**Title: Creating Greater Opportunities for Unmanned Aircraft Flight Operations**

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Department of Defense (DoD) and national security needs will likely continue to drive the greater part of the unmanned aircraft system (UAS) market for the foreseeable future. As a result of the major technology advancements that have occurred over the past decade there are more civil and non-military governmental uses for unmanned aircraft (UA) surfacing regularly and increasing annually. In several decades, it is envisioned that the volume of UA flights for commercial and governmental non-military applications could equal those being flown for military activities (Hottman, 2004). However, the growth of the civil UAS market is going to depend on the ability of non-military UA proponents to operate their UA in National Airspace System (NAS) for testing, research, and development to the degree that is necessary to warrant the expenditure of funds for UAS development.

The major problem facing both the military and other UAS proponents regarding UA flights in the NAS is the inability to comply with some of the regulatory requirements defined in 14 CFR 91, General Operating and Flight Rules; the major one is the requirement for pilots to see and avoid other aircraft (14 CFR 91.113(b)). The U.S. military and some other U.S. governmental organizations are able to more readily test and evaluate their UAS because of the availability of restricted area airspace to operate in where these flights are segregated from nonparticipating aircraft (14 CFR 91.133 and 14 CFR 73.13), thus providing an acceptable level of safety. Civil UAS developers and some potential non-military governmental clients for UA are very limited in what UA flight activities they can conduct. This situation exists due to the lack of available restricted airspace to operate in and the fact most civil UA uses for commercial and non-military applications will not be within already established restricted areas. Even some military missions encounter this problem. Therefore, creative ways are needed to provide civil UAS developers and government clients, including the DoD, the ability to operate UA more readily in the NAS.

In the mid-1980s, the FAA began allowing the DoD to conduct UA[1] flights in the NAS under limited conditions. The criteria and procedures for operating DoD UA in the NAS are defined in FAA Order 7610.4, Special Military Operations. Originally, these UA flights were authorized within positive control areas (PCA), restricted areas, warning areas, and other airspace whenever the DoD provided an alternative method for seeing other aircraft and eliminating potential conflicts. With rare exceptions, the initial DoD UA flights in the NAS were performed by smaller UA (e.g., Pioneer, Hunter, etc.). These UAs used line-of-site control technology and were therefore limited to basically the local area. When the Predator A UAS came on line in 1995, flight control technology was still line-of-sight. Yet, because of the Predator A's ability to operate at higher altitudes, the flight range of the UA was now more regional. With the advent of the Global Hawk UAS in 1998, flight control through satellite communication (SATCOM) technology was available. This technological advancement increased UA's operational capability from local and regional to national and even international in scope.

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[1] Initially referred to as Remotely Piloted Vehicle (RPV). Subsequently military organizations started using the term unmanned aerial vehicle (UAV)

In 1999, as a result of the increased number of UAS and advancement in operational capabilities, the FAA determined that they needed to have more oversight of DoD UAS operations in the NAS, outside of restricted areas and warning areas, than what the original criteria specified. Therefore, in concurrence with the DoD, additional criteria were added to that already contained in FAA Order 7610.4. The new criteria required the DoD UA proponent to obtain a Certificate of Authorization (COA) from the FAA for each UA project conducted outside restricted and warning area airspace. This new criteria also reflected that these "RPV" were aircraft and changed the terminology to "Remotely Operated Aircraft (ROA)." More recently, September 2005, the FAA Flight Standards (FS) organization issued the latest FAA policy on unmanned aircraft systems and once again changed the terminology, this time from ROA to UAS (Memorandum, AFS-400 UAS Policy 05-01).

There have been significant UAS technological achievements during the growth of the UAS industry over the past decade; including SATCOM control, voice communication relay through the UA, better command and control, and more reliability of the UA airframe and engine. Yet, the ability to operate UA in the NAS has become more difficult. Each of the modifications (1999 and 2005) by the FAA to the DoD's operation of UA in the NAS has specified more restrictive criteria and procedures. Now, more paperwork is required in the preparation of the Application for COA, and the COA process is lengthier because of more FAA organizations' involvement in the review of the UAS proponent's Application for COA. Yet, the major obstacle is UAS's inability to meet the same see-and-avoid requirement of manned aircraft (14 CFR 91.113(b). In fact, over the years the FAA has reduced the number of methods previously allowed to provide see and avoid for UA flights. In the 1999 changes, the FAA eliminated the use of the Control Firing Area (CFA) concept and in 2005 the use of radar monitoring was eliminated for see and avoid. Therefore, UA flight operations in the NAS are more restricted. Unless other methods of achieving flight safety are developed, the current situation will continue to exist until reliable and certifiable see-and-avoid technology that provides a comparable level of safety required of the manned aircraft community is developed and certified as a proven technology.

Considerable effort is being made to develop see-and-avoid technology for UA that will achieve an equivalent level of safety, comparable to manned aircraft flights. Yet, the projection from the FAA is that reliable and certifiable see-and-avoid technology is still a significant number of years away. Figure 1 depicts the Aerostar UAS with a modified nose for testing sense-and-avoid technology. For smaller classes of UAS, this technology will have to be of the micro caliber; therefore, it may be even longer before see-and-avoid technology is available for smaller UA. Based on this knowledge, methods other than see and avoid to prevent collisions between UA and other aircraft need to be considered, so that there is a greater opportunity for UA flight operation in the NAS for commercial and governmental endeavors while the see-and-avoid technology is being developed.


**Figure 1. NMSU Aerostar UAS Currently Used for Sense-and-Avoid Technology Demonstrations**

See and avoid is the long-standing bedrock for preventing collisions between aircraft; however, there are two other effective methods that can be used to achieve the same, if not higher, degree of safety;  The other methods are (1) performing flights within a "positive control (Pilot/Controller Glossary)" environment and (2) segregation of flight operations.  Flight operations within positive control airspace (Class A & B airspace) are required to be under the authorization and control of an air traffic control (ATC) facility.  Since the ATC facility will provide separation standards among all aircraft operating in Class A and B airspace, this assures the desired level of safety is achieved.  The applied ATC separation standards provide greater distance between aircraft than when pilots are applying see and avoid between one another.  The FAA recognizes that flights within positive control airspace do not literally meet the criteria contained in 14 CFR 91.113(b) (Statement in Memorandum, AFS-400 UAS Policy 05-01, dated September 16, 2005); however, they believe that flight in positive control airspace provides at least an equivalent level of safety comparable to see and avoid practiced by pilots of manned aircraft.  Another method of achieving flight safety is to segregate non-participating aircraft from airspace within which hazardous or unsafe activity is being conducted.  Restricted areas are created and Temporary Flight Restrictions (TFR) are implemented for this very purpose.  Figure 2 depicts a TFR used for fire-fighting purposes.  Safety is achieved as a result of non-participating aircraft avoiding flight within this designated airspace.

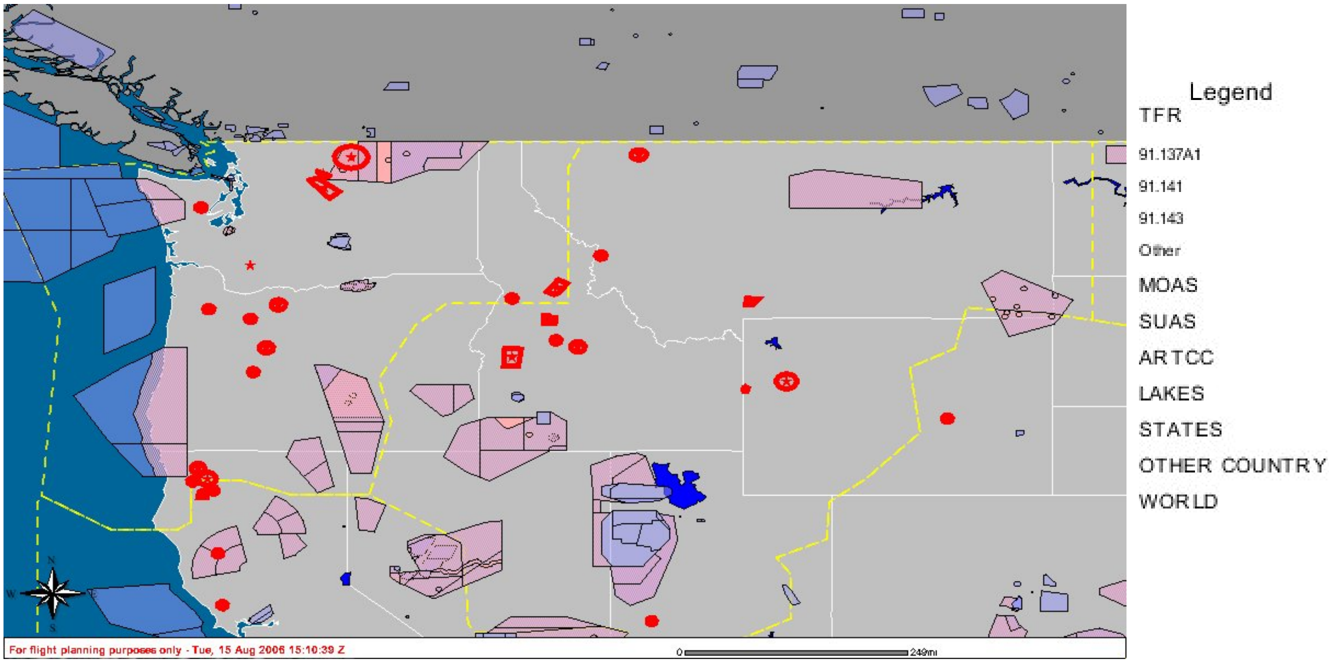


**Figure 2. Example of a TFR**

There are only a limited number of UA that are capable of flying in Class A airspace (FL180 through FL600). Additionally, UAS operations within Class B airspace (airspace surrounding major airports with large numbers of commercial flights and enplaned passengers), at this stage of UAS development, are not recommended, except under unusual circumstances. Therefore, developing creative ways of segregating UA flights from other aircraft should be pursued. The biggest concern with using the segregation method is the possibility of adversely impacting other airspace users' activities. It is imperative that the segregation method effort is well thought out and only started with UA flights that have minimal impact to other airspace users' operations and the ATC system. Of course, any such undertaking must be in concert with the FAA and other potentially affected airspace users. This initiative should be undertaken with opened mindedness of all parties using a crawl, walk, run approach.

There are two additional factors to consider when coordinating UAV airspace operations. First, most UAVs that exist today are not capable of maintaining the operating speed of other aircraft flying in the same environment. For example, the Predator B or Altair UAV operates at about half the operational speed of most other aircraft flying in the same altitude stratum. Because some UAVs operate differently than manned aircraft, airspace areas of high air traffic volume should be avoided, to the extent possible, consistent with the mission requirements. A second factor is the inability to communicate with Aeronautical Radio Incorporated (ARINC) when operating in oceanic airspace due to a lack of high frequency radio equipment. The purpose of this is to make position reports while flying in this airspace. In the instance of oceanic airspace operations, advance coordination must be performed with ARINC to determine their concurrence in accepting oceanic position reports by telephone.

There are three types of flight operations for both UAVs and manned aircraft: transitory operations, operations requiring path specificity, and operations requiring reserved airspace. Transitory flights are those where the flight operates from one location to another, without any specific path being necessary to accomplish the flight objective. Transitory flights provide the most flexibility for the operator and have the least impact on the NAS (ATC system and other airspace users). The second type, flights that require some specific routing or altitude assignment, provide less flexibility than transitory flights and therefore have a greater impact on the NAS. Finally, flights requiring reserved airspace are the least flexible for the operator and have the greatest impact on the NAS. This is because flight operations and ATC separation in the reserved airspace are based on separating non-participating aircraft from the airspace in lieu of allowing normal air traffic operations.

In today's airspace environment, segregation of flight operations is achieved by the FAA creating restricted areas, permanent and temporary, and also by implementing TFRs through the Notice to Airmen (NOTAM) process and pilots complying with the regulatory requirement to operate outside of these airspace areas. Restricted areas are established through the rule-making process in accordance with criteria defined in 14 CFR 11, General Rule Making Procedures, and FAA Order 7400.2, Procedures for Handling Airspace Matters. TFRs are created through the regulatory authority vested in the FAA administrator by Public Law and in accordance with the criteria specified in 14 CFR 91.137, General Operating and Flight Rules and 14 CFR 99.7, Security. The use of restricted areas can be beneficial for research, development, testing, and evaluating UAS airframes, engines, command and control, sensors, and enabling technology, for example; however, it is unlikely that non-military UAS mission airspace would coincide with the location of an already established restricted area. Creating a restricted area to support a particular non-military UAS mission is not realistic and is not needed. What is needed is the ability to develop airspace and regulatory criteria that will segregate certain defined UAS operations from non-participating aircraft, very similar to what is achieved through the implementation of a TFR. Creation of TFR for commercial or non-emergency or national security issues is not within the existing intent of the TFR regulations. Therefore, one idea to create opportunities for some UAS initiatives is to establish a new category of special use airspace UAS Operations Airspace (UOA). This new category of special use airspace, criteria, and procedures would be developed through the rule-making process.

Thoughts of developing a new category of SUA that could be used to segregate some UA operations from other aircraft will, of course, be controversial because of the fear that another piece of the NAS would become restrictive to some manned aircraft flights. Yet, in order to effectively foster the growth of other aviation systems, other airspace users will, on occasion, experience some situations where other airspace users are given some priority. For example, in the not to distance future, the NAS will begin to experience commercial space vehicle flight operations that will have an impact on some aircraft operations in the NAS. The FAA's concept of operation for the launch of these space vehicles is to create launch corridors that will be activated a few minutes before the flight, and other aircraft will be restricted from flying within the corridor while it is active. To reduce the amount of restrictions on other aircraft operations, the launch corridor will be designed into a number of segments and a particular segment will be opened to other air traffic after the space vehicle has traversed that segment. One concept for a space operation is depicted in Figure 3. These procedures will minimize the restrictions that are placed on other aircraft whose routes traverse the commercial space vehicle launch corridor.

Establishing a new category of SUA for UA could affect some manned aircraft flights; however, the extent of this impact can be kept at a very minimal level through effective planning and creation of procedures similar to those planned for commercial space vehicle flight operations. Procedures should be established so that any segregated airspace established specifically for a particular UA operation is active only on a real time basis. Consideration should be given to establishing regulatory criteria for the UA SUA, wherever feasible, that would enable pilots of non-participating aircraft to traverse the UA SUA at there discretion under VFR.

Recently, a TFR was implemented for a section of the United States and Mexico border within portions of Arizona and New Mexico under the criteria of 14 CFR 99, Security. This TFR contained language that enabled non-participating aircraft to traverse the TFR airspace under certain conditions. Similarly, procedures for UAS SUA could be established so manned aircraft could traverse this airspace. Procedures could be established so that pilots of non-participating aircraft could obtain information on the location (position, altitude, and direction of flight) of the UA in the UA SUA. Based on this knowledge, aircraft would be permitted to traverse the airspace under VFR at the pilot's discretion, knowing that the UA has no see and avoid capability. In essence, the regulatory criteria for the UA SUA would establish the UA as always having right-of-way over all other aircraft operating in the UA SUA.

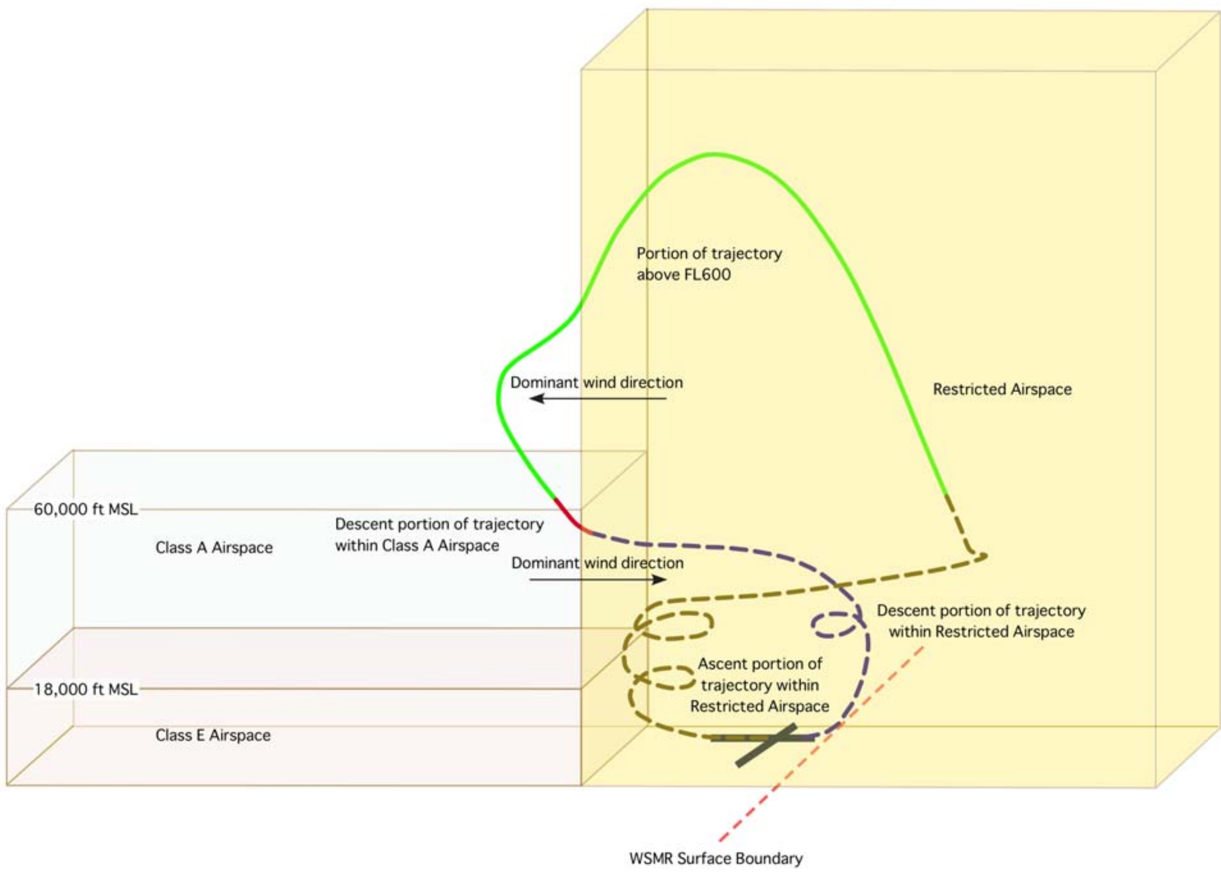


**Figure 3. An Example of Potential Coordinated Airspace in the Vicinity of a Commercial Space Operation**

A UAS test range is under consideration for southern New Mexico for UAS flights. This same area could be used to validate airspace concepts for "UAS operations airspace."

An example of where an operating UA SUA could be established would be over the Trans Alaska Pipeline System (TAPS). Initially the UA SUA could be established over the northern section of the pipeline, basically from Prudhoe Bay to Fairbanks. This UA SUA could be designed so that it is comprised of a number of route segments, with a ceiling of 2000 feet

MSL, and possibly another airspace block of 11,000 to 12,000 feet MSL. Other locations where UA SUA could be evaluated effectively would be along sections of the United State/Mexico border and also along the United Stated/Canada border. Other UA SUA could be considered wherever there is a potential for performing a productive UA mission or for flight testing, provided the surface area beneath the UA SUA airspace is sparsely populated and air traffic is light. Regardless of the number of possible locations for UA SUA, initially only one or possibly two locations should be selected to evaluate the feasibility and effectiveness of creating UA SUA for those UA that are unlikely to have the capability to possess a see and avoid system for the foreseeable future.

The question now is how to go about determining if this concept of creating a new category of SUA has merit and is worth pursuing. Perhaps, the RTCA or ASTM are venues that could be considered.

**References**


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14 CFR 91.113(b), General Operating and Flight Rules.

14 CFR 91.137, General Operating and Flight Rules.

14 CFR 99.7, Safety.

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