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Integrating Expanded and Non-Segregated UAS Operations into the NAS—Impact on Traffic Trends and Safety: Supplement F: Interview Study with FAA Test Sites and Integration Pilot Programs

June 24, 2022

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16. Abstract

The Federal Aviation Administration (FAA) seeks data-driven solutions to inform its regulation/standards development efforts and to inform FAA safety management systems toward the approval of new integrated Unmanned Aircraft System (UAS) capabilities. This study provides further insight into data needs for evaluating UAS CONcepts of OPeration (CONOPs). Data were collected using interviews, with a total of 9 FAA Test Sites or Integration Pilot Program (IPP)/Beyond lead organizations providing input.

Data regarding current waivers show that the Part 107 waiver or Certificates Of waiver or Authorization (COA) route is preferred for certain types of waivers, some waiver types are linked, some respondents specialize in certain types of waivers, acquisition of waivers and COAs that have more than one deviation is common, and demand for waivers related to Beyond Visual Line Of Sight (BVLOS) operations is high. The data also indicate that publication of a recent rule likely impacted waiver requests.

The same set of common CONOPs, with minor variations, were identified with current waivers, waivers requested in the past year, and expected future CONOPs to be developed in the next year. The expected future CONOPs indicated a shift in relative importance of some of the common CONOPs.

Respondents indicated that DAA systems are commonly used as mitigations. This is noteworthy given that such systems are not generally approved as a sole means for avoiding conflicts with other aircraft and thus are being utilized as part of the overall set of mitigations. DAA is also the dominant emerging/future technology for hazard mitigation/UAS National Airspace System (NAS) integration identified by respondents. All of the emerging technologies identified support BVLOS operations except, possibly, or Remote ID, improved payloads, and improved data feed capability.

Opportunities exist for leveraging this effort to further serve FAA needs. Several suggestions regarding future improvements are provided.

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Acronym	Meaning
ADS-B	Automatic Dependent Surveillance-Broadcast
BVLOS	Beyond Visual Line Of Sight
CA	Crewed Aircraft
COA	Certificates Of waiver or Authorization
C2	Command and Control
CONOP	CONcept of OPeration
DAA	Detect And Avoid
FAA	Federal Aviation Administration
HITL	Human In The Loop
IPP	Integration Pilot Program
IRB	Institutional Review Board
NAS	National Airspace System
NPRM	Notice of Proposed RuleMaking
PAO	Public Aircraft Operation
SRM	Safety Risk Management
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UND	University of North Dakota
VO	Visual Observer

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) seeks data-driven solutions to inform its regulation/standards development efforts and to inform FAA safety management systems toward the approval of new integrated Unmanned Aircraft System (UAS) capabilities. This study provides further insight into data needs for evaluating UAS CONcepts of OPeration (CONOPs). Data were collected using interviews. A total of 9 respondents provided input, with each being from either an FAA Test Site or Integration Pilot Program (IPP)/Beyond lead organization.

The first set of information gathered regards current types of waivers held by respondents. These data show that the Part 107 route is preferred for certain types of waivers (relative to COAs) and that the Certificates Of waiver or Authorization (COA) route is preferred for other types of waivers (relative to Part 107). These data also show that some waiver types are linked, some respondents specialize in certain types of waivers, acquisition of waivers and COAs that have more than one deviation/waiver type is common, and demand for waivers related to Beyond Visual Line Of Sight (BVLOS) operations is high.

Information regarding recently-requested waiver types led to the same conclusions and additional insights. One additional insights is that publication of the "Operation of Small Unmanned Aircraft Systems Over People" final rule (Department of Transportation 2021) likely impacted waiver requests.

Interview data regarding CONOPs enabled identification of the most common CONOPs. The same set of CONOPs, with minor variations, were identified with current waivers, waivers requested in the past year, and expected future CONOPs to be developed in the next year. The expected future CONOPs indicated a shift in relative importance of some of the common CONOPs.

The most common current mitigations used to enable common CONOPs are Detect And Avoid (DAA), Visual Observer (VO), and Strategic (e.g., low traffic density airspace). Respondents indicated that DAA systems are commonly used as mitigations. This is noteworthy given that such systems are not generally approved as a sole means for avoiding conflicts with other aircraft. DAA systems are likely being utilized as part of the overall set of mitigations with other mitigations, such as VOs, providing a layer of safety that enables the CONOPs/testing.

The dominant emerging/future technology for hazard mitigation/UAS National Airspace System (NAS) integration identified by respondents is DAA. Many other technologies/capabilities were also identified. Except, possibly, for Remote ID, improved payloads, and improved data feed capability, all of the emerging technologies identified support BVLOS operations.

CONOP performance evaluation metrics were placed into categories, and then reorganized into an alternative taxonomy of 5 primary categories. This taxonomy can be used to develop a dynamic list of specific metrics and their applications that would serve the UAS industry.

The final type of information gathered regards safety-case data types that are routinely collected. With few exceptions, the respondents are comprehensive in their data collection. Exceptions include data regarding security and communication processes, which are not surprising given that these are likely not viewed as safety critical as other types of data.

Opportunities exist for leveraging this effort to further serve FAA needs. Several suggestions regarding future improvements to the interview process are provided.

1 INTRODUCTION

The Federal Aviation Administration (FAA) seeks data-driven solutions to inform its regulation/standards development efforts and to inform FAA safety management systems toward the approval of new integrated Unmanned Aircraft System (UAS) capabilities. This report serves as a complement to Stansbury et al. (2020), which provides a comprehensive evaluation of:

- Data sets available for forecasting UAS activity and evaluating impacts.
- Data needs for evaluating UAS CONcepts of OPerationS (CONOPs).
- Utility of data in determining trends and forecasting future Unmanned Aircraft/Crewed Aircraft (UA/CA) encounters, and how the data can be improved for such applications.
- Waiver and Notice of Proposed RuleMaking (NPRM) data reporting requirements as they relate to Safety Risk Management (SRM).
- The validity of using reports of UAS sightings near aerodromes or other aircraft that could potentially, but not necessarily, result in a safety hazard/violation of operating limits.

This report supplements item 2 from this list by providing indications of current and future UAS CONOPs/UAS CONOPs trends based on an interview study involving participants in an FAA Test Site or an Integration Pilot Program (IPP), which can be used to identify data needs for evaluating those CONOPs.

2 DATA COLLECTION

2.1 Data Collection Approach

Data were collected using an off-line interview tool. The University of North Dakota (UND) administered data collection. The UND Institutional Review Board (IRB) was consulted regarding this study, and it was determined that IRB review was not needed because the interview questions were not about individuals, but are instead about UAS activities.

2.2 Respondents

The respondents are FAA Test Sites and Integration Pilot Program (IPP)/Beyond lead participants (leads of entities as opposed to partners). These entities were targeted owing to their roles in enabling UAS access to the National Airspace System (NAS) and, thus, their insights into UAS CONOPs. If an entity was both an FAA Test Site and IPP/Beyond participant, they were allowed to provide only one response. No respondents requested clarification regarding questions, although the short timeframe (approximately two weeks) may have constrained this process. Responses were gathered in January 2022.

2.3 Interview Material

The interview questions are provided in Appendix A. As indicated there, major sections/topics of the interviews are:

1. Instructions
2. Organization contact information
3. Current and recently-requested waiver types (questions 1-4)
4. Current and recently-requested CONOPs (questions 5-6)
5. Future CONOPs (question 7)
6. Current hazard mitigation methods/technologies (question 8)

7. Emerging/future technologies for hazard mitigation/UAS NAS integration (question 9)
8. CONOP performance evaluation metrics (question 10)
9. Types of data collected that contribute to safety cases (question 11)

3 RESULTS

Respondents from a total of 9 organizations responded to the interview questions. The results are described in the following sections.

3.1 Current and Recently-Requested Waiver Types

Current waivers are those that entities possess, while recently-requested waivers are new waivers (not renewals) that have been requested in the past year. Current and recently-requested waiver type data provide a baseline for operation types and CONOPs. As shown in Figure 1, the 9 organizations had a total of 297 Part 107 waivers and COAs (Certificates Of waiver or Authorization; an average of 33 per organization). None of the respondents indicated that they had other types of permissions beyond Part 107 waivers or COAs.

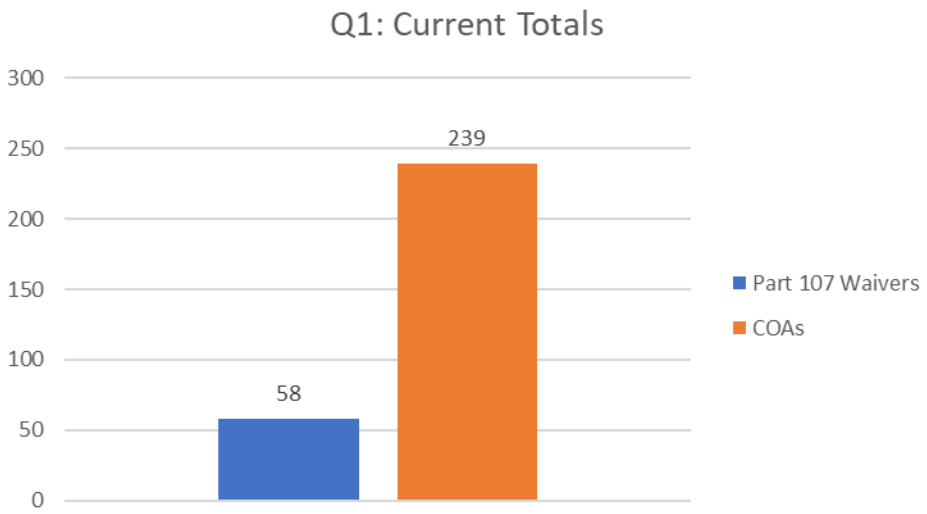

Figure 1. Total number of current Part 107 waivers (6 responses) and COAs (7 responses).

Figure 2 illustrates current waiver types (the 'R's along the x axis stand for Respondent). As indicated in this figure, 2 organizations did not provide this information.

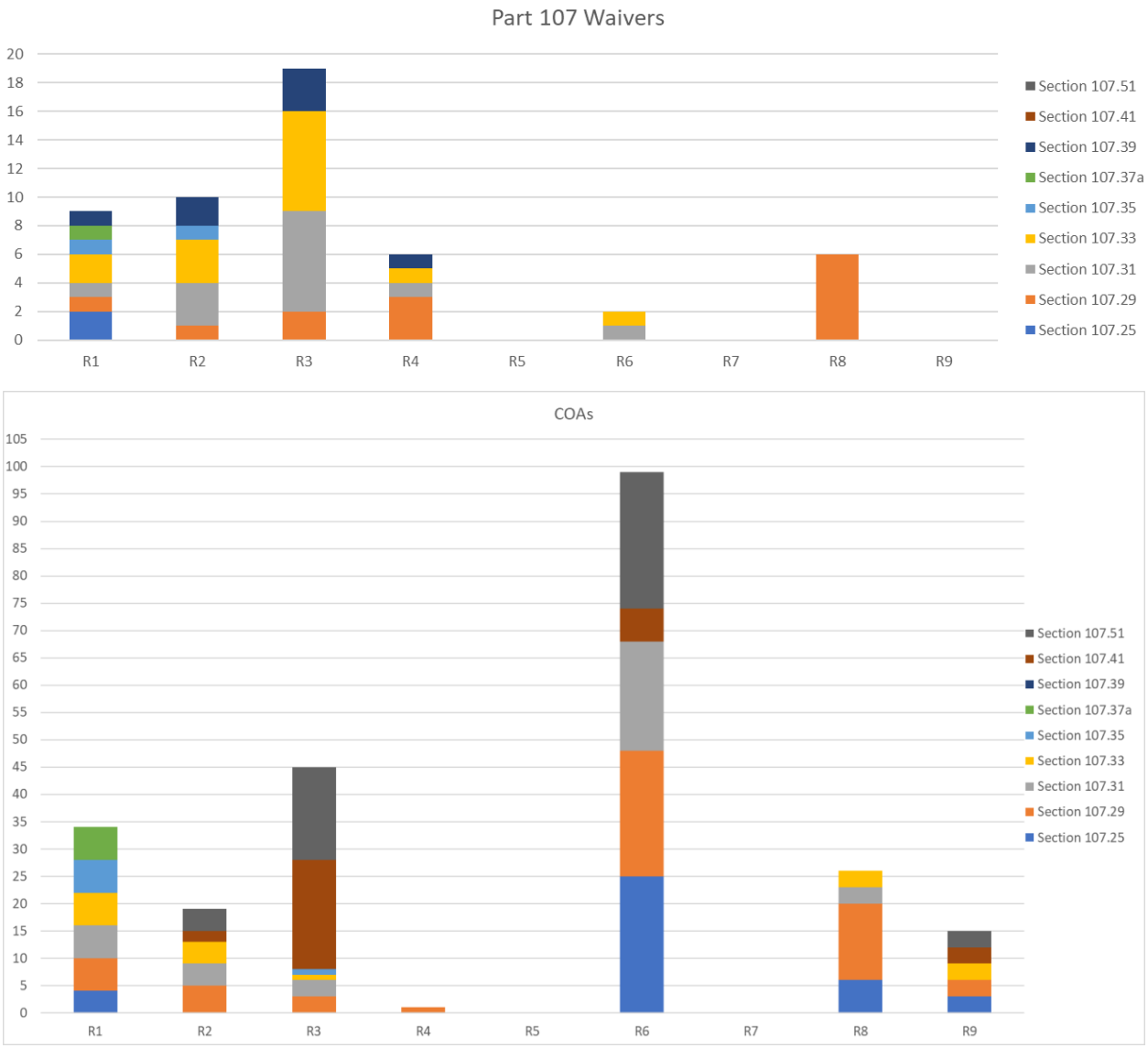

Figure 2. Types of current Part 107 waivers (top; 6 responses) and COAs (bottom; 7 responses).

Table 1 provides a summary of how common existing Part 107 waivers are by type. Table 2 provides the same for Part-107-equivalent waivers obtained through COAs. Categories are delineated subjectively through visual evaluation of charts. Future analyses could leverage percentages of overall waivers.

Table 1. Summary of how common existing Part 107 waivers are by type.

Waiver	Common	Present	Rare
107.25—Operation from a moving vehicle or aircraft		X	
107.29—Daylight operation	X		
107.31—Visual line of sight aircraft operation	X		
107.33—Visual observer	X		
107.35—Operation of multiple small unmanned aircraft systems		X	
107.37(a)—Yielding the right of way		X	
107.39—Operation over people	X		
107.41—Operation in certain airspace			X
107.51—Operating limitations for small unmanned aircraft			X

Table 2. As in Table 1 but for Part-107-equivalent waivers obtained through COAs.

Waiver	Common	Present	Rare
107.25—Operation from a moving vehicle or aircraft	X		
107.29—Daylight operation	X		
107.31—Visual line of sight aircraft operation	X		
107.33—Visual observer	X		
107.35—Operation of multiple small unmanned aircraft systems		X	
107.37(a)—Yielding the right of way		X	
107.39—Operation over people			X
107.41—Operation in certain airspace	X		
107.51—Operating limitations for small unmanned aircraft	X		

As is apparent from Tables 1-2, for certain types of waivers, Part 107 waivers appear to be preferred relative to COAs, while for other types of waivers COAs are preferred. For instance, operation over human beings (107.39) waivers are commonly acquired through Part 107 but not with COAs. Conversely, operation from a moving vehicle or aircraft (107.25) have been more commonly acquired through COAs. In addition, operation in certain airspace (107.41) and operating limitations for small unmanned aircraft (107.51) waivers have been common with COAs but practically non-existent with Part 107 waivers.

Some waivers are likely linked. For instance, for respondent 3, the number of Part 107.31 and 107.33 waivers are equal. This is likely because daisy-chained observers (observers distributed so as to extend the operational area; 107.33) are used as a means to enable visual line of sight waivers (107.31). As noted by Stansbury et al. (2020, §5.3.2.3), few waivers have utilized Detect And Avoid (DAA) technology, which is generally the most enabling approach for 107.31 waivered operations.

Figure 2 also indicates that some respondents specialize in certain types of waivers. Respondent 8, for instance, only reported operation at night (107.29) Part 107 waivers and reported this type of waiver as their dominant type for COAs. The majority of Part 107 waivers held by respondents

2 and 3 are visual line of sight aircraft operation (107.31) and visual observer (107.33) waivers. In contrast, respondent 1 had a fairly even distribution of waiver types for both Part 107 and COAs.

Acquisition of waivers and COAs having more than one deviation/waiver type is fairly common, as seen in Figure 3. Excluding the 2 organizations that did not respond, for 5 of 7 organizations, 50% or more of their Part 107 waivers and COAs involved more than one deviation. For 2 of these organizations all Part 107 waivers and COAs involved more than one deviation.

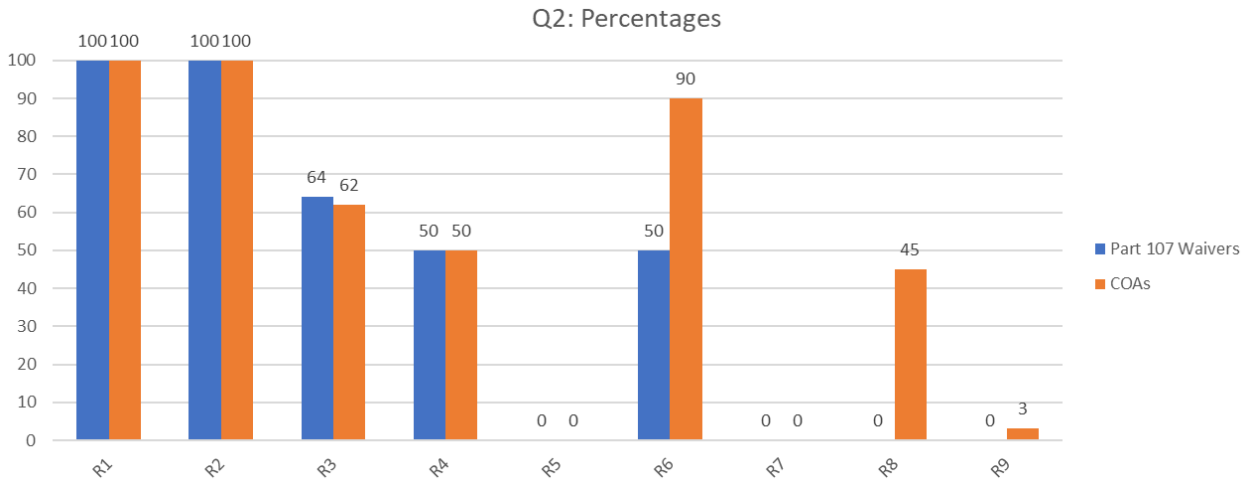

Figure 3. Percentage of Part 107 waivers (6 responses) and COAs (7 responses) that include deviation from more than one section.

As indicated in Figure 4, 55 new Part 107 waivers and COAs were requested in the previous year (2021). This is a significant percentage (18.5%) of the total number of waivers and COAs (297) possessed by the respondents. However, these are not directly comparable owing to the dependence upon approval rate.

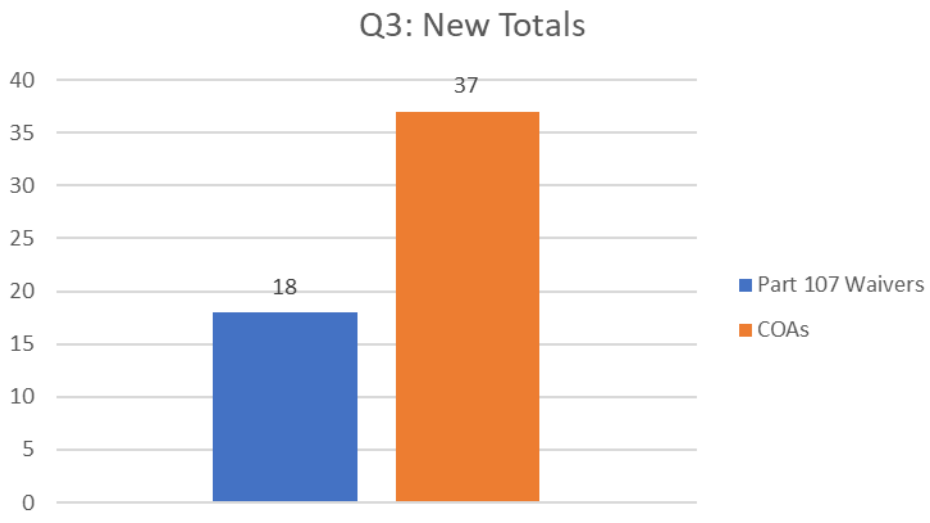

Figure 4. Total number of new Part 107 waivers (3 responses) and COAs (5 responses) requested in the previous year.

New Part 107 and Part-107-equivalent waivers requested through COAs are shown in Figure 5. As with existing waivers, no respondents indicated that they had requested other types of permissions.

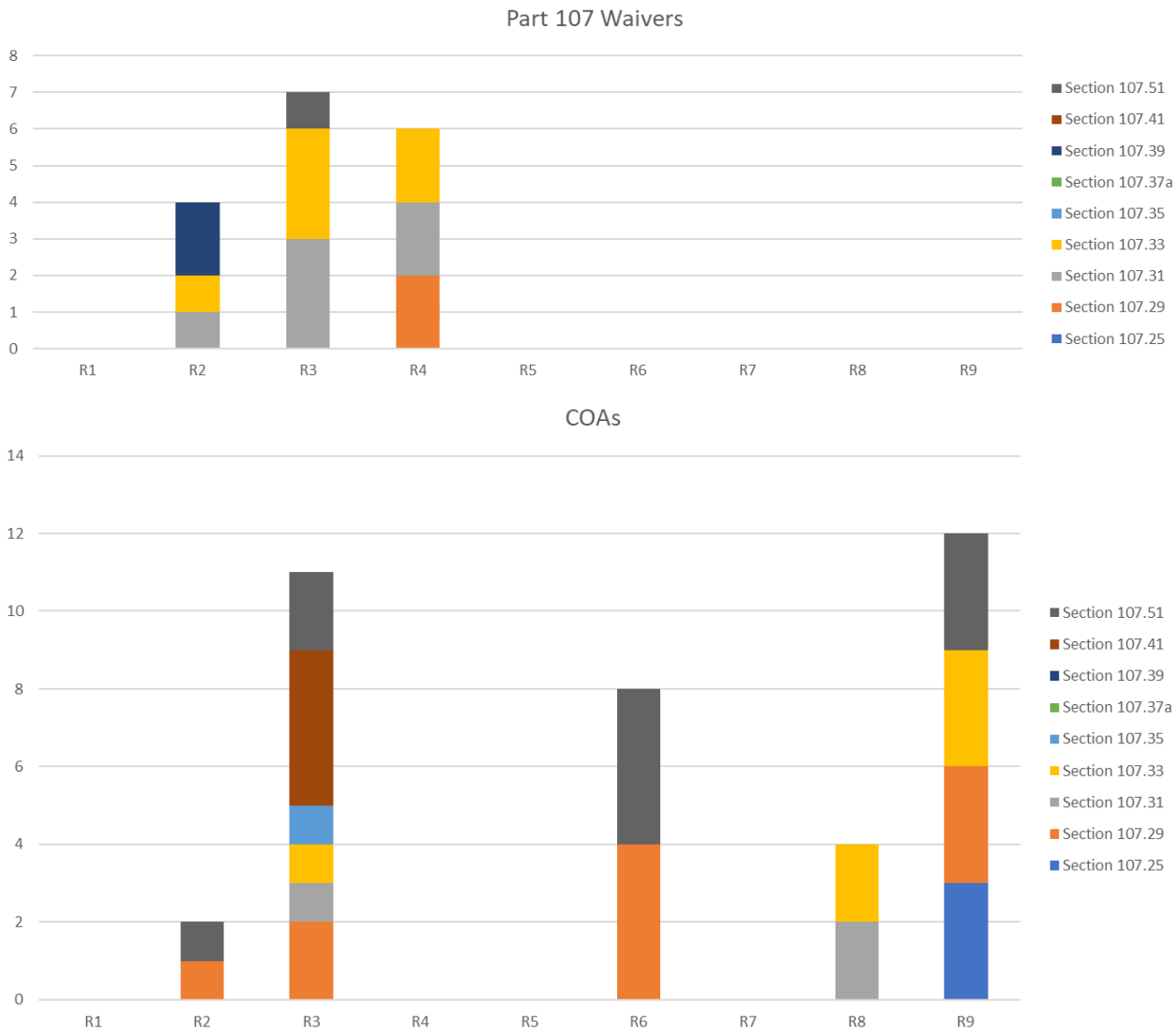

Figure 5. As in Figure 2 but for new requests during the past year. 3 responses were received for Part 107 waivers and 5 for COAs.

Summaries of new waiver requests are provided in Tables 3 and 4. Relative to existing Part 107 waivers (Table 1), new Part 107 waiver requests (Table 3) are:

- 107.25—Operation from a moving vehicle or aircraft: Rare compared to present
- 107.29—Daylight operation: Present compared to common
- 107.31—Visual line of sight aircraft operation: Of the same ranking (common)
- 107.33—Visual observer: Of the same ranking (common)
- 107.35—Operation of multiple small unmanned aircraft systems: Rare compared to present
- 107.37(a)—Yielding the right of way: Rare compared to present
- 107.39—Operation over people: Present compared to common
- 107.41—Operation in certain airspace: Of the same ranking (rare)
- 107.51—Operating limitations for small unmanned aircraft: Present compared to rare

Relative to existing Part-107-equivalent waivers obtained through COAs (Table 2), new Part-107-equivalent waiver requests (Table 4) are:

- 107.25—Operation from a moving vehicle or aircraft: Present compared to common
- 107.29—Daylight operation: Of the same ranking (common)
- 107.31—Visual line of sight aircraft operation: Of the same ranking (common)
- 107.33—Visual observer: Of the same ranking (common)
- 107.35—Operation of multiple small unmanned aircraft systems: Of the same ranking (present)
- 107.37(a)—Yielding the right of way: Rare compared to present
- 107.39—Operation over people: Of the same ranking (rare)
- 107.41—Operation in certain airspace: Present compared to common
- 107.51—Operating limitations for small unmanned aircraft: Of the same ranking (common)

Differences in how common new waiver requests are relative to existing waivers are likely driven by multiple factors. The first factor to consider is approval rate, which could produce apparent trends in how common waivers are even when submission rates are constant for different types of waivers. Another factor is the sample period. Since new waiver requests are from the past year and existing waivers are from multiple years, it is expected that some waivers will be less common in the new waiver request data. In addition, publication of the "Operation of Small Unmanned Aircraft Systems Over People" final rule (Department of Transportation 2021) enables routine operation of UAS at night or over people under certain conditions. This rule eliminates the need for some types of waivers, but not for all as some operations at night or over people may not conform to the specified conditions. The impact of this rule could be reflected in the Part 107 waiver requests dropping, relative to existing waivers, to present from common for 107.29 (daylight operations) and 107.39 (operation over people) waivers. Changes for these two types of waivers are not apparent in Part-107-equivalent waivers obtained through COAs, though 107.39 (operation over people) waivers are rare for COAs.

Other types of waiver requests that remain common for both Part 107 waivers and Part-107-equivalent waivers obtained through COAs are 107.31 (visual line of sight aircraft operations) and 107.33 (visual observer) waivers. These are common because of the high demand for Beyond Visual Line of Sight (BVLOS) capability. As indicated earlier, 107.31 and 107.33 waivers are likely linked owing to the use of daisy-chained observers.

Table 3. As in Table 1 but for new Part 107 requests during the past year.

Waiver	Common	Present	Rare
107.25—Operation from a moving vehicle or aircraft			X
107.29—Daylight operation		X	
107.31—Visual line of sight aircraft operation	X		
107.33—Visual observer	X		
107.35—Operation of multiple small unmanned aircraft systems			X
107.37(a)—Yielding the right of way			X
107.39—Operation over people		X	
107.41—Operation in certain airspace			X
107.51—Operating limitations for small unmanned aircraft		X	

Table 4. As in Table 1 but for new Part-107-equivalent COA requests during the past year.

Waiver	Common	Present	Rare
107.25—Operation from a moving vehicle or aircraft		X	
107.29—Daylight operation	X		
107.31—Visual line of sight aircraft operation	X		
107.33—Visual observer	X		
107.35—Operation of multiple small unmanned aircraft systems		X	
107.37(a)—Yielding the right of way			X
107.39—Operation over people			X
107.41—Operation in certain airspace		X	
107.51—Operating limitations for small unmanned aircraft	X		

As with existing waivers and COAs, requests for new waivers and COAs having more than one deviation is common, as seen in Figure 6. Respondents 1, 5, and 7 did not provide input for this question. One organization (respondent 8) experienced a significant increase in the percentage of requested COAs that include more than one deviation.

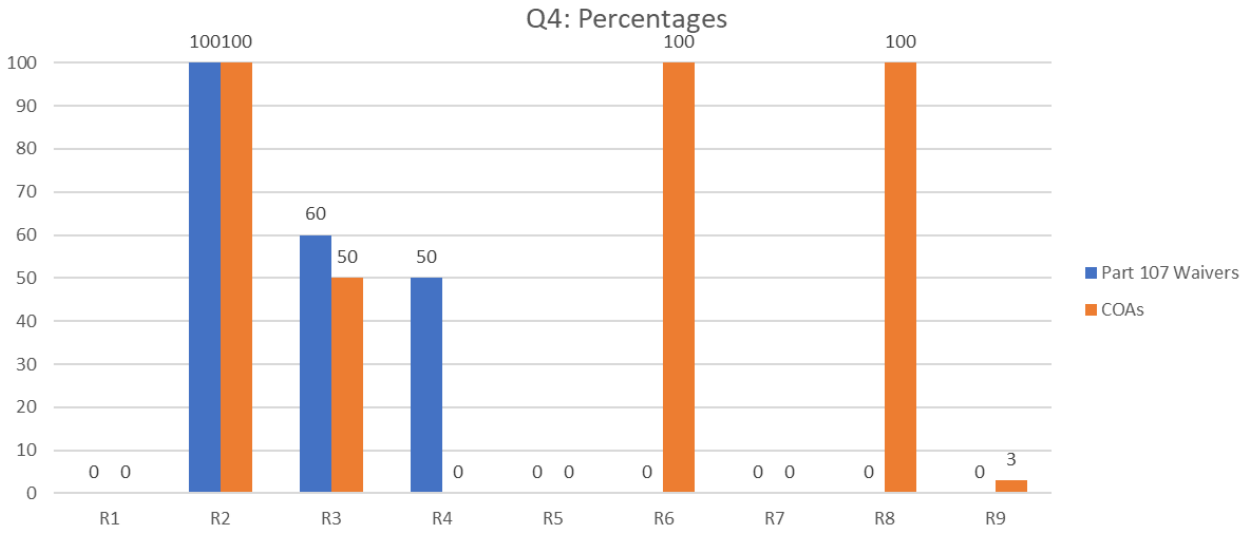

Figure 6. As in Figure 3 but for new requests during the past year. 3 responses were received for Part 107 waivers and 5 for COAs

3.2 Current and Recently-Requested CONOPs

CONOPs associated with existing Part 107 waivers and COAs are illustrated in Figure 7. Because a waiver or COA could be associated with multiple missions, respondents were provided the ability to indicate these as primary, secondary, or tertiary (Appendix A). For this question, 7 of 9 respondents provided input.

As indicated in Figure 7, the 'Research' CONOP stands out as the most common, followed by 'Other', 'Aerial Data Collection', 'Surveillance, Monitoring, etc.', 'Cargo Delivery', 'Inspection', and 7 others having values less than 10. The 'Research' CONOP may serve as a catch-all for many COAs in that aeronautical research is one of the functions that justify Public Aircraft Operations (PAOs), which are allowed by COAs (Cornell Law School 2022, §40125). Of the remaining more common CONOPs, 'Cargo Delivery' stands out given its relative complexity (e.g., Strande 2019). Its presence in these results is an indication of a maturing UAS industry.

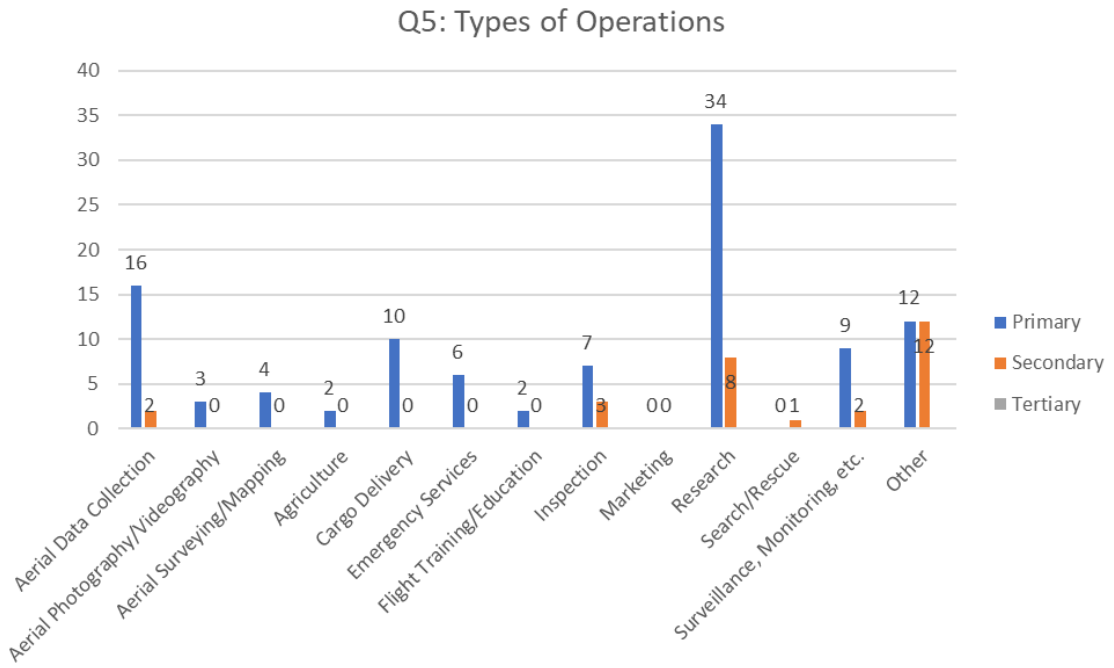

Figure 7. Types of operations associated with existing Part 107 waivers and COAs. 7 responses were received.

For CONOPs added in the past year (associated with waivers requested in the past year), 6 of 9 respondents provided input. In Figure 8, the 'Research' CONOP again stands out as the most common, followed by 'Aerial Data Collection', 'Surveillance, Monitoring, etc.', 'Cargo Delivery', 'Aerial Surveying/Mapping', and 8 others having values less than 4. These are the same common CONOPs as those associated with existing Part 107 waivers and COAs except 'Inspection' and 'Other' CONOPs are present in the existing list and 'Aerial Surveying/Mapping is present this (waivers in the past year) list. Notably, 'Cargo Delivery' is also present in CONOPs added in the past year.

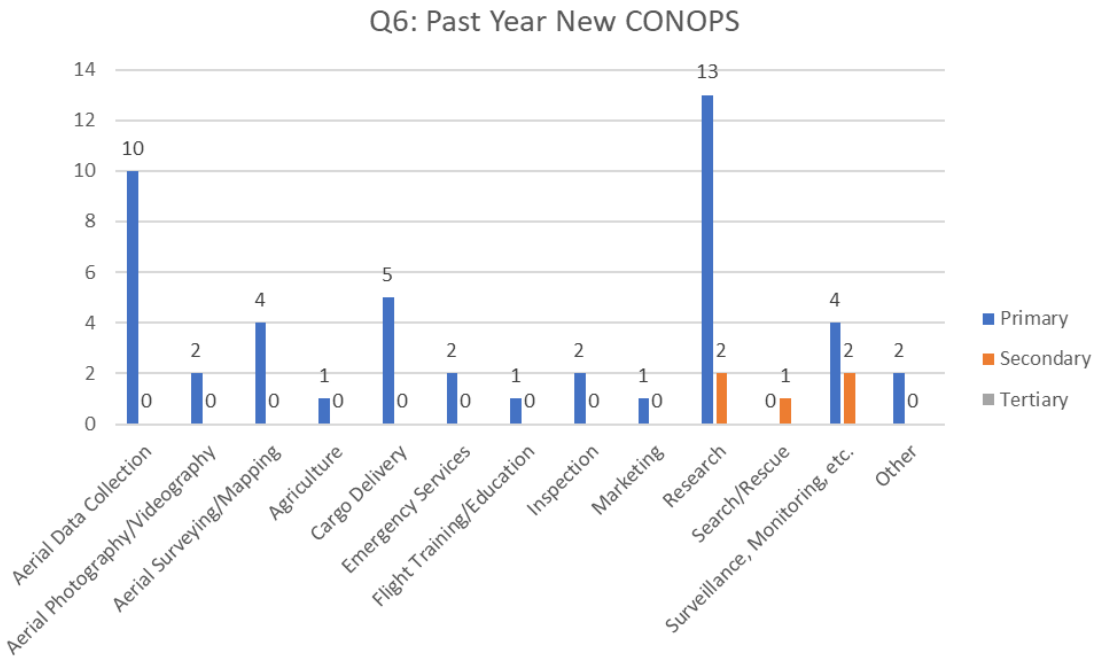

Figure 8. As in Figure 7 but for CONOPs associated with waiver applications in the past year. 6 responses were received.

3.3 Future CONOPs

Expected CONOPs in the next year, for which 7 of 9 respondents provided input, are illustrated in Figure 9. Common expected CONOPs are 'Aerial Data Collection', 'Research', 'Surveillance, Monitoring, etc.', 'Cargo Delivery', 'Inspection', and 'Aerial Surveying/Mapping'. These expected common CONOPs are equivalent to the common CONOPs associated with existing Part 107 waivers and COAs, with the exception of 'Other' being in the existing list and 'Aerial Surveying/Mapping' being in this list. These expected common CONOPs are equivalent to the common CONOPs requested in the past year, with the exception that this list includes 'Inspection'. Compared to existing (Figure 7) and CONOPs requested in the past year (Figure 8), the magnitudes/relative importance of CONOPs shifted for expected CONOPs in the next year (Figure 9). This is especially noticeable for 'Surveillance, Monitoring, etc.' and 'Aerial Data Collection'. These must be interpreted with the caveat that Figure 7 is impacted by approval rate whereas Figures 8 and 9 are not.

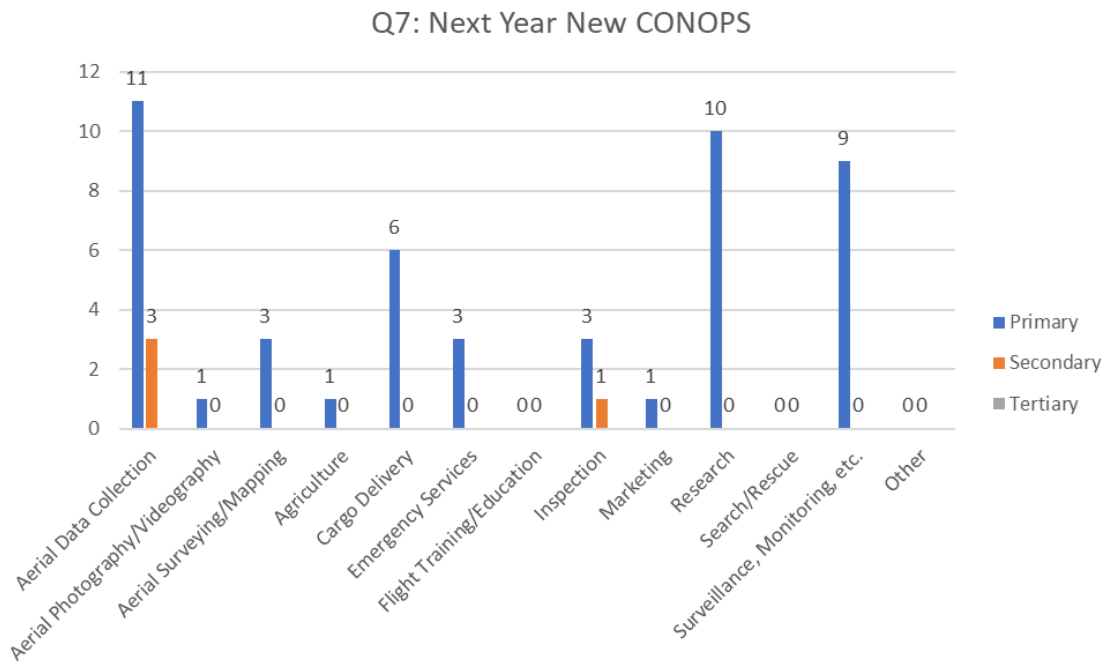

Figure 9. As in Figure 7 but for expected CONOPs in the next year. 7 responses were received.

3.4 Current Hazard Mitigation Methods/Technologies

Current mitigation methods are those that respondents are currently employing for current CONOPs. For question 8, all 9 respondents provided mitigations for 7 CONOPs categories, which are derived from each respondent's information regarding mitigations for their three most common CONOPs. Responses are illustrated in Table 5, in which the second column is the number of that type of CONOPs, ADS-B stands for Automatic Dependent Surveillance-Broadcast, and HITL stands for Human In The Loop. From Table 5, the 3 most common CONOPs are 'Research', 'Inspection', and 'Cargo Delivery'.

As indicated in Table 5, many mitigations are applied to enable CONOPs and evaluation of technologies that enable CONOPs (the latter is common with the 'Research' CONOP). The set of mitigations shown in Table 5 is far from comprehensive given the limited sample. The most common mitigations reported are DAA, Visual Observer (VO), and Strategic. It is important to recognize that DAA systems are commonly used as mitigations even though they are not generally approved as a sole means for avoiding conflicts with other aircraft. These results indicate that DAA systems are being utilized more as part of the overall set of mitigations with, likely, VOs providing a layer of safety that enables the CONOPs/testing. This is a change relative to Stansbury et al (2020, §5.3.2.3), wherein DAA was used sparingly as part of Part 107 waivers.

Table 5. CONOPs and associated mitigations for the respondent-defined most common CONOPs.

CONOPs	#	Strategic (e.g., location)	Shielding	Visual Observer	Chase Plane	Surveillance (e.g., ADS-B)	DAA	Injury Testing	Parachute	Airworthiness	Procedure	Design (e.g., high HITL)
Aerial Data Collection	1						1					
Aerial Photography/ Videography	0											
Aerial Surveying/Mapping	2	1		1		1						
Agriculture	0											
Cargo Delivery	4			2			2	1	1			
Emergency Services	3	1		1		1	1					
Flight Training/ Education	0											
Inspection	5	1		3			3	1	1			
Marketing	0											
Research	7	3	1	1	1	1	2			2	1	1
Search/Rescue	0											
Surveillance, Monitoring, etc.	2			1			1					
Other	0											
Total	24	6	1	9	1	3	10	2	2	2	1	1

3.5 Emerging/Future Technologies for Hazard Mitigation/UAS NAS integration

Table 6 summarizes responses to this question, which were provided by 8 of 9 respondents.[1] The dominant enabling technology is DAA, with 7 of the 8 respondents identifying that technology. Many other technologies/capabilities were also identified. Interestingly, only 1 respondent identified automation, which could be due to its broad nature and its being a part of other identified technologies. All of the emerging technologies in Table 6 support BVLOS operations except, possibly, for Remote ID, improved payloads, and improved data feed capability. It is likely that the demand for BVLOS operations motivated many of the responses provided to this question.

Table 6. Emerging technologies identified as most promising for facilitating sUAS NAS integration.

Technology	Number of Occurrences in Responses
Detect And Avoid	7
Improved Aircraft Performance (endurance, Vertical Take-Off and Landing, reliability)	2
Remote ID	2
Cooperative broadcast capabilities for UA	2
Improved payloads	2
Approved Command and Control (C2)	1
Improved parachutes	1
Improved data feed capability (e.g., 5G)	1
Automation	1
Enhanced navigation	1

3.6 CONOP Performance Evaluation Metrics

One topic of interest is metrics needed to evaluate CONOPs. Question 10 of the interview addressed this, and 8 of 9 respondents provided input.[2] Results are summarized in Table 7.

Responses in Table 7 are organized into 3 categories:

- Societal Benefit: Metrics that capture the benefit to society of a CONOP
- Categorical: Metrics categories within which many specific metrics reside
- Specific: Metrics that provide information regarding specific components of a CONOP

Categorical metrics define categories/dimensions for organizing specific metrics. In fact, societal benefit could be defined as a metric category. The 'Mitigation Performance' and 'Degradations' categories are linked in that for a specific degradation, mitigations are developed and their performance evaluated. These, in turn, align under the category of safety. Based on this input, then, a relatively simple organizational structure of metrics categories is

[1] This question is 9) from Appendix A: "9) What emerging technologies do you see as most promising for facilitating the integration of sUAS into the NAS?"

[2] Question 10) from Appendix A is: "10) In your opinion, what are the key performance metrics, both general and use case specific, that must be considered in determining the performance of a UAS CONOP?"

1. Safety
    a. Degradations
        i. Mitigation Performance
2. Consistency
3. Efficiency
4. Complexity
5. Societal Benefit

One might argue that consistency is a subcategory within safety given that mitigations must generally be consistent to produce risk mitigation. However, consistency could relate to other aspects, such as consistent accomplishment of a mission, and thus is not placed under safety herein.

The list of specific metrics is a subset of a much larger list. Development of a comprehensive and static list is not possible given that ongoing processes such as standards development result in identification of metrics. Development and maintenance of a (dynamic) list of specific metrics and their applications would serve the UAS industry.

Table 7. Metrics identified as useful to evaluating performance of a CONOP.

Metric	Type
Risk Offset Relative to Other Means of Mission Completion	Societal Benefit
Mission Success	Societal Benefit
Cost Savings	Societal Benefit
Safety	Categorical
Efficiency	Categorical
Complexity	Categorical
Consistency	Categorical
Mitigation Performance	Categorical
Degradations	Categorical
Aircraft Navigational Performance	Specific
Aircraft Reliability	Specific
Endurance	Specific
Number of Hours Flown	Specific
Number of Missions	Specific
Time to Mitigate Emergency (Emergency Resolution Time)	Specific
System Kinetic Energy	Specific
Engine Failure	Specific
Lost-Link Characteristics	Specific

3.7 Types of Data Collected (that Contribute to Safety Cases)

Another area of interest is types of data that contribute to safety cases that are routinely collected. This information relates to metrics required for evaluation of CONOPs. It also relates to safety case construction/evaluation and test data collection, which are central topics of Askelson et al.

(2020). The safety case framework and data elements described in Askelson et al. (2020) provided the structure for this question (question 11), for which all respondents provided input.

With few exceptions, the FAA Test Sites and Integration Pilot Program (IPP)/Beyond lead participants that responded are comprehensive in their data collection, as shown in Figure 10. Exceptions include data regarding security and communication processes in the CONOPs section, which are not surprising given that these are likely not viewed as safety critical as other types of data. Other exceptions are also present, including system data (e.g., flight logs), which again are not as safety critical (or directly indicative of safety). Non-collection of hazard cause and occurrence by one respondent (each) is a bit surprising given the safety criticality of that information.

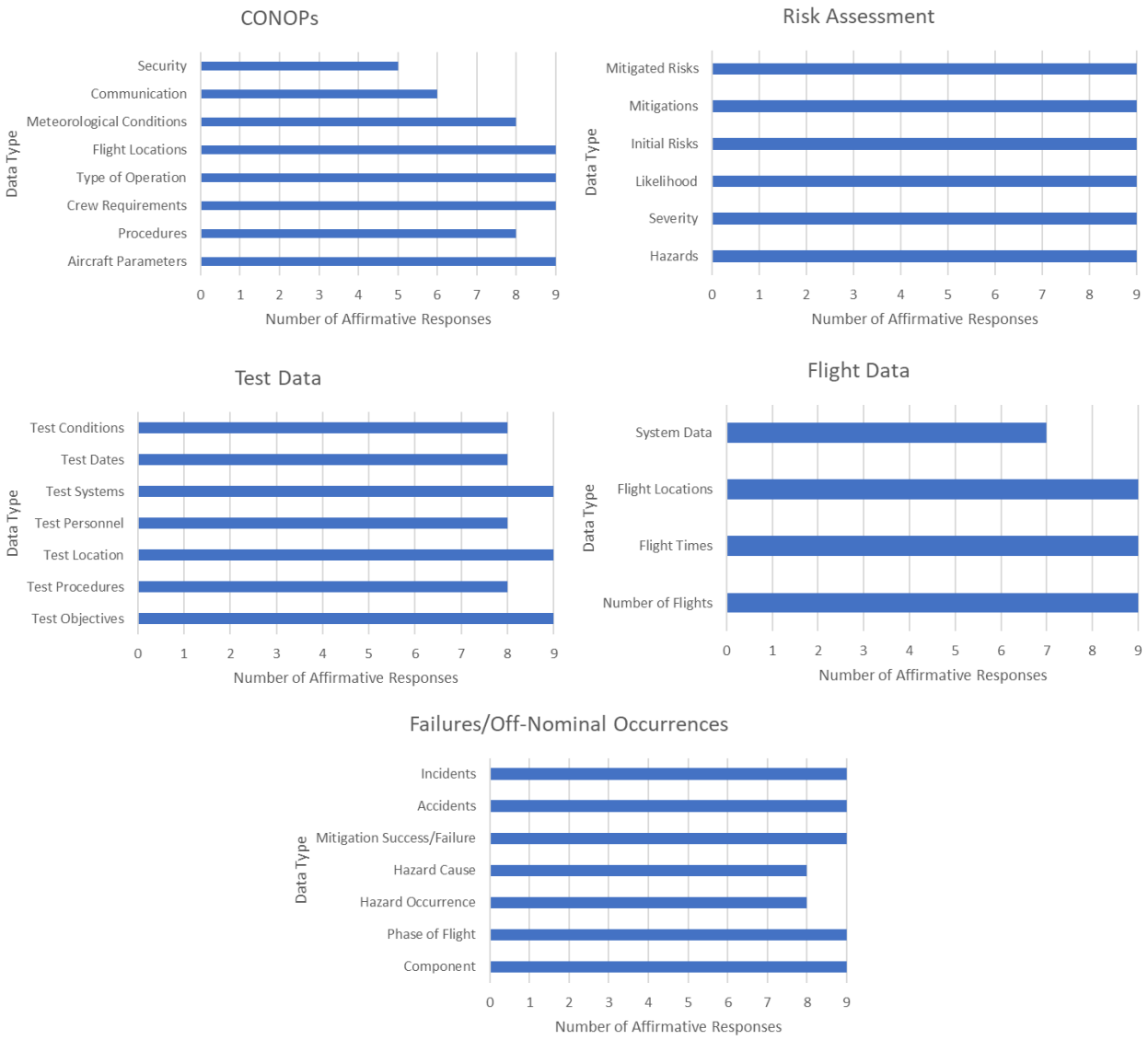

Figure 10. Types of data that contribute to safety cases that are routinely collected. 9 responses were received.

4 DISCUSSION

The interviews used to collect information regarding data needs for evaluating UAS CONOPs (Appendix A) produced a rich data set. Information collected provides insights regarding waivers, current and emerging CONOPs, hazard mitigations, emerging technologies, evaluation metrics, and types of data collected by respondents that contribute to safety cases. As is the case with the design of any interview questions, improvements are possible. Suggestions for future efforts are:

- Allowance of more time to complete the interviews with enhanced opportunity for respondents to ask clarifying questions if needed.
- Inclusion of questions to evaluate the role that new standards, NPRM, etc., have upon waiver requests.

- Leveraging of results such as those described herein to develop questions that enable expansion upon the high-level taxonomy presented in Section 3.6.
- Collection of additional historical data that are more enabling of trend analyses.

5 CONCLUSION

The FAA seeks data-driven solutions to inform its regulation/standards development efforts and FAA safety management systems toward the approval of new integrated UAS capabilities. As a complement to Stansbury et al. (2020), this study provides further insight into data needs for evaluating UAS CONOPs. Data analyzed herein were collected using interview questions, which are provided in Appendix A. A total of 9 respondents provided input, with each being from either an FAA Test Site or IPP/Beyond lead organization.

To understand data needs, the first set of information gathered regarded current and recently-requested waiver types. Information collected illustrated that the Part 107 route is preferred for certain types of waivers (relative to COAs) and that the Certificates Of waiver or Authorization (COA) route is preferred for other types of waivers (relative to Part 107). The data also indicated that some waiver types are linked, that some respondents specialize in certain types of waivers, that acquisition of waivers and COAs that have more than one deviation is common, and that demand for waivers related to BVLOS operations is high.

Information regarding recently-requested waiver types led to the same conclusions and additional insights. One additional insight is that publication of the "Operation of Small Unmanned Aircraft Systems Over People" final rule (Department of Transportation 2021) likely impacted waiver requests.

Interview data regarding existing/current CONOPs indicate that the most common CONOPs are 'Research', 'Other', 'Aerial Data Collection', 'Surveillance, Monitoring, etc.', 'Cargo Delivery', and 'Inspection'. Data regarding CONOPs associated with waivers requested in the past year produce the same list for most common CONOPs except 'Inspection' and 'Other' CONOPs are present in the existing list and 'Aerial Surveying/Mapping is present in the CONOPs-associated-with-waivers-requested-in-the-past-year list. Of these CONOPs, 'Cargo Delivery' stands out given its relative complexity (e.g., Strande 2019).

Common expected CONOPs in the next year are equivalent to the common CONOPs associated with existing Part 107 waivers and COAs, with the exception of 'Other' being in the existing list and 'Aerial Surveying/Mapping' being in the 'next year' list. Common expected CONOPs in the next year are equivalent to the common CONOPs added in the past year, with the exception that the 'next year' list includes 'Inspection'. Compared to existing and CONOPs added in the past year, the magnitudes/relative importance of 'Surveillance, Monitoring, etc.' and 'Aerial Data Collection' CONOPs shifted (increased) for expected CONOPs in the next year.

The most common current mitigations used to enable common CONOPs are DAA, Visual Observer, and Strategic (e.g., low traffic density airspace). Interviewees indicated that DAA systems are commonly used as mitigations. This is noteworthy given that such systems are not generally approved as a sole means for avoiding conflicts with other aircraft. These results indicate

that DAA systems are being utilized more as part of the overall set of mitigations with, likely, VOs providing a layer of safety that enables the CONOPs/testing.

The dominant emerging/future technology for hazard mitigation/UAS NAS integration identified by respondents is DAA. Many other technologies/capabilities were also identified. All of the emerging technologies identified support BVLOS operations except, possibly, for Remote ID, improved payloads, and improved data feed capability. It is likely that the demand for BVLOS operations motivated many of the responses to this interview question.

CONOP performance evaluation metrics aligned with the categories Societal Benefit, Categorical, and Specific. Responses suggested an alternative taxonomy of 5 primary categories. This taxonomy can be used to develop a dynamic list of specific metrics and their applications that would serve the UAS industry.

The final question regards types of data that contribute to safety cases that are routinely collected. With few exceptions, the FAA Test Sites and IPP/Beyond lead participants that responded are comprehensive in their data collection. Exceptions include data regarding security and communication processes, which are not surprising given that these are likely not viewed as safety critical as other types of data.

Opportunities exist for leveraging this effort to further serve FAA needs. Several suggestions regarding future improvements to the interview process are provided in the discussion section.

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Appendix A: Interview Questions

The following provides the interview questions.

FAA ASSURE A21 Test Site and IPP Interviews
Test Site and IPP Site Baseline Status for Expanded and Non-Segregated UAS Operations

Basis: The FAA desires information to support efforts to explore expanding flight operations. A research effort was set up by the FAA to gather this information to help guide regulations and guidance for expanded and non-segregated UAS operations. This interview is in support of this effort to gather operations information desired by the FAA.

Background: The FAA UAS Center of Excellence for UAS Research (ASSURE) project A21 – "Integrating Expanded and Non-Segregated UAS Operation into the NAS: Impact on Traffic Trends and Safety" is gathering data on the types and numbers of expanded and non-segregated UAS operations to be able to:

1. understand the emerging usage patterns and missions leading to expanded operations,
2. identify the operations and characteristics of non-segregated operations and potential traffic patterns, and
3. forecast future usage

The A21 research, as proposed, is focused on "expanded operations", defined as operations that are expanded through waived regulations per 14CFR §107.205 or imminent policy (e.g. NPRMs), and non-segregated operations, defined as operations occurring in airspace where the likelihood of encountering a manned aircraft is greater than zero. The expanded operations include Night Operations, Ops Over People, BVLOS and other waivered operations. The data provided below will set the baseline status for the different CONOPS relevant to sUAS expanded and non-segregated operations occurring at or with participating FAA UAS Test Sites and IPP/Beyond Sites.

Data Collection: All data and information collected will be held confidential and responses gathered will be made anonymous and not traceable to an individual or group.

Instructions: Please consider all sUAS expanded and non-segregated types of operations occurring at or in partnership with your Flight Test Site or IPP/Beyond group, whether they are flown under a Part 107 waiver, a COA, or other permission (e.g. Part 135 operation flown by a close partner) that allows a similar operation to occur. The definition of CONOPS used below is: a set of flights for a specific mission that occurs in a single geographic area. As an example, 500 cargo delivery flights in a neighborhood over a year would be a single CONOPS. That same set of flights in a different geographical area would be a separate CONOPS.

Company/Organization_____

Name_____

Email Address _____

Phone Number_____

Date_____

1) How many Part 107 waivers, COAs, and other permissions do your FTS, IPP group, and close partners possess that allow operations that deviate from the following sections (include all waivers and COAs in each category even if the approval includes deviations from more than one category):

Applicable Section	Part 107 waivers	COAs	Other
(a) Section 107.25—Operation from a moving vehicle or aircraft			
(b) Section 107.29—Daylight operation			
(c) Section 107.31—Visual line of sight aircraft operation			
(d) Section 107.33—Visual observer			
(e) Section 107.35—Operation of multiple small unmanned aircraft systems			
(f) Section 107.37(a)—Yielding the right of way			
(g) Section 107.39—Operation over people			
(h) Section 107.41—Operation in certain airspace			
(i) Section 107.51—Operating limitations for small unmanned aircraft			

2) What percentage of these waivers, COAs, and other permissions include deviations from more than one section?

Part 107 waivers:_____ COAs:_____ Other: _____

3) During the past year, how many new, not renewal, Part 107 waivers, COAs, and other permissions did your FTS and close partners request in each of the following categories?

Applicable Section	Part 107 waivers	COAs	Other
(a) Section 107.25—Operation from a moving vehicle or aircraft			
(b) Section 107.29—Daylight operation			
(c) Section 107.31—Visual line of sight aircraft operation			
(d) Section 107.33—Visual observer			
(e) Section 107.35—Operation of multiple small unmanned aircraft systems			
(f) Section 107.37(a)—Yielding the right of way			
(g) Section 107.39—Operation over people			
(h) Section 107.41—Operation in certain airspace			
(i) Section 107.51—Operating limitations for small unmanned aircraft			

4) What percentage of these new waivers, COAs, and other permissions include deviations from more than one section?

Part 107 waivers:_____ COAs:_____ Other: _____

5) What types of operations are your FTS and close partners currently conducting in association with the above waivers and COAs? Please enter the number of different CONOPs being flown in each category. (Please note that a waiver/COA/etc. could involve multiple missions. Please provide numbers in the secondary and tertiary columns when these categories are secondary or tertiary to the primary mission for the wavers/COAs.)

Applicable Operation	Primary	Secondary	Tertiary
a) Aerial Data Collection			
b) Aerial Photography/Videography			
c) Aerial Surveying/Mapping			
d) Agriculture			
e) Cargo Delivery			
f) Emergency Services			
g) Flight Training/Education			
h) Inspection			
i) Marketing			
j) Research			
k) Search/Rescue			
l) Surveillance, Monitoring, etc.			
m) Other			

Type of 'Other' Operation:_____

6) During the past year, how many new CONOPS were added to each of the following operational categories? Please enter the number of new CONOPs in each category. (Please note that a waiver/COA/etc. could involve multiple missions. Please provide numbers in the secondary and tertiary columns when these categories are secondary or tertiary to the primary mission for the wavers/COAs.)

Applicable Operation	Primary	Secondary	Tertiary
a) Aerial Data Collection			
b) Aerial Photography/Videography			

c) Aerial Surveying/Mapping			
d) Agriculture			
e) Cargo Delivery			
f) Emergency Services			
g) Flight Training/Education			
h) Inspection			
i) Marketing			
j) Research			
k) Search/Rescue			
l) Surveillance, Monitoring, etc.			
m) Other			

Type of 'Other' Operation:_____

7) During the next year, how many new CONOPS do you expect you and your close partners to develop in the following categories? (Please note that a waiver/COA/etc. could involve multiple missions. Please provide numbers in the secondary and tertiary columns when these categories are secondary or tertiary to the primary mission for the wavers/COAs.)

Applicable Operation	Primary	Secondary	Tertiary
a) Aerial Data Collection			
b) Aerial Photography/Videography			
c) Aerial Surveying/Mapping			
d) Agriculture			
e) Cargo Delivery			
f) Emergency Services			
g) Flight Training/Education			
h) Inspection			
i) Marketing			
j) Research			
k) Search/Rescue			
l) Surveillance, Monitoring, etc.			

m) Other			

Type of 'Other' Operation:_____

8) For the three most common types of CONOPS you and your close partners are conducting, what are your primary methods/technologies for mitigating hazards (e.g., DAA for BVLOS pipeline surveillance or structure masking)?

CONOPS #1: Operation type:_____
Primary methods/technologies for mitigating hazards:_____

CONOPS #2: Operation type:_____
Primary methods/technologies for mitigating hazards:_____

CONOPS #3: Operation type:_____
Primary methods/technologies for mitigating hazards:_____

9) What emerging technologies do you see as most promising for facilitating the integration of sUAS into the NAS?

10) In your opinion, what are the key performance metrics, both general and use case specific, that must be considered in determining the performance of a UAS CONOP?

11) What types of data do you collect?

	Con Ops:
	Procedures (aircraft operation, etc.)
	Crew Requirements (number, roles, etc.)
	Type of Operation (BVLOS, OOP, etc.)
	Flight Locations (geographic area, altitudes, etc.)
	Meteorological Conditions
	Communication (ATC, internal crew, community outreach, etc.)
	Security (cyber, physical, etc.)
	Risk Assessment:
	Hazards

	Severity
	Likelihood
	Initial Risks
	Mitigations
	Mitigated Risks
	Test Data:
	Test Objectives
	Test Procedures
	Test Location
	Test Personnel
	Test Systems
	Test Dates
	Test Conditions (e.g., meteorological conditions)
	Flight Data:
	Number of Flights
	Flight Times (or # hours of flights)
	Flight Locations
	System Data (e.g., flight logs)
	Failures/Off-nominal Occurrences:
	Component (people, hardware, software, etc.)
	Phase of Flight
	Hazard Occurrence
	Hazard Cause
	Mitigation Success/Failure
	Accidents
	Incidents

Other type(s) of data collected not listed above?_____