Unmanned Aircraft Pilot Medical and Certification Requirements

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ABSTRACT

A research effort was undertaken to establish unmanned-aircraft pilot medical and certification requirements. The effort consisted of a review of relevant literature, a summary of potential unmanned aircraft applications, a review of proposed applications by members of RTCA SC-203, the convening of a panel of subject matter experts, and interactions with groups engaged in the process of establishing unmanned aircraft pilot guidelines. The results of this effort were a recommendation and justification for use of the Class III medical certification and recommendations regarding the training and testing of unmanned - aircraft pilots.

INTRODUCTION

The rapidly expanding commercial Unmanned Aircraft (UA) industry presents a challenge to regulators whose task it is to ensure the safety of the flying public as well as others who might be injured as a result of an aircraft accident. The military has used unmanned aircraft for several decades with various levels of success. Within the last few years, commercial UA operations have increased dramatically. Most of these operations have concentrated on surveillance and advertisement, but several companies have expressed an interest in using unmanned aircraft for a variety of other commercial endeavors.

Although the term "unmanned aircraft" suggests the absence of human interaction, the human operator/pilot is still a critical element in the success of any unmanned aircraft operation. For many UA systems, a contributing factor to a substantial proportion of accidents is human error (Williams, 2004). The FAA needs guidance to assist in the decision of who will pilot UA and what type of training will be required. Research may be required: to investigate the effects on pilot performance of different types of console display interfaces; to determine how UA flight mission profiles affect pilot workload, vigilance, fatigue, and performance; to determine whether prior flight experience is important to operate a UA; to determine whether new opportunities present themselves in terms of the inclusion of persons with handicaps that were previously excluded from piloting aircraft but would not have difficulty with UA; and to investigate medical and physiological standards required to operate a UA.

To assist in developing guidance, an effort was begun to study UA pilot medical and certification qualifications. The approach consisted of several steps. First, a literature review of existing research on UA pilot requirements was conducted. Second, analyses of current and potential UA commercial applications and of current and potential UA airspace usage were completed. The third step in the process was the assembling of a team of subject matter experts that reviewed currently proposed UA pilot medical and certification requirements and made recommendations regarding how those requirements should be changed or expanded. This information, along with the other efforts, was used to develop preliminary task analyses of the unmanned aircraft piloting task. This paper is a summary of this effort.

UA Pilot Requirements Literature Review

The first task was to conduct a review of literature related to the development of UA pilot requirements. The literature fell into just a few basic categories. Many of the papers were recommendations regarding the development of requirements (e.g., DeGarmo, 2004; Dolgin, Kay, Wasel, Langelier, & Hoffman, 2001; Reising, 2003). The paper by Weeks (2000) listed current crew requirements for several different military systems. Finally, some of the papers were a reporting of actual empirical research addressing some aspect of pilot requirements (Barnes & Matz, 1998; Fogel, Gill, Mout, Hulett, & Englund, 1973; Schreiber, Lyon, Martin, & Confer, 2002).

The research by Fogel et al. (1973) was especially interesting because it was one of the earliest attempts to address the issue of UA pilot requirements. In the study, three groups of pilots were recruited to fly a simulation of a Strike remotely piloted vehicle. The first group consisted of Navy attack pilots with extensive combat aircraft experience. The second group consisted of radio-control aircraft hobbyists. The third group was composed of non-pilots with no radio-control aircraft experience. The results showed that, even though the Navy pilots were better than either of the other two groups, the other

groups showed significant improvement in flight control over the course of the sessions, leading the authors to state, "It is hypothesized that a broader segment of relatively untrained personnel could be brought up to the required level of skill with short time simulation/training provided they meet some minimum selection criteria" (Fogel, et al., 1973, p. 75). It should be noted that the control interface consisted of a joystick for controlling the aircraft (but no rudder pedals), with very little in the way of automation for simplifying the control task. However, the researchers did compare two types of flight control systems, with the joystick either directly controlling (simulated) aircraft surfaces or a more sophisticated control system where the joystick commanded the aircraft performance (bank and pitch) directly. The authors concluded that the performance control joystick was superior for aircraft control, regardless of the level of pilot experience.

The research by Schreiber et al. (2002) looked at the impact of prior flight experience on learning to fly the Predator UAS. Seven groups of participants were used in the study, ranging from no flight experience to prior Predator flight experience. Results showed that the group with no flying experience performed significantly worse than the other groups, while the group with previous Predator experience performed significantly better. This finding was expected. However, an unexpected finding from the study was that participants with various levels and types of non-Predator flight experience all performed relatively the same with the Predator system. The authors concluded that any type of flight experience with an aircraft with similar handling characteristics to the Predator was beneficial for flight training on the Predator system. The authors pointed out, though, that the study looked only at stick and rudder skills, and not at more general types of flight skills such as communication and airspace management. In addition, the study did not address whether other types of training, such as simulator training, would also be useful for the transfer of Predator flight skills.

While it might be possible to establish whether a certain type of training or experience is more effectively transferred to a particular UA system, such as the Predator, these studies have not answered the question of whether manned aircraft time is required to be a successful pilot of an unmanned aircraft. We know that certain systems, such as the U.S. Army Hunter and Shadow systems, are successfully flown by pilots with no manned-aircraft experience. However, once these systems begin flying in populated airspace, there is a question of whether a lack of manned-aircraft experience within the airspace might degrade the effectiveness of the pilot and the safety of the flight. Research is needed to address this issue.

UA Applications and Airspace Usage

For a summary of UA applications and airspace usage issues, please reference the technical report (Williams, in review).

Summary of Meeting on UA Pilot Medical and Certification Requirements

On July 26th, 2005, a meeting was held at the FAA Civil Aerospace Medical Institute (CAMI) in Oklahoma City, OK. The purpose of the meeting was to assemble a diverse group of subject matter experts, from industry, academia, the FAA, and the military, to discuss Unmanned Aircraft (UA) pilot medical and certification requirements.

Attendees included representatives of several groups currently working on the development of standards and guidelines for UA. There were representatives from NASA Access 5, ASTM F38, RTCA SC-203, and SAE-G10 at the meeting. In addition, Dr. Warren Silberman represented the FAA Airmen Medical Certification Division and the Office of Aviation Medicine in regard to the medical certification requirements discussion.

Because the meeting was for only one day, an attempt was made to focus the discussion as much as possible by providing a draft standard that was developed by the Flight Standards Division (AFS-400). In particular, two paragraphs from the draft UA standards were reviewed and discussed extensively during the meeting. These two paragraphs are shown below.

6.14 **Pilot/Observer Medical Standards**. Pilots and observers must have in their possession a current third class (or higher) airman medical certificate that has been issued under 14CFR67. 14CFR91.17 regulations on alcohol and drugs apply to both UA pilots and observers.

6.15 **Pilot Qualifications**. The intent of this paragraph is to ensure that UA pilots interacting with ATC have sufficient expertise to perform that task readily.

6.15.1 Pilots must have an understanding of Federal Aviation Regulations applicable to the airspace where the UA will operate.

6.15.2 If the UA is operating on an instrument flight plan, the UA pilot must have an instrument rating.

6.15.3 Pilots flying UA on other than instrument flight plans must pass the required knowledge test for a private pilot certificate as stated in 14CFR61.105 (or military equivalent) for all operations beyond visual line-of-sight and for all operations conducted for compensation or hire regardless of visual proximity.

6.15.4 Pilots requiring instrument ratings will be certificated pilots of manned aircraft.

6.15.5 Equivalent military certificates and training are acceptable in all cases.

In the end, it was decided that not enough was known about these aircraft to make an accurate assessment of all of the risks involved. Because of this, the decision was reached by the group that the original suggestion of a class III medical certification was good, with use of the existing medical waiver process for handling exceptions (e.g., paraplegics). This decision is also supported by the factors identified above that mitigate the severity of pilot incapacitation. However, there was some additional discussion that some applications might require a class II or I medical certification because of the increased risks involved. Imposing different certification requirements, though, would require a clearer specification of pilot certification levels and UA classes. The class III medical certification statement was believed to apply to many, if not all, existing commercial and public UA endeavors (public endeavors would include border patrol applications). The question thus arose as to what types of pilot certification would require a stricter medical certification. Since the document was viewed as certainly undergoing revisions in the future, no wording changes were suggested at this time for paragraph 6.14.

A complete summary of the meeting can be found in the technical report (Williams, in review).

Identification of Knowledge, Skills and Abilities

One final effort undertaken in the research this year was the development of a set of knowledge, skills, and abilities required by the UA pilot. Several groups are working on the development of pilot KSAs, including NASA Access 5 and SAE-G10. The KSAs that have been developed are very similar across the groups because they rely heavily on manned aircraft tasks.

There are, however, three areas that have been identified that distinguish manned from unmanned aircraft. These areas will be important during the development of training and test standards for these systems. The areas are 1) activities and information related to the data link, 2) activities and information related to the task of detecting, sensing, and avoiding aircraft, and 3) activities and information related to the handoff of control during the flight.

Data link issues cut across the entire flight, from pre-flight planning until recovery of the aircraft. It is important that the pilot have an understanding of the conditions that affect the data link during the flight, and be prepared to take appropriate action if the data link is lost. During pre-flight, the pilot should be aware of the weather conditions that will occur during the flight and understand how those conditions will affect the data link. The pilot must also know which portions of the flight might be susceptible to interference or blockage of the data link due to natural barrier or broadcasting. There should also be contingency plans during each leg of the flight in case of a loss of data link. During the flight, there should be procedures for attempting to re-establish the data link if it is lost, and for notifying others, such as air traffic control, if the data link cannot be re-established.

There should be established procedures for detecting, sensing, and avoiding other aircraft during the flight. These procedures might begin before the flight, with the notification of other traffic that an unmanned aircraft will be flying in the airspace. The limitations of whatever method is in place for detecting other aircraft should be well understood. Also, the procedures for avoiding aircraft should be understood and practiced before they have to be used.

The handoff of control during a flight will be a common occurrence for a great many UA systems. Control handoff can occur in a variety of ways. Each method introduces the possibility of human error and has been the cause of a variety of UA accidents (Williams, 2004).

SUMMARY AND CONCLUSIONS

There were two goals for the research that was conducted. The first was a specification of the medical requirements for UA pilots. The sec-

ond was a specification of the certification requirements for UA pilots.

The establishment of medical requirements for UA pilots was based on an analysis of the method for establishing the medical requirements of other occupations, including manned aircraft pilot. Rather than suggesting the creation of a new medical certification for UA pilots, it was decided to use an existing pilot medical certification. There were several reasons supporting this decision, including the bureaucratic difficulty in establishing a new certification level and the problems associated with training medical examiners who would be asked to assess whether pilots successfully met the new requirements.

Given that an existing medical certification was to be used, the question of which level of certification should be required was then based on the perceived level of risk imposed by the potential incapacitation of the UA pilot. The third class medical certification was judged to be the most acceptable based on the idea that there were several factors that mitigated the risk of pilot incapacitation relative to manned aircraft. First, factors related to changes in air pressure could be ignored, assuming that control stations for non-military operations would always be on the ground. Second, many of the current UA systems have procedures established for lost data link. Lost data link, where the pilot cannot transmit commands to the aircraft, is functionally equivalent to pilot incapacitation. Third, the level of automation of a system determines the criticality of pilot incapacitation, since some highly automated systems (e.g., Global Hawk) will continue normal flight whether a pilot is present or not.

The specification of certification requirements for UA pilots should be based on a task analysis of the UA piloting task and a specification of the knowledge, skills, and abilities needed for the task. While several groups have been working on completing such a task analysis, the work is still ongoing. Therefore, it is not possible at this time to reach definitive conclusions regarding certification requirements for UA pilots.

The available research on pilot qualifications shows that, while manned-aircraft experience is beneficial for piloting some UA systems (Schreiber et al., 2002), basic stick-and-rudder skills can also be mastered by those without flight experience (Fogel et al., 1973). This, of course, makes sense since even pilots with manned-aircraft experience had no flight experience at some point in their career. The question in regard to whether or not manned-aircraft flight experience should be a prerequisite for UA pilots centers on whether there is any learning that occurs during manned-aircraft flight training that would not be adequately addressed during training with an unmanned aircraft. One possibility is the idea of “shared fate”. The fact that the pilot does not share the fate of the aircraft might lead to differences in decision-making during a flight (McCarley & Wickens, 2005). Another possibility, though one that has not been addressed experimentally, is that a full understanding of the three-dimensional aspect of the aircraft in the airspace cannot occur without experience in the airspace. Research is required to address this issue.

An analysis of the types of applications expected for UA indicated that airspace usage might be neatly divided between applications that use only Class G airspace and those that use other classes. Those that use only Class G airspace, with the exception of flights within restricted areas such as military areas of operation, were limited to line-of-sight from the pilot. Those that utilized other classes of airspace were always beyond-line-of-sight. This distinction (line-of-sight vs. beyond-line-of-sight) might be a useful way to classify types of unmanned aircraft for purposes of airworthiness ratings as well as pilot ratings.

Finally, while both training and test standards should be structured similarly to manned aircraft training and testing, they should include areas that are unique to the piloting of unmanned aircraft. Three areas that were identified as unique were data link issues, detect, sense, and avoid issues, and control handoff issues. The development of training and testing standards will require that these issues be addressed completely.

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