# STATEMENT OF
# CAPTAIN TIM CANOLL, PRESIDENT
# AIR LINE PILOTS ASSOCIATION, INTERNATIONAL
# "ENSURING AVIATION SAFETY
# IN THE ERA OF UNMANNED AIRCRAFT SYSTEMS"
# BEFORE THE SUBCOMMITTEE ON AVIATION
# U.S. HOUSE OF REPRESENTATIVES
# OCTOBER 7, 2015

The Air Line Pilots Association, International (ALPA) represents more than 52,000 pilots who fly for 31 airlines in the United States and Canada. Thank you for the opportunity to provide our perspective on the critical importance of safely integrating unmanned aircraft systems (UAS) into the U.S. national airspace system (NAS), the most dynamic and diverse such system in the world. The NAS must be protected and maintained to deliver the safest and most efficient air transportation services in the world. Although our focus today is the NAS, we must point out that the safety issues highlighted are independent of any national airspace boundary and are faced by ALPA's pilots as we operate around the globe.

**UAS Risk Must Be Effectively Managed to Realize Benefits**

ALPA recognizes that UAS represent a significant potential for economic and societal benefit. They are uniquely suited for performing many types of dangerous flying that can keep pilots out of harm's way. ALPA supports robust development of this technology with one single overriding condition: integration of UAS into the NAS must be done safely, deliberately, thoughtfully, with full understanding of the possible risks also being introduced, and most importantly—with simultaneous development of effective mitigations for those risks. We have to do this right, or the enviable safety record we have achieved in airline operations will be at risk, and with it, the promise of employing unmanned systems for the benefit of the population.

As we have for many years, ALPA continues to be an active partner with both government and industry in developing standards that will lead to safe operation of unmanned systems in the NAS. Concurrently, we recognize that these standards are far from complete. Defining a safety framework for any new technology is necessarily a painstaking process, and ALPA, along with hundreds of extremely talented representatives from across aviation, is diligently pursuing that goal.

**UAS Sales Growth**

Among the most dramatic and challenging revolutions in aviation technology and operational capability to be introduced into the NAS is the UAS. There are many different types of UAS, and there seems to be an ever-expanding list of potential applications.

There are many published data sources that support this key fact: *there is tremendous growth in the sale and use of small UAS for both hobby and commercial use.* Research suggests that there are likely more than 700,000 UAS already in the hands of the public, many of whom undoubtedly have very little appreciation for, or understanding of, how to safely operate UAS in airspace that is used by commercial aviation.

Additionally, the FAA has stated that upwards of 1 *million* UAS could be sold this coming holiday season. Although the FAA has made strides toward developing a regulatory framework for the operation of some of these aircraft, much work remains. In the meantime, the FAA is publishing data that increasingly point to a UAS threat to safe operation of airline aircraft. Immediate action is required to address the documented hazards.

**FAA Addresses Commercial Small UAS Operations**

The FAA has taken initial steps to allow small UAS (sUAS, under 55 pounds) to begin operating in the airspace system with multiple restrictions intended to mitigate risk. The FAA has established an interim process of approval of commercial operations on a case-by-case basis. This is often referred to as the "Section 333 process" because the FAA's use of this strategy is based on that section of the most recent FAA authorization.

In addition to the interim approval process, the FAA published a notice of proposed rulemaking (NPRM) on Feb. 23, 2015, that addressed the commercial operations of sUAS. The NPRM, which was significantly based on FAA's 2009 recommendations of the Small UAS Aviation Rulemaking Committee, established a proposed framework for commercial operators to operate their sUAS. The NPRM formally established the definition of an sUAS, established pilot qualifications, and created operational limitations.

By the end of the notice's 60-day comment period, the FAA had received more than 4,000 comments. While ALPA supports the FAA's efforts to properly establish regulations for commercial sUAS operations, ALPA and other organizations encouraged the FAA to make some substantial changes.

The FAA is now reconciling ALPA's comments along with all of the others and will ultimately issue a final rule. Between the Section 333 process and the eventual sUAS rule, commercial operators are well on their way to having a defined path for approved NAS operations and a path for expansion of operations while insuring safety.

**The FAA Needs to Address All UAS to Ensure Safety Immediately**

The standards for some of the key capabilities of UAS, and the recommendations for the wide variety of rules that must be changed or developed to accommodate large UAS, are still years away. As a result, for the foreseeable future, without additional FAA action there will be no rules for the following UAS operations:

- Non-commercial operations by companies (e.g., pipeline or power line patrol by the pipeline/power line company employees)
- Recreational/hobbyist small and large UAS
- Commercial large UAS

ALPA recognizes that the commercial operations of large UAS are not developing as quickly as sUAS used for commercial, recreational and corporate operations. The FAA presently has rulemaking underway that addresses only one of these four types of UAS operations. The tremendous growth of sUAS in just the last 24 months when measured against the limited rules that the FAA has under way is inconsistent with the needs of the country for safe integration of UAS.

**Recent FAA Incident Report Data Is Demonstrative of ALPA Safety Concerns**

This August, the FAA published a list of pilot reports on UAS encounters. ALPA reviewed the 764 events, which cover only a 10-month period from November 2014 through August of 2015. Both the volume of events and many of the event descriptions are sobering reminders to the industry that the risk of a collision between a UAS and an airline aircraft has increased significantly. Consider these sample summaries (ALPA paraphrase):

New Jersey:

- 07/16/2015 Summary: Regional turboprop aircraft on a one-mile final approach to Runway 11 reported a remote controlled aircraft 50 feet below at Weequahic Park.

- 08/09/2015 Summary: Several aircraft on final to Newark Liberty International Airport reporting unidentified drone operating directly on final approach to Runway 4 right. The drone was reported to be at altitudes between 2,000 and 3,000 feet, between 8 miles and 13 miles out on the final approach. Three aircraft reported the drone in sight.

Oregon

- 05/17/2015 Summary: Regional jet at 1,000 feet on a two-mile final for Runway 34 left. Pilot reported seeing a drone at 600 to 700 feet off his left wing. It was approximately 400 to 500 feet from the aircraft. The drone was described as a yellow hobby-style helicopter with four rotors the size of a large bird.
- 07/21/2015 Summary: Turboprop commercial freight aircraft reported a "drone" at 1,100 feet on base for Runway 28 left over "Rocky Butte" (a hill approximately 2.5 miles southeast of Portland International Airport)

Washington

- 07/15/2015 Summary: Regional jet reported a drone at 2,400 feet on a 5-mile final to Runway 16 right. The pilot reported that the drone was above him on final and appeared to be a black quadcopter.

- 04/27/2015 Summary: Jet airliner was descending through 3,500 feet on the downwind near Vashon Island (near Seattle) and sighted a deep blue metallic drone. The drone passed about 100 to200 feet under his left wing and appeared to be traveling northwest.

ALPA also studied the work of others who have reviewed the FAA event data. The Center for the Study of the Drone, which is operated by Bard College in New York State, has indicated that of the total number of reported events in the database, 302 of the 764 reports were determined to be near misses. In other words, its analysis revealed that 39.5% of the FAA's events would potentially have met the FAA's near mid air collision (NMAC) criteria. In comparison, ALPA research of FAA data regarding manned-on-manned aircraft NMAC finds that a total of 41 NMAC reports were logged in the same period. It should be noted that FAA NMAC reports are voluntarily submitted and therefore likely not a comprehensive set of manned-on-manned NMAC reports.

It is clear that hundreds of NMAC of UAS over such a short time frame far exceeds an acceptable level of risk to manned aircraft in the NAS. Undoubtedly there will be many perspectives and opinions on what constitutes an acceptable level of risk. If the FAA UAS event data tallied 100 instead of 764, ALPA would still insist that there are too many unexpected encounters.

Instead of discussing subjective opinions on the risk that UAS pose on manned aircraft, ALPA suggests that the FAA should invite ALPA and others in the industry to work collaboratively to reach an agreement on the level of risk that is deemed acceptable, and then work to implement solutions to achieve the targeted risk levels. The rate of UAS encounters needs to be reversed, and ALPA is ready and willing to immediately contribute in a meaningful way to reverse the growing trend of UAS encounters.

**Non-Commercial and Recreational UAS Operations Appear to Be a Major Source of Reported UAS Events**

Although the FAA has made progress in attempting to educate non-commercial and/or hobby users as to the safe operation of their aircraft through its "Know Before You Fly" campaign, no regulations exist that govern the operation of the aircraft or the training and experience of the pilots. ALPA believes that the vast majority of the many "close encounters" with unmanned aircraft reported by airline flight crews are the result of users who either do not understand the potential severity of operating near airports and aircraft, or are completely unaware that they are doing so. The massive growth of this segment clearly has outpaced the FAA's ability to effect safety standards that apply to it, yet the FAA remains responsible for the safety of all operations in the airspace. This is a significant gap that must be addressed. The FAA must have the ability to ensure the safety of the NAS regardless of the types of unmanned operations being conducted, and it must have the resources necessary to act on that mandate. As we have said before, we simply cannot afford to quantify this hazard by analyzing the damage after an unmanned system collides with an airliner.

**UAS Frangibility Is Questionable and Untested**

ALPA is concerned about the impact of sUAS on an airline aircraft if there were a collision. There are numerous videos of UAS crashes online; in many cases the crashes occur without major damage to the camera and the visible parts of the sUAS. It appears that the sUAS are generally designed to be relatively rugged, as one would expect for a commercially viable product. This ruggedness however, needs to be evaluated in the context of the potential damage that an sUAS would impose on an airline aircraft should the two collide. We frequently hear the comment that most sUAS are small, lightweight plastic aircraft. While this is the case for the sUAS airframe itself, the multiple propulsion units, batteries, and on-board cameras are hard metal with a significant density that a bird, for instance, does not have.

Airplane engines, windscreens, and other components may suffer the impact of such material without resulting in loss of the aircraft, but the damage would be nevertheless significant. Jet engines, for example, are notoriously susceptible to foreign object damage (FOD) typically caused by small, hard objects found all over airports – nuts, bolts, rocks, tools, etc. Damage of this type, while rarely noted in conjunction with an accident, costs the industry billions of dollars every year.

Similarly, we have seen just in the past few months the extensive damage done to an aircraft in flight by hail, shattering both pilots' windscreens and severely damaging every part of the airplane that was hit. Here again, catastrophe was averted by the robustness of the airplane design and the skill of the flight crew, but the seriousness of striking hard objects in flight was clearly illustrated. Based on our experience with FOD, hail, and other objects striking transport aircraft, ALPA recommends design evaluations, modeling, and testing the collision impact of some of the more popular sUAS.

**UAS Conspicuity – Data Suggests That They Are Difficult to See Until Close**

ALPA is frequently asked to explain how visible an sUAS is to a flight crew of an airline aircraft. There are medical studies about the limits of human visual acuity and some limited study data on distances at which a pilot perceives other aircraft. However, because UAS can be of essentially an infinite variety of sizes, shapes, and colors, studies regarding traditional aircraft do not provide a good guide. Factors such as size, shape, contrast with background, and movement relative to the observer are all factors that complicate a pilot's ability to see a UAS until it is extremely close and often too late to safely take evasive action. It is important to note that from a safety perspective, a pilot simply seeing an object in the airspace is only part of the process. The object must be seen with enough clarity and at such a distance that a pilot has the ability to identify the object and determine if evasive maneuvering is necessary to avoid a collision. To our knowledge, no specific quantifiable data on observing UAS from an aircraft moving nearly 200 mph in time to avoid collision exist.

**ALPA Members Encouraged to Report UAS Sightings**

In order to continue to track the rate of UAS encounters, ALPA has taken the initiative to encourage pilots who encounter an sUAS to follow their company guidance and, where applicable, file a report of the encounter with the FAA. A dedicated page on ALPA's website (www.alpa.org), available to anyone, not just members, helps pilots understand whether the encounter was likely reportable as a near mid air collision and provides web links and information needed to submit the necessary information.

**True UAS Integration: Much to Do to Achieve One Level of Safety**

While it is easy to focus on very near-term, dynamic growth and the recent news created by the FAA, it is important to understand the broader challenges that still exist for nationwide integration of UAS into the NAS. By way of review, UAS are grouped into two separate categories, generally based on weight. Aircraft that weigh 55 lbs. or less are defined as "small" UAS (sUAS) and unmanned aircraft that weigh more than 55 lbs. are considered "large."

Small UAS are typically intended for use at low altitudes, in clear weather, and within sight of the pilot. However, the aircraft themselves are capable of achieving altitudes, speeds, and ranges that extend far beyond the intended limits of their use. In addition, applications are being developed to employ these aircraft in an autonomous role, meaning they could operate along a predetermined flight path without being under the direct control of a pilot. While the commercial applications for sUAS are expanding rapidly, so too is the appeal to hobby users. In both cases, the potential exists for these aircraft to stray into airspace occupied by other NAS users, most notably by airline aircraft near airports.

Large UAS aircraft can be as large as a small airliner and can operate essentially anywhere conventional aircraft operate, and in many cases have performance capabilities exceeding those of conventional aircraft. While differences in size, performance, and operational capabilities can vary greatly, there also exists a wide range of technology on the ground that forms the entire system that must be considered in evaluating the safety of integrating these aircraft into the NAS, not just the aircraft itself.

Until comprehensive solutions are developed and promulgated by the FAA, our overarching position is that no unmanned aircraft, public or civil, should be allowed unrestricted access to conduct flight operations into the NAS unless it meets all of the high standards currently required for every other airspace user. This means UAS must be designed to interoperate, with similar performance and functional requirements at the heart of their system, and have architectures embodying state-of-the-art safety technologies and system redundancies as required by currently certified commercial and general aviation airspace users. Of particular importance and concern is the ability of commercial aircraft operating in the NAS to safely perform see-and-avoid and collision avoidance maneuvers against UAS that may be operating in the same area.

ALPA's position is that the foundation of operating an aircraft, and the system functions therein, in a safe and responsible manner must be maintained at the same level of safety regardless of the location of the pilot or levels of automation. At the center of current commercial aviation flight operations is a well-trained, well-qualified professional pilot. A well-qualified pilot remains the single most important safety component of any commercial aircraft. A UAS should be able to operate as a part of the NAS, with similar certification standards and regulations to meet the target level of safety that is performed reliably and repeatedly by well-trained airline pilots and their aircraft in the NAS today. Accordingly, UAS operators performing commercial operations should be required to meet all the certification and equivalent safety requirements of a commercial operator. And the pilots flying the aircraft must meet equivalent training, qualification, and licensing requirements of pilots of manned aircraft in the same civil regulated airspace.

**UAS Design Standard Challenges**

Unmanned operations are envisioned to afford possibilities and convenience that offer the attraction of a flying technology beyond the conventions and constraints of modern aviation. The reality is quite different; new UAS technology currently lack **–** but must have **–** the standardization of safely integrated and interoperable certified systems, which the FAA requires of commercial operators in the NAS today. Without mature safety standards and without technologies that have certification standards and regulations, safety in the NAS may be significantly and negatively impacted, introducing more vulnerability and risk to commercial airline operations and to an overburdened Air Traffic Control system.

Currently, the UAS technologies, safety, and certifications for an end-to-end solution for NAS integration are immature. Patience and, most importantly, collaboration are needed to diligently examine all of the barriers and successfully develop comprehensive and fully mature solutions prior to widespread operational implementation into the NAS. We simply cannot afford to miss critical steps in technological design standards and safety analyses in an attempt to hastily satisfy a market demand, because the impacts to the safety of the NAS could be profound, far outweighing any benefits.

The introduction of multiple variations of UAS without first completing comprehensive risk analysis, rigorous testing, and robust aircraft and pilot certifications would set back the progress accomplished in aviation safety while simultaneously losing the public's trust of safe air travel. We believe that all aviation stakeholders should examine UAS integration to determine how these platforms may impact their operations.

**Technological Challenges Impacting Operations in the NAS**

A June 20, 2014, newspaper article[1] reported that 47 UAS accidents involving U.S. military and federal agencies' aircraft have occurred since 2001 – a safety record that no commercial business or airline could survive. These federal institutions have the authority to self-certify the airworthiness of their own UAS, which can involve modifying compliance with FAA certification standards to accommodate these agencies' unique mission requirements. This latitude and difference in priorities relative to commercial aviation is likely a contributing factor to the number of UAS accidents.

As such, it is easily understood that without the FAA's and other safety organizations' experience and collective guidance in aviation safety, lesser airworthiness standards and certification procedures will produce greater UAS accident rates. Moreover, these accident rates expose the importance of developing civil standards tailored explicitly to UAS technologies, airworthiness, and related certifications through established civil procedures.

Unlike their manned counterparts, a primary system on a UAS is the communication and control system ($C^2$). This system is what allows the pilot to remotely control the aircraft. The system transmits and receives command inputs (e.g., flight controls, navigation, aircraft status, and ATC communications) from the ground station via radio frequency to the unmanned aircraft (UA). The criticality of the $C^2$ system becomes self-evident, as it is the most vital single-system link depended upon for the UAS to successfully and safely operate. Link failure – which is exactly analogous to the pilot of an aircraft suddenly disappearing from the cockpit – may cause a multitude of unintentional, cascading events. The sole dependence on this vital system is a necessary aspect of UAS operations, but its failure is one of the primary causal factors as to why UAS have had many accidents.

The primary $C^2$ contributing failures are associated with latency issues – that is, the time between transmission and reception of a command to successfully operate the UAS. Unlike the human on-board pilot, whose control input is instantaneous, latency times can be from 3 seconds to as much as 30 seconds, perhaps more. When flying in the NAS, where immediate communication and required actions are expected to provide separation between aircraft, latency could cause more significant problems for ATC and manned aircraft in that airspace.

The varying degrees of UAS $C^2$ vulnerabilities and failures creates complex safety issues for UAS integration. The $C^2$ data, voice, and video requirements placed on operating UAS using radio waves or satellite create limitations that currently prevent UAS from performing to the safety level of manned commercial aircraft operations. If a UAS cannot maintain a $C^2$ link, the normal expectation of a UAS to perform the critical functions of ensuring separation from terrain, obstacles, and other aircraft, as well as collision avoidance responsibilities, will unduly place safety burdens on other NAS users.

Manned aircraft flown by pilots in the NAS today use instrument flight rules (IFR) to take advantage of the benefits of FAA's ATC separation services. However, a pilot's responsibility to see and avoid to remain well clear of other aircraft is a constant responsibility in the pilot's line of work, regardless of who or what else is monitoring the flight. Simply stated, pilots visually scan the airspace, especially when traffic is being reported to them by ATC, to identify the aircraft in question when a traffic alert is initiated or simply when a flight crew is flying into an airport that may not have a control tower to avoid all potential conflicts. The UAS needs to be equipped with the technological ability to maintain well clear of and

[1] "When Drones Fall from the Sky," *Washington Post*, June 20, 2014.

avoid collisions with other operators if it is to truly replicate the actions expected of every aircraft in the NAS.

A robust and safe UAS design should never result in the transference of safety responsibility – such as that for maintaining separation – to other operators and users. Accordingly, one of the most important capabilities yet to be developed for UAS operations is the detect and avoid (DAA) technology that is fully capable of performing two primary functions: staying well clear of other aircraft and, if that fails, retaining the ability to avoid an imminent collision using an active collision avoidance technology. While those capabilities in manned aircraft are accomplished by a combination of pilot skill and electronic means, UAS must solely rely on electronic means. The responsibility to avoid coming hazardously close to other aircraft is a shared responsibility.

In addition to the UAS ability to detect and avoid aircraft, other aircraft in the NAS must likewise be able to "see" any UAS that could pose a collision threat. Realistically, given sizes too small to be seen by the human eye until the aircraft is dangerously close, the ability to be seen must be done by electronic means.

A promising system to enable that capability is aAircraft cCollision aAvoidance sSystem for NextGen, or ACAS X. Currently in the research and development phase, only limited funding exists to develop and implement this groundbreaking technology. Additional funding for ACAS X (for manned aircraft) and ACAS Xu (for UAS) would accelerate this new capability. This new technology will likely play a critical role in the safe integration of UAS platforms into the NAS, as well as ensure harmonization of UAS with NextGen requirements.

**Geographically Limiting Technology for UAS Operations**

Technology exists to limit the geographical and vertical limits of unmanned aircraft operations, independent of the performance capability of the aircraft itself. Geographic and vertical limiting of UAS should be required for all UAS that are not intended to "mix" with conventional aircraft or in the vicinity of airports and other sensitive areas, regardless of whether the UAS is flown for business or recreation. Until the FAA mandates the use of such technology, the effectiveness of this solution will be somewhat limited.

Unfortunately, a software-based solution such as geographical and vertical fencing will be subject to hackers, or those intent on defying the regulations. Attempts to defeat such technology must be viewed as a deliberate act intended to create a hazard in the NAS and dealt with accordingly. Intentionally operating any aircraft whether manned or unmanned, in an unsafe manner is not a hazard to be mitigated – it is a deliberately unsafe act that, like intentionally shining a laser at an aircraft, cannot be tolerated and must result in an appropriate civil and/or criminal penalty.

**Summarizing ALPA's View on UAS Design, Certification, and Operations**

The pressure for rapid integration of UAS into the NAS must not result in incomplete safety analyses or technologies prior to any authorization approvals to operate. The urgency to allow UAS into the NAS with immature technologies and lack of appropriate standards and certifications at this time should not encumber other NAS users with additional safety burdens. Standards and technologies for UAS must be in place to ensure the same high level of safety as is currently present in the NAS before a UAS can be authorized to occupy the same airspace as airlines, or operate in areas where UAS might inadvertently stray into airspace used by commercial flights. It is critical that the decisions being made about UAS airworthiness and operational requirements fully address safety implications and complete interoperability functionalities (e.g., detect and avoid capability) of these aircraft flying in, around, or over the same airspace as manned aircraft and, more importantly, airline aircraft.

A well-trained and experienced pilot is the most important safety component of the airline system. The role of the pilot is a major area of concern within the UAS – and within the piloted-aircraft communities. UAS pilots should not be allowed to operate UAS in any commercial operation using non-licensed or private pilots.

It is impossible for a UAS pilot to react to anything other than an explicitly annunciated malfunction. A pilot on board an aircraft can see, feel, smell, and hear many indications of an impending problem and begin to formulate a course of action before even sophisticated sensors and indicators provide positive indications of trouble. This capability is necessarily lost without a pilot on board, so the margin of safety the pilot represents must be replaced by other means. UAS pilots should be trained, qualified, and monitored to meet the equivalent standards of pilots who operate manned aircraft in either private or commercial operations.

**ALPA Recommendations Pertaining to UAS Design and Operations**

1. A comprehensive, proactive UAS safety program should incorporate technology standards, safety analyses, certifications, and flight standards to ensure that introduction of UAS into the NAS will not degrade the existing NAS target level of safety.

2. Federal aviation regulations that specifically address UAS operators, operations, aircraft, and pilots must be developed. Any UAS-unique or UAS-specific regulations must be comparable and compatible with other existing regulations for other airspace users.

3. UAS are inherently different aircraft from manned aircraft and should be required to be equipped with safety-based technologies designed with both well clear and aActive collision avoidance functionalities at the heart of their system architectures to operate in normal and abnormal modes and conditions to maintain the current level of safety in the NAS.

4. Commercially operated UAS should be flown by pilots who hold a commercial license and an instrument rating to ensure the continuity of safety that now exists in the NAS.

5. Regulations containing certification standards, continuing airworthiness standards, and minimum equipment list requirements for UAS that are intended to operate commercially in the NAS must be developed.

6. Any person or persons in direct control of a UAS must be limited to the control of a single aircraft unless operations are conducted in special-use airspace.

7. Congress should work with industry stakeholders to develop an appropriate UAS integration funding mechanism.

**Near-Term Call for Action: A Four-Part Solution**

With the anticipated sale of 1 million UAS in the next 90 days, there is an immediate sense of urgency that must be considered. ALPA believes that a significant step toward the eventual solution to safely integrating UAS into the NAS includes four fundamental elements:

1. *Education:* Anyone who plans to fly UAS must understand the aircraft, the airspace, and the other aircraft that could be encountered while flying.

   In the case of UAS that might be flown for compensation or hire in civil airspace, the pilot must hold a commercial pilot certificate to ensure he or she possesses the appropriate skill and experience to meet safety standards designed to protect the flying public.

   Those flying UAS for recreational purposes must adhere to the FAA guidelines including potential minimum age requirements, keeping the UAS within line of sight, and flying at heights under 500 feet.

   ALPA urges Congress to provide definitive authority and remove any ambiguity about the extent to which the FAA has the authority to regulate sUAS operated for recreation and hobby. However, in the absence of congressional clarification, we believe FAA may be able to utilize its authority to ensure the safety of the national airspace by regulating all aircraft operations including recreationally flown UAS. ALPA stands ready to assist the agency in the swift development of these regulations and help achieve our shared goal of ensuring the safety of air transportation.

   Based on what the FAA has documented to date, the ongoing educational efforts under way by the FAA and recreational UAS segment are woefully inadequate. ALPA remains willing and able to assist.

2. *Registration:* Gathering basic information about the identity of the individual purchasing the UAS not only allows law enforcement authorities to identify the owner if the UAS were to encounter a problem, but it helps make clear the serious nature of operating a UAS in the U.S. NAS and the responsibility to safeguard public safety.

3. *Technology:* If UAS, either intentionally or unintentionally, are operated in airspace that airliners use, airline pilots need to be able to see them on cockpit displays, controllers need the ability to see them on their radar scopes, and UAS must be equipped with active technologies that ensure that the UAS is capable of avoiding collision with manned aircraft. In these types of operations, technology must enable the pilots to control and interact with them in the same manner as if the pilot were on board.

   If a UAS is restricted by regulations from operating in a particular geographic area and/or altitude, it must have technology that cannot be overridden that limits the geographic areas and altitude in which it can operate. This may include permanent locations such as the White House and all public airports, as well as temporary restrictions such as for wildfires or natural disaster areas.

4. *Penalties and enforcement:* UAS pilots must be properly trained and understand the consequences of possible malfunctions. Anyone flying a UAS that is a hazard to other aircraft in the airspace, especially those who choose to do so recklessly near airports, must be identified and appropriately prosecuted. We support the

criminalizing of intentionally unsafe operation of UAS and penalties for unintentional unsafe UAS operations. If additional funding is needed for this purpose, Congress should provide the resources needed without delay.

**Conclusions**

American aviation technology is experiencing its own "space race" akin to the 1960s. With phenomenal growth in aviation science and technological advancements in this modern digital age, the results are testimony to the advanced applications underpinning NextGen and associated programs. These technologies are designed at their core architectures to be safe, reliable, and repeatable to provide the efficiencies required to maintain the target level of safety as aviation transportation continues to grow.

The target level of safety for commercial air travel in the NAS should be proactively, not reactively, protected. We are fully aware that there is a strong desire by UAS proponents, and those who wish to become operators, to begin flying in the NAS as quickly as possible. Clearly, there are commercial, social, business, and international competitive advantages to a strong UAS industry. However, government and industry must take a longer view of this present state of technology to ensure that robust safety systems, in tandem with FAA-certified redundant systems of UAS, are developed that completely integrate with commercial airline operations and, above all, do so safely. An imprudent rush to create and implement minimum standards will not only harm safety, but potentially produce a setback for the future expansion of UAS operations for years to come.

Data show that UAS sales are skyrocketing while hazardous UAS encounters are also rapidly escalating. The need for immediate action is clear; but without comprehensive certification and operational rules and policies, the challenges we face will only continue to multiply.

On behalf of the more than 52,000 pilots whose top priority is safe transportation, we thank the committee for the opportunity to testify on this important subject and look forward to working together to ensure the safety of our air transportation system.