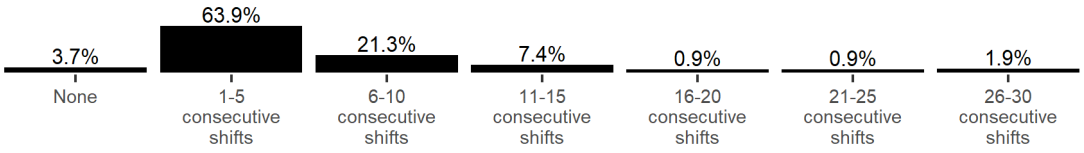
n
140



Results for *Item D9* 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*.

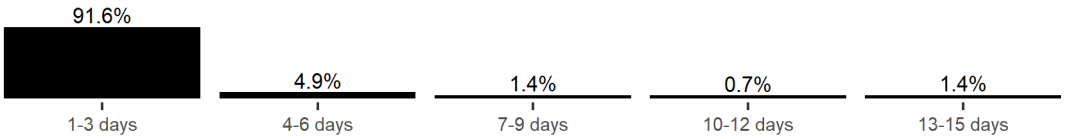
D9. In the last month, what is the maximum consecutive number of shifts of any kind you have worked without a day off?

n	mean	sd	min	max	median
108	5.99	4.58	0	28	5



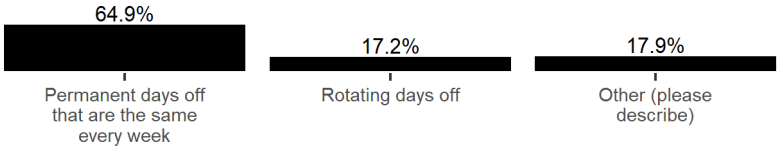
D10. How many days off in succession do you normally have?

n	mean	sd	min	max	median
147	3.12	7.45	1	90	2



D11. How are your days off currently organized?

n
151



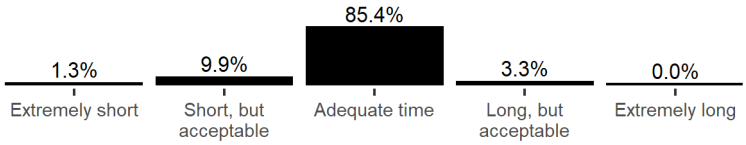
Results for *Item D11a* include respondents who indicated 'Other' on *Item D11* and provided a written response.

D11a. Other, please describe: (See Appendix A for a list of responses)

	n
2022	27

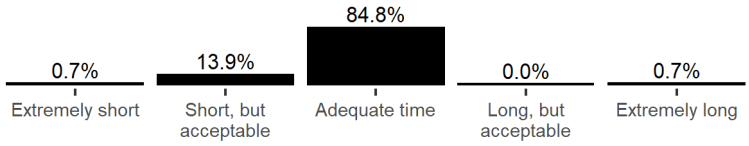
D12. Do you feel your time on position between breaks is:

n	mean	sd
151	2.91	0.42



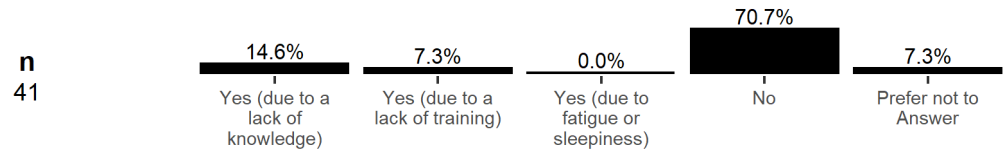
D13. Do you feel that the time you get on break is:

n	mean	sd
151	2.86	0.42



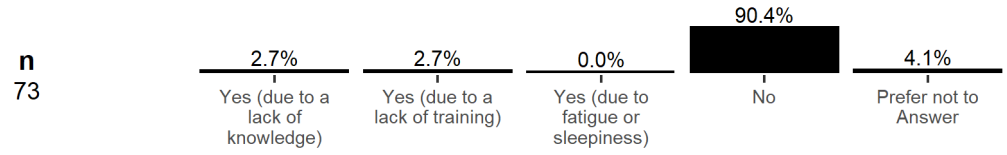
Results for *Item D14* include only respondents who indicated 'Manager or Supervisor' on *Item A1*.

D14. Have any of your employees had any operational deviations (e.g., accidental rule violation, accidental crash, or flyaway situations) in the last year?

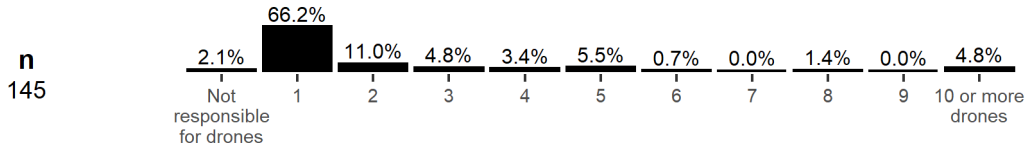


Results for *Item D15* include respondents who indicated 'Pilot/Operator with systems less than 55 pounds,' 'Pilot/Operator of systems equal to/greater than 55 pounds,' 'Engineer,' 'Cargo Operator ,' 'Sensor Operator,' or 'Other' on *Item A1*.

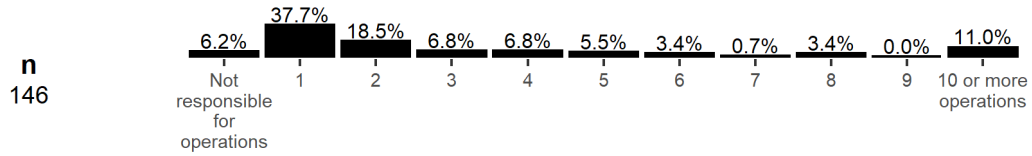
D15. Have you had any operational deviations (e.g., accidental rule violation, accidental crash, or flyaway situations) in the last year?



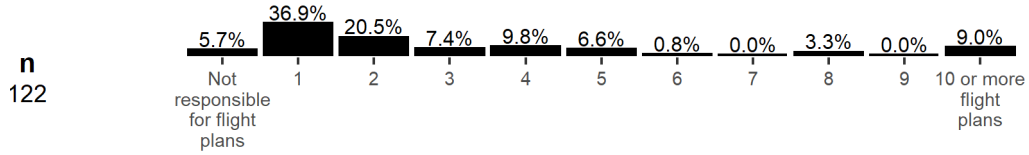
D16. How many drones are you responsible for each operation?



D17. How many operations are you responsible for each day?

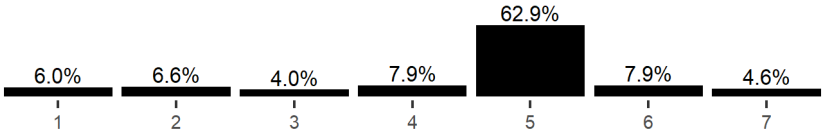


D18. How many flight plans are you responsible for planning each day?



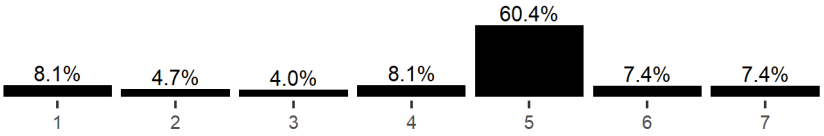
D19. In the last 3 months, what was the average number of duty days you worked in a 7-day week?

n
151



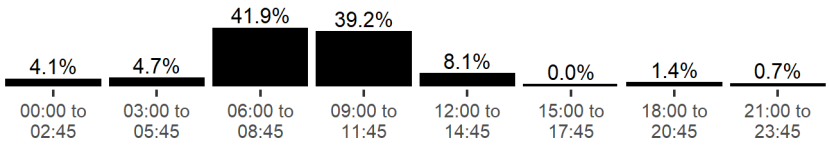
D20. In the last 3 months, what was the average number of duty days you worked consecutively in a 7-day week?

n
149



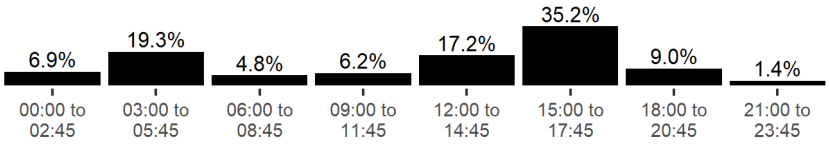
D21. In the last 3 months, what was the typical start time of your flights/operations?

n
148



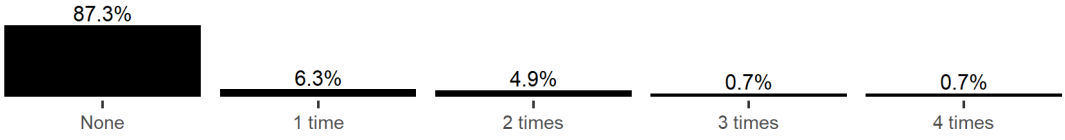
D22. In the last 3 months, what was the typical end time of your flights/operations?

n
145



D23. How many times in the last month did you work seven consecutive duty days without 24 hours of rest?

n	mean	sd	min	max	median
142	0.21	0.63	0	4	0



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 duty and rest included 14 open response items formatted for text entry. These items typically asked respondents to explain the job roles and operator duty and rest for UAS operators within their organization.

The responses shown in this appendix are verbatim responses with the exception of removing any personally identifying information and expletives, as needed.

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 4 and Table 5, 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 primary 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

A1. Currently, what is your primary job role? (required) *Other (please describe)*	
a. In brief, please describe your job role:	
*	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
*	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

A1b. In brief, please describe the main responsibilities of your job:	
*	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.
*	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.

A1b. In brief, please describe the main responsibilities of your job:	
*	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.
*	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.

A1b. In brief, please describe the main responsibilities of your job:	
*	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 liases 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.
*	I am responsible for building our drone fleet for last mile delivery and other applications

A1b. In brief, please describe the main responsibilities of your job:	
*	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 [Company] 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.

A1b. In brief, please describe the main responsibilities of your job:	
*	Standardization Instructor Operator
*	SUAS instructor
*	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.

A1b. In brief, please describe the main responsibilities of your job:	
*	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.
*	[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

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?	
*	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
*	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.

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?	
*	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
*	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
*	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

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

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:	
*	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.
*	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

Section B did not contain any items requesting text responses.

Section C. Fatigue and Fitness for Duty

Table B8

Responses provided by participants who indicated 'Manager or Supervisor' on Item A1, and who described the measures used to assess fitness for duty for their employees on Item C6. (n=32).

C6. Please describe what measures you use to assess fitness for duty for your employees.	
*	Announcement of potential Risk marrix
*	Comply with the FAA standards
*	Continue to preach taking care of your body in whatever capacity you think works for you
*	Gate check-in to operational areas verify mental alertness and general physical health conditions.
*	Hazard Identification and Risk Assessment Worksheet.
*	I lean on the IMSAFE checklist learned through flight training.
*	IMSAFE
*	IMSAFE personal checklist
*	Level of awareness and concentration, if the pilot is sufficiently rested, zero tolerance for use of alcohol/drugs
*	No policy
*	Observation / self-assessment
*	On job assessment.
*	pre check meetings before jobs
*	Pre-operation discussion face-to-face or via phone.
*	Preflight - Flight Risk Analysis Tools ORM checklists Self Assessment Surveys Others
*	Self assess
*	Self assessment and discussed at safety brief. IMSAFE.
*	self assessment daily
*	Self monitored
*	supervisors intuition
*	Training
*	Typically all manned measured are enforced with UAS operations
*	Verbal communication and observing body language
*	Visual and verbal assessments

C6. Please describe what measures you use to assess fitness for duty for your employees.	
*	Visual observation. Questioning. Background and drug screenings.
*	We are a small team and know each other well enough to determine if one of us seems unable to work or unfit for duty but that has never happened.
*	We are an on call service if they need to arrive awake and alert
*	We conduct a risk assessment prior to each flight.
*	We go over identifying stresses and fitness deficiencies. We stress that our pilots are not to fly when anything negative is self detected.
*	We operate in a college environment.
*	We use a pre-operation risk assessment that deals with fitness for duty. We also plan our work and schedule to allow for proper rest. All crew have "stop work authority" as well.
*	work product quality, alertness, general physical appearance, discussion with the pilots, IMSAFE checklist

Table B9

Responses provided by participants who indicated 'Yes' on Item C7, and who described the process for identifying fatigue hazards (n=14).

\C7. Does your organization have a process in place for identifying fatigue hazards in drone operations? *Yes (please describe)*	
a. If yes, please describe the process for identifying fatigue hazards:	
*	Area of operations (noise levels, ambient temp, direct sun), length of operation, single or multiple pilot crews, complexity of flights, time of day (day or night flight), medications, physical condition of pilot,
*	Based on FAA guidelines
*	Check list part of risk assessment conducted
*	Checklist discipline ORM checklists Buddy system Flight Risk Analysis CRM
*	Hazard Identification and Risk Assessment Worksheet.
*	If hazard is identified, local crew communicate with local lead, who files an SRS ticket, contacts mgmt., and potentially removes person in question from operations
*	internal processes that can not be shared.

\C7. Does your organization have a process in place for identifying fatigue hazards in drone operations? *Yes (please describe)*	
a. If yes, please describe the process for identifying fatigue hazards:	
*	pre flight meetings
*	Risk assessment prior to each job with specific questions.
*	Risk Identification flow chart and matrix
*	Risk management forms (part of)
*	SMS reporting
*	SMS, CRM, ORM and normal manned processes
*	Verbal responses that are coherent and articulate.

Table B10

Responses provided by participants who indicated 'Yes' on Item C8, and who described the process for documenting fatigue hazards (n=11).

C8. Does your organization have a procedure for documenting fatigue hazards as they are identified? *Yes (please describe)*	
a. If yes, please describe the process for documenting fatigue hazards:	
*	Can submit a risk management form as needed.
*	Form
*	FRAT - documents all events - pre and post flight.
*	internal processes that can not be shared.
*	notations/history for the particular AO, heat of day, humidity %, complexity level
*	Pre-Operation discussion is documented with date and answers to specific questions, and then the Interviewer's personal assessment
*	SMS reporting
*	SMS, CRM, ORM, FRAT and normal manned processes
*	SRS (Safety Reporting System), anyone can submit a ticket at any time, and prompts immediate review and triaging by our Head of Safety, to be further addressed by appropriate stakeholders as req'd (other mgmt. personnel)
*	submit a report and record the issue

C8. Does your organization have a procedure for documenting fatigue hazards as they are identified? *Yes (please describe)*	
a. If yes, please describe the process for documenting fatigue hazards:	
*	We have a web-based safety logging system where folks can submit various levels of safety concerns, "good catches", and incident/accidents.

Table B11

Responses provided by participants who indicated 'Yes' on Item C9, and who described what data is collected from employees (n=6).

C9. Does your organization collect data about fatigue risks from employees? *Yes (please describe)*	
a. If yes, please describe what data is collected from employees:	
*	CRM, ORM, SMS and FRAT are used every flight
*	Flight Risk Analysis Tools - Manual and Automated database
*	General discussion that includes question about recent sleep, drinking, drugs and random questions about general Part 107 rules and regs and random questions on company policy.
*	sharing of suggestions, experiences
*	SMS reporting
*	SRS tickets

Table B12

Responses provided by participants who indicated 'Other' on Item C11, and who described the factors they think contributed to their fatigue while on duty (n=15).

C11. Which of the following factors do you think contributed to your fatigue while on duty? *[mark all that apply] Other (please describe)*	
a. Other, please describe:	
*	Bad night sleep
*	Bad question, fatigue comes in many forms, may be age related, or health, or occupational, physiological, environmental. Mental and physical, two different things, open question, do you have a month
*	Client External Pressures

C11. Which of the following factors do you think contributed to your fatigue while on duty? *[mark all that apply]* *Other (please describe)*	
a. Other, please describe:	
*	Deployed operations in conflict zones
*	Don't travel well. Often feel fatigue from not getting enough sleep.
*	Frustration
*	Grass pollen allergies...
*	Inadequate pre-shift rest.
*	Physical outdoor elements, heat, cold exposure
*	Poor time management and self care.
*	Stress in a first responder environment which includes SWAT operations and SAR missions.
*	Temperature and humidity
*	Travel
*	WEATHER
*	Weather (extreme heat or cold)

Section D. Duty Periods

Table B13

Responses provided by participants who indicated the time on duty after which operator fatigue becomes risky Item D4, and who described why operator fatigue becomes risky after the amount of time indicated in D4 (n=139).

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	Unable to make decisions as quickly
*	"I think the risk here becomes a training issue. We ONLY train, and at this point, the instructors risk pushing through the training faster than standard. This discounts the student.
*	1) Stress as a first responder. 2) Visual focus on the GCS screen as well as re-focusing on the drone itself 3) Physical fatigue in standing, movement of the controls
*	6-hours that include periodic breaks. Breaks much be every 2-hours or less.

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	8 Hours is your standard work day. It is a good metric for measuring when someone will grow tired, bored, or restless, that's when mistakes are made.
*	Ability to full concentrate on flying and spatial awareness
*	ability to maintain focus in reduced after 8 hours.
*	actual flight operations are relatively short with walking time between each but by the end of the day the stress of walking, driving, and eye fatigue mixed with lighting conditions can add risk factors to operation
*	Acute alertness takes a toll on body
*	After 12 hours of operation the mind can start to blend things together. Especially if the same repetitive task is being performed.
*	After a typical day of 8 hours, to work 1.5 amount hits the limit of concentration to go 12 hours. Any longer creates fatigue.
*	An operator can become fatigued at any time. There are multiple factors; WEATHER, DEHYDRATION, LACK OF SLEEP, HUNGER, ETC.
*	An operator needs to stretch their legs every few hours to maintain sharpness.
*	Any fatigue becomes an issue regardless of actual time. Pilot must be encouraged to rest if needed.
*	Anything longer than a standard work day will see fatigue setting in. We take breaks with every battery change
*	As a trainer focus begins to be lost
*	At this time the operator is lost guaranteed to be extremely fatigued
*	Attention span diminishes greatly
*	Attention to details
*	Attention to minor details appears to becoming lacking. Automation lulls into false state of comfort.
*	bad question, depends on operation, person, environment, I will not answer, these time questions are poor, each is individual
*	Based on environmental conditions, drone operators typically operate outdoors in extreme temperature environments - after 8-hours of work in challenging conditions, mental alertness begins to degrade

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	Because it's past what has been trained for and doesn't allow for adequate rest.
*	Because people tend to zone out staring at a screen for longer.
*	Because staring at the sky and being exposed to the elements increases the physical and mental fatigue of the pilot greater than sitting inside at a workstation.
*	Because that equates to a standard working day and concentration levels, energy and fatigue are affected naturally after that period of time but we have never put ourselves in a situation where we operate continuously for that length of time without a decent break.
*	Being on hyper-focus is very tiring.
*	Boredom and distraction come into play
*	can make slow decisions causing a crash potentially
*	complacency
*	Complacency on multiple fronts.
*	Continuous minute by minute decisions making during training, reduced mobility, students restlessness, and vocal fatigue
*	Crews get tired and worn out
*	Decision making and reaction time
*	decrease in attention, eye fatigue, decrease in concentration
*	Dehydration and time between meals in the field setting
*	Depending on heat/cold conditions, this time may vary. But under normal operating conditions mental and physical alertness is strong during 8 hours
*	Depending on the mission, this is getting to be a long time for constant vigilance and undivided attention.
*	Depending on the operation this seems like a point at which an operators focus may drift. Human factors also start kicking in and the body needs separation from stresses involved in flight ops.
*	Depending on the operation, the pilot's hands could become stressed, their eyes could strain, and their mental focus would begin to suffer.
*	Depends on person and situation, but 8 hours is the standard working time for our pilots, so anything over that can become a risk.

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	depends on the operation and equipment.
*	Distractions and compliancy
*	During operation you need to be very alert and this can be draining. I think its hard to be 100% alert after flying drone flights for over 3 hours.
*	EXPERIENCE IN FIELD, I ONLY HAVE SO MANY NEURONS I THINK
*	Experience with extended (8-12) hour shifts operating tactical surveillance UAS in OIF and OEF. Operator attention to details and ability to follow instructions degraded after about 4 hours.
*	eye fatigue, complacency
*	eye strain
*	Fatigue
*	Flights are short due to battery life on sUAS so breaks naturally happen.
*	Flying a drone for 2 hours requires a lot of concentration and strains your eyes. This will increase risks the longer you fly
*	From personal experience and I remember learning about it in the Aviation safety course at the University of North Dakota.
*	General experience
*	Get it done-itis and complacency to procedures increase for long operations. We also consider travel to site time as part of the fatigue calculations.
*	Hard to concentrate on details for that amount of time
*	I am assuming 4 hours on duty before a break, am assuming not 4 solid hours of flight time. I would say after 2 straight hours of pure flying time a pilot needs a break.
*	I believe that taking short breaks after every hour of UAS flight operations is critical to maintain situational awareness, good communication with teammates, and maximum attention to environmental risks and hazards.
*	I go by how I feel and after observing my crew members over several shoots
*	I have worked as many as 13 hours in the seat straight during the early days after the 9/11 attacks. At about the 8 hour point attention to detail and fatigue from staring at the screens and monitoring radios starts becoming a factor.

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	If a person is tired or sick, their perception and attention may be negatively impacted. If any crew member determines that they are unfit for any reason, they must cease operations.
*	In ability to be vigilant, take prompt corrective actions, or make mistakes.
*	In our industry, a duty day this long would primarily consist of waiting around. This can cause complacency.
*	Inability to remain focused without a break
*	Isolation to a GCS and time devoted to system monitoring becomes hazardous after 8 hours. This also depends on the mission, the UAV type, and the environment. All of which may reduce this time.
*	it all depends on many external factors as well as personal factors. Can't answer the question as written
*	it can be extremely repetitive and boring
*	It is possible. Depending on environmental factors
*	It would depend on the mission. long loiter overwatch or surveillance vs a more active mission.
*	It's mentally taxing especially if there is only one crew member.
*	It's the end of a full working day for us.
*	Judgement
*	judgement and awareness
*	lack of awareness and judgment
*	Lack of vigilance
*	loss of focus
*	Loss of situational awareness, distraction through fatigue
*	Many tasks are mundane
*	mental fatigue
*	Mental fatigue
*	Mental fatigue and reaction times can become a factor

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	Mentally draining after a 10 hour day. This is a standard day in the film industry and we don't go over it. We are not flying the whole time, might sit around all day for 30 minutes of aerial operations.
*	Monotony leads potential complacency at this point
*	Most operations for my department do not required the pilot to continually operate the drone platform. There are built in breaks of time, so the actual flight time is less than 4 hours. Just repeating the same task over time becomes an issue.
*	Much like driving a vehicle, the first hour passes by relatively quickly. After an hour and a half it starts to become monotonous. After 2 hours, there is risk of feeling fatigued from the job.
*	Need to get the blood moving
*	Normal work day is enough, but eventually your mind starts to wander.
*	Normalcy in a slower-paced operational environment
*	Once again this question does not truly measure training operations. It does not take into account type of operation, location, number of students, or environment.
*	only so much focus that you can achieve after 8 hours
*	operating aircraft from a control terminal that is located inside becomes fatiguing after 8 hours. You will monitor outside weather patterns but you are in a different environment, so you dont feel whats being reported to you. its a slight dysphoria for prolonged times. so you need to get out of the area and walk around and "reset" .
*	Operator becomes complacent.
*	Operator becomes drowsy, reaction times are impaired.
*	Operator can take breaks as they see fit. No minimum time.
*	Our typical training classes are 2 to 3 hours long. In that time, we are entirely outdoors/in the field and go through 3 fully-charged multirotor batteries. We've taught this way since 2018 and have found that to be a sweet spot when it comes to maximizing learning and minimizing fatigue with both our flight instructors and new drone pilot students.
*	Overall performance decreases rapidly after this time in experience and we have the resources to change out operators sooner than most.
*	Past experience as a commercial pilot.

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	People need breaks to perform effectively. A burnout employee is not a good one.
*	People need downtime. We do not have a case we can cite, but this is an estimation.
*	Performing the same task over and over makes it hard to focus and the physical fatigue starts setting in. I say 10 hours assuming there are breaks in there. 4-5 hours without breaks.
*	personal experience...boredom and complacency become more prevalent
*	Physical strain
*	Repetitive nature of monitoring systems.
*	Revitalize eat and stay hydrated.
*	Sleepiness
*	Strain on eyes, mental focus
*	Stress begins to overload the pilot.
*	Subjective question to the type of operations
*	The ability to lose focus and to stay sharp for the sake of safe operations.
*	The human brain wanders and gets distracted
*	The operator can no longer make sound decisions regarding safety and cannot operate the aircraft efficiently.
*	The pilot eyes need to be rested after that time frame.
*	The question is whether 8 hours is too much, but whether 8 hours every day is too much. Day 6, hour 7 most operators stop seeing the instrument trends that will allow them to make the safest decisions in a timely manner. Most automated flight is obnoxiously simple, but anything beyond approx. 60 hours a week and you start losing the ability to make the best decision when automation fails and emergency procedures are necessary.
*	The time on duty isn't as much of a factor as the time of day. Operations beginning at 2 am are far riskier than operations of the same duration that begin at 8 am. A rapidly changing and unpredictable schedule also impacts risk by limiting the ability to get sufficient sleep.
*	Their attention to the flight will decrease and ability to make rapid decisions will decrease.

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	There are various factors that may change my answer to the previous question. For example, is the operator the sole operator of the mission, or are there other crew members? Is the weather unbearably hot during the operation? In any event, my answer to the last question is based on the worst case scenario.
*	they are tired mentally strained
*	This has been studied by the military and performance begins to drop after this time.
*	This is a difficult one to evaluate in terms of "hours" because we break up our options into "days" and "half-days" . I determined this number with our half day being approximately 5 hours - 1 hour of prep, 2-3 hours of UAV operation or ground control point setting, 1 hour of breakdown. I find that within the operation of a half-day, fatigue sets in and a break/reset is needed. Often we are doing hours of prep, travel, setting ground control in the field, setting up UAV control stations, charging batteries, etc. In some ways, flying the UAV is the least fatiguing part of the whole process. Even just determining restroom facilities for the crew is a difficulty not incurred by airline pilots. Time at or away from a control station can be a poor measure of "duty time" for most drone pilots as their responsibility to fly the drone can be as little as 20% of their overall day's duty. For us in the drone mapping world, setting ground control is the most physically taxing aspect, especially in very hot or cold weather. Something I think the FAA should also consider is that crew operations with UAS are extremely dynamic compared to what an ATP-rated pilot would experience. A UAV pilot can have a 2 hour job in the spring at a pleasant 70-degree F day or they can have 30 minutes on a construction site in the middle of summer with temperatures reaching 90 degrees F. The summer day is going to cause fatigue much faster than the spring day because of environmental factors.
*	This is a poorly worded question. Are you saying that the pilot is already fatigued when arriving for duty? Or that he/she is getting fatigued while operating?
*	This is hard to answer because it has a lot to do with the type of mission and the environmental conditions. Even the type of UAS plays a factor
*	Tired, complacent,
*	too long to be able to pay attention even with breaks
*	Too long to stay focused
*	too tired
*	Tunnel vision and complacent issues

D4. After how much time on duty does operator fatigue become risky?	
a. Why do you believe operator fatigue becomes risky after this amount of time?	
*	UAS flight for Public safety requires a lot of attention in the airspace and on ground operations being monitored. This is an extra duty and operators are on call 24X7
*	Usually when operations begin early in the morning, by the time an operator has hit the 6 hour mark, it's well into the day and after lunch time. By this time, most operators are pretty fatigued when you add in either the heat or cold of the day.
*	We don't have scenarios of long missions. We also often fly with two certified pilots (one acts as visual observer and one flies) and we usually take turns flying so there is rest in between.
*	We have seen increases in drone damage with flights longer than 3hrs
*	When we are flying all day, the tasks are very similar and mundane. There are times when you can get complacent and you just need to take a break from all of the screens.
*	Without adequate break time situational awareness can falter.
*	yes
*	Yes
*	Yes
*	Yes
*	Yes, complacency, attentiveness, and situational awareness begin to diminish.
*	You should always be aware of this risk.
*	You start forgetting important tasks
*	You stop being attentive and probably need a break mentally and physically

Table B14

Responses provided by participants who indicated 'Other' on Item D11, and who described how their days off are currently organized (n=27).

D11. How are your days off currently organized? *Other (please describe)*	
a. Other, please describe:	
*	As scheduled around classes

D11. How are your days off currently organized? *Other (please describe)*	
a. Other, please describe:	
*	as work demands but we try to get a two day period of rest after the 40 hour work week ends
*	Based on needs
*	Changes based on need but typically Saturday and Sunday are off
*	Days off are based on the end of the rotational units.
*	Days off depends on student needs, questions, and grading assignment workload.
*	Depending on student availability
*	Depends on clients and scheduling
*	Depends on project deadlines
*	Depends on semester.
*	Flex Fridays, Off every other Friday
*	Generally same days every week, depends on the project and workload
*	I am able to take days off depending on what the jobs I have scheduled, what the weather forecast looks like, and what my personal preferences are each week.
*	I am self employed, semi retired, I set my own schedule, and I wear many hats, these questions do not pertain to me
*	I don't have a set schedule. I could work Wed-Sun, then have Monday off or Sun-Wed and have Thursday off. It changes daily.
*	I dont take days off
*	I work when the business needs me to. Sometimes that includes weekend, sometimes it doesn't. It's my business so i'm very much in control of my own schedule.
*	I work when there are jobs to complete
*	It depends on what projects and deadlines we have.
*	Mission and contract dependent. In US operations its typically mon-fri. When deployed it can be continuous operations with varying schedules.
*	Mission dependent
*	Normal Saturday and Sundays off but sometimes these are interrupted for a mission or demonstration.

D11. How are your days off currently organized? *Other (please describe)*	
a. Other, please describe:	
*	Part-time hourly
*	Usually weekends but sometimes operations will dictate your two days or more falling during the week.
*	We take a day off when we can. Our employees have scheduled days off
*	we work 12 days on 2 days off. so our days off vary
*	When deployed we work 12 hour shifts, 7 days a week for the duration of the deployment. The only days off we get are related to weather cancels or maintenance cancels. Deployments for my company are 80-95 days in duration.