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UAS in the NAS: Survey Responses by ATC, Manned Aircraft Pilots, and UAS Pilots

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Acronyms

AGL	Above Ground Level
ATC	Air Traffic Controllers
CDTI	Cockpit Display of Traffic Information
FAA	Federal Aviation Administration
ft	feet
GCAS	Ground Collision Avoidance System
GCS	Ground Control Station
lbs	pounds
NAS	National Airspace System
RA	Resolution Advisory
TCAS	Traffic alert and Collision Avoidance System
UAS	Unmanned Aircraft Vehicles

Abstract

NASA currently is working with industry and the Federal Aviation Administration (FAA) to establish future requirements for Unmanned Aircraft Systems (UAS) flying in the National Airspace System (NAS). To work these issues NASA has established a multi-center "UAS Integration in the NAS" project. In order to establish Ground Control Station requirements for UAS, the perspective of each of the major players in NAS operations was desired. Three on-line surveys were administered that focused on Air Traffic Controllers (ATC), pilots of manned aircraft, and pilots of UAS. Follow-up telephone interviews were conducted with some survey respondents. The survey questions addressed UAS control, navigation, and communications from the perspective of small and large unmanned aircraft. Questions also addressed issues of UAS equipage, especially with regard to sense and avoid capabilities. From the civilian ATC and military ATC perspectives, of particular interest are how mixed operations (manned / UAS) have worked in the past and the role of aircraft equipage. Knowledge gained from this information is expected to assist the NASA UAS Integration in the NAS project in directing research foci thus assisting the FAA in the development of rules, regulations, and policies related to UAS in the NAS.

1 Background

The NASA "UAS Integration in the NAS" project is tasked with facilitating the process of developing the rules, regulations, and requirements needed to safely fly unmanned aircraft vehicles (UAS) of a variety of sizes and capabilities in the National Airspace System (NAS). The U.S. General Accountability Office (2012) recently published a status report of progress towards integration efforts led by the Federal Aviation Administration (FAA) towards UAS integration. A UAS access research and development roadmap has also been developed by the NASA Langley Research Center (Verstynen, Foggia, & Hoffler, 2010). Key to the success of having UAS fly in the NAS, regardless of their size, is attention to the human factors issues of the Ground Control Station (GCS). The U. S. Department of Defense (2012) has published a GCS Human-Machine Interface Development and Standardization Guide, and other publications (e.g., McCarley & Wickens, 2005) have focused on the human factors issues of UAS in the NAS.

The purpose of the present paper is to present findings from on-line surveys and interviews that were conducted sampling the three major players involved when UAS are flying in the NAS. The surveys were targeted at air traffic controllers (ATC), including military ATC, pilots of manned aircraft, and UAS pilots. The surveys recorded the participant's background and experience in their area of expertise, followed by questions asked of all three groups as well as questions unique to the ATC, manned aircraft pilot, and UAS pilot operational domains. In addition, follow-up interviews were conducted with a subset of the survey respondents in order to obtain more detailed information and respondent opinions on a small-UAS in the NAS scenario not included in the on-line surveys. Survey responses and comments can be found in Appendices A, B, and C. Appendix D presents the questions asked and responses during the follow-up interviews.

2 Methodology

Separate on-line surveys were created and administered to ATC, pilots of manned aircraft, and pilots of UAS. These on-line surveys were hosted on web-based SurveyMonkey (SurveyMonkey Inc., Palo Alto, California, USA, www.surveymonkey.com). Survey content was reviewed by the NASA Langley Research Center Institutional Review Board and a "*Human Subject Research Volunteer Informed Consent Statement*" was presented at the beginning of the survey, with the survey respondent having to select "I Agree" in order to continue on to the survey questions.

For respondents there was a two-step process, firstly signing on to the NASA Langley Human Subjects Recruitment website, and registering with contact information. Secondly, respondents would receive an Access Code which would need to be entered on the survey website. This Access Code permitted a NASA Langley human subjects recruiter to pay subjects who were eligible to be paid (non-government, non-military), and to provide contact information for follow-up interviews, while keeping all other identifying information out of the response data files. To recruit survey respondents, the human subjects recruiter sent targeted emails to organizations identified by the research team (e.g., FAA, selected military bases, general aviation and commercial pilots, and selected manufacturers). There was a set of questions that were asked of all three groups as well as questions unique to each of the groups. The survey for ATC had 48 questions, the survey for pilots of manned aircraft had 46 questions, and the survey for UAS pilots had 72 questions. There were text box comment fields for most questions.

Portable Document Format (PDF) layouts of the web-based surveys can be found in Appendices E, F, and G.

3 Results

Detailed breakdown of the survey responses and comments can be found in Appendices A, B, and C. For the ATC group, usable responses were obtained from 8 persons (5 male, 3 female), with a range of years as a Certified Professional Controller from 0 – 36, with a median of 7 years. For the manned-aircraft pilot group usable responses were obtained from 25 persons (24 male, 1 female) who had a mean of 12,213 flight hours with a range of 2,203 to 28,000 flight hours. The UAS pilots group was comprised of 8 persons (7 male, 1 female) who had a mean of 549 hours piloting a UAS with a range of 73 to 2,000 hours. Several of the UAS pilots were also certificated manned-aircraft pilots with a mean of 1,468 flight hours with a range of 50 to 4,800 flight hours. Most respondents (90.5%) indicated that they would be willing to participate in a follow-up telephone interview.

3.1 Questions Asked of All Groups

Selected questions asked of all three groups will be presented in this section. Figure 1 shows the responses from each of the three groups to the question "Should the rules and requirements for the various classes of controlled airspace (Classes A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?" An interesting finding here is the decrease in "yes" responses from both Manned Aircraft Pilots and ATC towards the Class E and G Airspace, while the UAS Pilots did not show this change. This is also interesting in that many of the UAS pilots who responded have also been manned-aircraft pilots. This may reflect that the UAS pilot group expects to meet whatever rules and requirements there are for a given Airspace.

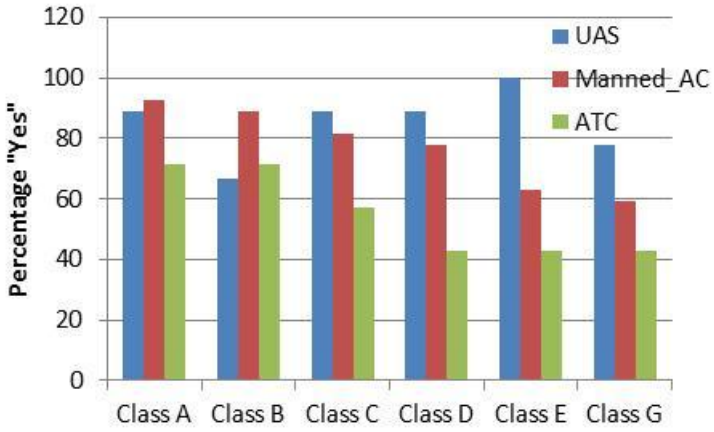

Figure 1. Survey responses to "Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?"

Figures 2, 3, and 4 show responses to related questions concerning the need for separate or special airspace depending on the size and equipage of the aircraft. In Figure 2, the aircraft description is a small UAS without ATC communications and not transmitting position information. In this case the figure shows that some 58% of ATC respondents, about 80% of manned aircraft respondents, and about 50% of UAS pilots indicated "agree" or "strongly agree" to this statement. However, there were some UAS pilots who "strongly disagree".

Figure 3 asks the same question but for small UAS "with ATC and transmitting position information", and the responses shift dramatically towards "disagree" or "strongly disagree" with regard to needing separate or special airspace. This result shows the importance of equipment that provides information that will allow the UAS to be "seen" and "communicated with" on perceptions of whether separate or special airspace will be needed.

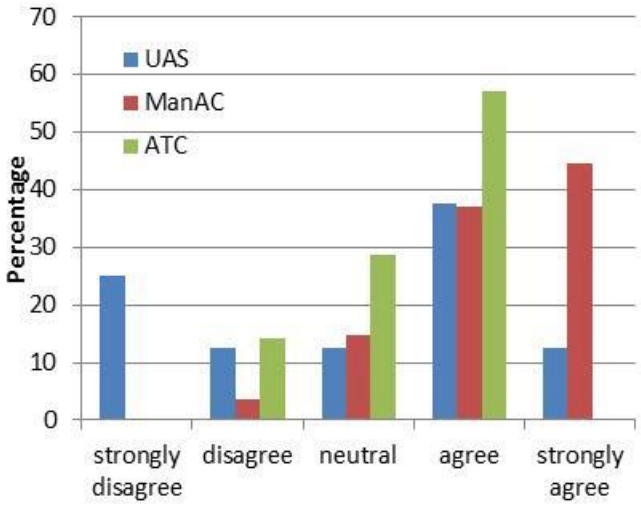

Figure 2. "I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations."

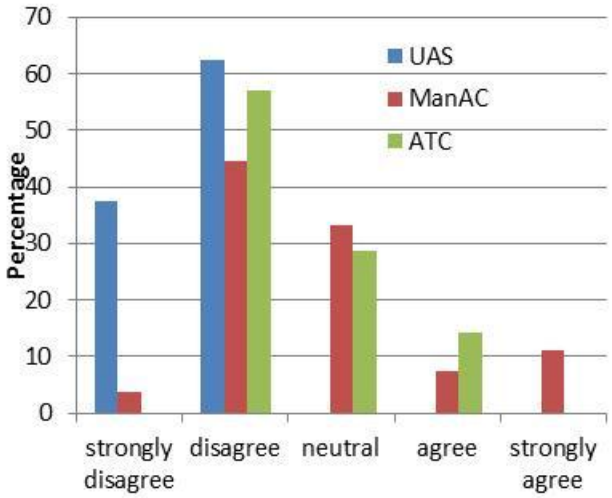

Figure 3. "I believe that small UAS (under 55 lbs) with ATC communications and transmitting position (ADS-B) information will need separate or special airspace for their operations."

Figure 4 shows the responses for medium and large UAS (>55 pounds (lbs)) with communications and transmitting position information. UAS Pilot responses were 100% "disagree" or "strongly disagree", indicating that separate or special airspace would not be needed. The responses of the other

groups were more scattered across the scale but divided fairly evenly between the agree and disagree ends of the scale indicating a diversity of thought on this issue.

It is interesting that for the ATC group, the "agree" category was much higher for the medium and large UAS than for the similarly equipped small UAS shown in Figure 3. This may reflect a weighting of operational differences (*e.g.*, Airspace Classes, airports needed, collision damage potential) between the small and larger UAS in the response to this question for the ATC group. This may also reflect that controllers would not expect small UAS to be directly sequenced in with manned aircraft and that there would be procedural separations for them.

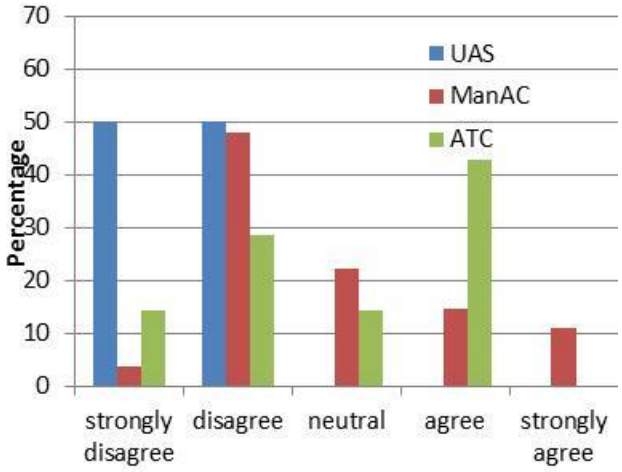

Figure 4. "I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position (ADS-B) information will need separate or special airspace for their operations."

3.2 Manned Aircraft Pilots Questions

Several questions on the survey for pilots of manned aircraft addressed the display of UAS on traffic displays and the overhearing of communications ("party-line" information) between ATC and these aircraft. Figure 5 shows the results for the question "When flying in an area in which UAS Operations are being conducted, how important is it to know that an aircraft shown on a Cockpit Display of Traffic Information (CDTI) is unmanned? (*e.g.*, through symbology or data-tag information)". As shown in Figure 5, about 74% rated this information as either "desirable" or "essential". Two pilots, commenting on this question, said they needed to know if the UAS has TCAS (Traffic alert and Collision Avoidance System) and if the UAS will automatically respond to an RA (Resolution Advisory). Another comment said that knowing the traffic aircraft was unmanned was more important if it was not able to respond to TCAS. There was no follow-up question asked regarding the lack of TCAS in many General Aviation manned aircraft.

In Figure 6, the results are shown for the question "When flying in an area in which UAS Operations are being conducted, how important is it that you hear ATC communications with the unmanned aircraft pilot? (sometimes referred to as the "party line")" The responses here show 85% indicated that having "party line" information was "desirable" or "essential" and no one indicated that it was "not important". Comments to this question said having this information: (1) was part of total situation awareness; (2) is a

way to know if the UAS is responding appropriately to ATC and operator input; and, (3) is another trap for errors such as a clearance given in error or misunderstood that another set of ears might act as a barrier against. There was no question designed to test the difference in response for communications with UAS operations versus the lack of communications with a manned aircraft that is not operating on a Center or Approach/Departure frequency.

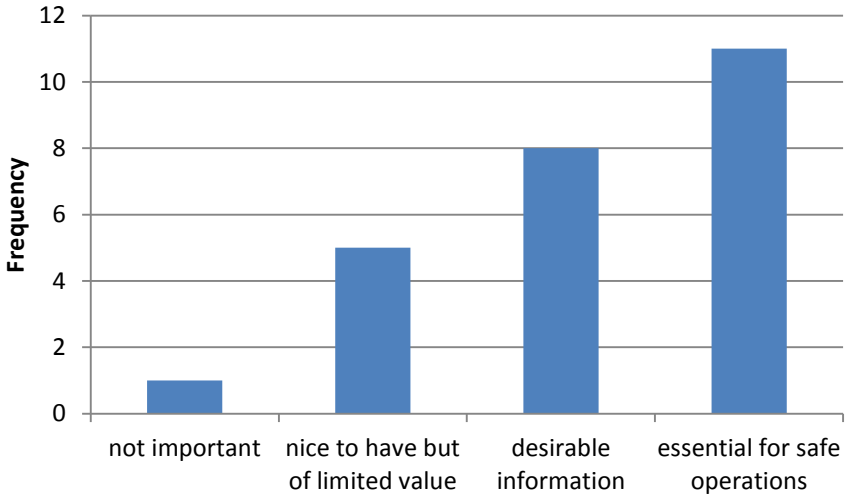

Figure 5. "When flying in an area in which UAS Operations are being conducted, how important is it to know that an aircraft shown on a Cockpit Display of Traffic Information (CDTI) is unmanned? (e.g., through symbology or data-tag information)" – manned aircraft question

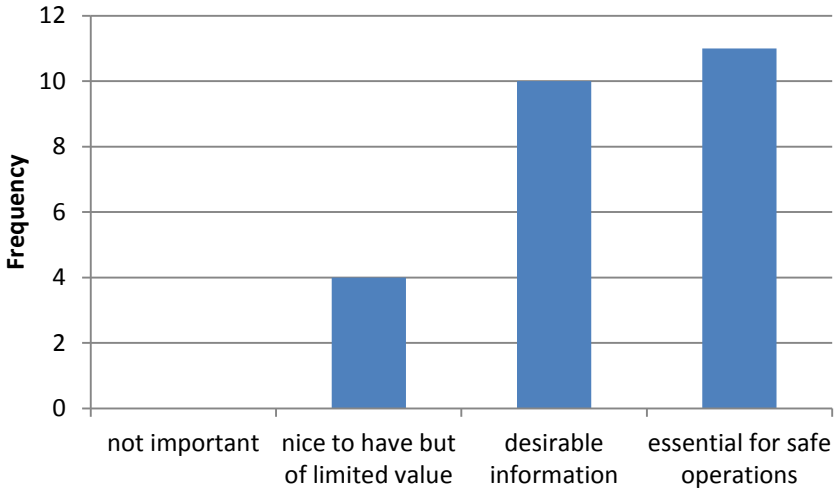

Figure 6. "When flying in an area in which UAS Operations are being conducted, how important is it that you hear ATC communications with the unmanned aircraft pilot? (sometimes referred to as the "party line")" – manned aircraft question

Figure 7 presents the results for the question "If you are flying 1000-3000 ft [feet] Above Ground Level (AGL) in an area in which small UAS (under 55 lbs) are operating below 400 ft AGL, how important is the display of that aircraft on a Cockpit Display of Traffic Information (CDTI) display?" The responses here show 66% indicating that this information would be "desirable" or "essential", while

only 14.8% indicated that this information was "not important". Comments to this question noted that: (1) this information would be vital for altitude separations less than 1000 ft; (2) small UAS (under 55 lbs) would be nearly impossible to see air-to-air; and, (3) this information, while valuable, may not be available on many older generation General Aviation aircraft.

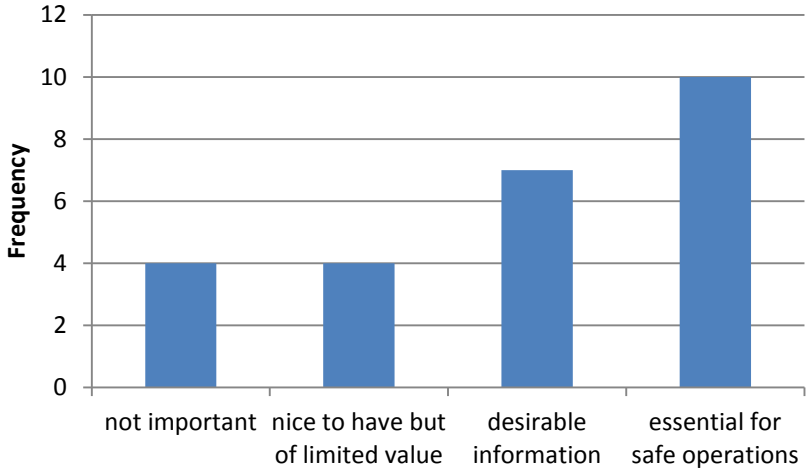

Figure 7. "If you are flying 1000-3000 ft Above Ground Level (AGL) in an area in which small UAS (under 55 lbs) are operating below 400 ft AGL, how important is the display of that aircraft on a Cockpit Display of Traffic Information (CDTI) display?" – manned aircraft question

3.3 Selected ATC Questions

While the full set of ATC questions and responses may be found in Appendix B, several questions frequently encountered in discussions of unmanned aircraft will be looked at here. One of those questions was: "When working manned aircraft and UAS in your airspace of responsibility, how important would it be to know that an aircraft shown on your radar display is unmanned? (e.g., through symbology or data-tag information)." ATC respondents were evenly divided between "desirable" and "essential", with no responses of "not important" or "nice to have." Comments said this information would be "essential" for many reasons, including the lack of maneuverability and climb rate of UAS aircraft, as well as their inability to see and avoid, thus making this important information a controller will need to know to make decisions regarding traffic calls, separation, and sequencing.

A related question concerning display of small UAS was "When you are working aircraft in your airspace of responsibility, in which small UAS (under 55 lbs) are operating below 400 ft AGL and more than 3 miles from an airfield, how important is the display of that aircraft (data tag information) on your radar display?" No ATC respondents indicated that this was "essential" information. The response of highest frequency was "desirable" (57%), followed by "not important" (28%) and "nice to have" (14%). Comments included: (1) aircraft in Class D airspace can have arrival/departure route/pattern altitudes as low as 500 ft AGL; (2) in general, not important unless those operations are conducted within Class D airspace or in close proximity to the traffic pattern of any airports; and, (3) below 400 ft makes it generally safe, but would still want to know they were there to give traffic call-outs to low-operating aircraft/helicopters.

3.4 Selected UAS Pilot Questions

The full set of UAS Pilot questions and responses may be found in Appendix C. Selected questions frequently encountered in UAS discussions will be looked at here. When viewing these results, keep in mind that the respondents indicated that they have experience with UAS of differing sizes and equipages. There were a number of open-ended questions addressing the GCS and related issues. One of these was "What sensory cue information, not provided currently, would help improve your situation awareness of the environment of the aircraft, the integrity of the aircraft's flight and its mission?" Comments included: (1) integrated displays for traffic (from ATC), TCAS, GCAS (ground collision avoidance system), weather; (2) pilot's view camera; (3) weather radar; (4) being able to see other traffic and weather surrounding UAS; (5) audible cues would be helpful if the UA is not instrumented adequately; and, (6) spoken messages.

The next question was "How often is the UAS camera system used for navigation purposes?" Responses included (1) never (most frequent response); (2) almost never, it can be useful in the terminal area; (3) for emergencies only; (4) often, especially to avoid weather; and (5) whenever any clouds or precipitation is proximate. A related question was "How often is the UAS camera system used for "see and avoid" purposes?" The responses here included (1) never or rarely"; (2) never, the field of view is too wide; (3) taxi only, and it only views forward; (4) weather avoidance primarily, not traffic; and, (5) almost always during takeoff, departure and then during approach and landing.

In answer to the question "Can a single UAS pilot perform all the tasks necessary to fly safely in the NAS?" The responses were 7 "yes" to 1 "no". Responses to the question "How frequently during a typical mission are you in contact with ATC or other aircraft?" yielded a majority of respondents indicating either "occasionally" or "routinely." In response to the question "How frequently does the UAS automation do something unexpected?", answers were evenly distributed across "never", "rarely", and "occasionally", but no one indicated "routinely."

The following question addressed voice communications and communications latency: "If there is voice communications in the GCS, what could be improved to enable better voice communications, and has latency or delay in voice communications been a problem?" Responses included: (1) better radio equipment; (2) a second or third radio instead of just one; (3) second radio and radio selector; (4) no problems with latency or delay; (5) a faster link with a higher bandwidth; latency and delays are always a problem; faster link decreases the amount of processing the aircraft does with the voice signal; (6) latency is not normally a problem, however sometimes signal quality can be poor; and (7) latency is only a problem when the radios are busy and operations are by satellites; it can be hard to break in to make a call.

Monitoring "party line" communications, previously addressed in the manned aircraft section, also has importance for UAS pilots. This is illustrated by a comment noting that hearing ATC communications with other aircraft, including UAS "helps the UAS operator paint a mental picture of where other aircraft are, what weather conditions they are experiencing and also be aware of any emergency situations that arise." This survey respondent also noted that "I'm a firm believer that the radio calls of other aircraft are an important situational awareness tool."

3.5 Respondent Comments

Additional comment data is presented below. Although not statistically significant, respondents' comments do suggest trends in areas that may need additional research and the various concerns they have with UAS integrating into the NAS. The data and comments show that Manned-aircraft pilots level of comfort with UAS in the NAS depend largely on the equipage of the UAS and whether they will be able to hear their communications with ATC and see them on traffic displays. Some Manned-aircraft pilots were skeptical about safely integrating UAS in the NAS. ATC comments indicated that UAS can be safely integrated once procedures are developed, especially lost link and sense-and-avoid procedures, and they have experience with UAS in their airspace. Not surprisingly, UAS pilots believe that UAS can be safely integrated into the NAS once standard communication protocols are followed and they have access to the standard NAS navigational databases.

3.5.1 UAS Integrating into Manned Airspace

The comments reflect that manned-aircraft pilots have concerns regarding the ability of UAS to safely integrate into manned airspace. Several said "[g]reater restrictions [for UAS] are essential until they are shown to be unneeded." Some manned-aircraft pilots and some ATC comments indicated that "UAS should be prohibited in some … airspace, such as B, C, & D." "In other cases, … the rules and requirements must be MUCH more stringent" and when UAS are flying in the area "NOTAMs should be required for all areas of UAS operation." Not surprisingly, UAS pilots thought that the airspace restrictions on UAS should be equivalent as long as the UAS can "obey ATC instructions" and "with proper controller training [and] clear procedures for all aircraft involved." Many involved with ATC indicated that UAS "[operational] information needs to be published and adhered to, and controllers need training on UAS operations so they are aware of what to expect from UAS aircraft." Both ATC and UAS pilots said that communication between the UAS and ATC was key to safely integrating UAS into the NAS because the operations would remain predictable.

To aid with UAS navigation through the airspace, both UAS pilots and ATC said that "UAS need to be able to navigate to NAVAIDS and fixes like manned aircraft." Again, this would help with communication and predictability. While navigating through the airspace with manned aircraft in the vicinity, several commented that "UAS should be required to give way to ALL aircraft"; however, some ATC respondents did mention that they would "lean more towards UAS having right of way due to [its] limited visibility and maneuverability."

3.5.2 Indicating UAS to ATC and Manned-Aircraft Pilots

Both ATC and manned-aircraft pilots thought that indicating UAS on CDTI and ATC displays "seems essential" especially "[i]f operating above 500' [AGL]." Even when flying "[b]elow 400 ft … [ATC] would still want to know [UAS] were there to give traffic to low-operating aircraft/helicopters." However, when UAS are in Class G Airspace, comments indicated that UAS may not have to broadcast their position with a transponder. Some manned-aircraft pilots predicated their need for specific UAS CDTI information on whether the UAS can "respond to a TCAS resolution advisory." If the UAS did not have TCAS, then the manned-aircraft pilots did want an indication that the vehicle is a UAS on their CDTI. No follow-up questions were asked to explore whether this attitude would be the same if the vehicle was a manned aircraft operating without TCAS and Resolution Advisory capability.

3.5.2 Communicating with ATC

Manned-aircraft pilots, ATC, and UAS pilots agreed that the "[c]ommunication skills of a UAS pilot need to be equivalent to that of a manned-aircraft pilot." The "party-line" is especially important to manned-aircraft pilots because "ATC comm[unications] are a vital piece of the situational awareness puzzle in the airspace" and some manned-aircraft pilots said they "need to know if the UAS is responding appropriately to ATC and operator input." When ATC and UAS are communicating, ATC and manned-aircraft pilots indicated "[t]here should be no delay" because ATC often gives the "immediately." Furthermore, the communications should include distinctive call signs indicating that it is a UAS. When there is a lost communication link between ATC and the UAS, the use of a land line for communications would suffice although the UAS should "exit from IFR airspace." There was no question exploring the party-line issue from the perspective that, currently, not all manned aircraft operate on the same communications frequency (e.g., General Aviation in some airspace classes).

As for lost link between the GCS and the UAS, most respondents indicated that procedures need to be in place before each UAS flight in order for the UAS vehicle to be predictable to both ATC and manned-aircraft pilots. However, "if no plan is available then [the] pilot should contact ATC letting them know that there is no preplanned path for lost link. In [this] case, the [UAS] pilot and ATC should remain in constant communication and ATC should keep other aircraft out of the area until issue is resolved."

3.5.3 Airspace Procedural Needs

Both manned-aircraft pilots and ATC generally wanted UAS pilots to file flight plans and "they need to be much more detailed in scope and information provided to the controller." A few UAS pilots and manned-aircraft pilots did mention that "VFR flight plans are not a requirement for manned aircraft and [it may not] be useful for a UAS … especially for small UAS." When flying VFR, many ATC and manned-aircraft pilots indicated "[o]bstruction and cloud clearance requirements should be higher" but UAS pilots responded that "clearance should normally be the same" because "[t]he UAS operation is the same whether in weather or not." In addition, for both VFR and IFR UAS flights, many manned-aircraft pilots indicated that procedural altitude separation between UAS and manned aircraft is needed "in order to keep manned aircraft safe."

3.5.4 Sense and Avoid Concerns

Manned-aircraft pilots and ATC indicated "UAS need to be equipped with sense-and-avoid capability." Furthermore, this capability needs to be greater than a manned-aircraft pilot's ability to see and avoid because "UAS will most likely never be able to see/avoid as well as manned aircraft, so … they should have a greater buffer or tighter control when operating near other aircraft." Furthermore, some manned-aircraft pilots wanted "an indication that the UAS senses my aircraft and its ability to avoid is intact" such as having an autonomous TCAS RA on the UAS. Some respondents also thought that the "UAS should be sequestered in special airspace … until it is proven to be unneeded." A few manned-aircraft pilots also commented that "UAS under 55 lbs would be nearly impossible to see air to air" so the UAS's sense-and-avoid capabilities are necessary.

4 Implications for UAS Design

Based on the survey responses and information from the follow-up interviews, there are two areas that will be briefly covered here. These are see-and-avoid / sense-and-avoid and workload.

In the area of see-and-avoid, it was noted that most UAS aircraft have not been designed for visual conspicuity. Improvements in this area can be made through high visibility colors and through the use of strobe and/or anti-collision lights. It was noted that the Light Emitting Diode (LED) strobes can even be used on small UAS. With regard to sense-and-avoid, answers to many of the questions indicate the desire of both ATC and manned aircraft pilots to know the presence of the UAS (such as through ADS-B), so advisories can be issued if needed by ATC, or for pilots, whether the UAS will respond to a TCAS RA. The UAS pilots also noted that the mission for UAS is typically quite different from that of manned aircraft in that it is typically not a Point A to Point B operation, and may involve sustained operations in a certain area with transits in and out to return to base.

UAS in the NAS have workload implications for ATC, manned aircraft pilots, and pilots of the unmanned aircraft. For the UAS pilot, there can be less workload than for a manned aircraft pilot if inner loop control is done by the aircraft (e.g., airspeed and altitude hold and fly heading). However, if failures occur, such as a Global Positioning System failure, high workload can occur as there may be no backup for the primary system. As noted in the survey responses, UAS camera imagery, as it exists at present, may not be of a resolution or field-of-view to assist in the piloting task. This seems an area ripe for research and development, especially in light of small low cost video sensors and on-board video processing to reduce downlink bandwidth. It has also been noted that GCS are typically not limited in terms of display area, so that has led to separate displays for different functions instead of intelligent integration of information which can reduce workload.

From the ATC perspective, it was noted that for military mixed operations of UAS and manned aircraft, an increased buffer is often needed around the UAS due to factors such as longer runway occupancy times or wake considerations following larger manned aircraft. For a controller used to the pacing of manned aircraft only operations, higher workload can result as additional traffic maneuvering may be required to establish and maintain the larger buffers. This higher workload may be evident especially for controllers new to this environment. It was reported that having a manned aircraft in the mix with UAS can actually result in lower ATC workload than a stream of UAS only, as the manned aircraft can respond and maneuver more quickly as well as self-separate from other traffic.

5 Conclusions

One of the drivers leading to development of the surveys reported in the present paper was interest in how varied the responses would be between the three major players in NAS operations: Air Traffic Controllers, pilots of manned aircraft, and pilots of UAS. One conclusion that can be drawn is that the pilots of UAS, responding for unmanned aircraft with ATC communications and transmitting position information, and in the medium or large classes, are most likely to agree that these aircraft will not need separate or special airspace for their operations. There is not that same agreement among the pilots of manned aircraft or ATC respondents, and comments note the lack of a track record to date on which to base confidence in such operations. This means that confidence in these operations may change, and improve, as a track record is established based on successful operations. In the area of confidence of operations and potential regulations, one survey respondent noted “greater restrictions are essential until they are shown to be unneeded.” Specific concerns noted include lost-link and determining what path lost-link aircraft will be taking. Another concern from ATC with UAS experience is lost-link in proximity to the airfield in high density UAS operations due to frequency congestion and radio link issues. In these high density operations cases there is the potential for multiple lost link aircraft at the

same time. It was also interesting to note that while UAS operations seems to be a hot news item at the present time, some of the survey respondents have been flying such aircraft for many years, although in specially designated airspace. It is the advances in processing power, materials, and miniaturization that have made the current generation of UAS effective, and the capabilities of small UAS so impressive.

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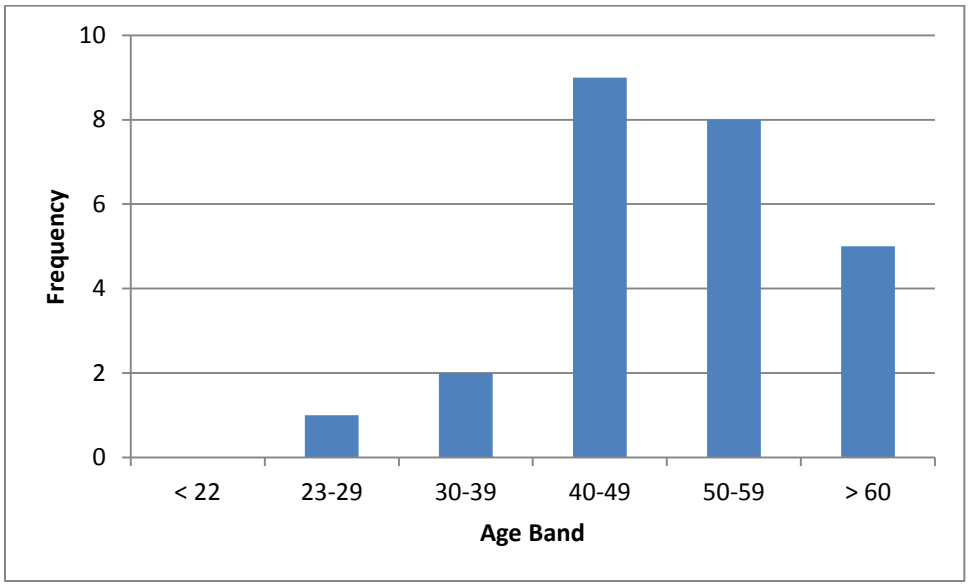
Appendix A – Results of Online Survey for Manned Aircraft Pilots

Respondent text answers and comments are noted in *Italics*

Questions 1-5 addressed agreement with purposes of the study, informed consent and comments about it, agreement that age of respondent was over 18, and Access Code for completing survey.

Question 6. Please Indicate your age.



7. Please indicate your Gender.
   24 Male, 1 Female

8. What Pilot Certificates do you have? (e.g., Private, Commercial, or ATP)

- *ATP (16 responses)*
- *PPSEL Commercial Rotorcraft*
- *Commercial, ATP*
- *ATP, Commercial*
- *Private Commercial ATP Engineer*
- *ATP /Commercial*
- *ATP airplane and ATP Rotorcraft*
- *ATP, Commercial, Flight Engineer*
- *ATP, Flt Engineer*
- *ATP, FE*

9. What Pilot Ratings do you have? (e.g., SEL, MEL, Instrument, CFII, Helicopter, etc.)

- *SEL, MEL, CFII*
- *Helicopter Instrument*
- *SEL, MEL, Instrument,*
- *SEL, MEL, CFI, Helicopter, Instrument, Flight Engineer, Instrument Ground Instructor*
- *SEL, MEL*

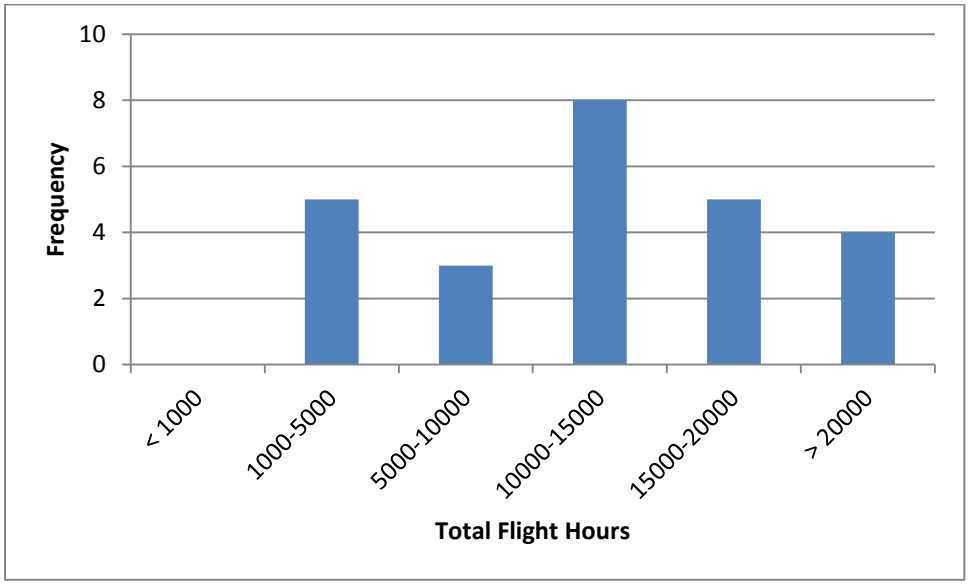
- *SEL & MEL*
- *SEL, MEL, CFII*
- *mel, instrument*
- *SEL. MEL, military flight instructor.*
- *CFI, CFII MEI*
- *SEL MEL Instrument 757/767 Type rating*
- *MEL,INSTRUMENT,CFII,HELICOPTER,GLIDER*
- *MEL*
- *SEL/MEL/CFI,CFII,MEI*
- *Comm SEL, MEL, Instr, CFI(non-current)*
- *MEL, CFII MEI*
- *SEL MEl Instrument*
- *ATP airplane ATP helicopter FE 727*
- *SEL, MEL, Instrument*
- *SEL MEL INSTRUMENT*
- *SEL, MEL, Instrument,*
- *SEL, MEL, Commercial, Inst., CFI, CFII Type Ratings in B737, A320, B777*
- *727/757/767*
- *Airplane Multiengine land A-320, A-330, B727, B737, B-757, B767 Authorized Experimental Aircraft: Grumman OV1*

10. Top Four aircraft you have flown (by hours).
    - *Boeing 757, Boeing 767, MD88, Boeing 737.*
    - *UH-1N, UH-1E, TH-1L, TH-57C*
    - *B767/757, C141, B737, B727*
    - *B767, B757, MD80, B727*
    - *A320, A330, B747-4, DC-9*
    - *SF340 SR22 C182 C172 PA44*
    - *757, 767, DC10, 727*
    - *Boeing 737, Boeing KC 135 , Cessna T-37, Boeing 757*
    - *B-777, B-767, B-727, B-737*
    - *B-767,737, F/A-18, F-14D*
    - *HU-25 (FA20) T-44 (C90) T-34*
    - *737 757/767 DHC 8 EMB 110*
    - *B-777/6000HRS B-737-800/600HRS A310/5000HRS B757/B767/2500HRS*
    - *Dash 8 A320 B757 B737*
    - *B767/757, B737, MD-80, B727*
    - *767, 757, 727, A300-600R*
    - *FA20, BE35, T34, T44*
    - *DC-9 B-767 HS125/700 YS11*
    - *Boeing 767/757 SH-360 and R-44*
    - *CL-65, SF-340, DA-40, AC-500*
    - *767, 757, 727, 727*

11. Total flight hours

Mean Hours	12212.92
Median Hours	11500
Minimum	2203

Maximum	28000
St Dev	7205.01



12. Total simulator hours

Mean Hours	593.48
Median Hours	460
Minimum	20
Maximum	3000
St Dev	648.97

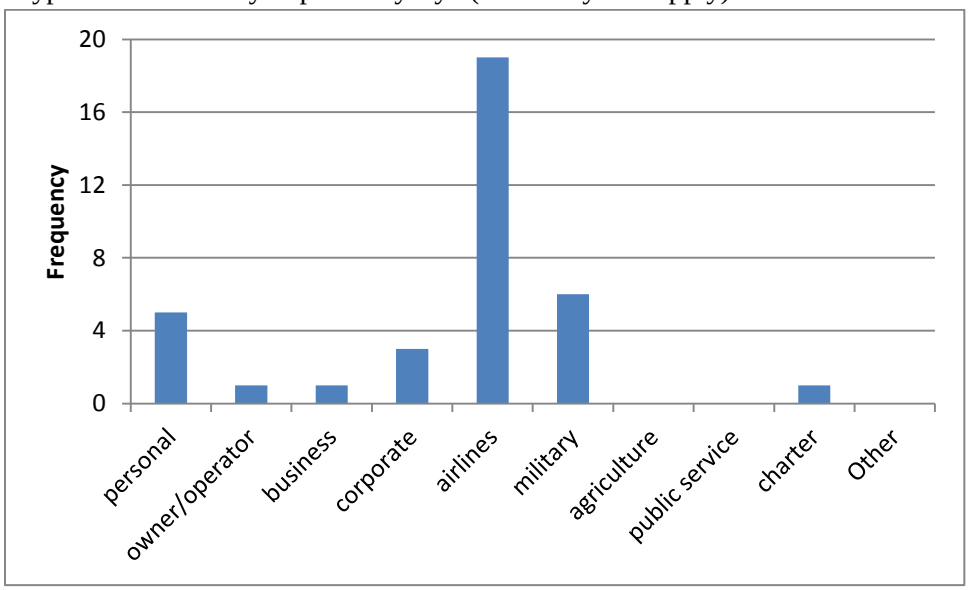
13. Total fixed-base simulator hours

Mean Hours	135
Median Hours	32.5
Minimum	0
Maximum	1000
St Dev	263.79

14. Total motion-base simulator hours

Mean Hours	472.25
Median Hours	375
Minimum	17
Maximum	2900
St Dev	575.65

15. What type of mission do you primarily fly? (check any that apply)



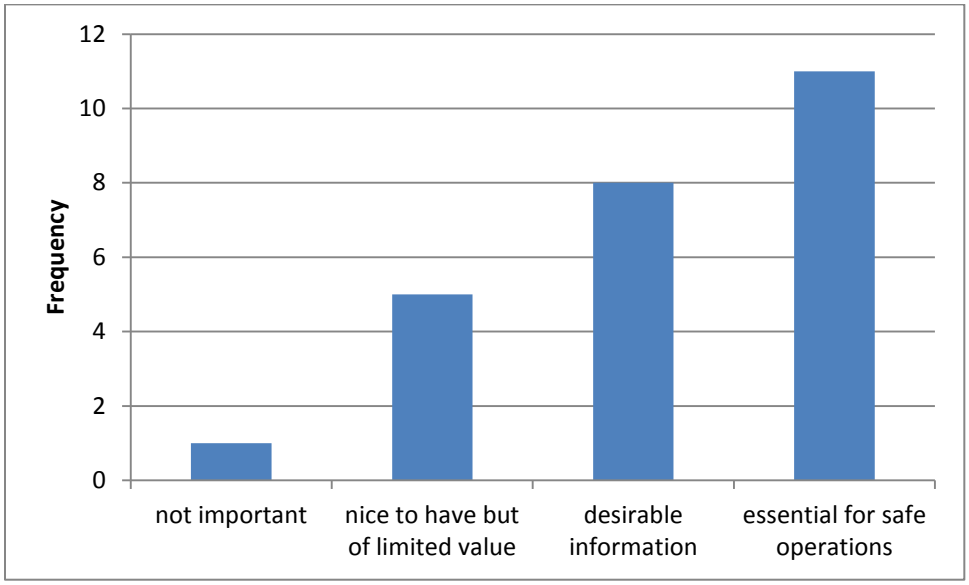
16. Please indicate the airport at which you base your airplane or fly from most frequently. (Airport ID or nearest City)

- *KMSP*
- *Hampton, VA*
- *ORD (4 responses)*
- *KMIA*
- *KJGG. KPHF*
- *KORF*
- *New York*
- *JFK, NY*
- *MOB*
- *DFW*
- *KMIA, KTMB*
- *Washington DC*
- *JFK*
- *JFK*
- *KECG*
- *Kric*
- *Miami International*
- *Memphis*
- *CVG*
- *KIAD*
- *KMIA*
- *KCLT*

17. At which altitude band does most of your flight operations take place?

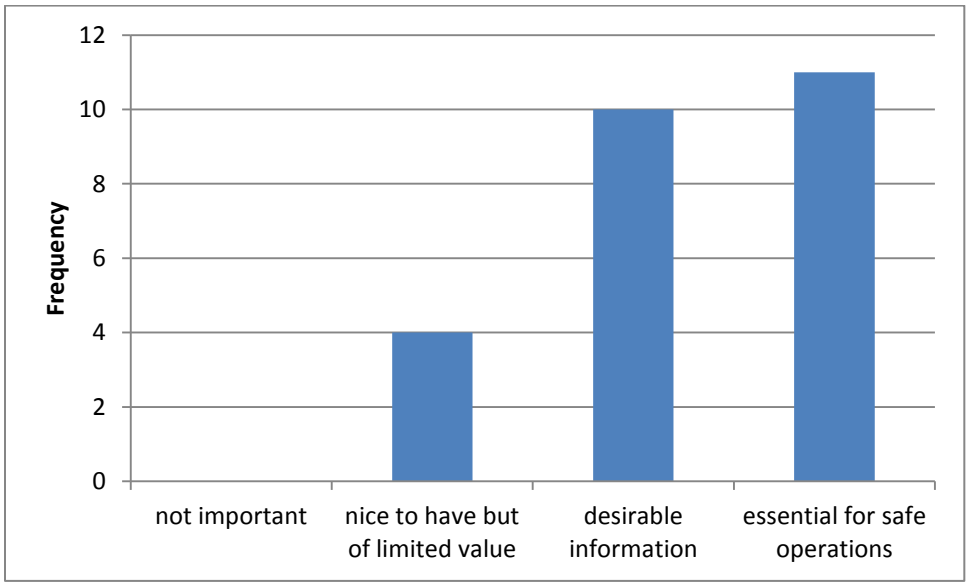
1000-3000 ft., count of 2
18000-40000 ft., count of 22
Over 40000 ft., count of 1

18. When flying in an area in which UAS Operations are being conducted, how important is it to know that an aircraft shown on a Cockpit Display of Traffic Information (CDTI) is unmanned? (e.g., through symbology or datatag information)



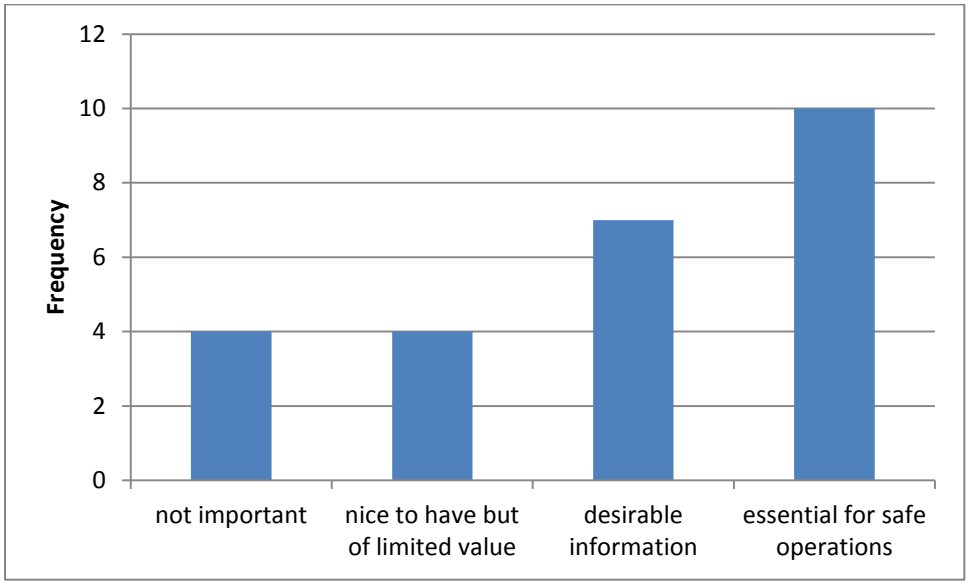
- *With the understanding that operational understanding may dictate non secondary transponding*
- *I need to know if the UAS has TCAS and will automatically respond to an RA.*
- *does not matter in avoidance situations*
- *Near midair over Afghanistan and Iraq.*
- *Good information, if the target gets close, I now know that it is unmanned and to be prepared for anything. At least at this juncture with regard to UAS operating near commercial traffic there is not a solid track record of operations.*
- *Maybe essential for safe operations?*
- *This answer is based on the assumption that the UAV can also respond to a TCAS resolution advisory. If it does not have that capability then having that information would be desirable.*

19. When flying in an area in which UAS Operations are being conducted, how important is it that you hear ATC communications with the unmanned aircraft pilot? (sometimes referred to as the "party line")



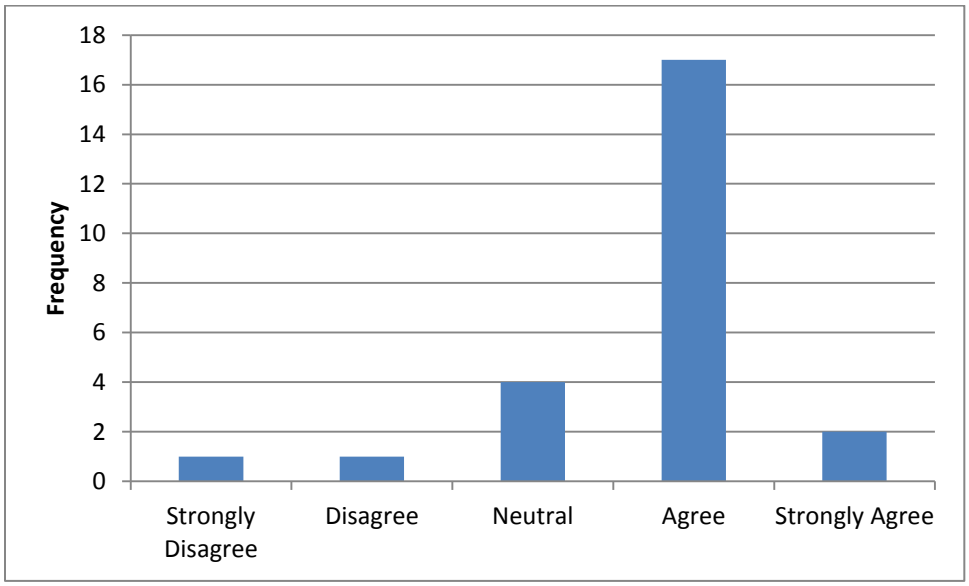
- *Essential to know that any traffic is in the area*
- *I need to know if the UAS is responding appropriately to ATC and operator input.*
- *we gather information and maintain situational awareness by listening to atc communications with other aircraft*
- *Near midair over Afghanistan and Iraq.*
- *It is part of total situational awareness.*
- *Hearing communications with other aircraft is part of Threat and Error Management. If a clearance was given in error, or was misunderstood having another set of ears listening to the transmission could well be the barrier that traps such an error.*

20. If you are flying 1000-3000 ft Above Ground Level (AGL) in an area in which small UAS (under 55 lbs) are operating below 400 ft AGL, how important is the display of that aircraft on a Cockpit Display of Traffic Information (CDTI) display?



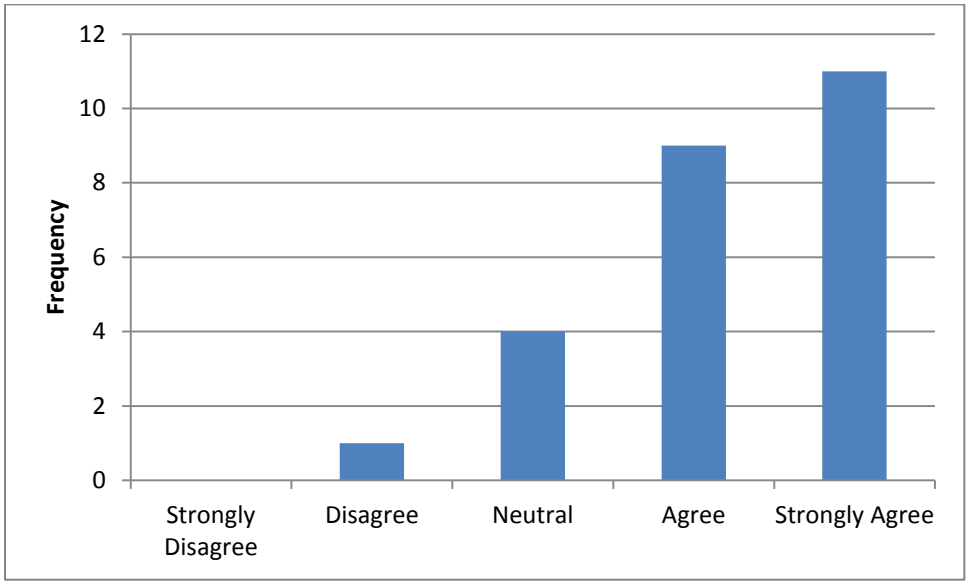
- *A collision can occur at this altitude as well as any other.*
- *below that we will be in class b or c airspace and not uas should be there*
- *Larger vertical separation does not seem as critical, however if vertical separation were less than 1,000 feet I believe it would be vital. I believe a UAS under 55 lbs would be nearly impossible to see air to air.*
- *When I am flying in a light aircraft I could be cruising at those altitudes. Most of the light aircraft that I fly don't have the capability to electronically see other traffic. Its the old fashion way of looking out the window to avoid other aircraft. I have been doing that for 46 years. When flying for the airline, the only time that at those altitudes is on departure and on approach. In either case it is a terminal area which is very controlled. Airlines do operate into some airports, however, that do not have a control tower. In any case, if the aircraft has the capability to at least display other traffic then it would be beneficial.*

21. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.



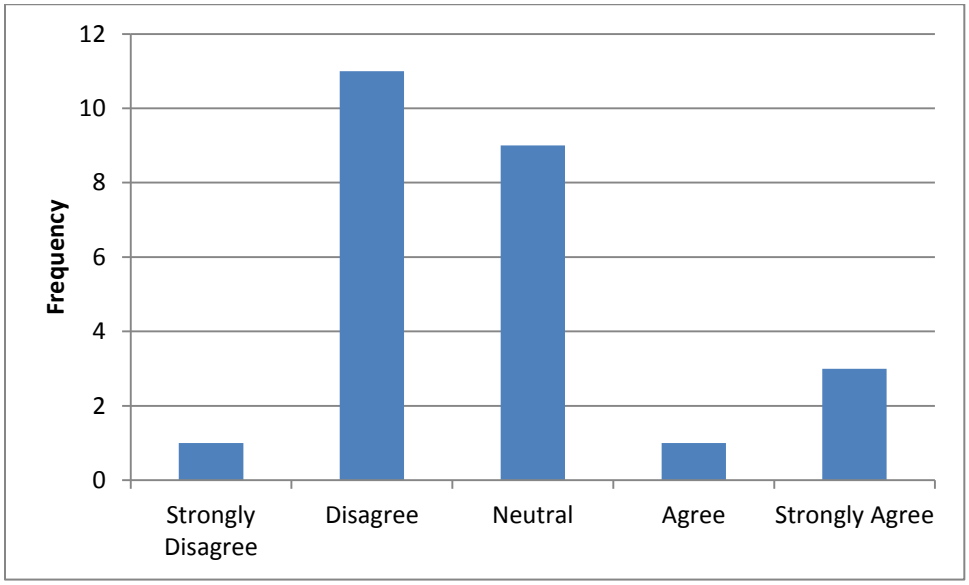
- *I will still need to be convinced that the operations are compatible.*
- *assuming that UAS is under 100% positive control*
- *It can be done safely, and with the rapid curve in technology it is only a matter of time, getting the framework set up now is imperative.*
- *I do not have enough information to agree or disagree with the statement. I believe that when controlled by an Air Traffic Controller or a Tower Controller then UAS and manned aircraft can share the same airspace.*
- *Knowing that the technology is there, but not knowing what the UAS capability is I cannot give this question a "strongly agree".*

22. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADSB) information will need separate or special airspace for their operations.



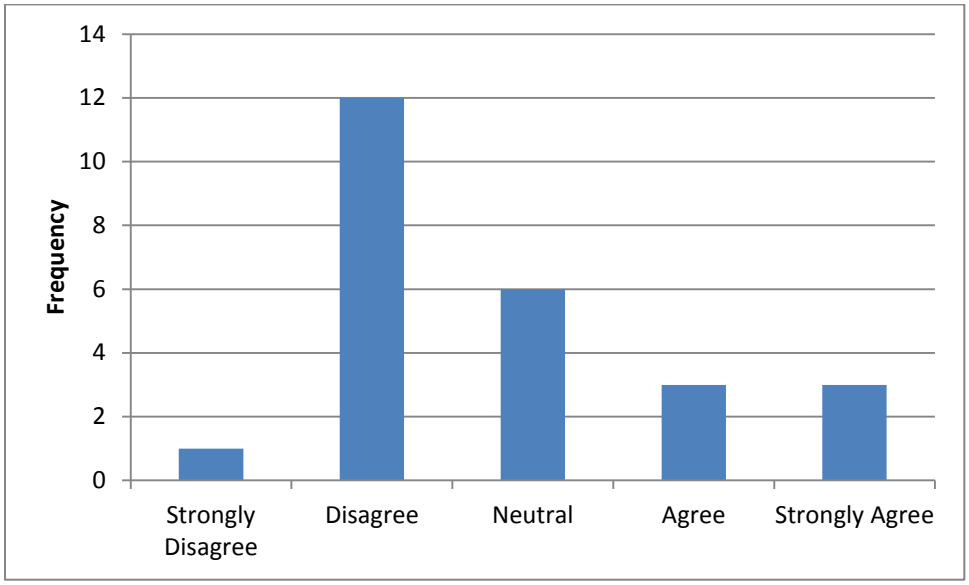
- *Assuming they remain outside of controlled airspace*
- *If it is blind and mute, flying in proximity to manned aircraft is an unacceptable risk.*
- *If operating above 500' agl.*

23. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADSB) will need separate or special airspace for their operations.



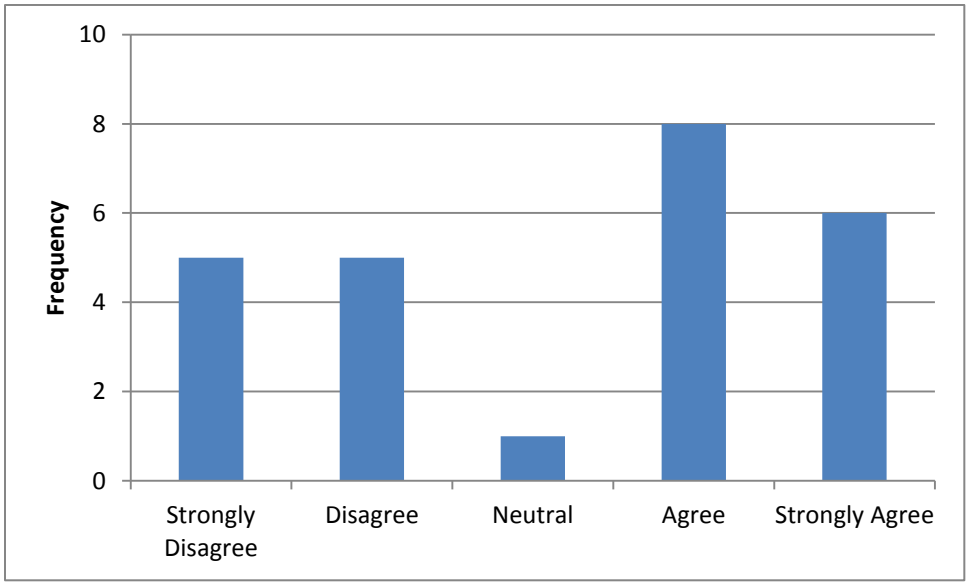
- *Assuming they remain in positive control*

24. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADSB) will need separate or special airspace for their operations.



- *Assuming they transpond in controlled airspace*
- *This would depend on the regulations and restrictions that accompany this kind of operation.*
- *Limited knowledge on the state of the art UAS systems so I'd had to make assumptions about their ability to interact with normal air traffic.*

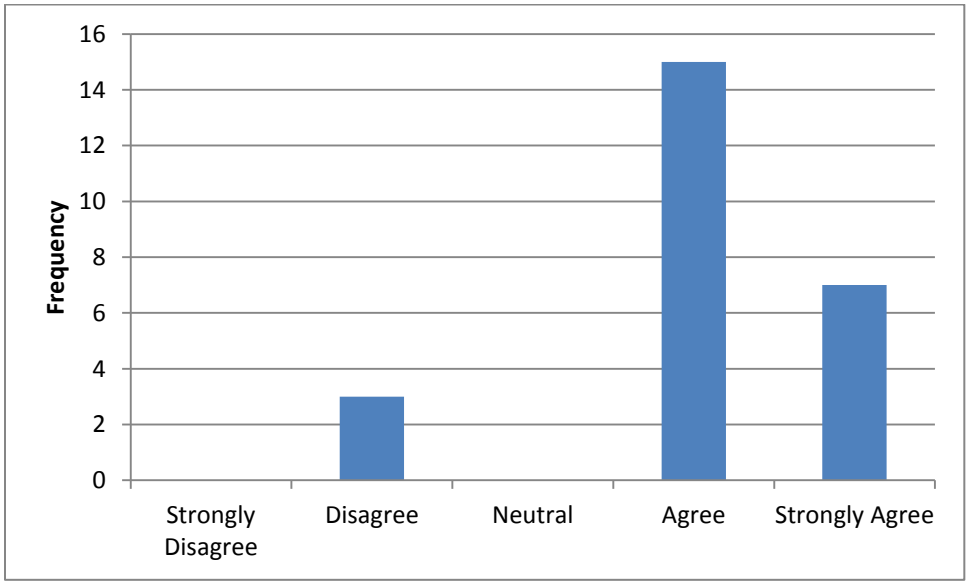
25. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.



- *All UAS need sense and avoid in lieu of human eyeballs and reactions.*
- *They should be more restrictive*

- *I disagree because the safety rules/requirements for UAS operating in the NAS should be more stringent, not the same.*
- *I believe UAS without sense and avoid equipment should have much more strict rules and requirements for the areas where they are allowed to operate.*

26. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.



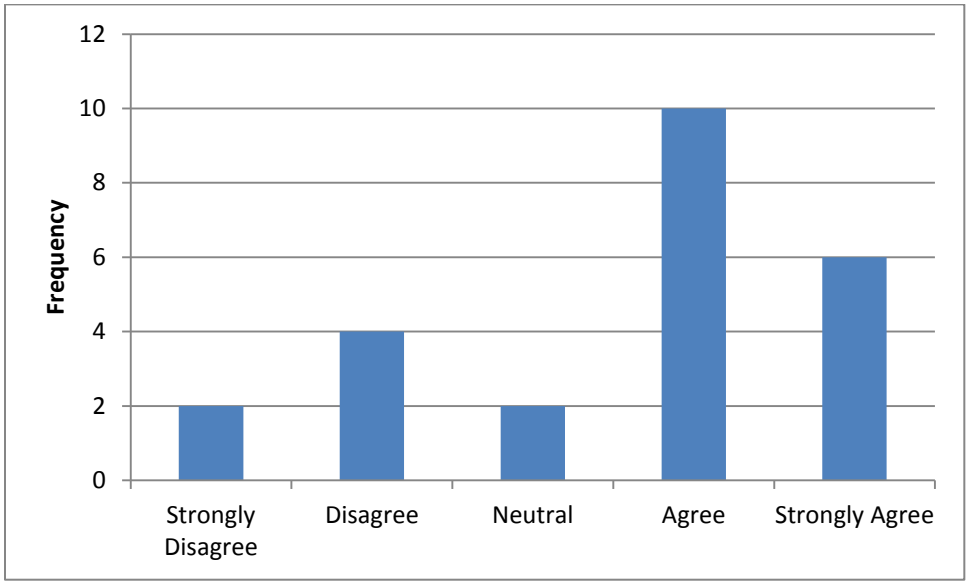
- *For the same reason that sense and avoid equipment is used in manned aircraft!*
- *UAS operations will need to be more restrictive until historical data show this restriction to be unneeded.*
- *I disagree because the safety rules/requirements for UAS operating in the NAS should be more stringent, not the same.*
- *Should be stronger*

27. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

- Yes 17
- No 7

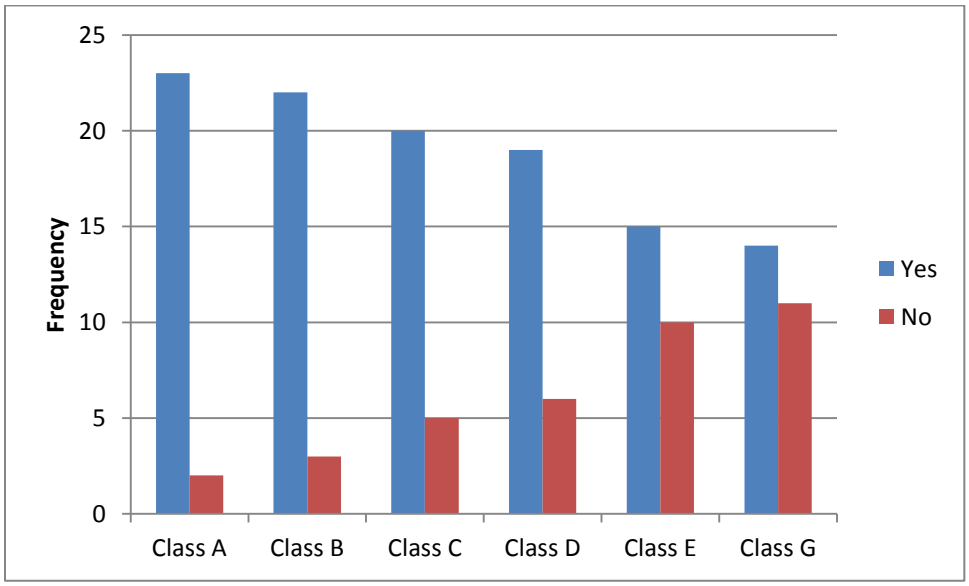
- *They should, to some extent be expanded due to lack of human operator on board*
- *Assuming automatic sense and avoid, spacing must be greater until it is proven to be unneeded.*
- *This is kinda tough, since it's already hard to see a small 55 lb UAS. Lighting should be bright on the UAS, and probably a special color to identify that it is unmanned.*
- *Use of TCAS and UAV autonomous response to TCAS resolution advisories.*
- *Not sure what the question is asking. UAS have no pilots so THEY can't do see and avoid.*
- *No see and avoid too risky*
- *At the least the UAS should have ADS capability and be equipped with TCAS and the ability to respond to an RA. It might even be better if it could do this autonomously.*

28. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.



- *Sense and avoid equipment is critical for UAS*
- *Obviously they can operate in the clouds unlike VFR aircraft*
- *Greater restrictions are essential until they are shown to be unneeded.*
- *let them operate zero zero if they want to*
- *Don't know their landing/approach capabilities.*
- *Operating VFR in airspace occupied by other aircraft that do not have the electronic ability to detect the UAS will be a safety issue. Even with that ability a pilot of a light aircraft may not be paying much attention to an electronic display while flying in VFR conditions.*

29. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?



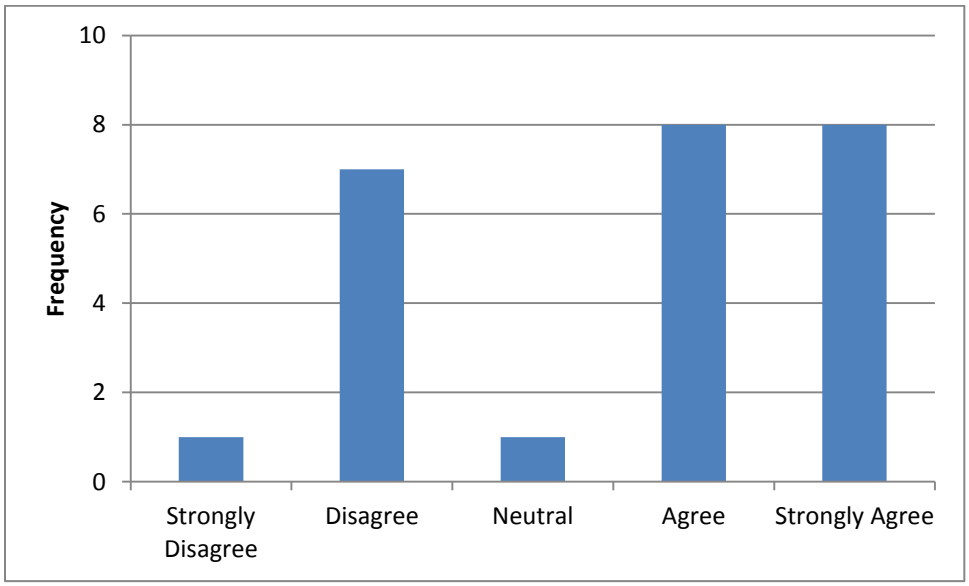
- *Greater restrictions are essential until they are shown to be unneeded.*
- *Communication should always be required.*
- *NOTAMs should be required for all areas of UAS operation and I do not believe that UAS should be allowed near airports or congested airspace in class E or G.*
- *Its like playing golf...everyone plays by the same rules.*

30. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

- Yes 18
- No 7

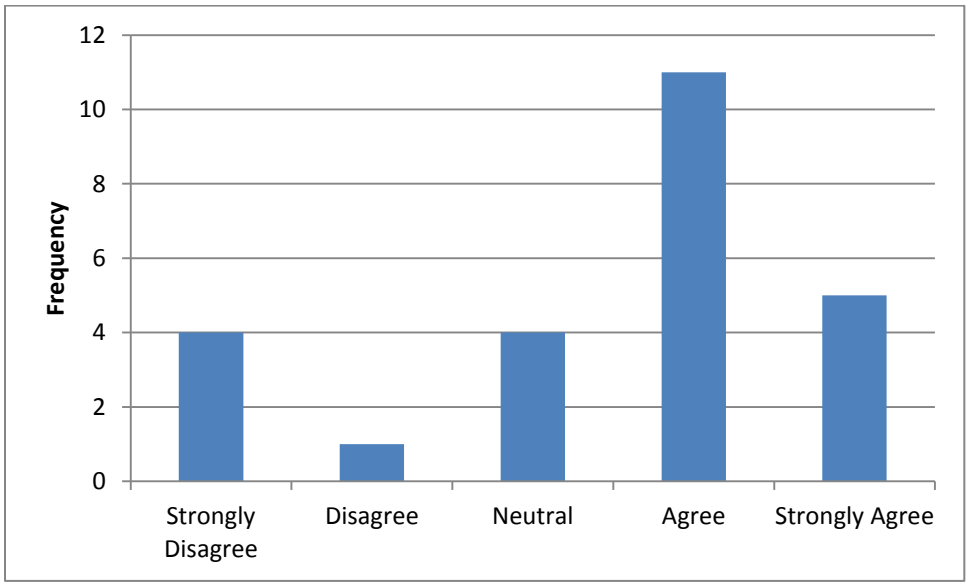
- *For SAR information if nothing else*
- *Flight plan should always be required and mane the operator directly responsible for operation as well as equipment capability.*
- *A flight plan should always be required.*
- *I'm under the impression that they'd operate in positive control airspace and wouldn't be wandering around in VFR areas.*
- *VFR flight plans are not a requirement for manned aircraft and I don't see how it would be useful for a UAS to be any different.*

31. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.



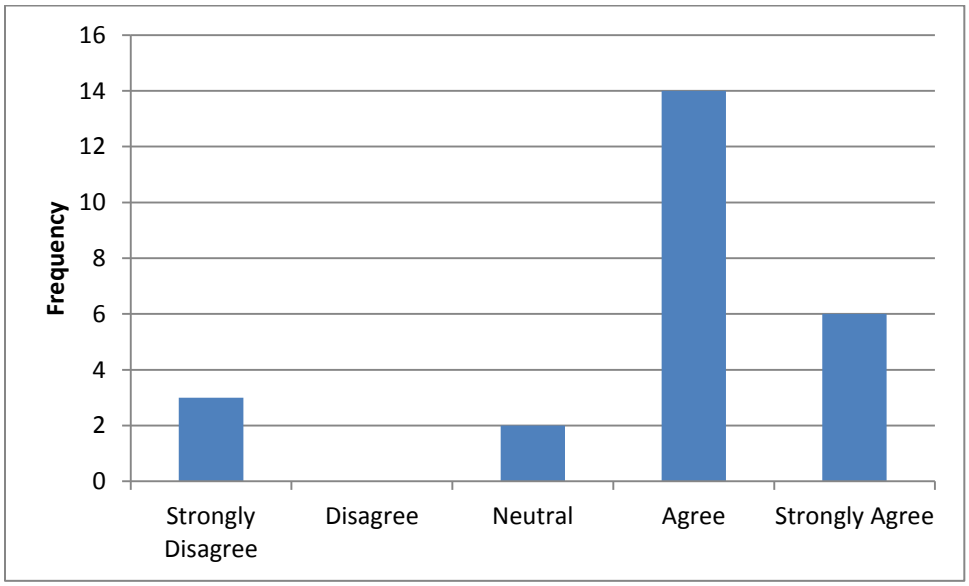
- *UAS lacks vision available to none UAS aircraft*
- *Greater restrictions are required until proven to be unneeded.*
- *less restrictive for uas operations*
- *Should be more restrictive*

32. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.



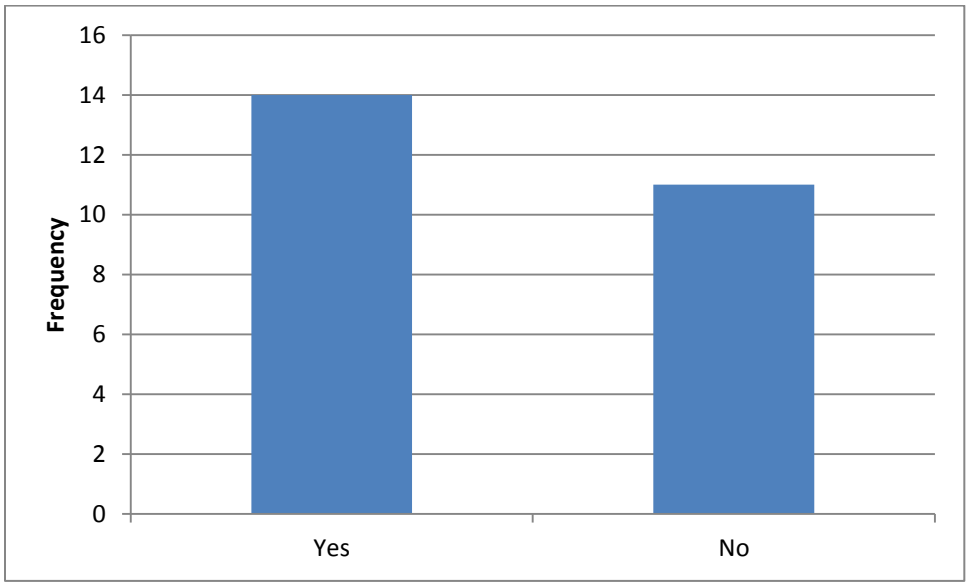
- *By virtue of their size none UAS be unable to comply*
- *UAS should always give way until proven to reliably consistently do otherwise.*
- *Unless operating below 500' agl or in restricted / special use airspace.*
- *I believe any manned aircraft should have the right of way.*

33. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.



- *Assuming they are properly lighted*
- *UAS should always give way until proven to reliably consistently do otherwise.*
- *provided the UAS is under positive ATC control*
- *I believe any manned aircraft should have the right of way.*

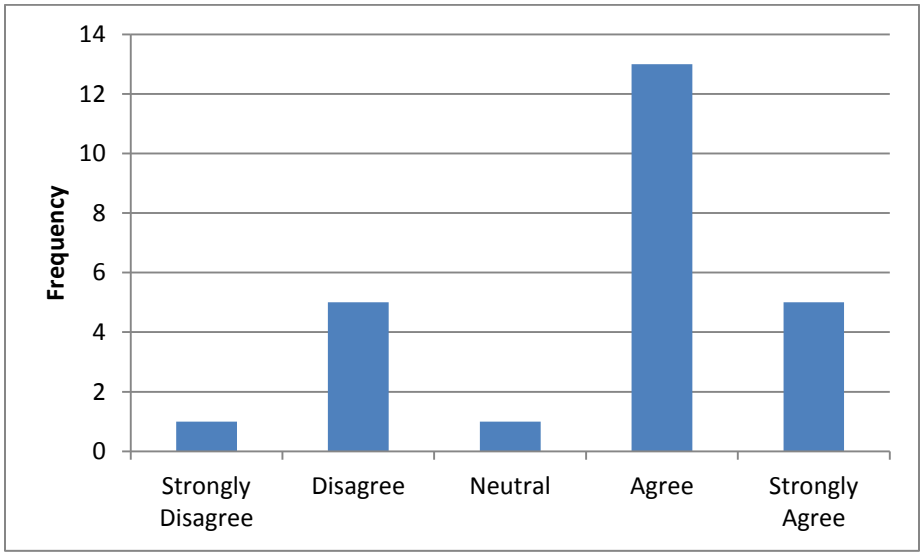
34. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?



- *Let's start with sharing airspace and be sure that separation is assured in all conditions. I am uncomfortable with close terminal operation not knowing how the uas aircraft will respond to loss of contact....*
- *Assuming UAS are at least as reliable and none UAS aircraft*
- *Because the UAS aircraft don't have the real capability to "see and avoid" other aircraft like Manned aircraft does. This is very important especially when ATC gets really busy and "forget" to advise of other traffic in the area*
- *They should be given priority handling to expedite their arrival*
- *Only when no other option is available and then with greater spacing.*
- *this is a very dynamic environment that relies on pilot intervention for safety more than the cruise altitudes. keep them out of the class b/c/d airspace*
- *The consequences of loss of control of the UAS are too serious to mix then with manned traffic.*
- *All aircraft pose a safety issue if operating outside standard procedures. Allows for easier / smoother traffic flow.*
- *at low impact/volume airports I do not see an issue, provided the UAS in under positive ATC control and/or radar contact*
- *I don't see them needing to use "airports" in the same way as manned aircraft, particularly the smaller units.*
- *Not yet, this need to be phased on an incremental level, with training and understanding of the "meshed" operations taught to UAS pilots and manned aircraft pilots.*
- *I have an extremely hard time seeing the value/benefit of having UAS's operating into the U.S's largest airports. I'm under the impression, perhaps mistaken, that UAS' would be operating from military airfields under positive ATC control (IFR) the entire time.*
- *Do not trust the reliability of uas refer to Iran lost uav!!!!!!!*
- *Only in strictly controlled environments and they should be separate when possible.*
- *UAS and manned aircraft in the same airspace at the same time will inevitably lead to midair collisions and deaths.*
- *This answer has an exception. If the UAS can respond to ATC instructions just as a manned aircraft does then it shouldn't matter. It should not, however, operate at an airport that does not*

have a control tower. I perceive that there is a limited field of vision and its operation with other manned aircraft at an uncontrolled airport could compromise safety.

35. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.



- *IFR Yes, VFR NO*
- *Seems to me that it might make sense to offset UAS's by a couple hundred feet.*
- *UAS should operate on a thousand plus 500' increments for added safety.*
- *IFR yes. VFR maybe even/odd plus 250'*

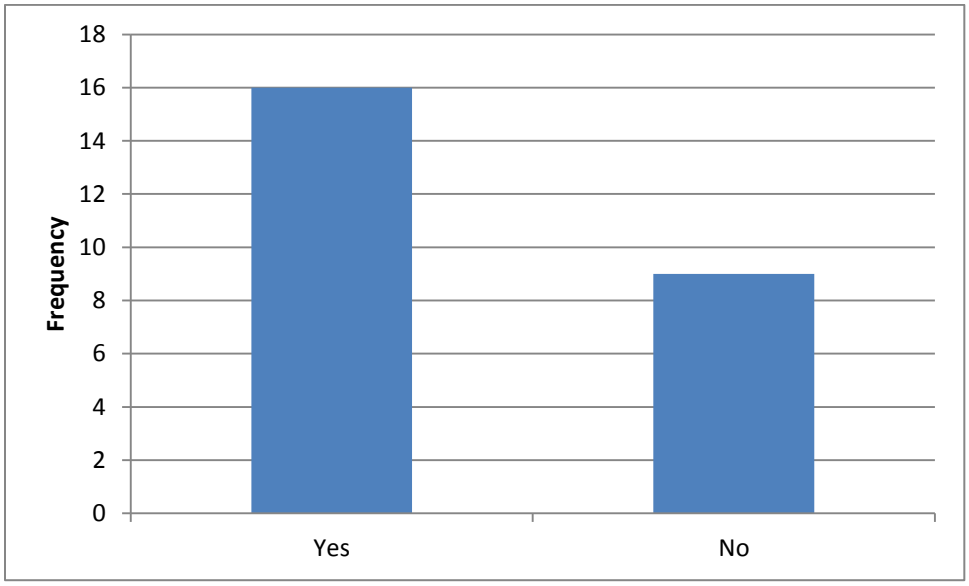
36. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

Yes 11
No 14

- *There should be no voice delay. I can't tell you how many times I have heard atc give the instruction "immediately". A 4 second delay added to pilot response time is unacceptable.*
- *4 Seconds may be a critical delay*
- *I don't know enough about their long range communications, but I do know that if there is a delay in communications with the UAS, this could pose a serious threat to other aircraft in the area*
- *Onboard automated sense and avoid.*
- *only in the most unique of situations could this be a safety issue*
- *I think it will pose a problem for controllers, but not a significant problem.*
- *In heavily congested airspace such as the NY, ATL or LAX, responses need to be immediate.*
- *a keep them away from planes with humans on board*
- *I am not familiar with the technical aspects of ground based communication but I think UAS could use ground based systems for communication while still using satellites for control.*
- *RF (radio frequency) links can be disrupted at any time for a myriad of reasonsl. Without CONSTANT RF links control of UAS is lost.*
- *Only if the TCAS system can respond as quickly as conventional A/C.*

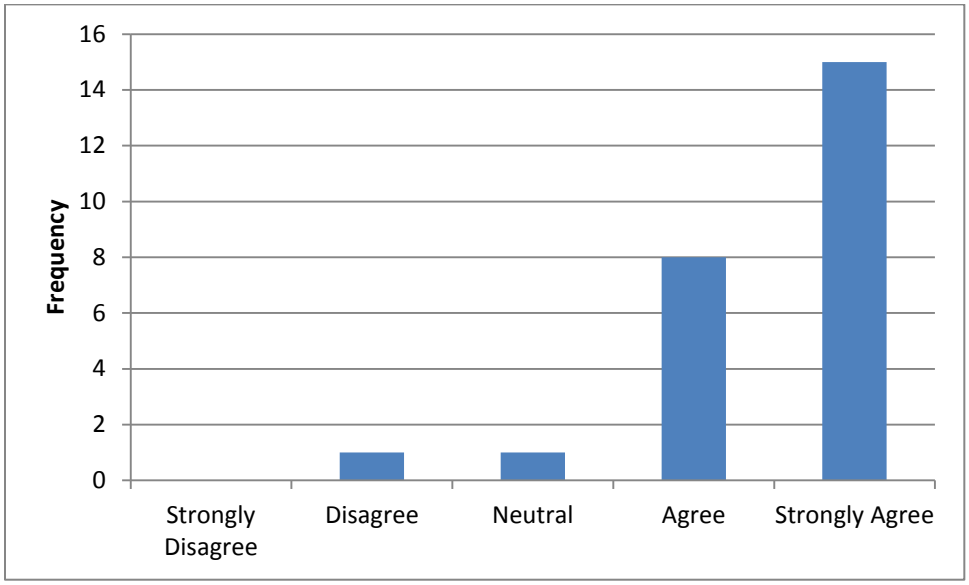
- *In the terminal area this is something that I think ATC will easily adjust to when they know that they are dealing with a UAS. On the other hand, when its busy they pretty much want an immediate response.*

37. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?



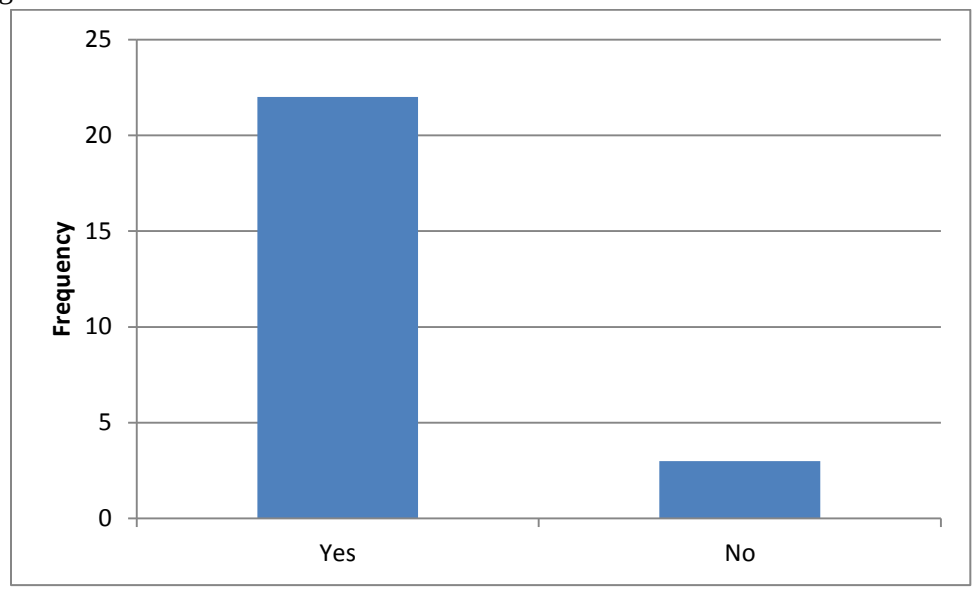
- *as long as compliance capability is onboard the UAS*
- *I should have an indictaion that the UAS senses my aircraft and it's ability to avoid is intact.*
- *Only to the extent that a TCAS RA should be autonomous.*

38. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).



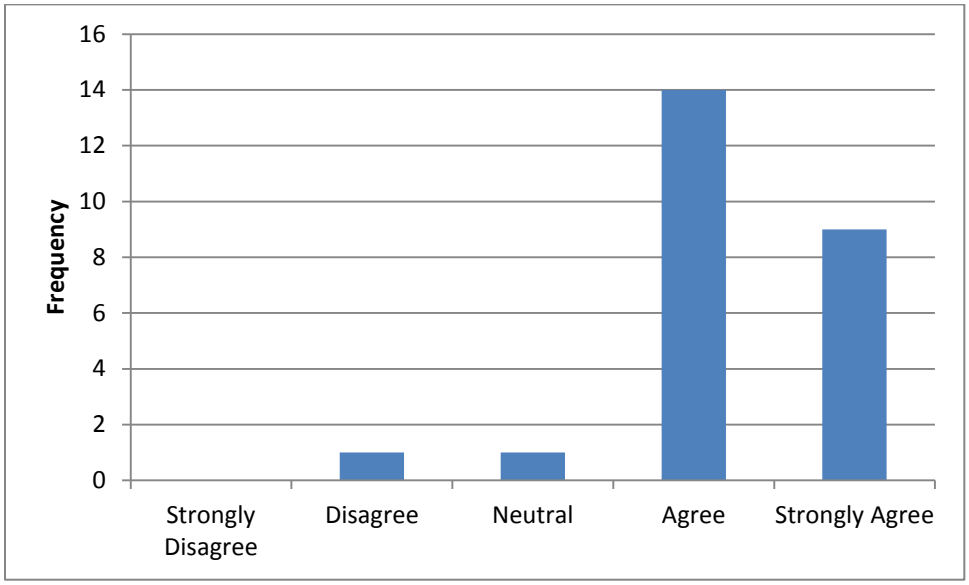
- *Not just required to be capable, but required period.*

39. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?



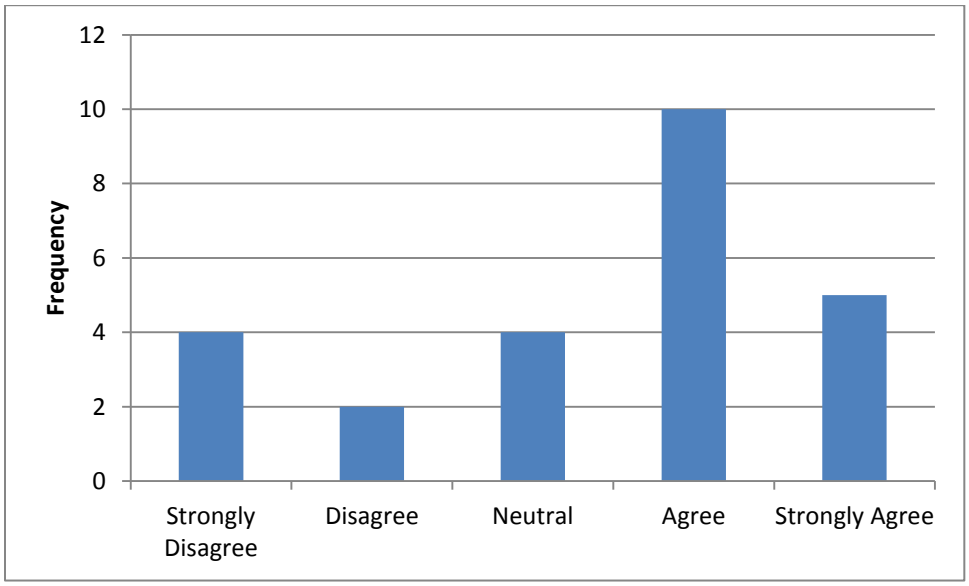
- *Not just required to be capable, but required period.*
- *UAS should be able to comply with RTAs also.*

40. Indicate your extent of agreement or disagreement with the following statement. The enroute navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.



- *Procedures/capabilities should be greater for UAS.*
- *GPS navigation is the only one needed.*

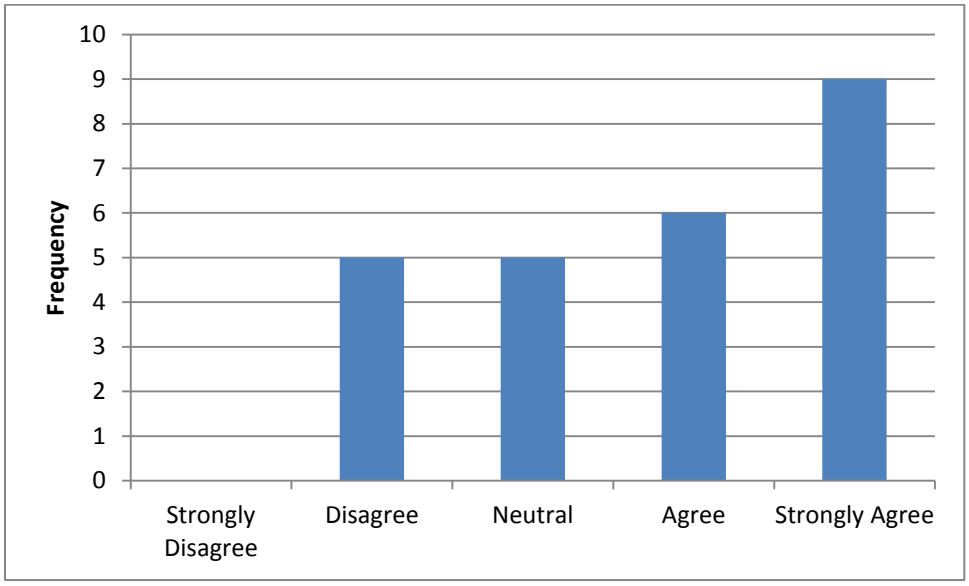
41. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.



- *They should be augmented with advisories to manned aircraft*
- *Yes, every aircraft, manned or unmanned should be required to follow the same procedures so that everyone is on the same sheet of music*

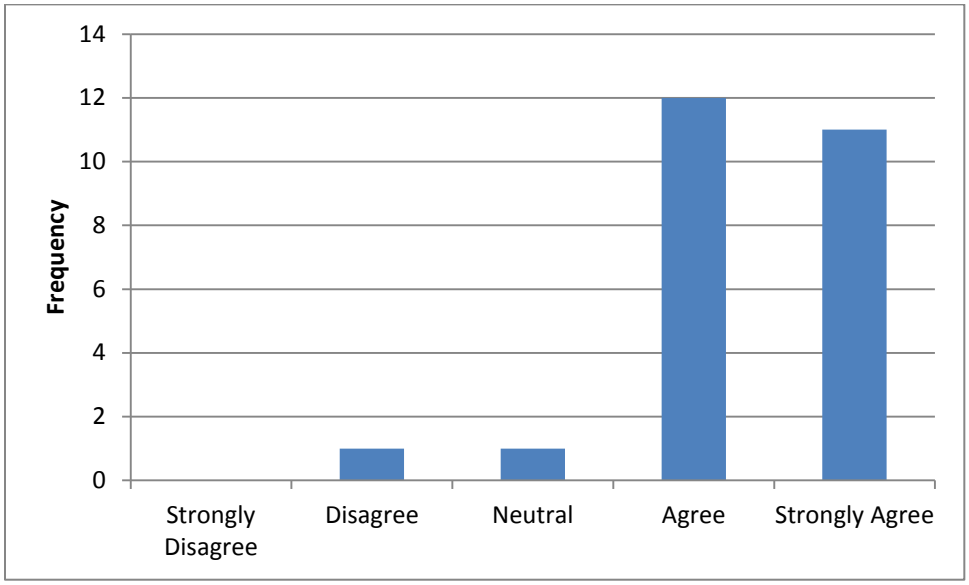
- *NORDO should require an expeditious exit from IFR airspace.*
- *these relay on vfr rules in vmc. i do not believe that uas should operate vfr in any situation*
- *assuming landline communications are still available to the GCS*
- *Land lines? Phone call from operator to ATC as a back up for the ATC comm link would allow some leeway on lost comm procedures.*
- *There should be an alternate means for the UAS controller to contact an air traffic controller when both are on the ground, however the UAS should land immediately when the aircraft has had any type of communications failure.*
- *Procedures/capabilities should be greater for UAS*
- *There will need to be a lost comm procedure, but not necessarily the same as conventional piloted A/C.*
- *It seems to me that a land line phone connection could work as a backup until normal communications could be reestablished or the UAS has landed.*

42. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.



- *I am unfamiliar UAS contingency*
- *30 seconds can equal 4 miles. That is unacceptable.*
- *that would be unacceptable in airspace with passenger carrying airliners*
- *30 seconds is right about the maximum acceptable time for loss of control link.*
- *Unless the aircraft has collision avoidance logic built into its flight systems such as TCAS which can communicate with other aircraft.*
- *Procedures/capabilities should be greater for UAS*
- *If the TCAS system works independently, then it should not pose a problem.*
- *I don't know what the autoflight capability is or what system redundancy there may be in the event that a loss of control link was to occur.*

43. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations. (Aircraft executes ATC accessible lost link procedure)



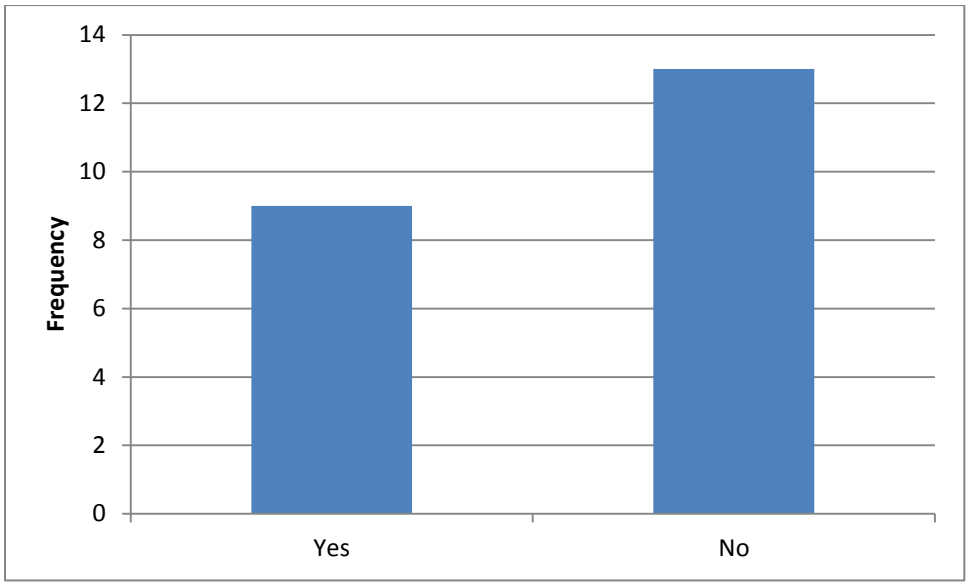
- *What are self-destruct procedures?*
- *What is command and ATC are both lost? There needs to be an ability for the UAS to self sense that condition and execute an expeditious escape plan. That system should have it's own power source in the event of a complete electrical failure.*
- *goes without saying*
- *Unless the aircraft has collision avoidance logic built into its flight systems such as TCAS which can communicate with other aircraft. Even then I do not feel safe knowing there could be uncommanded aircraft flying through congested airspace.*
- *Redundancy must be built into the system.*
- *Whatever it uses for navigation; i.e. IRU, GPS, synthetic vision, infrared or something else it eventually has to land. I am not familiar with ATC accessible lost link procedure, but what caused the problem is the first place. Can the UAS be controlled at all? ATC could certainly alert other aircraft on the frequency of the situation and vectors to avoid it if required. Maybe it will be programmed to attempt a landing at some remote airfield where it would be little risk to anyone at or around the airport. If these sort of things are considered and programmed into the flight then I don't see there being that much of a hazard.*

44. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

- *Same rules*
- *APB released to aircraft in vicinity of UAS lost com aircraft*
- *none*
- *Should have a emergency procedure built in to put it into a standard pattern holding at a specific altitude.*
- *Continuous self test of all comm and data links and an alternate means of communicating with the operator in the event of a 'stuck mike' or other disrupting event.*
- *stay out of areas where "see and avoid " is determined to be a large contributor to safety like traffic patterns. have special procedures for lost control.*

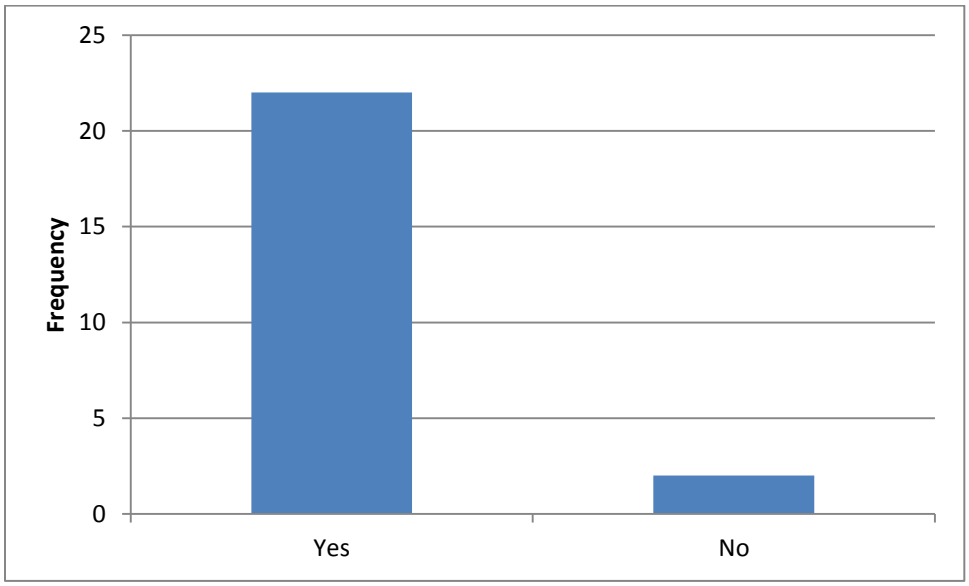
- *UAS communications should include a distinctive call sign.*
- *Advise aircraft in the vicinity should be notified of loss of control link.*
- *NONE*
- *None, they need to be integrated into the system as manned aircraft are so the system can maintain continuity.*
- *none*
- *Much more restrictive until proven otherwise*
- *With any communication or control link failure, even temporary, the UAS should be required to land and undergo a maintenance check.*
- *Deconflict the airspace*
- *None come to mind.*
- *If its not already in place, establish a land line procedure in the event of lost communications. Otherwise communication and procedures should be the same.*

45. Is there any additional information concerning UAS operations that should be available to pilots of manned aircraft during NAS operations?



- *Special designation on tcas*
- *Their proximity of their operations*
- *The type/size of the UAS*
- *Transponder Mode C for all flights*
- *Ability for manned aircraft to have an indication that the UAS senses their presence and is operating normally. I should also know that the operator is a fully trained and certified pilot that is being monitored and supervised by another fully trained and certified pilot.*
- *UAS operations should be posted in the NOTAMS.*
- *differing symbology on TCAS displays to alert manned aircraft pilots of UAVs operating in their area.*
- *NOTAMs any time a UAS will be operating in any airspace and its proposed route of flight. ATC should provide traffic updates to pilots in the vicinity of any UAS*
- *Pilots need to know everything about the whereabouts and intentions of the UAS in their area.*

46. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?



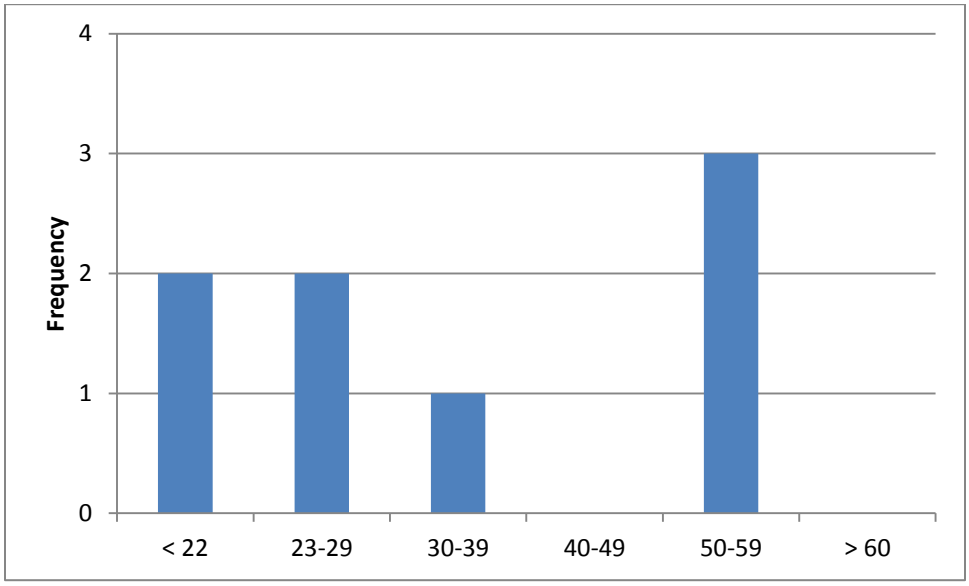
- *I admit that I don't really know enough about UAS and their operation to offer solid advice. However, if they are going to be operated in the same airspace as my plane, then I feel as though their operation should closely mirror the same operational procedures as traditional manned aircraft. I don't care if there is a man in it or not. If I were to have a mid-air with one then there is a good chance I'm not going to make dinner. So, they ought to be operated under similar guidelines that I am used to. In this way their operation will be predictable to me. I think this will enhance safety.*
- *Thank you for the opportunity to allow me to participate in this survey.*

Appendix B – Results of Online Survey for ATC

Respondent text answers and comments are noted in *Italics*

Questions 1-5 addressed agreement with purposes of the study, informed consent and comments about it, agreement that age of respondent was over 18, and Access Code for completing survey.

Question 6. Please Indicate your age.



7. Please indicate your Gender.

Male: 5
Female: 3

8. How many years have you been a Certified Professional Controller (Public or Military)?

Mean Years	13.06
Median Years	7
Minimum	0
Maximum	36
St Dev	14.2

9. How many of these years have you worked in staff positions?

Two responses: 1 & 2

10. What ATC facility ratings have you held?

- *Flight Data Ground Control*
- *CKB ROA Control Tower Operator Radar Controller*
- *I am fully qualified at {xyz} base control Tower*
- *tower*
- *TRACON, ENROUTE(Radar)*
- *Certified Tower Operator (CTO) x 4*
- *Control Tower CTO*
- *Tower - 5 GCA - 1 Radar APCH - 2*

11. Are you currently facility rated?

Yes 5
No 2

- *Training*
- *Retired, but as far as I know, the rating didn't disappear*
- *Retired: 2010*

12. Are you currently working active control, or are you in a staff position (if so, what position)?

- *active*
- *Neither, retired*
- *yes*
- *No, retired 2010*
- *Active control*
- *Active control*
- *Currently working*

13. What type of experience do you have with UAS operations in your airspace (e.g. active control, coordination, etc.)?

- *active control*
- *None*
- *active control*
- *Minimal as a CPC*
- *Pattern operations, active control, coordination, procedure development, etc. I work at xyz base which is primarily UAS operations (MQ-1 and MQ-9)*
- *active control, coordination.*
- *Active control all positions*

14. Were UAS operations in any way lacking in capability to aviate in the NAS? If so, suggest any possible remedies for the problems UAS experience in their ability to aviate in the NAS.

- *I work Class D in restricted airspace outside of the NAS, however, no problems I am aware of.*
- *Did not experience any uas ops*
- *no*
- *Complete, updated IFR/VFR database, as required by regulations, including intersections, VORs, and other commonly used navaids/fixes in the NAS. As opposed to a strictly lat/lon, coordinate nav database as some UAS utilize.*
- *The UAS aircraft I've worked with are capable of most of the same things as manned aircraft, but are unable to react quickly to control instructions. This may be limited to certain types of aircraft, but the MQ-1 and MQ-9s generally do not make quick turns, so for example, if a controller tells the pilot to turn 90 degrees north, it takes about 10 seconds before the aircraft to start the turn. This could become an issue if evasive-type maneuvers are needed; however, I believe these type maneuvers are more likely to happen in a tower pattern vs. NAS airspace outside VFR pattern work. This also may just be a limitation of certain UAS aircraft. Some possible remedies are instituting a "buffer" around UAS aircraft operating in NAS in addition to normal separation requirements, and most importantly: effective controller training and awareness of UAS performance and limitations. These aircraft are also limited based on the frequencies used to control it in the air; it's not uncommon for the aircraft at xyz to go "lost link" in which the pilot loses comm/control of the aircraft and it flies on it's own to a predetermined*

point. I'm unsure of how that would work in NAS airspace...if the controllers would be made aware of a UAS's lost link waypoints and then separate other aircraft from those, or if the UAS would just orbit at it's current location when it goes lost link. I also am unsure if that is limited to MQ-1/MQ-9 aircraft or if the "lost link" patterns are used with other type UAS. If they are used, a remedy would be to determine the best flight path when UAS go lost link; in my opinion I would rather an aircraft just orbit at it's current location when lost link rather than fly a predetermined path (except for during tower pattern ops where you would want it to proceed away from the runway/tower pattern).

- *no*
- *No*

15. Were UAS operations in any way lacking in capability to navigate in the NAS? If so, suggest any possible remedies for the problems UAS experience in their ability to navigate in the NAS.

- *Not that I am aware of.*
- *N/A*
- *no*
- *See answer above, some UAS systems do not have the capability to navigate via NAS fixes and rely solely upon coordinates and the ability of the operator/pilot to convert.*
- *The only issues with navigation I've noticed are when the UAS pilots are given a VFR point to proceed to that is not on their "normal pattern routes". They have difficulty seeing points based on land references as their visual range is limited depending on what type camera and how good the feed is. They prefer to use lat/longs vs. ground reference points which could become an issue when flying VFR. A remedy would be to ensure points controllers use have an associated lat/long the controllers can access easily. I don't foresee this being much of a problem outside VFR pattern operations.*
- *No*

16. Were UAS operations in any way lacking in capability to communicate in the NAS? If so, suggest any possible remedies for the UAS communications problems.

- *Sometimes they'd have a lost link, procedures are already in place for that.*
- *N/A*
- *no*
- *Communication latency with satellite based com systems*
- *UAS are probably most capable of communicating as the pilot is sitting in a ground location. The pilots of UAS at xyz are able to pick up a phone and call the tower or Supervisor of Flying (or other UAS pilots) if they have radio issues. One thing to keep in mind during tower operations is that UAS pilots cannot see light gun signals; the only remedy I suggest for radio failure is to ensure pilots call ATC facilities on recorded phone lines so the conversations are recorded just as they would be on a frequency.*
- *Minor radio and coordination problems*

17. Describe any problems you encountered with UAS lost-link situations.

- *none*
- *N/A*
- *n/a*
- *None as CPC*
- *The biggest problem with lost-link is the sheer volume of lost-link situations that happen when multiple UAS are flying in the tower pattern. This is due to congestion of frequencies (the frequencies the UAS are using) and limited line-of-sight abilities on the field. The scariest thing*

about lost-link as a controller is not knowing the exact flight path or altitudes of the lost link profiles. The pilots can usually provide this information, but when the UAS first goes lost link it can sometimes be a scramble to get all other UAS aircraft away from what is perceived to be the intended flight path of the lost-link a/c.

- *non currently*
- *Different companies create different lost link procedures. Other than that it just requires a few minutes to find out where he's going.*

18. Suggest any possible remedies for the problems you encountered with lost-link situations.

- *none*
- *N/A*
- *n/a*
- *Pilot/ATC training and standardization of procedures. Proper ATC briefings prior to UAS operations*
- *The MQ-1 and MQ-9 lost-link general routes and waypoints are published in our local flying regulation, so we know (or at least have a pretty good idea of) the path the aircraft will most likely fly when it goes lost link. A remedy to the problem of controllers not knowing the flight path is to publish lost-link planned routes and waypoints that UAS can use for each area of operation. That way controllers can train on them and have a good understanding of what to expect when an aircraft goes lost link. As for the problem of volume of aircraft; I'm not as familiar with how the frequencies and line-of-sight capabilities are determined or improved...but multiple UAS aircraft operating in one area could lead to multiple lost-link situations based on what I've seen at xyz.*
- *na*
- *standardization*

19. Describe any issues with UAS operations that are incompatible with "traditional" operations in the NAS.

- *Everything is VFR in restricted airspace but you can't use "see and avoid" with UAS.*
- *N/A*
- *n/a*
- *Nav database - Pilot qualifications (IFR rated, manned pilot?) - Standardization of lost-link procedures - Mitigation of "fly-away"*
- *I have only worked military towers, so I'm not as familiar with radar operations or other airspace operations, but the biggest "incompatibility" is the fact that UAS cannot see very well, but often only fly VFR operations. This will change how controllers sequence them, and how they separate them, and makes it difficult for UAS pilots to comply with some instructions (regarding VFR reference points or traffic calls).*
- *being able to coordinate/sterilize the airspace adequately to ensure no conflict in case of lost-link/go around procedures.*
- *No see and avoid, other than that, it's just another airplane*

20. If you have worked mixed Manned Aircraft/UAS operations in your airspace, what information did you find to be necessary to enable these mixed operations to be carried out safely?

- *All the ops letters and written procedures.*
- *N/A*
- *ATC briefings packages - ATC training on UAS capabilities, limitations, performance, lost-link, etc*

- *Characteristics of both aircraft involved, and altitudes. UAS cannot space themselves from other aircraft due to their inability to see/avoid or determine specifically where that aircraft is, and will not adjust their flight path based on traffic. Manned aircraft often cannot see the UAS because of their small size and slow speed. In order to carry out mixed operations safely, the controller needs to know the speeds and likely turn rates/perch points/pattern flight paths so they can effectively sequence the manned and UAS aircraft. Sequencing calls can only be used with manned aircraft, so controllers have to be very proactive in telling the UAS pilot exactly where they want them to fly and at exactly what altitude to ensure separation from manned aircraft as the UAS pilots cannot see other aircraft and adjust their flight path accordingly. It takes some practice, which is why I say controllers really need effective training from someone who has worked UAS (especially someone who has worked mixed unmanned/manned traffic). The way UAS are worked is not the same way controllers are used to working manned aircraft (normal sequencing, cutoffs, and "control methods" don't always work) and needs to be taught by someone with experience.*
- *What the UAS is programmed to do in take-off, approach, lost-link, emergency bail-out, and landing.*
- *Pilots are unfamiliar with UAV airspeeds, that's about it*

21. When working manned aircraft and UAS in your airspace of responsibility, how important would it be to know that an aircraft shown on your radar display is unmanned? (e.g., through symbology or data-tag information)

Not important	0
Nice to have but of limited value	0
Desirable information	3
Essential for safe operations	3

- *This information seems essential for many reasons!*
- *The (lack of) maneuverability and climb rate of UAS aircraft, as well as their inability to see and avoid, are essential pieces of information a controller will need to make decisions regarding their traffic calls, separation, and sequencing.*
- *It's just one of those things that a controller should be aware of*

22. When you are working aircraft in your airspace of responsibility, in which small UAS (under 55 lbs) are operating below 400 ft AGL and more than 3 miles from an airfield, how important is the display of that aircraft (data tag information) on your radar display?

Not important	2
Nice to have but of limited value	1
Desirable information	4
Essential for safe operations	0

- *Aircraft in our class D have arrival/departure route/pattern altitudes as low as 500 ft AGL.*
- *In general, not important unless those operations are conducted within Class D airspace or in the close proximity to any airports traffic pattern*
- *Below 400 ft makes it generally safe, but I would still want to know they were there to give traffic to low-operating aircraft/helicopters.*

23. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.

Strongly Disagree	0
Disagree	2
Neutral	0
Agree	4
Strongly Agree	1

- *Until issues stated previously are resolved, UAS cannot safely be integrated and will have to rely upon present system of TFRs and other SUA*
- *With the proper training of both controllers and pilots, and effective procedures regarding UAS operations, both types aircraft can operate safely in the same airspace. But there will not be a 0% accident rate, and it will probably take some mishaps (just like it has/does with manned aircraft) to show where the deficiencies in training/procedures lie...but I don't think that means UAS can't generally operate safely in NAS airspace.*

24. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations.

Strongly Disagree	0
Disagree	1
Neutral	2
Agree	4
Strongly Agree	0

- *I don't know much about these aircraft, their characteristics, or their flying operations to know if it would be a concern that they were operating without ATC communications. I'm hesitant to agree that any aircraft should ever operate without some sort of position information or communications. The small size doesn't mean it can't hurt or disable another aircraft.*
- *Difficult for me to comment, I've only worked with the tiny guys 1 time*

25. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

Strongly Disagree	0
Disagree	4
Neutral	2
Agree	1
Strongly Agree	0

- *I think with good position information and ATC communications, small UAS can operate safely in most types of airspace.*

26. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

Strongly Disagree	1
Disagree	2
Neutral	1
Agree	3
Strongly Agree	0

- *I work these type aircraft at xyz every day, and often have to mix them with manned aircraft including heavies and fighters. I know they can operate without needing separate or special airspace. But they do need ATC communications and position information to be safe. As for their "missions", they do use range airspace...but based on what sort of operations they are trying to perform, I think they could use any type airspace as long as they were communicating and giving position information.*
- *They are just another airplane!*

27. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	2
Neutral	2
Agree	1
Strongly Agree	2

- *Regardless of SAA capability.*
- *I think they would need to be a little more stringent for UAS. If they can't sense/avoid, and we know they can't see/avoid, the safety rules/requirements might need to be adjusted but I can't think of any good examples. I will try and email if I come up with anything in particular.*

28. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	2
Neutral	1
Agree	2
Strongly Agree	2

- *Should still be more stringent...even being able to sense an aircraft (I assume this means using radar of some kind?) does not give good enough information to ensure avoidance. For example, seeing an aircraft target on our tower radar display does not tell me what angle that aircraft is at, what small turns it's making, or when it changes direction (takes a few sweeps). So I would not want to have that be my primary means of determining how to avoid that aircraft.*

29. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

Yes 1
No 6

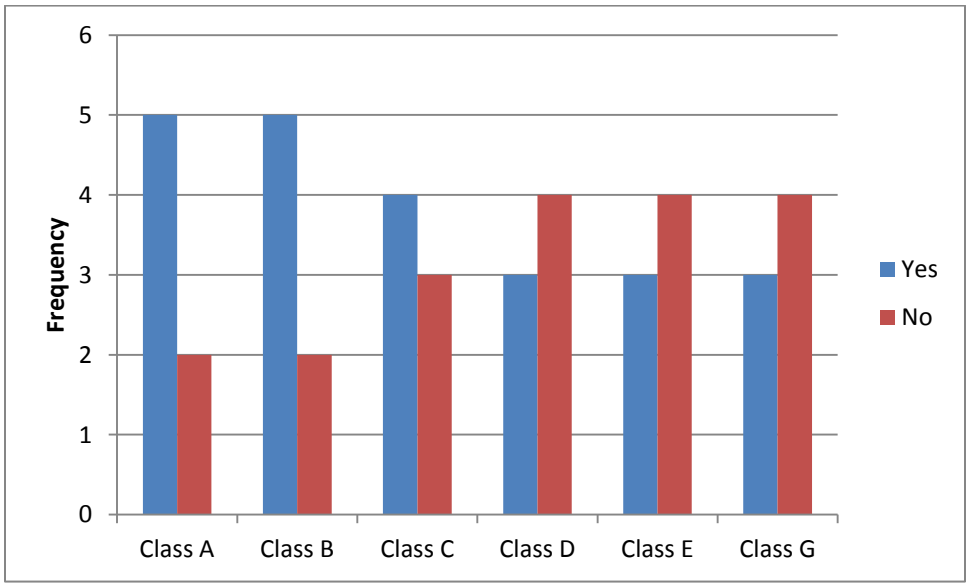
- *Can a UAS really keep a good sight on other traffic?*
- *While the see & avoid requirements for manned aircraft are probably outdated and based on obsolete assumptions, the human decision making system has the ability to quickly apply corrections when mistakes are made or traffic is spotted at the last second. I am concerned that without human split second decision making abilities, the "sense" and avoid systems on UAS would need to be absolutely perfect and without error, which I believe is impossible to accomplish.*
- *I'm not sure what "sense and avoid" refers to, but UAS aircraft, unless operating in a special use airspace, should be under ATC control/communications. Their inability to see limits what they can avoid.*
- *UAV's cannot see and avoid, they should be IFR, problem solved. The tiny ones obviously won't be IFR and must use extremely low alt's and remain at least 5 miles away from none participating airports.*

30. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	3
Neutral	2
Agree	0
Strongly Agree	2

- *Need much higher minimums*
- *I can't think of any rules that would need to be different when it comes to weather...that might fall under aircraft characteristics or pilot ratings. I do know that wind and rain limitations are much more restrictive for the UAS I work with as they are very sensitive to winds and precipitation. This could be a factor in the NAS but I don't know that the rules would need to be changed for UAS regarding their sensitivity.*

31. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?



- *I don't have enough experience for these answers to be taken seriously.*
- *I believe that UAS should be prohibited in some of the above airspace, such as B, C, & D. In other cases, I believe the rules and requirements must be MUCH more stringent.*
- *Should be no difference, or at least no less restrictive but perhaps more restrictive.*
- *I'm saying yes only because the general rules and requirements should be pretty much the same. But UAS-specific procedures and training should always be done as their characteristics are different and will need to be treated a little differently when being controlled.*

32. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

Yes	5
No	2

- *They need to be much more detailed in scope and information provided to the controller.*
- *Should always indicate that they are unmanned aircraft, otherwise I think they could be pretty similar.*

33. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	2
Neutral	2
Agree	2
Strongly Agree	1

- *Obstruction and cloud clearance requirements should be higher. Obstruction for public safety. Cloud clearance for aviation safety.*

- *I would have to know more about other types of UAS but usually the pilot will say if he wants a larger buffer regarding cloud clearance/obstructions. This would be something to make controllers aware of, though...that UAS pilots often want additional distance from obstructions and clouds.*

34. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.

Strongly Disagree	1
Disagree	0
Neutral	4
Agree	1
Strongly Agree	0

- *UAS should be required to give way to ALL aircraft.*
- *I would lean more towards the UAS having right of way due to limited visibility and maneuverability.*

35. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.

Strongly Disagree	1
Disagree	3
Neutral	1
Agree	2
Strongly Agree	0

- *UAS should be required to give way to ALL aircraft.*
- *Same as above...would lean more towards UAS having right of way due to limited visibility and maneuverability.*
- *I think UAS's should be incorporated on set routes and deconflicted from all manned aircraft*
- *To the extent possible, UAV's should have the right of way do to limited camera view. See UAV and avoid it.*

36. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?

Strongly Disagree	3
Disagree	4
Neutral	0
Agree	0
Strongly Agree	0

- *Traffic pattern ops are volatile and need constant attention by the controller, necessitating frequent amendments of instructions and clearances.*
- *too hard to deviate (downwind extensions, 360's)*
- *Not yet, until lost-link, fly-away procedures are established and standardized. Additionally, properly defining the role of the Visual Observer and what, if any conflict resolution responsibility overlaps that of ATC.*
- *Absolutely...but only with proper controller training, clear procedures for all aircraft involved, and keeping the tower pattern limited in number when UAS are present. UAS pattern/ground ops*

information needs to be published and adhered to, and controllers need training on UAS operations so they are aware of what to expect from UAS aircraft in tower patterns.

- *Again, I think they should operate on their own runway and own movement area.*
- *I work at xyz base, home of the Predator. One to a full stop ops are rather simple but we work UAV's with some mix doing multiple patterns for hours. My opinion is UAV training should be done at a UAV airport with limited mix.*

37. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.

Strongly Disagree	1
Disagree	1
Neutral	2
Agree	2
Strongly Agree	1

- *If there is a way to separate manned and unmanned ops using an altitude structure of some kind, WITHOUT depriving the pilot or controller of any current usable altitudes, it should be considered.*
- *See comments above*
- *It should be pretty close. Too many changes or additional rules can make it difficult for both pilots and controllers to keep things straight, and if UAS can adhere to most of the altitude assignment procedures it would be better for everyone involved to keep them the same, in my opinion.*
- *At least 2,000 feet separation from Sfc-180. 5,000 180 and up*

38. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

Yes	5
No	2

- *See several comments above. Separate the operations of manned and unmanned using any means possible. Altitude, airspace (prohibited in some classes) or special use airspace.*
- *Limit com to line-of-sight when integrated, otherwise treat as a TFR or ALTRAV*
- *Depends on what sort of operations are being done and in what type of airspace, but any voice delay can pose problems. I don't think it means UAS can't be safely integrated, though. A solution might be to train controllers and pilots on the fact that this delay might be present with UAS, and the UAS pilot to state there is a voice delay when communicating with others.*
- *Possibly.*

39. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?

Yes	4
No	3

- *Yes, ... response time due to communications, response time due to not having a head with eyes that swivels in the UAS... response time due to not having a head with a brain in the UAS... all this and more require an ERROR FREE system.*

- *As long as they prove to be as capable as a pilot, in the cockpit*
- *Discussed in previous questions, but UAS will most likely never be able to see/avoid as well as manned aircraft, so I think they should have a greater buffer or tighter control when operating near other aircraft.*

40. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).

Strongly Disagree	0
Disagree	1
Neutral	0
Agree	2
Strongly Agree	4

- *I agree, but I seriously doubt that this will be practical in the day to day operations.*
- *I know they physically cannot comply with some things (for example, an MQ-1 in hot temperatures physically cannot climb well at ALL). As for "proceed direct, expedite, maintain, etc."...they should be expected to do all those things. If there are specific things they absolutely are physically unable to do, those things need to be in a regulation and need to be trained on so controllers and other aircraft are aware of the things UAS cannot comply with. I don't know much about other type UAS but there are some things with MQ-1s and MQ-9s I would say they are incapable of complying with, and as long as controllers are aware, it's not unsafe.*

41. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?

Yes	5
No	1

- *I'm not as familiar with crossing restrictions due to tower-only experience. But same as before...if there are specific things proven to be impossible for UAS to do, it's still likely they can fly safely as long as everyone is aware of the limitation.*

42. Indicate your extent of agreement or disagreement with the following statement. The en-route navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	1
Neutral	3
Agree	0
Strongly Agree	3

- *I'm unfamiliar with FMR.*

43. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	3
Neutral	2
Agree	0
Strongly Agree	2

- *Lost com procedures should be developed specifically for UAS and their unique missions. i.e., No human would be delayed if the aircraft were to land ASAP.*
- *They should be mostly the same, with the added option of using telephone communications if necessary (and I mean if it's a very serious situation and there is no other way to communicate with the aircraft).*
- *The GCS has a phone, they can call the controlling facility and vice versa*

44. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.

Strongly Disagree	1
Disagree	1
Neutral	2
Agree	0
Strongly Agree	3

- *I wouldn't say it's a significant hazard, but it could be if controllers and pilots are not properly trained on and aware of lost link procedures. It could also be a hazard if the lost link procedures themselves are not effective, safe, or sensible.*
- *I believe UAV's should be separated by enroute standards*

45. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations (Aircraft executes ATC accessible lost link procedure).

Strongly Disagree	1
Disagree	1
Neutral	1
Agree	0
Strongly Agree	3

- *Terrorists? It's already been done to drones overseas.*
- *As long as the lost link procedures are accessible by ATC I don't think it's a significant hazard.*
- *Controllers must know lost link heading and alt.*

46. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

- *none*
- *Lost communications procedures might need to be altered (due to inability to see light gun signals, etc.). Pattern operations might need to be different (due to UAS capabilities and inability to see/avoid/sequence especially if using ground reference points). Pilot should relay location/altitude information more often to assist both controllers and pilots in seeing them.*
- *more than standard separation for UAS systems*
- *Possibly identify them as a UAS like we do heavys*

47. Is there any additional information concerning UAS operations that should be available to ATC (ATM or Controllers) during NAS operations?

Yes 3
No 2

- *All kinds of backup procedures and lots and lots of useful training... not the military speak or government speak that routinely gets churned out in the name of "training."*
- *Depends upon the level of integration, and whether or not previous stated issues have been resolved*
- *Lost link procedures. Tower controllers should actually be trained in person by someone with UAS experience, in my opinion. I've seen a lot of experienced guys come through xyz base and get taken for a ride trying to work UAS in the pattern. It's a whole different way of thinking as far as pattern controlling goes, and is difficult to figure out on one's own. UAS aircraft characteristics need to be available to ATC. "FAQs" prepared by UAS-experienced controllers should probably be available to controllers (what UAS are most likely to do in certain situations, how they fly, what they can see/not see, how they taxi on the ground, how long for takeoff/landing to allow, etc.). General performance information as well as limitations should be available (at least at first).*
- *lost link mission, GCS phone #*

48. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?

Yes 5
No 2

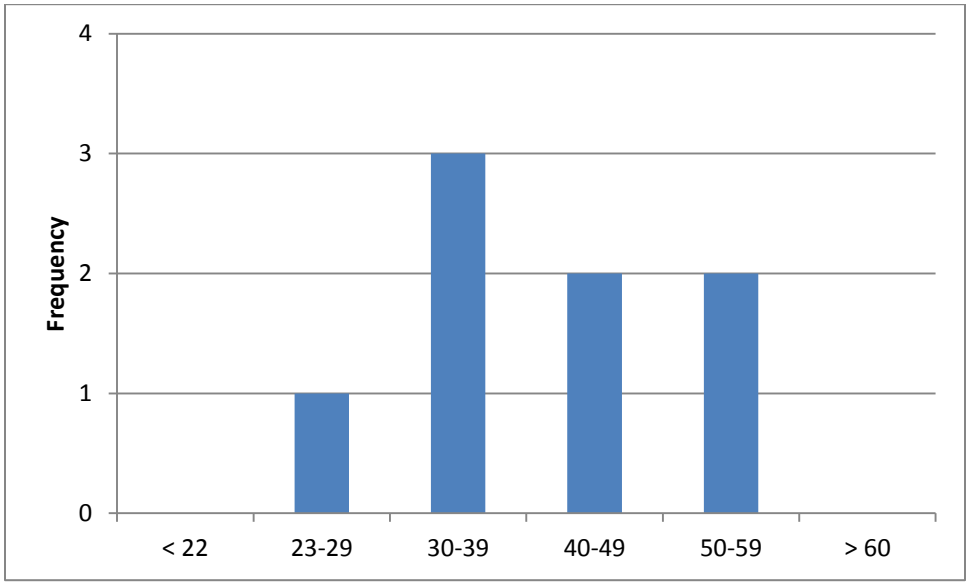
- *Again, this is based on my knowledge of aviation and my experience in ATC. I have had no actual experience with UAS.*

Appendix C – Results of Online Survey for UAS Pilots

Respondent text answers and comments are noted in *Italics*

Questions 1-5 addressed agreement with purposes of the study, informed consent and comments about it, agreement that age of respondent was over 18, and Access Code for completing survey.

Question 6. Please Indicate your age.



7. Please indicate your Gender.
   Male: 7
   Female: 1

8. What Pilot Certificates do you have? (e.g., Private, Commercial, ATP, or None)
   - *Commercial*
   - *Private Commercial Military Pilot Military Pilot Instructor Military Pilot Evaluator*
   - *Private*
   - *Commercial*
   - *Commercial*
   - *Commercial*
   - *Commercial*

9. What Pilot Ratings do you have? (e.g., SEL, MEL, Instrument, CFII, Helicopter, none)
   - *MEL centerline thrust*
   - *SEL MEL Instrument*
   - *SEL*
   - *Instrument, SEL*
   - *SEL, Instrument*
   - *SEL, MEL, Instrument*
   - *SEL, MEL, Instrument, CFI, Helicopter, Glider*

10. Top Four aircraft you have flown (by hours).
    - *MQ-9, F-16, T-38, T-37*
    - *C-130 RQ-4 TC-12 T-37*
    - *RQ-7B, C-172/G*
    - *Cessna 172/152, Global Hawk, Piper Arrow, Piper Warrior.*
    - *C-21, C-130, E-8, T-37*
    - *C130, CN235, T-34, T-44*
    - *Piper Pawnee, Piper Warrior, Cesna 182, Cessna Caravan.*

11. If you fly manned aircraft, what type of mission do you primarily fly? (check any that apply)
    - *Personal (3 responses)*
    - *Military (1 response)*
    - *I do not fly manned aircraft (4 responses)*

12. Total manned aircraft flight hours

Mean Flt Hours	1467.75
Median Flt Hours	808.5
Minimum	50
Maximum	4800
St Dev	1669.50

13. Total manned aircraft simulator hours

Mean Sim Hours	112.25
Median Sim Hours	41
Minimum	0
Maximum	400
St Dev	137.40

14. Total manned aircraft simulator hours (type and hours)

	Fixed Base	Motion Base
Mean Sim Hours	34.33	48.67
Median Sim Hours	22	12
Minimum	0	0
Maximum	100	168
St Dev	36.21	69.90

15. UAS-specific Experience (type and hours)

	UAS Spec	UAS Sim	UAS piloting
Mean Sim Hours	154.29	335.00	549.38
Median Sim Hours	100	87.5	211
Minimum	20	10	73
Maximum	550	1500	2000
St Dev	182.20	510.12	708.13

16. What types of UAS have you flown?
    - *MQ-9*
    - *RQ-4*
    - *RQ-7B*
    - *Global Hawk RQ-4A and RQ-4B*

- *RQ-4 Global Hawk*
- *MQ-9B Guardian*
- *Gnat 750, IGnat, Pioneer, Exdrone, Pointer, Thorpe 2000, Cobra, Manta, Silver Fox, KillerBee*
- *NASA Flying Controls Testbed (J-FLiC)*

17. What type of training, specific to UAS, did you receive prior to flying?
    - *Formal Training Unit*
    - *RQ-4 Initial Qualification Training*
    - *Army UAV Ground School, Imagery Analysis, System Emplace/Displace*
    - *USAF formal training for the Global Hawk*
    - *Simulator & Academics*
    - *MQ-9B ground school (overview, systems, procedures, etc.), cockpit procedure trainers, simulators*
    - *OJT, Classroom, Flight, Simulator, Flight Test*
    - *Jet-powered model aircraft pilot training*

18. Do you think that the training you received was sufficient to fly the UAV?
    Yes 7 responses

    - *Yes, but I have much experience flying manned aircraft that lends itself to flying UAVs.*

19. What training have you received that would help you to fly a UAS in the National Airspace System (NAS)?
    - *Instrument flight rules to include basic airspace structure and control (associated with my traditional pilot training for manned aircraft, not my UAS FTU)*
    - *Prior AF Undergraduate Pilot Training, and C-130 training and experience.*
    - *Private Pilot Ground School, Instrument Ground School, Manned Flight Hours*
    - *Extensive academics on the NAS, Crew resource management classes, Instrument Refreshers Classes, and other operational experience as a navigator planning and executing mission within the NAS. Constantly applying the "Aviate, Navigate, Communicate" mind-set during all phases of flight within the NAS.*
    - *Simulator and actual manned experience*
    - *Datalink training. How the aircraft will respond in a lost link situation. Other than that, not much really.*
    - *DoD Navigator, FAA Instrument.*
    - *Us Naval test Pilot School, Private Pilot ground school*

20. Indicate your extent of agreement or disagreement with the following statement. The UAS training you received was sufficient for you to be able to communicate with ATC or other aircraft in the National Airspace System (NAS).

Strongly Disagree	1
Disagree	3
Neutral	1
Agree	2
Strongly Agree	1

    - *Training focused on flying in MOA's or restricted areas with minimal ATC interaction.*

- *More training on different types and usage of radios would be helpful. I already have extensive knowledge of comms with ATC/other aircraft from manned flying, so that was an advantage. Without that previous experience, I can see how learning the different radios & procedures would be an intimidating experience.*
- *It was always expected that I already had the requisite NAS skills.*

21. At which altitude band does most of your UAS flight operations take place?

Freq	Altitude Band
0	0-500 ft MSL
1	501-1000 ft MSL
0	1001-3000 ft MSL
2	3001-7000 ft MSL
1	7001-12000 ft MSL
0	12001-18000 ft MSL
1	18001-40000 ft MSL
3	40001 and over

22. When flying in an area in which manned aircraft operations are being conducted, how important is it that your UA is shown on other aircraft Cockpit Displays of Traffic Information (CDTI) along with manned aircraft in your proximity? (e.g., through symbology or data-tag information)

not important	1
nice to have but of limited value	0
desirable information	4
essential for safe operations	3

- *I also think it's important for UAS pilots to be able to see the same information that manned aircraft are seeing.*
- *Until all aircraft have CDTI it does not adequately improve safety.*

23. When flying in an area in which other UAS Operations are being conducted, how important is hearing ATC communications with other manned and/or unmanned aircraft pilots? (sometimes referred to as the "party line")

not important	0
nice to have but of limited value	0
desirable information	5
essential for safe operations	3

- *I'm a firm believer that the radio calls of other aircraft is an important situational awareness tool. It helps the UAS operator paint a mental picture of where other aircraft are, what weather conditions they are experiencing and also be aware of any emergency situations that arise.*
- *A visual display is more important.*
- *ATC comms are a vital piece of the situational awareness puzzle in the airspace the MQ-9B regularly operates.*
- *This helps me as a UA Pilot develop situational awareness if the information is not displayed to me.*

24. If you are flying a small UAS (under 55 lbs) at or below 400 ft AGL (above ground level) how important is awareness of manned aircraft operating at altitudes of 1000 - 3000 ft in the area?

not important	0
nice to have but of limited value	3
desirable information	0
essential for safe operations	0

- *While it is nice to hear this information, only those pilots acting responsibly are making radio calls. There has been traffic at low altitude and who do not make appropriate radio calls. The outside observer is the most important link for safety in this situation.*

25. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.

Strongly Disagree	0
Disagree	1
Neutral	0
Agree	2
Strongly Agree	5

- *UASs are as reliable a system as the pilot. I have observed no system-specific detractions.*
- *Not yet, UAS training standards need to be more uniform, especially in lieu of manned a/c.*
- *I believe both UAS and manned aircraft could safely share the same airspace currently. I believe it could be safer with an improvement in technology for ATC, manned aircraft and the UA community (i.e. enable TCAS usage in NAS for UAS, onboard sense and avoid systems/airborne radar, limiting UAS to only IFR operations).*
- *I have been doing this for over 25 years, well before 2005 when the FAA declared UAS as aircraft. If all the pilots are aware of UAS via proper radio calls, I have never had an issue with safety. It is important that we all speak the same language on the common radio frequency.*

26. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations.

Strongly Disagree	2
Disagree	1
Neutral	1
Agree	3
Strongly Agree	1

- *Not necessarily, as long as they remain in Class G, it may not be an issue. NOTAMs for manned aviation of uas activity might suffice.*
- *Depends on traffic volume.*
- *As long as operations are not where manned aircraft and helicopters normally operate at low altitude.*

27. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

Strongly Disagree	3
Disagree	5
Neutral	0
Agree	0
Strongly Agree	0

- *This is a desired safety configuration and will improve manned/unmanned interoperability. A ground safety observer is still required in this configuration.*

28. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

Strongly Disagree	4
Disagree	4
Neutral	0
Agree	0
Strongly Agree	0

- *If pilots share common rules and language few problems will be encountered. Medium and Large UAS are easier to see. The UAS crew will still be required to meet See and Avoid with ground observers or chase planes.*

29. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree	1
Disagree	2
Neutral	0
Agree	4
Strongly Agree	1

- *Depends on type of airspace.*
- *Until UAS can self-separate "visually", UAS should be sequestered in special airspace.*
- *The difficulty is quantifying the "equivalent level of safety". Manned aircraft pilots do not have 100% effective scan, but the rules should be the same for both. If the UAS does not have S&A equipment it would still need to meet 91.113 with ground observers or chase planes.*

30. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	0
Neutral	0
Agree	4
Strongly Agree	4

- *In this case the ground observer and chase plane is not required.*

31. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

Yes 6
No 2

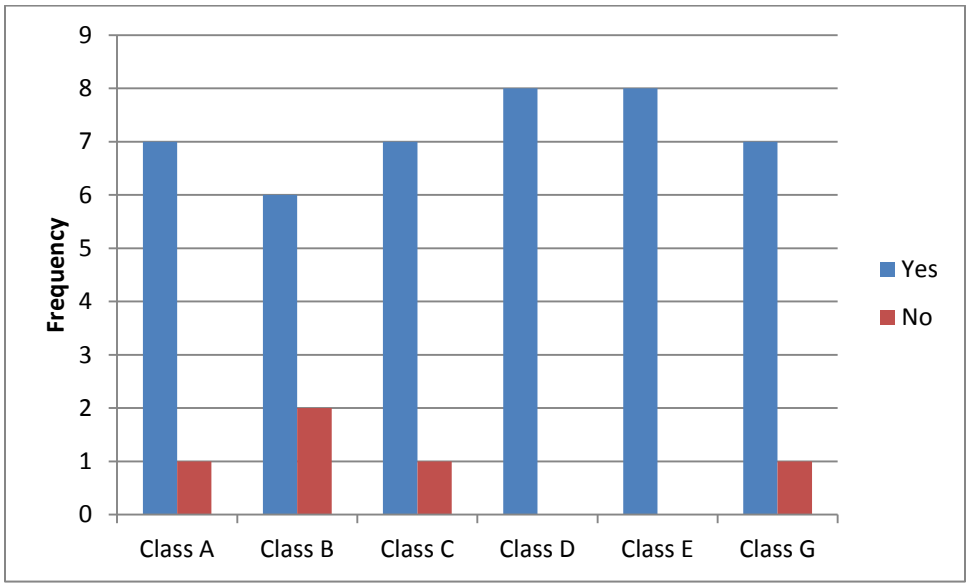
- *TCAS, even if only in TA mode for Situational awareness of other traffic*
- *External sources like ground based radar could suffice, if onboard sense and avoid sensors are not available. Also, UAS operations should be conducted in an area where relatively light "non-participating" traffic is present.*
- *The difficulty is quantifying the "equivalent level of safety". Manned aircraft pilots do not have 100% effective scan, but the rules should be the same for both. If the UAS does not have S&A equipment it would still need to meet 91.113 with ground observers or chase planes.*

32. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

Strongly Disagree 1
Disagree 2
Neutral 0
Agree 2
Strongly Agree 3

- *No UAS can be truly VFR, due to limited range of vision, when compared to manned a/c.*
- *Depending on the sense and avoid sensor/system weather may not be a factor.*
- *Most weather rules are for pilot safety. The UAS operation is the same whether in weather or not. The only limitation is the UA capability to operate in visible moisture and/or freezing conditions. As an example, a UA need not wait for VFR ceiling to launch or recover if it will be VFR on top as long as aircraft separation is maintained.*

33. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?



- *Additional restrictions may be necessary for UAS to operate safely in Class B airspace.*
- *Except for some weather rules as in question 32. Equipage, permission, and communication should be the same.*
- *I am unfamiliar with reqmts for A, B, and C*

34. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

Yes 7
No 1

- *Except for some weather rules as in question 32. For example, IFR minimums and alternates should not matter to the UA if it is equipped for all-weather operations.*
- *not for small UAS*

35. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	1
Disagree	2
Neutral	0
Agree	2
Strongly Agree	3

- *Cloud clearance should normally be the same to allow a manned aircraft time to maneuver flying from IMC to VMC. Obstruction clearance is for noise and ground safety. Small UAS should not be required to have the same obstacle separation if safe flight can be maintained.*

36. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.

Strongly Disagree	2
Disagree	1
Neutral	1
Agree	3
Strongly Agree	1

- *Small UAS should always give way to manned aircraft.*
- *however, I'm not sure how easy it is to see a small UAS for effective see-and-avoid techniques.*
- *Not sure. Depends on the capabilities of the small UAS.*
- *A UA of any size should give way to the manned aircraft including a self destruct maneuver to avoid a collision. There are no souls on board to protect.*
- *small UAS should always yield right of way*

37. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.

Strongly Disagree	1
Disagree	0
Neutral	0
Agree	4
Strongly Agree	3

- *A UA of any size should give way to the manned aircraft including a self destruct maneuver to avoid a collision. There are no souls on board to protect.*
- *Unmanned should always yield to manned a/c*

38. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?

Yes	7
No	1

- *As long as NOTAMs on the activity are issued and operators are able to obey ATC instructions, should not be an issue.*
- *The pattern and approach path is very predictable and can be safely flown in the vicinity of manned aircraft. If an emegency arises, the UAS's behavior is also predictable. It can suspend (hold), fly a heading, go-around, and adhere to all instructions from ATC. On the surface there is a spotter who watches the ground operations to ensure safety.*
- *If UAS operations are conducted in a familiar environment (with ATC controllers who are familar with system behavior and capabilities) manned and unmanned aircraft may be integrated.*
- *With proper equipment in place (ground control station), this could be done safely and effectively.*
- *Yes if the UAS crew is properly trained and the UA is properly equipped.*
- *Not initially for commercial airports*

39. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.

Strongly Disagree	1
Disagree	1
Neutral	3
Agree	2
Strongly Agree	1

- *UAS operational altitudes should be assigned based on designed capabilities in order to keep manned aircraft safe.*
- *I think they could be, but there maybe valid procedures where UASs are flown at different crusing altitudes to improve flow control within the NAS.*
- *UAS lost link behavior may drive alternate altitude assignment requirements.*
- *For the most part I agree but there are times when it does not make sense. If on a published route, the UA should comply. However, most UA do not fly from airport to airport. Rather they are utility aircraft that depart an airport and go to a working area where they orbit. Also, UA are generally slower than manned aircraft and are easily overtaken by faster manned aircraft.*

40. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

Yes	2
No	6

- *For CONUS operations the delay will be significantly less even if satellite is used.*
- *Local comm link in terminal area*

41. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?

Yes	5
No	3

- *wide-angle nose camera with approximately 90 degrees total view to provide peripheral vision equivalent.*
- *UAS ground segments should integrate onboard sensors with ATC feeds and other ground/network based situational awareness tools.*
- *Usage of the GPS location system implemented in newer a/c to give better awareness of surroundings.*
- *Since it is technically possible to have better capabilities on UAS, it would add a degree of increased safety and reassurance to all that the UAS operator is also aware of other air traffic.*
- *If sense and react time is equivalent to see and react times, requirements should be the same.*
- *The rules should be the same. However if this equipment were required of all manned and unmanned aircraft, then yes, as it would provide a higher level of safety.*
- *Sensor fusion of visual and other detection modes*

42. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).

Strongly Disagree	0
Disagree	0
Neutral	1
Agree	4
Strongly Agree	3

- *I do think that the next generation of UAS should afford all of that capability for the operator, to proceed direct to any named point or intersection, expedite a descent, and even hold as published. The current system that I'm familiar with, can fly a specific heading, suspend (hold position in an orbit pattern), and fly a very long duration flight so if need be, the UAS can be delayed in a non-congested area until a safe transit can be made.*
- *Yes if the UA is in that environment. However, ATC must realize that the performance of the UA may be limited.*

43. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?

Yes	8
No	0

- *Yes if the UA is in that environment. However, ATC must realize that the performance of the UA may be limited.*

44. Indicate your extent of agreement or disagreement with the following statement. The en-route navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	0
Disagree	1
Neutral	0
Agree	5
Strongly Agree	2

- *Depends on what altitude you plan on operating at.*
- *It is important that all pilots follow the same rules regardless of aircraft type (with some weather or pilot safety exemptions).*

45. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.

Strongly Disagree	2
Disagree	2
Neutral	2
Agree	2
Strongly Agree	0

- *UAS have the option to use phone or internet to communicate.*

- *The UAS pilot can contact the controlling agency via telephone to ensure the latest ATC instructions are complied with.*
- *Use the telephone.*
- *Wording in this question is a little difficult*
- *The lost comm procedure is a pilot safety regulation. If ATC can track the aircraft to its destination, it might be allowed. However, if approaching Class B/C airspace for a published approach, it should be the same for the safety of other aircraft. Eventually, a manned aircraft that cannot regain communications will be forced to land. It might be better to land early with sufficient fuel than to risk other options, manned or unmanned.*

46. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.

Strongly Disagree	1
Disagree	6
Neutral	0
Agree	0
Strongly Agree	1

- *Here too, a temporary lost link may require a phone call to the controlling agency, but the UAV will squawk the 7600 transponder code to alert other aircraft.*
- *This is no worse than temporary loss of voice communications. The UA will fly safely until the link is regained.*
- *Assumes relatively high level of automation and onboard flight plan does not require frequent update from ground station*

47. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations. (Aircraft executes ATC accessible lost link procedure)

Strongly Disagree	2
Disagree	3
Neutral	2
Agree	1
Strongly Agree	0

- *So long as the UAS behaves in a predictable fashion, ATC should be able to adjust to lost-link profiles.*
- *The behavior of the UAS during lost link is predictable and shared with ATC so the risk posed to other aircraft can be mitigated.*
- *If pilot and ATC can predict aircraft behavior the risk isn't "significant".*
- *If lost link procedure is designed safely and executed properly, risk to NAS operations could be minimal.*
- *This is a better situation than a manned aircraft with IFR lost comms. The UA will safely navigate to its home base or alternate with the lost link.*
- *Would be reduced significantly by onboard sense and avoid enroute to lost link position*

48. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

- *UAS pilot should continuously have ATC telephone number available in case of lost link. ATC must monitor and be ready to relay data on radio and/or Guard.*
- *Departure and arrival routes should be further standardized to accomodate predictable flight patterns for UAS.*
- *I think they should be the same.*
- *None*
- *None*
- *They should be the same.*
- *Lost comm/command link procedures*

49. Is there any additional information concerning UAS operations that should be available to pilots of manned aircraft during NAS operations?

Yes 6
No 2

- *Lost link details (altitude, loiters/times, basic route of flight, destination) in the event communication delay of lost link exists or confirmation of actual UAS location is delayed.*
- *Pilots should be made aware of common UAS flights patterns and operating areas to as to adjust their routes for max efficiency.*
- *NOTAMs*
- *Slight delay with satellite operations. No onboard observers/observation capability to enable see and avoid.*
- *Pilots of manned aircraft should also have ADS-B and "Sense and Avoid" equipment to enhance safety.*
- *manned aircraft would benefit from knowing intended route of UAS for several minutes (maybe 10) in advance*

50. For the following questions, indicate which UAS (aircraft type) the responses apply to.

- *MQ-9*
- *RQ-4*
- *RQ-7B*
- *Global Hawk.*
- *RQ-4*
- *MQ-9B*
- *Cobra UAS (115 lb)*
- *NASA J-Flic*

51. Which levels of flight control / automation is the UAS equipped with? (check all that apply)

3 Manual Control
4 Partial Automation
7 Fully Automated

- *MQ-9B, with the exception of auto-land and auto-takeoff.*
- *The aircraft is equipped for Auto takeoff and landing, transponder and pilot view camera.*

- *Landing /takeoff usually performed manually (external pilot in visual contact) but ~200 auto takeoffs and ~50 autolandings. Flights typically fully automated with minimal interaction from ground control station (internal pilot)*

52. Do you have the capability to easily alternate between automated, partially-automated and manual flight?

Yes 6
No 2

- *MQ-9B.*
- *Simple one button (computer or controller) operation.*

53. What type of input devices does the Ground Control Station (GCS) for this UAS utilize? (check any that apply)

8 point & click
7 keyboard input
1 dial (knob) input
3 control stick
4 hardware buttons
2 software defined buttons (physical buttons adjacent to display)
1 touchscreen

- *Other: Trackball, levers*

54. For this vehicle, what phases of flight within a UAS mission are most appropriate for each of the levels of control listed below? Please check the appropriate boxes.

	Taxi	Takeoff	Climb	Cruise	Mission	Descent	Land
Manual	2	2	0	0	1	0	2
Partial Auto	2	1	4	6	6	4	1
Fully Auto	2	6	5	4	2	5	6

- *It is unlikely that a pre-programmed mission will continue as planned. The ability to loiter, vector is needed for flexibility until a new plan is created. Manual is used as an emergency only option in flight.*

55. What sensory cue information, not provided currently, would help improve your situation awareness of the environment of the aircraft, the integrity of the aircraft's flight and its mission?

- *integrated displays for traffic (from ATC), TCAS, GCAS, weather.*
- *Pilot's view camera*
- *weather radar*
- *Being able to see other traffic and weather surrounding UAS.*
- *After 25 years of operation I have found that I no longer require sensory input to safely control the aircraft. That may be a training issue. Audible cues would be helpful if the UA is not instrumented adequately.*
- *Spoken messages*

56. How often is the UAS camera system used for navigation purposes?

- *Whenever any clouds or precipitation is proximate.*
- *Not at all.*

- *Rarely, only in a case of GPS failure.*
- *almost never, it can be useful in the terminal area*
- *Never*
- *Often, especially to avoid weather.*
- *For emergencies only.*
- *Never*

57. How often is the UAS camera system used for "see and avoid" purposes?
    - *Weather avoidance primarily, not traffic.*
    - *Taxi only, and it only views forward.*
    - *Never*
    - *almost always during takeoff, departure and then during approach and landing.*
    - *Rarely, forward looking IR with limited field of view.*
    - *Hardly ever. Only if we are lucky enough to catch another aircraft with the ball.*
    - *Never. The field of view is too wide.*
    - *Never*

58. As the UAS pilot how and under what circumstances are you allowed to override the automated flight control system?
    - *Pilot discretion, no restrictions.*
    - *all instances except taxi, takeoff, and landing.*
    - *In instances of waveoff from landing.*
    - *anytime.*
    - *Emergency procedure only.*
    - *Click of a button on the control stick, or menu button. If UAS is doing something unexpected, I would discontinue autopilot usage.*
    - *Full auto to partial, as required. To manual, for emergencies only.*
    - *Switch to manual control with handheld controller, UAV always within visual range*

59. What type of indicator does your GCS have to tell you that you are in fully automated flight?
    - *Screen indications learned by the pilot.*
    - *Marker on the display.*
    - *Knobs are ghosted*
    - *N/A, the flight can always be altered*
    - *Flag on primary flight display*
    - *Visual indicator on menu display/screen.*
    - *GCS mode indicator.*
    - *Red/green indicator for auto/manual (green automated)*

60. What type of indicator does your GCS have to tell you that you are no longer in automated flight?
    - *Screen indications learned by the pilot.*
    - *Same marker on the display.*
    - *knobs are not ghosted.*
    - *N/A*
    - *Different color flag on primary flight display*
    - *Visual indicator on menu display/screen*
    - *GCS mode indicator, camera.*
    - *Red - no longer automated*

61. Can a single UAS pilot perform all the tasks necessary to fly safely in the NAS?

Yes 7
No 1

- *For short durations, a single pilot is sufficient. Obviously for longer operations, safety would dictate pilot rotation. At all times there should be a second individual in the other GCS seat (sensor operator), who often acts like a copilot. They don't ever fly the UAS but they do help with checklists, backups, running emergency procedures, etc. A single pilot could do it, but having that second body in the seat helps with workload.*
- *If the controls, intercom and radio are properly configured.*
- *If operations are within visual range one pilot can suffice if the mission/flight plan is simple*

62. For pilots of small UAS (under 55 lbs) with Line-Of-Sight operations (aircraft in direct view) how do you split your head up/down time?

- *N/A (5 Responses)*
- *I always used a ground observer.*
- *Very little head down time, usually ask for verbal updates from spotter or GCS operator. Fully automated flight allows for some head-down time, usually limit to 5 sec.*

63. How frequently does the UAS automation do something unexpected?

never	3
rarely	3
occasionally	2
routinely	0

- *It's possible for the pilot to be in error just like any other aircraft, but the UAV itself--that I've experienced--has not done something unexpected. If a malfunction of a system occurs, the operator will quickly know what the corrective action is, some malfunctions may cause the need to land early or ask ATC for a present position orbit delay. Even lost link, the UAVs behavior is not unexpected, if the engine quits, if will descend and try to land but that would also be predictable with some fore-warning possible to ATC and in that situation the UAV will squawk 7700.*
- *The times I've seen the UAS do something unexpected, it turned out the aircraft did exactly what it was supposed to do and I had made an error somewhere.*
- *Once per year is my experience.*
- *Most likely in new configuration/installation or software change to support testing requirement*

64. Is your present Ground Control Station capable of voice communications with ATC?

Yes 6
No 2

- *Two-way communication is possible, although the transmission is often garbled or broken, with delays, by the link medium.*
- *Single programmable radio with and integrated intercom.*

65. If there is voice communications in the GCS, what could be improved to enable better voice communications, and has latency or delay in voice communications been a problem?

- *Two or three radios vs. just one. No problems with latency or delay.*
- *A faster link with a higher bandwidth. Latency and delays are always a problem. Also, decreases the amount of processing the aircraft does with the voice signal.*
- *Better Radio Equipment*
- *I have not noticed any significant latency issues.*
- *Latency is not normally a problem, however sometimes signal quality can be poor.*
- *If we had an ATC "center" relay tower closer to our GCS, we wouldn't have to fire up the satellite in order to communicate with Miami Center. We could handle comms through LOS. Latency is only a problem when the radios are busy and we are operating over the satellites. It can be hard to break in to make a call.*
- *A second radio and radio selector.*

66. How frequently during a typical mission are you in contact with ATC or other aircraft?

never	1
rarely	0
occasionally	2
routinely	5

- *We monitor traffic at all times but operate VFR. Per verbal agreement we call ATC to check in and check out, plus reply when called upon.*
- *At NAS Pax (Webster Field) the Mission Commander (not UAS pilot) talks to ATC/ other a/c*

67. If your aircraft received an ATC instruction to turn left 30 degrees, how long would it take before the aircraft would begin making the turn? (seconds) and how many control inputs would be required?

- *Two (no pilot delay) to five (slight pilot delay). One or two (stick and hold or stick with trim button). Third option to input heading via touchscreen/keyboard (3-4 inputs total).*
- *10*
- *2 sec, 1 control input*
- *About 10 seconds. 2 clicks of the mouse to make the turn. The point clicks override heading and can either type in the new heading or drag the heading bug 30 degress left and click execute.*
- *5-10 seconds. Three control inputs-1. place flight display in override (mouse click). 2. Select heading (type) 3. Execute heading (mouse click)*
- *2-4 seconds. All it would take is an input to the control stick and a button push.*
- *One mouse click to activate heading mode, 2-3 buttons to input heading. 5 seconds total. 1 second if manual is invoked.*
- *~ 1sec if manual mode ~ 5 sec if executed in auto through ground station*

68. If your aircraft received an ATC instruction to descend 1000 ft, how long would it take before the aircraft would begin making the descent? (seconds) and how many control inputs would be required?

- *Two to five. Three or four - same as Question 67 but with two additional button inputs to deselect altitude hold (prior to stick or stick and trim)*
- *5 sec*
- *2 sec, one control input*
- *about 10 seconds for altitude changes as well. the pilot enters the new altitude into the window and clicks execute. it takes a few seconds for the UAV to acknowledge the instruction and execute the descent.*

- *About 5 seconds. Two inputs: 1. enter new altitude (type). 2. Execute new altitude (mouse click)*
- *3-5 seconds. For altitude change, in autopilot, there's a few menus to dig through before we enter new assigned altitude, so it takes a little longer. If in manual flight, descent could begin in the 2-4 second range.*
- *One mouse click to activate altitude mode, 3-5 buttons to input altitude. 7 seconds total. 1 second if manual is invoked.*
- *same as above. Throttle/elevator in manual Click(s) on altitude decrease button in auto*

69. Have you flown a UAV with other aircraft within the same airspace?

	Yes	No
Mix of Manned and UAS	8	0
UAS of differing sizes	4	3

- *Map with aircraft locations, either voice or computer chat communication.*
- *Reliable ATC function with many procedures to make flight patterns predictable. Feeds from ATC radar displays and Mode 3 tracking systems are also useful.*
- *Location and altitudes of other a/c.*
- *A clear understanding of ATC instructions. If unable to comply with an instruction provide a clear and concise request for a rapid resolution of the situation. UAV operators can often hold their aircraft outside of a busy area to alliviate controller work load during busy times.*
- *ATC control helps.*
- *Standard info of position, altitude, heading, airspeed, and intentions.*
- *A working transponder and radio. Proper voice communications in the traffic pattern.*
- *Reliable comm with ATC, personnel familiar with ATC phraseology*

70. Have you had operational experience with aircraft separation by altitude or corridor or in areas of protected airspace?

Yes	8
No	0

- *Normally autopilot, but either suffices.*
- *autopilot. manual flight is possible, but very cumbersome and time consuming.*
- *FMS*
- *Autonomous*
- *Autopilot*
- *With autopilots and FMS.*
- *J-FLiC UAS flown on autopilot at UAS Pax Webster Field ~ 100 flights*

71. Do you feel disconnected from the aircraft you fly? If so, please explain, and note what would reduce this disconnect.

- *No, surprisingly connected.*
- *Yes. The aircraft is just a blip on a screen. The only way to fix this is to make the interface with the aircraft like jacking in to the Matrix.*
- *Yes, pilot's camera.*
- *No*
- *Yes. There's no physical connection with the UAS other than visually on a screen. Not sure there's anything that could reduce the disconnect, unless you create a full motion simulator to sit in.*

- *No. I have always felt as if I am in the UA. My ability to project myself has helped me in many emergency recoveries.*
- *No*

72. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?

Yes 8
No 0

Appendix D – Interview Questions and Responses

Interview Questions for Manned Aircraft Pilots

Experience with Mixed Operations: Yes No

Manned Aircraft Pilots

1. **(TASK: AVIATE)** Are there specific problems that you can identify that would affect a pilot's capability to effectively operate a UAS or small UAS in a controlled airspace environment, as opposed to flying in uncontrolled or protected airspace?

    - In your opinion, are there any additions or changes to the control device or GCS that may improve this capability?

2. **(TASK: NAVIGATE/SAA)** What do you believe are the major issues for concern relating to mixed manned-aircraft/unmanned-aircraft airspace operations?

    - What major technical issues do you believe need to be overcome before it will be feasible for UAS and small UAS to be capable of effectively navigating within controlled airspace along with manned aircraft within controlled airspace?

    - As a pilot of a manned aircraft, what information would you need to be capable of effectively avoiding a UAS or small UAS in the vicinity of your aircraft?

    - What additional information do you believe could be displayed to the UAS or small UAS pilot that would enhance his/her ability to effectively navigate within controlled airspace?

    - Do you believe that the existing sources of information and current control device or GCS displays will be capable of providing this information, or will addition information sources or displays be necessary?

3. **(NAVIGATE-Workload)** Do you believe that mixed manned-aircraft/unmanned-aircraft operations will result in excessive workload for the manned aircraft pilot and, if so, what could be done to mitigate this problem?

4. **(TASK: COMMUNICATE)** Can you think of any communication problems (either voice or control link) which are unique to UAS or small UAS that would hinder their ability to become safely integrated with manned aircraft within controlled airspace operations?

    - How might these problems be remedied?

Interview Questions for ATC

Experience with Mixed Operations: Yes No

ATC

1. **(TASK: NAVIGATE/SEPARATE)** What do you believe are the major issues for concern when working mixed manned-aircraft/unmanned-aircraft airspace operations?

    - What major technical issues do you believe need to be overcome before it will be feasible for UAS and small UAS to be capable of effectively navigating within controlled airspace along with manned aircraft?

2. **(TASK: NAVIGATE/INFORMATION)** What additional information do you believe could be displayed to ATC that would allow UAS to integrate into controlled airspace on an equivalent level with manned aircraft?

    - Do you believe that the existing sources of information and current controller displays will be capable of providing this information, or will addition information sources or displays be necessary?

3. **(NAVIGATE-Workload)** Do you believe that mixed manned-aircraft/unmanned-aircraft operations will result in excessive workload for the Air Traffic Controller and, if so, what could be done to mitigate this problem?

4. **(TASK: COMMUNICATE)** Can you think of any communication problems (either voice or control link) which are unique to UAS or small UAS that would hinder their ability to become safely integrated with manned aircraft in controlled airspace operations?

    - How might these problems be remedied?

Interview Questions for UAS Pilots

Experience with Mixed Operations: Yes No

UAS/small UAS Pilots

5. **(TASK: AVIATE)** Are there specific problems that you can identify that would affect a pilot's ability to effectively operate a UAS or small UAS in a controlled airspace environment, as opposed to flying in uncontrolled or protected airspace?

    - Are there any additions or changes to the control device or GCS that you can think of that may improve this capability?

    - Is there any additional information that could be presented to the UAS or small UAS pilot that might improve his/her situation awareness of the vehicle's flight status (e.g. attitude, altitude, airspeed and their rates of change)?

6. **(TASK: NAVIGATE/Technical)** What major technical issues do you believe need to be overcome before it will be feasible for UAS and small UAS to be capable of effectively navigating within controlled airspace?

7. **(TASK: NAVIGATE/Information)** What additional information do you believe could be displayed to the UAS or small UAS pilot that would enhance his/her ability to effectively navigate within controlled airspace?

    - Are the current information sources and information displays sufficient for navigation, or do you believe addition information sources or displays are necessary?

8. **(TASK: NAVIGATE-SAA)** What do you believe are the major issues for concern relating to mixed manned-aircraft/unmanned-aircraft airspace operations?

    - As a UAS pilot, what information would you need to effectively avoid other aircraft in the vicinity of your aircraft (e.g. traffic information), and can this information be displayed on current control devices or GCS displays?

    - Does the UAS/small UAS that you operate incorporate a camera system with real-time video imagery downlink to a pilot's display and, if so, do you believe that the camera system can be effectively used for detecting other aircraft in the vicinity of your aircraft?

9. **(NAVIGATE-Workload)** Do you believe that mixed manned-aircraft/unmanned-aircraft operations will result in excessive workload for the UAS or small UAS pilot and, if so, what could be done to mitigate this problem?

10. **(TASK: COMMUNICATE)** Can you think of any communication problems (either voice or control link) which are unique to UAS or small UAS that would hinder their ability to become safely integrated with manned aircraft within controlled airspace operations?

    - How might these problems be remedied?

sUAS Scenario

The NRC (Nuclear Regulatory Commission) is conducting an inspection of a nuclear power plant to determine the health of the plant's power lines, and to determine if any radiation can be detected in the surrounding area. The nuclear power plant is located just inside the 5-mile radius of Class D airspace, but is not in line with the approach or departure routes of the airport's only runway. In order to accomplish the mission, a two-man crew is using a Raven sUAS (under 55 lbs) equipped with an electro-optical (EO) device and a radiation sensor. The crew will be in radio contact with the airport tower during the mission, and will be monitoring airport traffic on the tower frequency, as all aircraft are required to do in class D airspace. The control tower will be advising all aircraft on the tower frequency of the NRC mission upon initial contact, while the mission is in progress. The mission will restrict the Raven's operations to within a 400-yard radius of the plant, at or below 400 ft. AGL for a period of time lasting no longer than one hour. The Raven will remain within visual line-of-sight of the crew at all times, while they conduct the mission and watch for any aircraft that may approach the mission area.

1. Do you believe that this NRC mission can be conducted safely, without the need to restrict the airspace around the nuclear power plant?

2. What potential hazards do you believe could result from this sUAS mission?

3. What safety measures do you believe are not addressed in the scenario, as it is described?

4. If the mission were to be conducted as described above, what additional safety measures, technologies or information do you think could make this mission as safe as any manned aircraft operations in the same Class D airspace?

Interview Responses by Category

1. Problems and Remedies Aviating UAS in Controlled Airspace

UAS Pilot

- *Control is no problem*

ATC

- *Line-of-sight control frequency congestion between aircraft in the terminal environment causes control inputs to either go to another UA, or not to cause the desired effect on the intended UA. This is not a problem with KU satellite bands, but they can't be used in the terminal area because of time-lag. UHF frequency performs worse than VHF.*

2. Technical Problems and Remedies Navigating UAS in Controlled Airspace

UAS Pilot

- *UAS need to be able to navigate to NAVAIDS and fixes like manned aircraft.*
- *Piccolo lacks de-clutter ability.*
- *Having an FMS would be beneficial.*

ATC

- *Line-of-sight control link frequency congestion in the terminal area and UHF problems.*
- *Controllers need special training on how to handle UAS because of their operational characteristics.*
- *Unmanned aircraft don't climb very well – it's good for controllers to know pattern, speed, limited capabilities of the aircraft*
- *UAS take a long time when on the runway for full stops– they have to stop, explore the runway a bit, stop, explore, etc… this is due to their limited rotation ability on the nose wheel*
- *In addition to LOS dropouts, the wrong video signal can also occur for UA mission payloads*
- *Backup telephone land-line very useful at this airfield.*

3. Information Needs to help UAS Navigate in Controlled Airspace

UAS Pilot

- *Verbal-to-text translator for ATC commands would be beneficial.*
- *HUD camera view with PFD overlay.*
- *ADS-B in to see other aircraft*

- *TIS-B to see other aircraft.*
- *Graphical weather information.*
- *Nowcasted weather information that is not just an out-of date snap-shot.*
- *Control input feedback information.*
- *Simulated aircraft environment information.*
- *GCS interface needs to be designed to be task-driven, prioritizing aviation/navigation/communication information and inputs to reduce searching through layers of non-relevant tasks.*
- *Chart information (including NAVAIDS and airports) needs to be readily available to the pilot.*
- *All task-related information should be easily viewable to the pilot position to eliminate the need for turning around to look for other display screens.*

ATC

- *Lost Link – the unmanned aircraft is pre-programmed to go to a certain waypoint. ATC needs to immediately know what the lost-link procedure is when the lost-link occurs.*

4. Major Issues of Concern for Mixed UAS/Manned Aircraft Operations

UAS Pilot

- *UAS need to be equipped with sense-and-avoid capability.*
- *Camera can't be used for see-and-avoid because of its limitations.*
- *GCS is currently designed as a computer work station. It must be designed to be task-driven to the pilot's needs.*
- *NAS Voice switch with its voice-over-internet protocol (VoIP) will improve communications for mixed operations.*
- *FAA currently fears mixed operations and ties the hands of UAS Integration is a slow-moving process.*

ATC

- *UAS can have a lost-link occurrence at any time, so ATC allows more spacing between them and other aircraft to compensate for the time it takes for both the pilot and ATC to know of the occurrence, and be able to do something about it (such as execute lost-link procedure and the associated actions).*
- *UAs must be provided increased spacing behind other aircraft, because there is no one on board to notice wake turbulence in a timely manner.*
- *UAS can't be instructed to turn to follow another aircraft, because they can't abide by visual rules of flight.*

5. Mixed UAS/Manned ACFT Operations Workload Problems/Remedies

UAS Pilot

- *UAS pilot has less workload than a manned aircraft pilot.*
- *Fully manual flight in a sUAS has a very high workload.*
- *Manual flight of UAS in a mixed environment provides the UAS pilot a higher workload than automated flight.*
- *The Terminal area provides a high workload for the UAS pilot.*

ATC

- *Terminal ATC has high workload with UAS because they need more time than manned aircraft to clear the runway.*
- *ATC has to pay more attention to UAS than manned aircraft.*
- *UAS-only operations provide ATC higher workload than mixed operations in the terminal area. ATC can ask manned aircraft to see and avoid UA visually.*

6. UAS Communications Problems/Remedies for Mixed UAS/Manned ACFT Operations

UAS Pilot

- *In mountainous areas, a radio relay for LOS voice communications may be necessary.*
- *UAS ATC-pilot communications need to be integrated into the party-line communications with other aircraft, so that other aircraft know where the UAS is operating.*
- *NAS Voice Switch will be an improvement for mixed operations.*
- *A checklist should be developed and strictly adhered to, in order to ensure that lost-link and return home waypoints are correctly programmed.*
- *Communication skills of a UAS pilot need to be equivalent to that of a manned aircraft pilot.*
- *It would be beneficial to be capable of switching to another satellite when the signal begins to break up with the current one in use (redundant SATCOM).*

ATC

- *In addition to radio or textual communications, a telephone backup communication between the UAS pilot and ATC is necessary.*

NRC sUAS Mission

1. **Do you believe that this NRC mission can be conducted safely, without the need to restrict the airspace around the nuclear power plant?**

UAS Pilot

- *Yes. Have completed many similar missions.*
- *A NOTAM concerning the operation should be published.*

ATC

- *Yes, just keep other aircraft away from the sUAS operations area.*
- *ATC needs to know what the mission is and what is going on during the mission. Then there is no need to restrict the airspace.*
- *A restricted operations zone, similar to the one used for military helicopters at Norfolk (ORF) could be used.*
- *As long as the pilot maintains communications with ATC to keep them advised of their location, everything should be fine.*

2. **What potential hazards do you believe could result from this sUAS mission?**

UAS Pilot

- *Other aircraft showing up*
- *Could have a fly-away with lost-link, if wrong waypoints are programmed.*
- *In the event of failure or pilot error, hazards could result in the deviation of the UA from its assigned mission area.*
- *Good communications with ATC could mitigate hazards.*

ATC

- *Lost Link: If a preplanned flight path is available concerning lost link, it should be relayed to ATC prior to start of mission; otherwise, if no plan is available then pilot should contact ATC letting them know that there is no preplanned path for lost link. In the latter case, the pilot and ATC should remain in constant communication and ATC should keep other aircraft out of the area until issue is resolved.*

3. **What safety measures do your believe are not addressed in the scenario, as it is described?**

UAS Pilot

- *Airport confusion: Manned aircraft pilots unfamiliar with the airport and its surroundings.*
- *Mitigation strategy for lost-link issues, such as a "fly away."*
- *Qualifications of Raven pilot, especially ability to communicate effectively w/ATC.*

ATC

- *ATC needs predictability. Should have a planned lost-link procedure that ATC has immediate access to.*

4. **If this mission were to be conducted as described above, what additional safety measures, technologies or information do you think could make this mission as safe as any manned aircraft operations in the same Class D airspace?**

UAS Pilot

- *Pilot Attentive issues such as mission workload and see-and-avoid for periods greater than 15 minutes.*
- *It would be good if technology could be developed that would alert sUAS pilot of other aircraft were approaching the mission area (e.g. ADS-B and TIS-B).*
- *Programmable LED strobe lights (bright white) and especially a white anti-collision light. Paint UA with bright colors (no camo!).*
- *High visibility colors*
- *Qualifications of sUAS pilot, especially ability to communicate effectively with ATC.*

ATC

- *Telephone back-up communications.*
- *UAS should be treated as manned aircraft*
- *Separation procedures by having a pre-plan memorandum*

Appendix E – Survey for Pilots of Manned Aircraft

UAS in the NAS: Survey for Pilots of Manned Aircraft

***1. The National Aeronautics and Space Administration (NASA) is presently working with industry and the FAA to establish future requirements for Unmanned Aircraft Systems (UAS) flying in the National Airspace System (NAS). This is a general survey about your experiences and future expectations of flying in the NAS when UAS may also be present in the NAS. Please do not include any classified information in your comments.**

The survey will take about 20 minutes of your time.

The survey contains some questions about you and your background; however, no personally identifying information is asked or associated with any of your responses. Your participation in this questionnaire is voluntary, and any information you provide will be kept strictly confidential, and will be de-identified and not associated with you in our analyses. All information from this questionnaire is secured via Secure Socket Layer (SSL) encryption, and data are transmitted privately via secure channel.

Please click "I agree" below to indicate that you have read and understand this information, and then click "Next".

- ○ I agree

***2. Please choose the appropriate response below.**

- ○ I certify that I am at least 18 years of age.
- ○ I am under 18 years of age.

UAS in the NAS: Survey for Pilots of Manned Aircraft

Human Subject Research Volunteer Informed Consent Statement

Federal regulations require researchers to obtain signed consent for participation in research involving human subjects that uses federal funding, equipment, or in which federal personnel are involved.

After reading the information and the Statement of Consent below, if you wish to consent, please indicate so by selecting "I Agree" at the bottom of the next page. If you have questions about this research, you may contact one of the Principal Investigators listed below:

Title of Research: Unmanned Aircraft Systems in the National Airspace System: A Survey for Pilots of Manned Aircraft

Principal Investigator/Phone & e-mail:

James R. Comstock, Jr., Ph.D. Principal Investigator, NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6643 james.r.comstock@nasa.gov

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Raymon McAdaragh, Aerospace Psychologist, SGT Inc., NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6055 raymon.mcadaragh@nasa.gov

I. Statement of Procedure:

Thank you for your interest in this research. You will find a summary of the major aspects of this research below, including the risks and benefits of participating. Please feel free to ask any questions about the survey at any time. Questions may be directed to the Principal Investigators listed above. Carefully read the information provided below. IF YOU WISH TO PARTICIPATE in this research please select "I Agree" on the next page. Any information you provide will be maintained in strict confidence to protect your privacy.

II. I understand that:

- This is a research activity in which information is being gathered from Pilots of Manned Aircraft concerning your experiences and future expectations of flying in the NAS when UAS may also be present in the NAS.
- If I consent to participate in this research, I understand I will be participating in a survey that will take approximately 20 minutes with the potential for participating in a future telephone interview (your choice).
- I may contact any of the Principal Investigators, listed above, if I have any questions regarding this research before, during, or after my participation.

III. Compensation

Non-government volunteers will be compensated for their participation ($50.00).

Civil servant or government volunteers who participate in the research do so in their official capacity.

IV. Potential Risks

- There are no apparent risks associated with participation in this research. In the event that something does occur, I may request to stop my participation at any time, which will not impact my compensation.

UAS in the NAS: Survey for Pilots of Manned Aircraft

V. Potential Benefits

I will derive no personal benefit apart from the compensation noted above, except the knowledge that my participation and input as a NAS user or controller has been taken into consideration as NASA directs research at critical issues. The larger benefits are to the development of Rules, Regulations, and Policies related to UAS in the NAS.

VI. Confidentiality

- I understand that any public release of any data will be done in a manner that does not associate me with the data.
- I understand that the data files recorded during my participation in this research activity may be shared with other researchers within NASA (and outside NASA, if applicable) and that these files will not be associated with my identity.
- I do voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed.

VII. Voluntary Participation

Taking part in this study is voluntary. I may withdraw from participating or be asked to withdraw from participating at any time. Such a decision will not result in any penalty or loss of benefits to which I may otherwise be entitled.

VIII. Safety

As a voluntary test subject participating in this research, I understand that:

- NASA is committed to ensuring my safety, health, and welfare plus the safety and health of all others involved with this research.
- I should report any accident, injury, illness, and changes in my health condition, hazards, safety concerns, or health concerns to any of the Principal Investigators listed above. If I am unable to reach the above named individuals or am not satisfied with the response I receive, I should contact the NASA Langley Research Center (LaRC) Safety Office at (757) 864-7233 or the Chairperson of the LaRC Institutional Review Board, Mr. Jeffrey S. Hill, at (757) 864-5107
- If I detect any unsafe condition that presents an imminent danger to me, or others, I have the right and authority to stop the research activity. In such cases the Principal Investigator and associated research personnel will comply with my direction, stop the activity, and take action to address the imminent danger.

XI. Statement of Consent:

- I certify that I have read and fully understand the explanation of procedures, benefits, and risks associated with the research herein, and I agree to participate in the research described herein. My participation is given voluntarily and without coercion or undue influence, and I also voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed. I understand that I may discontinue participation at any time. I have been provided a copy of this consent statement. If I have any questions or modifications to this consent statement, they are written below.

3. Please enter any questions or modifications as noted above.

***4. Please select "I Agree" to indicate that you have read and agree with the Informed Consent, and then click "Next" to continue to the survey.**

I Agree

***5. Enter the Access Code that was supplied to you in the invitation to complete the survey.**

UAS in the NAS: Survey for Pilots of Manned Aircraft

6. Please indicate your age.

- under 22
- 23 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 and over

7. Please indicate your Gender.

- Male
- Female

8. What Pilot Certificates do you have? (e.g., Private, Commercial, or ATP)

9. What Pilot Ratings do you have? (e.g., SEL, MEL, Instrument, CFII, Helicopter, etc.)

10. Top Four aircraft you have flown (by hours).

11. Total flight hours

12. Total simulator hours

13. Total fixed-base simulator hours

14. Total motion-base simulator hours

UAS in the NAS: Survey for Pilots of Manned Aircraft

15. What type of mission do you primarily fly? (check any that apply)

- [ ] personal
- [ ] owner/operator
- [ ] business
- [ ] corporate
- [ ] airlines
- [ ] military
- [ ] agriculture
- [ ] public service
- [ ] charter

Other (please specify)

16. Please indicate the airport at which you base your airplane or fly from most frequently. (Airport ID or nearest City)

17. At which altitude band does most of your flight operations take place?

- ( ) 0-500 ft MSL
- ( ) 501-1000 ft MSL
- ( ) 1001-3000 ft MSL
- ( ) 3001-7000 ft MSL
- ( ) 7001-12000 ft MSL
- ( ) 12001-18000 ft MSL
- ( ) 18001-40000 ft MSL
- ( ) 40001 and over

UAS in the NAS: Survey for Pilots of Manned Aircraft

18. When flying in an area in which UAS Operations are being conducted, how important is it to know that an aircraft shown on a Cockpit Display of Traffic Information (CDTI) is unmanned? (e.g., through symbology or data-tag information)

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

19. When flying in an area in which UAS Operations are being conducted, how important is it that you hear ATC communications with the unmanned aircraft pilot? (sometimes referred to as the "party line")

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

20. If you are flying 1000 - 3000 ft Above Ground Level (AGL) in an area in which small UAS (under 55 lbs) are operating below 400 ft AGL, how important is the display of that aircraft on a Cockpit Display of Traffic Information (CDTI) display?

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

21. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments

22. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

23. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

24. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

25. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

26. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

27. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

○ Yes

○ No

If "No" what see and avoid or sense and avoid capabilities do you think would make UAS operations acceptable in the NAS?

28. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

29. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?

	Yes	No
Class A	○	○
Class B	○	○
Class C	○	○
Class D	○	○
Class E	○	○
Class G	○	○

Comments:

30. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

○ Yes

○ No

Comments:

31. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

32. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

33. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

34. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?

○ Yes

○ No

Explain why or why not.

35. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

36. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

- Yes
- No

If yes, what are solutions to the delayed response time issue?

37. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?

- Yes
- No

Comments:

38. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

39. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?

- Yes
- No

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

40. Indicate your extent of agreement or disagreement with the following statement. The en-route navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

41. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

42. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Pilots of Manned Aircraft

43. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations. (Aircraft executes ATC accessible lost link procedure)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

44. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

45. Is there any additional information concerning UAS operations that should be available to pilots of manned aircraft during NAS operations?

○ Yes

○ No

If Yes, please explain.

46. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?

○ Yes

○ No

Comments:

Appendix F – Survey for Air Traffic Controllers

UAS in the NAS: Survey for Air Traffic Controllers

***1. The National Aeronautics and Space Administration (NASA) is working with industry and the Federal Aviation Administration (FAA) to establish future requirements for Unmanned Aircraft Systems (UAS) flying in the National Airspace System (NAS). This is a general survey about your experiences with flights of UAS in the NAS. This survey is divided into the following sections: ATC Operations Background, General Questions Concerning UAS Operations, and Expected UAS Rules and Requirements. Please do not include any classified information in your responses.**

The survey will take about 20 minutes of your time.

The survey contains some questions about you and your background; however, no personally identifying information is asked or associated with any of your responses. Your participation in this questionnaire is voluntary, and any information you provide will be kept strictly confidential, and will be de-identified and not associated with you in our analyses. All information from this questionnaire is secured via Secure Socket Layer (SSL) encryption, and data are transmitted privately via secure channel.

Please click "I agree" below to indicate that you have read and understand this information, and then click "Next".

- ○ I agree

***2. Please choose the appropriate response below.**

- ○ I certify that I am at least 18 years of age.
- ○ I am under 18 years of age.

UAS in the NAS: Survey for Air Traffic Controllers

Human Subject Research Volunteer Informed Consent Statement

Federal regulations require researchers to obtain signed consent for participation in research involving human subjects that uses federal funding, equipment, or in which federal personnel are involved.

After reading the information and the Statement of Consent below, if you wish to consent, please indicate so by selecting "I Agree" at the bottom of the next page. If you have questions about this research, you may contact one of the Principal Investigators listed below:

Title of Research: Unmanned Aircraft Systems in the National Airspace System: A Survey for Air Traffic Controllers

Principal Investigator/Phone & e-mail:

James R. Comstock, Jr., Ph.D. Principal Investigator, NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6643 james.r.comstock@nasa.gov

Anna C. Trujillo, Senior Research Engineer, NASA LaRC Crew Systems and Aviation Operations Branch 757-864-8047 anna.c.trujillo@nasa.gov

Raymon McAdaragh, Aerospace Psychologist, SGT Inc., NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6055 raymon.mcadaragh@nasa.gov

I. Statement of Procedure:

Thank you for your interest in this research. You will find a summary of the major aspects of this research below, including the risks and benefits of participating. Please feel free to ask any questions about the survey at any time. Questions may be directed to the Principal Investigators listed above. Carefully read the information provided below. IF YOU WISH TO PARTICIPATE in this research please select "I Agree" on the next page. Any information you provide will be maintained in strict confidence to protect your privacy.

II. I understand that:

- This is a research activity in which information is being gathered from Air traffic Controllers (including Military) concerning your ATC Operations Background, General Questions Concerning UAS Operations, and Expected UAS Rules and Requirements.
- If I consent to participate in this research, I understand I will be participating in a survey that will take approximately 20 minutes with the potential for participating in a future telephone interview (your choice).
- I may contact any of the Principal Investigators, listed above, if I have any questions regarding this research before, during, or after my participation.

III. Compensation

Non-government volunteers will be compensated for their participation ($50.00).

Civil servant or government volunteers who participate in the research do so in their official capacity.

IV. Potential Risks

- There are no apparent risks associated with participation in this research. In the event that something does occur, I may request to stop my participation at any time, which will not impact my compensation.

UAS in the NAS: Survey for Air Traffic Controllers

V. Potential Benefits

I will derive no personal benefit apart from the compensation noted above, except the knowledge that my participation and input as a NAS user or controller has been taken into consideration as NASA directs research at critical issues. The larger benefits are to the development of Rules, Regulations, and Policies related to UAS in the NAS.

VI. Confidentiality

- I understand that any public release of any data will be done in a manner that does not associate me with the data.
- I understand that the data files recorded during my participation in this research activity may be shared with other researchers within NASA (and outside NASA, if applicable) and that these files will not be associated with my identity.
- I do voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed.

VII. Voluntary Participation

Taking part in this study is voluntary. I may withdraw from participating or be asked to withdraw from participating at any time. Such a decision will not result in any penalty or loss of benefits to which I may otherwise be entitled.

VIII. Safety

As a voluntary test subject participating in this research, I understand that:

- NASA is committed to ensuring my safety, health, and welfare plus the safety and health of all others involved with this research.
- I should report any accident, injury, illness, and changes in my health condition, hazards, safety concerns, or health concerns to any of the Principal Investigators listed above. If I am unable to reach the above named individuals or am not satisfied with the response I receive, I should contact the NASA Langley Research Center (LaRC) Safety Office at (757) 864-7233 or the Chairperson of the LaRC Institutional Review Board, Mr. Jeffrey S. Hill, at (757) 864-5107
- If I detect any unsafe condition that presents an imminent danger to me, or others, I have the right and authority to stop the research activity. In such cases the Principal Investigator and associated research personnel will comply with my direction, stop the activity, and take action to address the imminent danger.

XI. Statement of Consent:

- I certify that I have read and fully understand the explanation of procedures, benefits, and risks associated with the research herein, and I agree to participate in the research described herein. My participation is given voluntarily and without coercion or undue influence, and I also voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed. I understand that I may discontinue participation at any time. I have been provided a copy of this consent statement. If I have any questions or modifications to this consent statement, they are written below.

3. Please enter any questions or modifications as noted above.

***4. Please select "I Agree" to indicate that you have read and agree with the Informed Consent, and then click "Next" to continue to the survey.**

I agree

***5. Enter the Access Code that was supplied to you in the invitation to complete the survey.**

UAS in the NAS: Survey for Air Traffic Controllers

6. Please indicate your age.

- under 22
- 23 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 and over

7. Please indicate your Gender.

- Male
- Female

8. How many years have you been a Certified Professional Controller (Public or Military)?

9. How many of these years have you worked in staff positions

10. What ATC facility ratings have you held?

11. Are you currently facility rated?

- Yes
- No

Comments:

12. Are you currently working active control, or are you in a staff position (if so, what position)?

13. What type of experience do you have with UAS operations in your airspace (e.g. active control, coordination, etc.)?

UAS in the NAS: Survey for Air Traffic Controllers

14. Were UAS operations in any way lacking in capability to aviate in the NAS? If so, suggest any possible remedies for the problems UAS experience in their ability to aviate in the NAS.

15. Were UAS operations in any way lacking in capability to navigate in the NAS? If so, suggest any possible remedies for the problems UAS experience in their ability to navigate in the NAS.

16. Were UAS operations in any way lacking in capability to communicate in the NAS? If so, suggest any possible remedies for the UAS communications problems.

17. Describe any problems you encountered with UAS lost-link situations.

18. Suggest any possible remedies for the problems you encountered with lost-link situations.

19. Describe any issues with UAS operations that are incompatible with "traditional" operations in the NAS.

20. If you have worked mixed Manned Aircraft/UAS operations in your airspace, what information did you find to be necessary to enable these mixed operations to be carried out safely?

UAS in the NAS: Survey for Air Traffic Controllers

21. When working manned aircraft and UAS in your airspace of responsibility, how important would it be to know that an aircraft shown on your radar display is unmanned? (e.g., through symbology or data-tag information)

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

22. When you are working aircraft in your airspace of responsibility, in which small UAS (under 55 lbs) are operating below 400 ft AGL and more than 3 miles from an airfield, how important is the display of that aircraft (data tag information) on your radar display?

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

23. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments

UAS in the NAS: Survey for Air Traffic Controllers

24. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

25. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

26. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

27. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Air Traffic Controllers

28. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

29. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

○ Yes

○ No

If "No" what see and avoid or sense and avoid capabilities do you think would make UAS operations acceptable in the NAS?

30. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

31. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?

	Yes	No
Class A	○	○
Class B	○	○
Class C	○	○
Class D	○	○
Class E	○	○
Class G	○	○

Comments:

UAS in the NAS: Survey for Air Traffic Controllers

32. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

- Yes
- No

Comments:

33. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

34. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

35. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

UAS in the NAS: Survey for Air Traffic Controllers

36. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?

- Yes
- No

Explain why or why not.

37. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

38. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

- Yes
- No

If yes, what are solutions to the delayed response time issue?

39. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?

- Yes
- No

If "Yes," what greater capabilities should be required, and why? If "No," why not?

UAS in the NAS: Survey for Air Traffic Controllers

40. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

41. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?

○ Yes

○ No

Comments:

42. Indicate your extent of agreement or disagreement with the following statement. The en-route navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

43. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for Air Traffic Controllers

44. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

45. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations (Aircraft executes ATC accessible lost link procedure).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

46. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

47. Is there any additional information concerning UAS operations that should be available to ATC (ATM or Controllers) during NAS operations?

○ Yes

○ No

If Yes, please explain.

UAS in the NAS: Survey for Air Traffic Controllers

48. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?

- Yes
- No

Comments:

Appendix G – Survey for UAS Pilots

UAS in the NAS: Survey for UAS Pilots

***1. The National Aeronautics and Space Administration (NASA) is presently working with industry and the FAA to establish future requirements for Unmanned Aircraft Systems (UAS) flying in the National Airspace System (NAS). This is a general survey about your experiences and future expectations of flying UAS in the NAS. Please do not include any classified information in your comments.**

The survey will take about 20 minutes of your time.

The survey contains some questions about you and your background; however, no personally identifying information is asked or associated with any of your responses. Your participation in this questionnaire is voluntary, and any information you provide will be kept strictly confidential, and will be de-identified and not associated with you in our analyses. All information from this questionnaire is secured via Secure Socket Layer (SSL) encryption, and data are transmitted privately via secure channel.

Please click "I agree" below to indicate that you have read and understand this information, and then click "Next".

- ○ I agree

***2. Please choose the appropriate response below.**

- ○ I certify that I am at least 18 years of age.
- ○ I am under 18 years of age.

UAS in the NAS: Survey for UAS Pilots

Human Subject Research Volunteer Informed Consent Statement

Federal regulations require researchers to obtain signed consent for participation in research involving human subjects that uses federal funding, equipment, or in which federal personnel are involved.

After reading the information and the Statement of Consent below, if you wish to consent, please indicate so by selecting "I Agree" at the bottom of the next page. If you have questions about this research, you may contact one of the Principal Investigators listed below:

Title of Research: Unmanned Aircraft Systems in the National Airspace System: A Survey for Pilots of Unmanned Aircraft Systems

Principal Investigator/Phone & e-mail:

James R. Comstock, Jr., Ph.D. Principal Investigator, NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6643 james.r.comstock@nasa.gov

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Raymon McAdaragh, Aerospace Psychologist, SGT Inc., NASA LaRC Crew Systems and Aviation Operations Branch 757-864-6055 raymon.mcadaragh@nasa.gov

I. Statement of Procedure:

Thank you for your interest in this research. You will find a summary of the major aspects of this research below, including the risks and benefits of participating. Please feel free to ask any questions about the survey at any time. Questions may be directed to the Principal Investigators listed above. Carefully read the information provided below. IF YOU WISH TO PARTICIPATE in this research please select "I Agree" on the next page. Any information you provide will be maintained in strict confidence to protect your privacy.

II. I understand that:

- This is a research activity in which information is being gathered from Pilots of Unmanned Aircraft Systems about your experiences and future expectations of flying UAS in the NAS.
- If I consent to participate in this research, I understand I will be participating in a survey that will take approximately 20 minutes with the potential for participating in a future telephone interview (your choice).
- I may contact any of the Principal Investigators, listed above, if I have any questions regarding this research before, during, or after my participation.

III. Compensation

Non-government volunteers will be compensated for their participation ($50.00).

Civil servant or government volunteers who participate in the research do so in their official capacity.

IV. Potential Risks

- There are no apparent risks associated with participation in this research. In the event that something does occur, I may request to stop my participation at any time, which will not impact my compensation.

UAS in the NAS: Survey for UAS Pilots

V. Potential Benefits

I will derive no personal benefit apart from the compensation noted above, except the knowledge that my participation and input as a NAS user or controller has been taken into consideration as NASA directs research at critical issues. The larger benefits are to the development of Rules, Regulations, and Policies related to UAS in the NAS.

VI. Confidentiality

- I understand that any public release of any data will be done in a manner that does not associate me with the data.
- I understand that the data files recorded during my participation in this research activity may be shared with other researchers within NASA (and outside NASA, if applicable) and that these files will not be associated with my identity.
- I do voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed.

VII. Voluntary Participation

Taking part in this study is voluntary. I may withdraw from participating or be asked to withdraw from participating at any time. Such a decision will not result in any penalty or loss of benefits to which I may otherwise be entitled.

VIII. Safety

As a voluntary test subject participating in this research, I understand that:

- NASA is committed to ensuring my safety, health, and welfare plus the safety and health of all others involved with this research.
- I should report any accident, injury, illness, and changes in my health condition, hazards, safety concerns, or health concerns to any of the Principal Investigators listed above. If I am unable to reach the above named individuals or am not satisfied with the response I receive, I should contact the NASA Langley Research Center (LaRC) Safety Office at (757) 864-7233 or the Chairperson of the LaRC Institutional Review Board, Mr. Jeffrey S. Hill, at (757) 864-5107
- If I detect any unsafe condition that presents an imminent danger to me, or others, I have the right and authority to stop the research activity. In such cases the Principal Investigator and associated research personnel will comply with my direction, stop the activity, and take action to address the imminent danger.

XI. Statement of Consent:

- I certify that I have read and fully understand the explanation of procedures, benefits, and risks associated with the research herein, and I agree to participate in the research described herein. My participation is given voluntarily and without coercion or undue influence, and I also voluntarily consent to sharing the data files recorded during my data collection session, as long as my identity is not disclosed. I understand that I may discontinue participation at any time. I have been provided a copy of this consent statement. If I have any questions or modifications to this consent statement, they are written below.

3. Please enter any questions or modifications as noted above.

***4. Please select "I Agree" to indicate that you have read and agree with the Informed Consent, and then click "Next" to continue to the survey.**

I Agree

***5. Enter the Access Code that was supplied to you in the invitation to complete the survey.**

UAS in the NAS: Survey for UAS Pilots

6. Please indicate your age.

- under 22
- 23 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 and over

7. Please indicate your Gender.

- Male
- Female

8. What Pilot Certificates do you have? (e.g., Private, Commercial, ATP, or None)

9. What Pilot Ratings do you have? (e.g., SEL, MEL, Instrument, CFII, Helicopter, none)

10. Top Four aircraft you have flown (by hours).

UAS in the NAS: Survey for UAS Pilots

11. If you fly manned aircraft, what type of mission do you primarily fly? (check any that apply)

- ☐ personal
- ☐ owner/operator
- ☐ business
- ☐ corporate
- ☐ airlines
- ☐ military
- ☐ agriculture
- ☐ public service
- ☐ charter
- ☐ I do not fly manned aircraft

Other (please specify)

12. Total manned aircraft flight hours

13. Total manned aircraft simulator hours

14. Total manned aircraft simulator hours (type and hours)

Fixed Base Sim

Motion Base Sim

15. UAS-specific Experience (type and hours)

UAS specific training

UAS simulator

UAS piloting

16. What types of UAS have you flown?

UAS in the NAS: Survey for UAS Pilots

17. What type of training, specific to UAS, did you receive prior to flying?

18. Do you think that the training you received was sufficient to fly the UAV?

19. What training have you received that would help you to fly a UAS in the National Airspace System (NAS)?

20. Indicate your extent of agreement or disagreement with the following statement. The UAS training you received was sufficient for you to be able to communicate with ATC or other aircraft in the National Airspace System (NAS).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

21. At which altitude band does most of your UAS flight operations take place?

- 0-500 ft MSL
- 501-1000 ft MSL
- 1001-3000 ft MSL
- 3001-7000 ft MSL
- 7001-12000 ft MSL
- 12001-18000 ft MSL
- 18001-40000 ft MSL
- 40001 and over

UAS in the NAS: Survey for UAS Pilots

22. When flying in an area in which manned aircraft operations are being conducted, how important is it that your UA is shown on other aircraft Cockpit Displays of Traffic Information (CDTI) along with manned aircraft in your proximity? (e.g., through symbology or data-tag information)

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

23. When flying in an area in which other UAS Operations are being conducted, how important is hearing ATC communications with other manned and/or unmanned aircraft pilots? (sometimes referred to as the "party line")

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations

Comments:

UAS in the NAS: Survey for UAS Pilots

24. If you are flying a small UAS (under 55 lbs) at or below 400 ft AGL (above ground level) how important is awareness of manned aircraft operating at altitudes of 1000 - 3000 ft in the area?

- not important
- nice to have but of limited value
- desirable information
- essential for safe operations
- no experience with small UAS operations

Comments:

25. Indicate your extent of agreement or disagreement with the following statement. In general, I believe that manned aircraft and UAS can safely share the same Airspace.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments

26. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) without ATC communications and without transmitting position (ADS-B) information will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

UAS in the NAS: Survey for UAS Pilots

27. Indicate your extent of agreement or disagreement with the following statement. I believe that small UAS (under 55 lbs) with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

28. Indicate your extent of agreement or disagreement with the following statement. I believe that Medium and Large UAS operating in the NAS with ATC communications and transmitting position information (ADS-B) will need separate or special airspace for their operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

29. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS without sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

30. Indicate your extent of agreement or disagreement with the following statement. In general, the safety rules/requirements for UAS operating in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

UAS in the NAS: Survey for UAS Pilots

31. Should the see-and-avoid rules/requirements for UAS operating in the NAS be the same as those for manned aircraft?

- Yes
- No

If "No" what see and avoid or sense and avoid capabilities do you think would make UAS operations acceptable in the NAS?

32. Indicate your extent of agreement or disagreement with the following statement. The weather-related rules and requirements for UAS operating VFR in the NAS with sense and avoid equipment should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

33. Should the rules and requirements for the various classes of controlled airspace (A, B, C, D, E, & G) be the same for UAS operations as they are for manned aircraft?

	Yes	No
Class A		
Class B		
Class C		
Class D		
Class E		
Class G		

Comments:

UAS in the NAS: Survey for UAS Pilots

34. Should the rules and requirements pertaining to the filing of flight plans (VFR & IFR) for UAS NAS operations be the same as those for manned aircraft?

- Yes
- No

Comments:

35. Indicate your extent of agreement or disagreement with the following statement. The rules and requirements pertaining to obstruction and cloud clearance for UAS operating VFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

36. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for small UAS (under 55 lbs) operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

37. Indicate your extent of agreement or disagreement with the following statement. The right-of-way rules for medium/large UAS operating in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

UAS in the NAS: Survey for UAS Pilots

38. Should UAS and manned aircraft operations be integrated in the terminal area (surface operations and traffic pattern)?

- Yes
- No

Explain why or why not.

39. Indicate your extent of agreement or disagreement with the following statement. UAS operations in the NAS (VFR & IFR) should be conducted according to the same operational altitude assignment procedures as manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-					

Comments:

40. Do you believe that the communications response delay caused by long range control and communications links (e.g., by satellite, up to 4 seconds voice delay) will pose a significant problem in the ability of UAS to become safely integrated into NAS operations?

- Yes
- No

If yes, what are solutions to the delayed response time issue?

41. Should the detect-sense-and-avoid requirements for UAS operating in the NAS be of a greater capability than the see-and-avoid requirements of manned aircraft operating in the same airspace?

- Yes
- No

If "Yes," what greater capabilities should be required, and why? If "No," why not?

UAS in the NAS: Survey for UAS Pilots

42. Indicate your extent of agreement or disagreement with the following statement. UAS operating in the NAS should be required to be capable of complying with all the same ATC instructions as manned aircraft. (e.g., expedite descent; proceed direct XYZ).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

43. Should UAS operations in the NAS be required to be capable of complying with all the same ATC crossing restrictions as manned aircraft in similar situations?

○ Yes

○ No

Comments:

44. Indicate your extent of agreement or disagreement with the following statement. The en-route navigation procedures/capabilities for UAS with comparable equipment (e.g., Flight Management System) operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

45. Indicate your extent of agreement or disagreement with the following statement. The lost voice communications procedures for the case in which Communications with ATC are lost, but Ground Control Station to aircraft command link is functioning, for UAS operating IFR in the NAS should be the same as those for manned aircraft.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

UAS in the NAS: Survey for UAS Pilots

46. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS temporary (less than 30 seconds) loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

47. Indicate your extent of agreement or disagreement with the following statement. The potential for a UAS permanent loss of control link (Ground Control Station command link to the Aircraft) poses a significant hazard to NAS operations. (Aircraft executes ATC accessible lost link procedure)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
-	○	○	○	○	○

Comments:

48. What communication rules or procedures do you believe are (or should be) different concerning UAS in the NAS, if any?

49. Is there any additional information concerning UAS operations that should be available to pilots of manned aircraft during NAS operations?

○ Yes

○ No

If Yes, please explain.

50. For the following questions, indicate which UAS (aircraft type) the responses apply to.

UAS in the NAS: Survey for UAS Pilots

51. Which levels of flight control / automation is the UAS equipped with? (check all that apply)

- ☐ Manual Control
- ☐ Partial Automation
- ☐ Fully Automated

Comments:

52. Do you have the capability to easily alternate between automated, partially-automated and manual flight?

- ○ Yes
- ○ No

Comments:

53. What type of input devices does the Ground Control Station (GCS) for this UAS utilize? (check any that apply)

- ☐ point & click
- ☐ keyboard input
- ☐ dial (knob) input
- ☐ control stick
- ☐ hardware buttons
- ☐ software defined buttons (physical buttons adjacent to display)
- ☐ touchscreen

Other (please specify)

UAS in the NAS: Survey for UAS Pilots

54. For this vehicle, what phases of flight within a UAS mission are most appropriate for each of the levels of control listed below? Please check the appropriate boxes.

	Taxi	Takeoff	Climb	Cruise	Mission	Descent	Land
Manual	☐	☐	☐	☐	☐	☐	☐
Partially Automated	☐	☐	☐	☐	☐	☐	☐
Fully Automated	☐	☐	☐	☐	☐	☐	☐

Comments:

55. What sensory cue information, not provided currently, would help improve your situation awareness of the environment of the aircraft, the integrity of the aircraft's flight and its mission?

56. How often is the UAS camera system used for navigation purposes?

57. How often is the UAS camera system used for "see and avoid" purposes?

58. As the UAS pilot how and under what circumstances are you allowed to override the automated flight control system?

59. What type of indicator does your GCS have to tell you that you are in fully automated flight?

UAS in the NAS: Survey for UAS Pilots

60. What type of indicator does your GCS have to tell you that you are no longer in automated flight?

61. Can a single UAS pilot perform all the tasks necessary to fly safely in the NAS?

- Yes
- No

Comments:

62. For pilots of small UAS (under 55 lbs) with Line-Of-Sight operations (aircraft in direct view) how do you split your head up/down time?

63. How frequently does the UAS automation do something unexpected?

- never
- rarely
- occasionally
- routinely

Comments:

64. Is your present Ground Control Station capable of voice communications with ATC?

- Yes
- No

If yes, is the present voice communications system reliable?

UAS in the NAS: Survey for UAS Pilots

65. If there is voice communications in the GCS, what could be improved to enable better voice communications, and has latency or delay in voice communications been a problem?

66. How frequently during a typical mission are you in contact with ATC or other aircraft?

- never
- rarely
- occasionally
- routinely

Comments:

67. If your aircraft received an ATC instruction to turn left 30 degrees, how long would it take before the aircraft would begin making the turn? (seconds) and how many control inputs would be required?

68. If your aircraft received an ATC instruction to descend 1000 ft, how long would it take before the aircraft would begin making the descent? (seconds) and how many control inputs would be required?

69. Have you flown a UAV with other aircraft within the same airspace?

	Yes	No
Mix of Manned and UAS		
UAS of differing sizes		

If "Yes," what information did you find to be necessary to operate in the mixed environment?

UAS in the NAS: Survey for UAS Pilots

70. Have you had operational experience with aircraft separation by altitude or corridor or in areas of protected airspace?

- Yes
- No

If "Yes," was the UAS flown manually or with an autopilot or flight management system?

71. Do you feel disconnected from the aircraft you fly? If so, please explain, and note what would reduce this disconnect.

72. Would you be willing to participate in a follow-up telephone interview with NASA Researchers to clarify information provided on this survey?

- Yes
- No

Comments:

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

NASA currently is working with industry and the Federal Aviation Administration (FAA) to establish future requirements for Unmanned Aircraft Systems (UAS) flying in the National Airspace System (NAS). To work these issues NASA has established a multi-center "UAS Integration in the NAS" project. In order to establish Ground Control Station requirements for UAS, the perspective of each of the major players in NAS operations was desired. Three on-line surveys were administered that focused on Air Traffic Controllers (ATC), pilots of manned aircraft, and pilots of UAS. Follow-up telephone interviews were conducted with some survey respondents. The survey questions addressed UAS control, navigation, and communications from the perspective of small and large unmanned aircraft. Questions also addressed issues of UAS equipage, especially with regard to sense and avoid capabilities. From the civilian ATC and military ATC perspectives, of particular interest are how mixed operations (manned/UAS) have worked in the past and the role of aircraft equipage. Knowledge gained from this information is expected to assist the NASA UAS Integration in the NAS project in directing research foci thus assisting the FAA in the development of rules, regulations, and policies related to UAS in the NAS.

15. SUBJECT TERMS

Air traffic control; Survey; Unmanned aircraft systems; aircraft; pilotless

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