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Unmanned Aircraft Pilot Medical Certification Requirements

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Final Report

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16. Abstract This research study was undertaken to create recommendations for unmanned aircraft pilot medical certification requirements. The effort consisted of 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 second-class medical certification.					
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EXECUTIVE SUMMARY

This research addressed the medical requirements necessary for unmanned aircraft (UA) pilots for successful flight in the National Airspace System (NAS). Given that an existing medical certification was recommended, the question of which class of certification to propose was based on the perceived level of risk imposed by the potential incapacitation of the UA pilot. A second-class medical certification was judged to be the most acceptable, considering that there were several factors that mitigated the risk of pilot incapacitation relative to those of manned aircraft. First, factors related to changes in air pressure could be ignored, assuming that control stations for non-military operations would be on the ground. Second, many of the current UA systems have procedures that have been 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 because some highly automated systems (e.g., Global Hawk) will continue normal flight whether a pilot is or is not present.

UNMANNED AIRCRAFT PILOT MEDICAL CERTIFICATION REQUIREMENTS

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 varying 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 Federal Aviation Administration (FAA) needs guidance to assist in deciding who will pilot UA and the training required. Research may be required to investigate the effects on pilot performance of different types of console display interfaces; how UA flight mission profiles affect pilot workload, vigilance, fatigue, and performance; and to determine whether prior flight experience is important in both training and operation of UA. Also, it is important to determine whether new opportunities present themselves in terms of the inclusion of handicapped persons previously excluded from piloting aircraft but not expected to have difficulty with piloting a UA, and to investigate medical and physiological standards required to operate UA.

To assist in developing guidance, a research effort was begun to produce recommendations regarding UA pilot medical qualifications. The approach consisted of three steps. First, a literature review of existing research on UA pilot requirements was conducted. Second, an analysis of current and potential UA commercial applications and an analysis of current and potential UA airspace usage was completed. The third step in the process involved assembling a team of subject matter experts to review proposed UA pilot medical and airman certification requirements and make recommendations regarding how those requirements should be changed or expanded. This paper is a summary of that effort.

UA PILOT REQUIREMENTS LITERATURE REVIEW

The first task was to review the literature related to the development of UA pilot requirements. Appendix A presents a bibliography of research related to the development of UA pilot requirements. The literature fell into 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 reported 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 was composed of non-pilots with no radio-control aircraft experience. The results showed that, even though the Navy pilots scored better than either of the other two groups, the non-pilot groups showed significant improvement in flight control across 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., p. 75).

In the study, 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, both Predator and manned aircraft, on learning to fly the Predator unmanned aircraft system (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 at relatively the same level on 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. They 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 transfer to the Predator.

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, like 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.

Finally, in regard to pilot medical qualifications, the literature review failed to find any research that was relevant. While it might be possible to make the argument that studies showing the benefit of manned aircraft experience for the piloting of certain systems suggest that medical qualifications should be similar to manned aircraft qualifications, the more reasonable conclusion is that no research is available to guide the decision on medical qualifications.

UA APPLICATIONS AND AIRSPACE USAGE

After completion of the literature review, the second task was an assessment of current and near-term UA applications, along with an assessment of the types of airspace usage that would be required for the applications. It is of critical importance that we anticipate the types of activities that will be accomplished using UA. The activities that they will perform will determine the kinds of systems required, the types of airspace that will be flown through, the level of automation that will be used, and the pilot skills and abilities needed to perform the task. The airspace requirements will, in turn, determine the expected degree of interaction with air traffic control and with other aircraft that will occur during typical flights.

The potential applications to which UA can be employed is expansive. However, they all fall into just a few basic categories, based on the type of payload that is carried and its function. The primary purpose for unmanned aircraft stems from the need to place a payload of some type in an aircraft. These needs fall into the categories of 1) Sensor/Surveillance, 2) Payload Delivery, 3) Orbiting, and 4) Transport.

Sensor/Surveillance

By far, the largest category of current applications for UA, both military and civilian, is Sensor/Surveillance. The placement of a camera or other type of sensor on an aircraft has a great many uses. The types of applications vary widely in regard to the type of sensor employed, the level of detail required, and what is being surveilled.

Within the category of sensor/surveillance, we can distinguish between moving and stationary targets. We can also distinguish between the need for real-time download of data or the collection of information that can be analyzed later.

A few current sensor/surveillance applications include logging inspection, pipeline and power line inspection, border patrol, and crop analysis. Potential applications include those involving law enforcement, agriculture, construction, media, the petroleum industry and public utilities (James, 1994), as well as data collection for archaeologists, surveyors, and geologists (Aerospace Daily, 1994). Other applications include monitoring wildfires, floods, and crops (Dino, 2003).

Payload Delivery

Payload delivery applications refer to the use of a UA to deliver a non-reusable payload. For military UA, this refers to ordnance delivery such as air-to-air or air-to-ground missiles. Civil applications of payload delivery would be crop dusting or fire fighting. Air-to-air refueling is also an example of payload delivery. For each of these applications, the payload is expendable and is not intended to return with the aircraft. This aspect distinguishes the payload delivery category from other categories.

Orbiting

Orbiting applications require that the aircraft maintain position at a particular location for reasons other than surveillance. At least three applications present themselves in this category. One is the use of UA at high altitudes to act as communication satellites. Telecommunications companies could use UA to relay signals for mobile phones, for example. Another application is the use of UA for advertising purposes; banner towing, for example.

Transport

Transport applications refer to the carrying of goods and/or people from one location to another. Express mail delivery to small towns is one potential transport application (Aerospace Daily, 1994). For this category, the payload is not expendable and is expected to survive the flight intact. In addition, the payload is intended to be moved from one location to another, as opposed to those applications where the payload is returned to the point of origin.

Airspace Usage

It is important that we anticipate how these various applications will impact the airspace. Table 1 lists various types of UA applications, organized by the type of airspace that will be utilized. The airspace categories are

listed (from top to bottom) in terms of the criticality of sense-and-avoid technology required to fly in that airspace. The term “transition” in the table refers to the fact that the aircraft might take off from a public use airport (Class B, C, or D airspace) and have to transit through this airspace before getting to the location where the focal activity will occur.

We have differentiated between two types of Class G airspace, depending on whether the area underlying that airspace is populated or not. Flight in Class G airspace sometimes originates from a public use airport, depending on the size of the aircraft or its ability to land and takeoff vertically or without a runway. These factors led to the differentiation of four separate categories that deal with Class G airspace. The category called “high altitude flight” refers to flight above FL430 (43,000 feet above mean sea level), which is still within Class A airspace but is rarely used by air carriers. Flight within Class E airspace was considered more critical than flight within Class A airspace in regard to the sense-and-avoid issue because Class A is positively controlled airspace and because equipment requirements for aircraft within Class A are more stringent than equipment requirements for Class E.

RTCA Scenarios

In an effort to gauge the types of applications and systems that are expected, a review was made of 63 unmanned aircraft flight scenarios that were developed by members of RTCA Special Committee 203 on Unmanned Aircraft Systems. These scenarios are posted on their limited-access Web site.

The scenarios describe systems that range in weight from 200 grams up to 96,000 pounds. Many of the scenarios use existing military systems. Sometimes these scenarios are military in nature, but more often the scenarios involve civilian use of a military system. After

Table 1. Listing of applications by airspace requirements.

Airspace\Application	Surveillance	Payload	Orbit	Transport
Class G only unpopulated	RC apps, crop inspection			
Transition to Class G unpopulated	Pipeline inspection	Crop dusting		
Class G only populated	Building fire inspection			
Transition to Class G populated	Powerline inspection		Advertisement	
Transition to high altitude flight	Environmental imaging		Pseudo satellite	
Transition to Class A	Crop surveys	Air refuel		Cargo/people
Transition to Class E	Law enforcement		Banner towing	Cargo

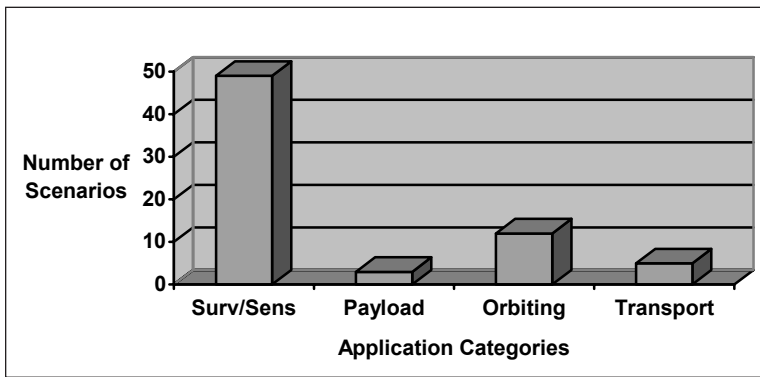


Figure 1. Breakdown of RTCA scenarios by application category

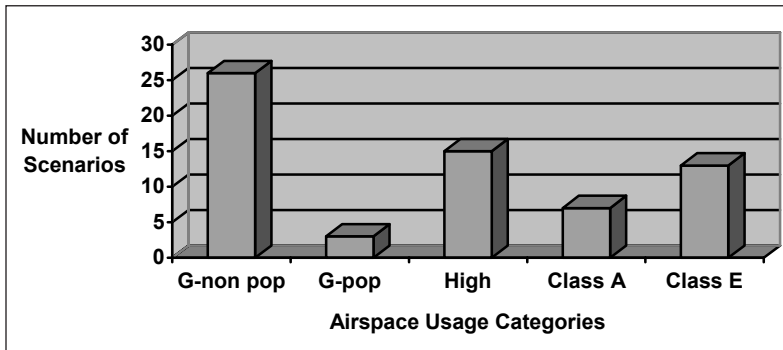


Figure 2. Breakdown of RTCA scenarios by airspace usage category.

reviewing each of the scenarios, the following figures were constructed to categorize the types of applications proposed and the types of airspace that will be used. Figure 1 shows how the scenarios fall into the four basic types of applications described above.

As can be seen from Figure 1, most scenarios, 49 (78%), fell into the Sensor/Surveillance category. The Orbiting category was a distant second, although it should be pointed out that test flights were placed into this category. The Transport applications included the delivery of mail and the transportation of donor organs. Finally, the Payload applications included two in-flight refueling scenarios and a military strike mission.

Figure 2 shows the breakdown of scenarios according to how they would use the airspace. Airspace usage categories are those referenced earlier. It should be noted that the numbers in Figures 1 and 2 add to greater than the number of scenarios because some of the suggested scenarios included more than one application and more than one type of airspace being used.

Figure 2 does not show two of the airspace usage categories because there were no scenarios associated with those categories. Those categories were *transition to non-populated Class G* airspace and *transition to populated Class G* airspace. That these categories were not included

in the scenarios suggests that the types of systems expected to fly in Class G airspace would be able to take off and land without the need for a runway. All of the scenarios occurring within Class G airspace assumed that the aircraft would be launched and recovered within Class G airspace. Scenarios occurring within a military operational area (MOA) were classified as Class G airspace over a non-populated area. Scenarios occurring within Class G airspace over a populated area (G-pop in the figure) involved monitoring automobile traffic, transporting donor organs to hospitals, and police surveillance. It is interesting to note that the majority of scenarios used airspace in a manner that minimized the need for sense-and-avoid technologies. One conclusion that was evident from reviewing the RTCA scenarios is that a distinction can be made between systems that remain within the line-of-sight of the pilot and those that do not. This distinction could prove useful when it comes to specifying airworthiness and pilot classifications.

SUMMARY OF A MEETING ON UA PILOT MEDICAL REQUIREMENTS

On July 26, 2005, a meeting was held at the FAA Civil Aerospace Medical Institute (CAMI) in Oklahoma City, OK, of a diverse group of subject matter experts from industry, academia, the FAA, and the military to discuss UA pilot medical requirements. Table 2 lists the attendees and contact information.

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

Given that the meeting encompassed only a single day, an attempt was made to focus the discussion as much as possible by providing to the group a draft standard that was developed by the FAA Flight Standards Division (AFS-400). In particular, one paragraph from the draft UA standard (shown below) was reviewed and discussed extensively during the meeting.

Table 2. Attendee listing.

Name	Organization	E-mail	Phone
Adams, Rich	FAA AFS-430	rich.adams@faa.gov	202-385-4612
Beringer, Dennis	FAA/CAMI AAM-510	dennis.beringer@faa.gov	405-954-6828
Berson, Barry	Lockheed Martin/Access 5	barry.berson@lmco.com	661-572-7326
Eischens, Woody	MTSI/Access 5	weischens@mtsi-va.com	703-212-8870 x133
Goldfinger, Jeff	Brandes Associates/ASTM F38	jgoldfinger@brandes-assoc.com	775-232-1276
Johnson, Marca	Access 5	marca@direcway.com	410-961-3149
McCarley, Jason	U of Illinois Institute of Aviation	mccarley@uiuc.edu	217-244-8854
Silberman, Warren	FAA/CAMI AAM-300	warren.silberman@faa.gov	405-954-7653
Swartz, Steve	FAA AFS-430	steven.swartz@faa.gov	202-385-4574
Tvaryanas, Anthony	USAF (311 HSW/PE)	anthony.tvaryanas@brooks.af.mil	210-536-4446
Williams, Kevin	FAA/CAMI AAM-510	kevin.williams@faa.gov	405-954-6843

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. The provisions of 14CFR91.17 on alcohol and drugs apply to both UA pilots and observers.

Current pilot medical requirements are separated into three classes. Table 3 lists the requirements for each class.

The first topic discussed was whether the agency should create a new medical certification category for UA pilots or use an existing certification. The rapid consensus by the group was that the creation of a new certification would be prohibitive for a number of reasons related to the difficulty, expense, and time of initiating any new rulemaking activity.

The next topic addressed which existing medical certification(s) to use. Several suggestions were generated by the group, including the use of the Air Traffic Controller (ATC) medical certification and the use of an automobile driver's license. Regarding the ATC medical certification, the argument presented was that the activity of a UA pilot was, in some ways, closer to that of an air traffic controller. However, it was pointed out that there was very little difference between the ATC medical requirements and the second-class medical certification requirements. The real question, then, could be reduced to whether or not a second-class medical was required.

The discussion regarding the use of an automobile driver's license, as is done in Australia and in the United States for the Sport Pilot Certificate, centered on the idea of accountability and professionalism. Some of the group maintained that there was a need to instill at least a minimal level of accountability and professionalism upon UA pilots, and that the use of a driver's license would not accomplish this goal. Others, however, suggested that the pilot certification process could be used

to instill professionalism and accountability and that a stronger rationale, using medical reasons, should be established before discarding the use of a driver's license for medical requirements.

As a follow-up to the meeting, Anthony Tvaryanas provided a useful summarization regarding the establishment of occupational medical standards. Basically, there are two separate reasons to establish medical standards for occupations. The first is predicated on the need within individual organizations to establish medical standards that comply with the Americans with Disabilities Act. The procedure includes an analysis of the job requirements (knowledge, skills, and abilities) for a particular position. Because the analysis is for each individual job, there is no generalizable medical standard. After the job requirements are established, the medical examiner, as described by Tvaryanas, "typically receives a list of the job essential tasks (stand for 2 hrs, lift 25 lbs, etc.). The examiner determines and reports whether the individual can or cannot perform the essential tasks outlined by the employer. If they cannot, the organization has a duty to attempt to accommodate the individual (redesign the job), unless it poses an undue burden on the organization, or the individual poses an undue hazard to the safety of self or others. This approach is fraught with the potential for litigation" (Tvaryanas, personal communication).

The second reason for establishing medical standards is to protect the public from occupations where public safety is potentially at risk, such as transportation (including air transport) and the nuclear industry. Medical standards for these occupations are not based on an analysis of the specific tasks but, instead, are focused on the risk of impairment or incapacitation due to the pathology of any preexisting medical conditions. These standards also usually stipulate provisions for drug and alcohol testing. The establishment of medical standards for unmanned

Table 3. Pilot medical certification standards.

Certificate Class Pilot Type	First-Class – Airline Transport	Second-Class – Commercial	Third-Class - Private
Distant Vision	20/20 or better in each eye separately, with or without correction.		20/40 or better in each eye separately, with or without correction.
Near Vision	20/40 or better in each eye separately (Snellen equivalent), with or without correction, as measured at 16 in.		
Intermediate Vision	20/40 or better in each eye separately (Snellen equivalent), with or without correction at age 50 and over, as measured at 32 in.		No requirement.
Color Vision	Ability to perceive those colors necessary for safe performance of pilot duties.		
Hearing	Demonstrate hearing of an average conversational voice in a quiet room, using both ears at 6 feet, with the back turned to the examiner or pass one of the audiometric tests.		
Audiology	Audiometric speech discrimination test (Score at least 70% discrimination in one ear): <div style="text-align: center;"> <u>500Hz</u> <u>1,000Hz</u> <u>2,000Hz</u> <u>3,000Hz</u> Better Ear 35Db 30Db 30Db 40Db Worse Ear 35Db 50Db 50Db 60Db </div>		
Ear, Nose & Throat	No ear disease or condition manifested by, or that may reasonably be expected to be manifested by, vertigo or a disturbance of speech or equilibrium.		
Blood Pressure	No specified values stated in the standards. 155/95 Maximum allowed.		
Electrocardiogram	At age 35 & annually after age 40.	Not routinely required.	
Mental	No diagnosis of psychosis or bipolar disorder or severe personality disorders.		
Substance Dependence & Substance Abuse	A diagnosis or medical history of substance dependence is disqualifying unless there is established clinical evidence, satisfactory to the Federal Air Surgeon, of recovery, including sustained total abstinence from the substance(s) for not less than the preceding 2 yrs. A history of substance abuse within the preceding 2 yrs is disqualifying. Substance includes alcohol and other drugs (i.e., PCP, sedatives and hypnotics, anxiolytics, marijuana, cocaine, opioids, amphetamines, hallucinogens, and other psychoactive drugs or chemicals.)		
Disqualifying Conditions Note: Pilots with these conditions may still be eligible for “Special Issuance” of a medical certificate.	Examiner must disqualify if the applicant has a history of: (1) diabetes mellitus requiring hypoglycemic medications; (2) angina pectoris; (3) coronary heart disease that has been treated or, if untreated, that has been symptomatic of clinically significant; (4) myocardial infarction; (5) cardiac valve replacement; (6) permanent cardiac pacemaker; (7) heart replacement; (8) psychosis; (9) bipolar disease; (10) personality disorder that is severe enough to have repeatedly manifested itself by overt acts; (11) substance dependence; (12) substance abuse; (13) epilepsy; (14) disturbance of consciousness without satisfactory explanation of cause; and (15) transient loss of control of nervous system function(s) without satisfactory explanation of cause.		

aircraft pilots clearly falls under the second reason. Thus, the suggestion by Tvaryanas and others in the group (e.g., Eischens) was that it is important to identify the factors associated with the risk of pilot incapacitation for unmanned aircraft in deciding on the appropriate level of medical certification. In addition, it is important that we understand these factors as they relate to manned aircraft to obtain an objective assessment.

Ultimately, the primary driver of the decision of which certification level to use was the current perception of risk for these aircraft. One member of the group offered the following comment in regard to the definition of acceptable risk:

I think the core issue is defining acceptable public risk from UA operations and applications. This has historically driven (at least in part) the evolution of the current stratified pilot and medical certification systems for manned aviation. This cut-point (acceptable versus unacceptable risk) is not defined by the medical, scientific, or engineering communities, but rather by the policy community (e.g., our political/regulatory institutions). For example, the current '1% rule' (derived from European civil aviation standards) for risk of incapacitation in commercial aviation is a policy threshold. It could just have easily been a '2% rule' or a '5% rule.' The point is that it is a completely arbitrary boundary. The function of the medical/scientific community is to then quantify an individual's risk to determine whether they may exceed this arbitrary threshold. This is accomplished in part by setting certification standards. It is inherently futile for the medical and scientific communities to try to set standards without the policy community first defining 'acceptable risk.' I would urge the FAA to consider this core issue early, and then return to a discussion of standards setting. Once 'acceptable public risk' is defined, setting medical standards becomes more an academic exercise rather than a policy debate (A. Tvaryanas).

Regarding the risk of pilot incapacitation, at least a few factors distinguish this risk from manned aircraft. First, factors related to changes in air pressure can be ignored, assuming that control stations for non-military operations will always be on the ground. Second, it was pointed out by one participant that 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 (Goldfinger, personal communication). For those systems with an adequate procedure for handling a lost data link, pilot incapacitation does not compromise safety to the same extent as it would in a manned aircraft. 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 (Tvaryanas, personal communication).

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 third-class medical certification was adequate, with use of the existing medical waiver process (also called "Authorization of Special Issuance") for handling exceptions (e.g., paraplegics). This decision was also supported by the factors identified above that mitigate the severity of pilot incapacitation. However, there was additional discussion that some applications might require a second- or first-class 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 third-class medical certification statement was believed to apply to many, if not all, existing commercial and public UA endeavors (e.g., border patrol applications). The question then arose as to what types of pilot certification would require stricter medical certification. Because the document was viewed as sufficient for present needs, no wording changes were suggested for paragraph 6.14.

Since the meeting, the FAA Office of Aerospace Medicine has suggested that a second-class medical certification might be more appropriate for UA pilots. The main reasons for this recommendation are that some UA pilots are required to maintain visual contact with the aircraft and a third-class medical certification requires only 20/40 vision, with or without correction. On the other hand, second-class medical certification requires 20/20 vision, with or without correction. A second reason for a second-class medical is that there are currently no commercial pilots that have less than a second-class medical. A replacement paragraph has been drafted that will change the medical certification requirement to second-class. The paragraph is as follows:

Pilot/Observer Medical Standards. Pilots and observers engaging in flight operations for compensation or hire who will, in the course of their duties, perform visual collision avoidance duties IAW¹ paragraph 6.20 of this policy, must have in their possession a current Second-Class airman medical certificate that has been issued under 14 CFR 67, Medical Standards And Certification. Pilots and observers engaged in flight operations of other than a commercial nature will possess a current Class Three medical certification. The provisions of 14 CFR 91.17, Alcohol or Drugs, applies to both UA pilots and observers. The Department of Defense will establish guidelines for medical fitness that, in the judgment of the services, provides a similar standard.

¹ In accordance with (IAW)

SUMMARY AND CONCLUSIONS

The goal of the research was a recommendation of the medical requirements for UA pilots. The recommendation for the level of medical class for UA pilots was based on an analysis of the method for establishing the medical requirements of other occupations, including manned-aircraft pilots. Rather than suggesting the creation of a new medical class for UA pilots, the group decided to recommend an existing pilot medical certification. There were several reasons supporting this decision, including the difficulty of establishing a new certification level and the problems associated with training medical examiners that would be asked to assess whether UA pilots successfully met the new requirements.

Given that an existing medical certification was recommended, the question of which class of certification to propose was based on the perceived level of risk imposed by the potential incapacitation of the UA pilot. The original recommendation of a third-class medical certification was replaced with the implementation of a second-class medical in the standards. The decision was based on the idea that there were several factors that mitigated the risk of pilot incapacitation relative to those of 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 that have been 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 because some highly automated systems (e.g., Global Hawk) will continue normal flight whether a pilot is or is not present.

Against these mitigating factors was the fact that most UA operations were anticipated to be public use, such as border patrol flights or commercial activities. Manned-aircraft pilots in these instances are required to have a second-class medical certification. In addition, there is very little difference between a second- and third-class medical certification. The major differences are the vision requirements (20/20 vs. 20/40 correctable) and how often they must be renewed.

Finally, the waiver process available to pilots provides that handicapped persons can still receive a medical certification. All that is required is a demonstration of their ability to pilot the aircraft effectively. This process gives individuals who might not be able to fly manned aircraft an opportunity to receive medical certification for flying an unmanned aircraft. However, issues with pilot airman certification must still be resolved before this can occur.

REFERENCES

- Aerospace Daily (1994). Future of UAVs depends on commercial, not military markets. *Aerospace Daily*, 170(39), 308.
- Barnes, M.J. & Matz, M.F. (1998). Crew simulations for unmanned aerial vehicle (UAV) applications: Sustained effects, shift factors, interface issues, and crew size. *Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting*, 143-7.
- DeGarmo, M. (2004). *Issues concerning integration of unmanned aerial vehicles in civil airspace*. Mitre Corporation Report # MP04W0000323.
- Dino, J. (2003). NASA to dedicate new unmanned aerial vehicle technology center. Retrieved on 3/26/2004 from NASA News Web site, URL http://amesnews.arc.nasa.gov/releases/2003/03_56AR.html.
- Dolgin, D., Kay, G., Wasel, B., Langelier, M., & Hoffman, C. (2001). Identification of the cognitive, psychomotor, and psychosocial skill demands of uninhabited combat aerial vehicle (UCAV) operators. Downloaded on 3/10/2005 from URL <http://forum.nomi.med.navy.mil/articles/safeucav/>.
- Fogel, L.J., Gill, R.S., Mout, M.L., Hulett, D.G., & Englund, C.E. (1973). *Principles of display and control design for remotely piloted vehicles*. Decision Science, Inc. second semi-annual technical report on Contract #N00014-72-C-0196, Project # NR 196-119/11-29-71 455.
- James, T. (1994). Multi-mission/multi-agency reconfigurable UAV. *Unmanned Systems, Winter*, 41-2.
- McCarley, J.S. & Wickens, C.D. (2005). *Human factors implications of UAVs in the national airspace*. University of Illinois Institute of Aviation Technical Report (AHFD-05-5/FAA-05-1). Savoy, IL: Aviation Human Factors Division.
- Reising, J.M. (2003). The role of operators in uninhabited military vehicles: A NATO perspective. *Proceedings of the 12th International Symposium on Aviation Psychology*, Dayton Ohio, April 14-17, 988-92.
- Schreiber, B. T., Lyon, D. R., Martin, E. L., & Confer, H. A. (2002). *Impact of prior flight experience on learning Predator UAV operator skills* (AFRL-HE-AZ-TR-2002-0026). Mesa, AZ: Air Force Research Laboratory, Warfighter Training Research Division.

Weeks, J.L. (2000). *Unmanned aerial vehicle operator qualifications (AFRL-HE-AZ-TR-2000-0002)*. Mesa, AZ: Air Force Research Laboratory, Warfighter Training Research Division.

Williams, K.W. (2004). *A summary of unmanned aircraft accident/incident data: Human factors implications*. U.S. Department of Transportation, Federal Aviation Administration technical report (DOT/FAA/AM-04/24). Washington, DC: Office of Aerospace Medicine.

APPENDIX A

UA PILOT QUALIFICATIONS BIBLIOGRAPHY

- Barnes, M.J. & Matz, M.F. (1998). Crew simulations for unmanned aerial vehicle (UAV) applications: Sustained effects, shift factors, interface issues, and crew size. *Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting*, 143-7.
- Barnes, M. J., Knapp, B. G., Tillman, B. W., Walters, B. A., Velicki, D. (2000). *Crew systems analysis of unmanned aerial vehicle (UAV) future job and tasking environments* (Technical Report ARL-TR-2081). Aberdeen Proving Ground, MD: Army Research Laboratory.
- Biggerstaff, S., Blower, D.J., Portman, C.A., & Chapman, A.D. (1998). *The development and initial validation of the unmanned aerial vehicle (UAV) external pilot selection system* (NAMRL 1398). Pensacola, FL: Naval Aerospace Medical Research Laboratory.
- DeGarmo, M. (2004). *Issues concerning integration of unmanned aerial vehicles in civil airspace*. Mitre Corporation Report # MP04W0000323.
- DeGarmo, M. & Nelson, G.M. (2004). *Prospective unmanned aerial vehicle operations in the future national airspace system*. Paper presented at the American Institute of Aeronautics and Aeronautics' 3rd "Unmanned Unlimited" Technical Conference, Workshop and Exhibit, September 20-22, Chicago, IL.
- Dolgin, D., Kay, G., Wasel, B., Langelier, M., & Hoffman, C. (2001). *Identification of the cognitive, psychomotor, and psychosocial skill demands of uninhabited combat aerial vehicle (UCAV) operators*. Downloaded on 3/10/2005 from URL <http://forum.nomi.med.navy.mil/articles/safeucav/>.
- Fogel, L.J., Gill, R.S., Mout, M.L., Hulett, D.G., & Englund, C.E. (1973). *Principles of display and control design for remotely piloted vehicles*. Decision Science, Inc. second semi-annual technical report on Contract #N00014-72-C-0196, Project # NR 196-119/11-29-71 455.
- Hall, E.P. & Tirre, W.C. (1998). *USAF air vehicle operator training requirements study* (AFRL-HE-BR-SR-1998-0001). Brooks Air Force Base, TX: Air Force Research Laboratory, Human Effectiveness Directorate.
- Kiggans, R.G. (1975). *Air Force RPV operators: Rated vs non-rated* (MSThesis Number GSM/SM/75D-15). Wright-Patterson AFB, OH: Air Force Institute of Technology.
- Reising, J.M. (2003). The role of operators in uninhabited military vehicles: A NATO perspective. *Proceedings of the 12th International Symposium on Aviation Psychology*, Dayton Ohio, April 14-17, 988-92.
- Schreiber, B. T., Lyon, D. R., Martin, E. L., & Confer, H. A. (2002). *Impact of prior flight experience on learning Predator UAV operator skills* (AFRL-HE-AZ-TR-2002-0026). Mesa, AZ: Air Force Research Laboratory, Warfighter Training Research Division.
- Tirre, W.C. (1998). Crew selection for uninhabited air vehicles: Preliminary investigation of the air vehicle operator (AVO). *Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting*, 118-22.
- Walters, B.A., Huber, S., French, J., & Barnes, M.J. (2002). *Using simulation models to analyze the effects of crew size and crew fatigue on the control of tactical unmanned aerial vehicles (TUAVs)* (ARL-CR-0483). Aberdeen Proving Ground, MD: Army Research Laboratory.
- Weeks, J.L. (2000). *Unmanned aerial vehicle operator qualifications* (AFRL-HE-AZ-TR-2000-0002). Mesa, AZ: Air Force Research Laboratory, Warfighter Training Research Division.

