Office of the Chief Scientist for Human Factors

Human Factors Vertical Flight

Program Review
FY01

Dr. William K. Krebs, Vertical Flight Human Factors Program Manager

Federal Aviation Administration
AAR-100 (Room 907A)
800 Independence Avenue, S.W.
Washington, D.C. 20591
phone (202) 267-8758
e-mail: william.krebs@faa.gov
http://www.hf.faa.gov/krebs

The Federal Aviation Administration Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) vertical flight human factors program is a relative new research domain. Research in this area is meant to identify specific human factors associated with helicopter flight regimes within the National Airspace System. Such issues include certification and regulation of civilian flights with night-vision-goggles devices, simultaneous non-interfering operations, and implications of tilt-rotor controls. Other current research requirements include head-up displays for general aviation rotorcraft, low speed helicopter/power lift displays, and vertical flight IFR approach lighting requirements.

The following report summarizes projects between October 1st, 2000 and December 31st, 2001. These projects attempt to address requirements identified by the Federal Aviation Administration Flight Standards and Certification offices. The intent of this report is to allow Federal Aviation Administration sponsors to determine whether their requirements have been satisfactorily addressed, allow investigators to receive feedback from Federal Aviation Administration sponsors and other interested parties, and to provide feedback to the AAR-100 vertical flight human factors program manager on the quality of the research program. Basically, this document is a means of holding each group (sponsor, investigator, AAR-100 program manager) accountable to ensure that the program is successful.

The vertical flight human factors program research has focused on two areas: night vision goggles and simultaneous non-interfering operations. The FY01 projects are described in Appendix I and the requirements that are mapped to these projects are located in Appendix II.

Appendix III lists the FY02 funded projects ($220,000 contract dollars) and the proposed FY03 (estimated $118,000 contract dollars) and FY04 projects.

Address questions or comments to:

William K. Krebs, Ph.D.

Appendix I

Human Factors Vertical Flight

FY01 Project Summaries

Project Title: Night Vision Goggles (NVGs) and NVG Equipment with Market Potential

Primary Investigator: Dr. Carol Simpson, PLRA, 485 Summit Springs Road, Woodside, CA 94062 (e-mail: simpson@merlin.arc.nasa.gov)

FAA Sponsor Organization: ASW (POC: Lorry Faber)

Sponsor's Requirement Statement: This research will contribute to formulating an AC and Noticed for Proposed Rulemaking (NPRM) for civil operations for general aviation and rotorcraft for NVG certification and operations. There is currently no guidance for NVG's except for military specifications and regulations which may not be adequate for civil use.

Research Project's Goal: The purpose of this research is to develop a list of present and, where possible, near term marketable NVG devices that may be reasonably submitted for civil certification. Additionally, this study assessed each potentially marketable device for compliance with the minimum Minimum Operational Performance Standards (MOPS) requirements, referred to herein as the "MOPS baseline". The information in this report will assist in building the database of information required for establishing both appropriate certification criteria, and effective certification procedures and measurements.

Best Accomplishment: Found that the MOPS set a high standard that can only be met by the highest performing goggles on the market.

Project Summary: The purpose of this study was to survey the market and identify NVGs that meet MOPS requirements. This was accomplished and the information provided shows a clear picture concerning the full spectrum of NVG appliances that are available on the market that could potentially be used use by civil operators. The study results let the reader compare the technical specifications of the NVGs listed and to understand the strengths and weaknesses of each product when compared to the MOPS baseline.

The research methodology used was a straight-forward presentation of the results of data collection, data analysis and data conclusion and comments. NVG design technical terms were defined and the baseline MOPS requirements were presented to set the "information stage" before presenting the data collection results for comparison. The data collection results were broken down into sections with the first presenting goggles that met the MOPS, and the second section presenting those that did not.

There were 13 different sets of NVGs analyzed. Of these, 6 goggles met the MOPS requirements (with select tubes installed), and 7 goggles clearly did not

meet the minimum specification. Prices of these goggles ranged from $550 to $9000. All of the American made goggles had export restrictions, including the oldest model AN/PVS-5, to protect the intensifier tube design technology.

Scientific and Technical Objectives: The goal of this task was to research and develop a list of marketable NVG devices that may be reasonably submitted for civil certification. The primary list was limited to devices that meet the minimum operational performance requirements or equivalent for AN/ANVIS-6 or the OMNI III contract. A secondary list is provided that shows products on the market that are marginal or unacceptable potential for civil use. Each device listed has been compared to the MOPS requirements. The following information is provided for each device: Manufacturer (or potential manufacturer), Anticipated date available, Anticipated or actual price, Technical data, Brief analysis of technical aspects relative to human factors issues, Limitations and advantages in comparison to the MOPS baseline, and Recommendations regarding suitability of equipment for the civil market and potential certification issues.

Recommendations for testing equipment based on potential suitability in cases where there is a lack of technical data relating to human performance.

Technical Approach: This effort entailed data collection, data organization and categorization, data analysis, data summary, and conclusions with comments regarding the potential for future civil use of the subject NVGs. An information comparison matrix is provided that clearly indicates the design strengths and weaknesses of selected NVGs as compared to the MOPS baseline.

Data collection. Data collection was primarily be accomplished by Internet search for manufacturers and distributors of NVGs. The MOPS was used as a baseline against which each NVG device listed was compared. Known manufacturers (foreign and domestic) of NVGs were contacted for technical specifications concerning their products.

Data organization and categorization. Data is organized and categorized by its potential to meet the specifications outlined in the MOPS. The devices in the list are arranged from high probability to low probability of meeting performance standards.

Data analysis. The available specifications for each candidate NVG were compared against the MOPS baseline. A summary of the known or predicted performance is provided.

Data conclusions and comment. Conclusions were drawn and stated with respect to each NVGs performance capabilities compared to the MOPS requirements. Conclusions were also drawn with reference to human factors issues apparent with the equipment and comments have been provided concerning the potential for civil use of each NVG device in the NAS.

Results: Several facts were made evident by this study. First, the MOPS sets a high standard that can only be met by the highest performing goggles on the market. It is apparent from this research that only two U.S. companies possess the technology to produce the quality of image intensifier tubes required to meet the minimum operational performance standards for civil use of NVGs.
Intensifier tube optical performance was the biggest discriminator in nearly every case. It was obvious that without the latest version of a Generation III tube, the goggle could not produce the system resolution required to provide a sharp image on a dark, moonless night. The latest GEN III tube provides very good to excellent low light level performance and can be used in illumination levels down to starlight only. The image is clean and with excellent contrast, and has a long tube life (10,000 hrs.). The gain, resolution, signal to noise ratios, automatic brightness control, and minimal blooming effects of the modern GEN III tubes offer exceptional performance advantages over older generation tubes.

Most of the goggles that did not meet the specification had GEN I tubes installed. These tubes were developed in the 1960's using vacuum tube technology. They require a full moon to achieve an acceptable level of performance. This tube is characterized by excessive blooming and distortion from light sources in the field of view. GEN I tubes have a light amplification of only 1,000 times in comparison with GEN III tubes at 40,000 times. Operating life is only 2,000 hrs.

A second criterion that proved to be a discriminator involved not the ability to look through the NVG, but instead, the ability to look under and around it. All of the Russian candidates and one older model U.S. goggle have "full face" designs that block all vision under and around the goggle. This design blocks an unaided view of the instrument panel and overhead switches. When looking inside using aided vision (through the NVG), the pilot must re-focus one or both of the intensifier tubes from infinity (normal flight mode) to a close-in focus adjustment to see clearly. This cannot be accomplished quickly enough during normal or emergency operations to be considered safe enough for civil use.

This analysis of commercially available NVG devices has served as a beta test of the utility of the MOPS. In the area of goggle form function, i.e. usability, the MOPS was a good discriminator between acceptable and unacceptable devices. In the area of electro-optical performance the MOPS is currently very limited in its requirements and was not a good discriminator between systems that will or will not provide civil aviation users with the necessary visual cues during flight with NVG devices. A recommendation resulting from this study is that electro-optical performance requirements for OMNI III and OMNI IV be reviewed and adapted as needed for addition to the MOPS.

This analysis has also indicated some areas for human performance testing that would provide useful data for civil NVG requirements. Finally, and most importantly, this report will hopefully provide guidance and technical background

information to those who as civil operators and pilots or as government flight standards staff must make decisions as to the acceptability of specific NVG devices for civil aviation.

Impact/Applications: The information contained in this document is intended to provide the reader with a clear picture concerning the full spectrum of NVG appliances that are available on the domestic and foreign market that could potentially be used use by civil operators. This document may also be used to compare the technical specifications of various NVGs on the market, and understand the strengths and weaknesses of each product when compared to the MOPS baseline. A primary source for hardware performance requirements in the MOPS was the military contract for NVGs referred to as the OMNI IV contract. Requirements relevant to civil aviation operations were merged with requirements unique to civil aviation by SC-196 in developing the NVG MOPS. While these two documents could each be cited for many of the MOPS requirements, this study makes reference exclusively to the requirements as stated in the MOPS.

Technology Transfer: none

Journal Articles: none

Books or Chapters: none

Technical Reports: none

Conference presentations/abstracts:

Simpson, C.A., Turpin, T., and Gardner, D.R. (2001). Human Factors Issues for Civil Aviation Use of Night Vision Goggles, Unpublished Report. Submitted to Federal Aviation Administration Office of the Chief Scientist for Human Factors, Washington, D.C.

Patents Issued or Pending: none

Honors: none

Related Projects: none

Project Title: Inexpensive Night Vision Imaging System Field Evaluation Methodology

Primary Investigator: Dr. Lee Task, Task Consulting, 5513 Snowbank Circle, Dayton, OH 45431 (e-mail: lee.task@wpafb.af.mil)

FAA Sponsor Organization: ASW (POC: Lorry Faber)

Sponsor's Requirement Statement: This research will validate and expand the draft AC material in Part 27 and Part 29 concerning NVG certification for rotorcraft civil operations. This material only suggests one means of compliance, which many operators have complained is not cost effective, and not the sole means. However, without this research there is uncertainty if another means may be safe to an overall NVG operation.

Research Project's Goal: The objective of this effort is to devise inexpensive, alternative methods to accomplish a final NVIS field evaluation that is as accurate and repeatable as the currently accepted military method that uses expensive calibrated illumination sources and radiometric measurement equipment. The final methodology may be based on use of significantly less expensive equipment or may be devised such that essentially no measurement equipment is required.

The currently accepted practice for making a final determination of the compatibility of a lighting system with a night vision goggle (NVG) is to compare visual acuity through the NVGs with and without the lighting activated. The present configuration for this procedure was developed by the military and requires relatively expensive illumination sources and radiometric measurement equipment (costs in excess of $100K). In addition, the military method has not been validated for repeatability or reproducibility so this will also have to be addressed in the current effort. The problem is how to achieve the same level of Night Vision Imaging System (NVIS) field assessment results without using expensive equipment.

Best Accomplishment: The literature search found that the "standard" military methodology isn't really all that standard and is not well documented when it comes to details.

Project Summary: The program had a late FY01 start. So far, the project has conducted a literature search to investigate what are the currently available acuity/resolution charts, cheap light meters, etc.

Scientific and Technical Objectives: (1) Completion of verified, calibrated, "cockpit" simulator, (2) Completion of theoretically acceptable alternative methods, (3) Completion of laboratory validation studies of alternative methods

Technical Approach: Currently two technical approaches are envisioned for this effort. The first approach will investigate possible NVIS compatibility test methodologies that do not depend on any type of measurement equipment and the second approach will investigate methods that require a bare minumum of inexpensive or easily fabricated equipment. These will be explored in the second part of Phase 1 (milestone 2). An example of the first approach is to have observers make judgements on light level by viewing through the NVGs. It is not critical to know the exact light level but rather just that the NVGs are operating at their optimum. This occurs if the NVG is providing a lot of light output but is not saturated. One way of judging this light level condition may be to have the observer increase the light level until the NVG output scene does not get any brighter. Then have the observer lower the light level until the output is judged to be about 80% of the saturated level. The actual light level would not be known but even with a considerable margin of error on the judgement of the 80% level (say from 95% down to 50%) this would still mean the NVGs are operating at optimum. In a similar fashion, a cheap, non-calibrated light meter could be attached to the output of the NVGs to achieve an output level of about 80% of saturated using the same basic technique.

Since the accepted military technique has not been tested for repeatability and reproducibility it will be necessary to devise a means to accomplish this test. To this end a laboratory-level simulation of an NVIS cockpit will be fabricated and evaluated with the existing military-approved evaluation methodology. This simulated cockpit will include a means to adjust the level of compatibility (e.g. by changing cockpit light level or spectrum) so that the approved evaluation methodology will result in three possible conditions. These conditions will be: a pass condition (no loss of VA), a marginal pass condition (loss of only 1 element level – 12.25%), and a fail condition (loss of 2 element levels – 24.5%). The methodologies developed in Phase 1 will then be tested against this "calibrated" simulated cockpit to determine if they reliably produce the same results. At least two organizations should verify the compatibility nature of the simulated cockpit. These will most likely be AFRL/HEC at Wright-Patterson AFB, OH and either AFRL/HEA at Mesa, AZ or NAWC at Patuxent River, MD.

The simulated cockpit will consist of an adjustable lighting section, a transparency section for viewing through, and perhaps a glare section to simulate incompatible lighting outside of the field of view of the NVGs. The transparency section will most likely consist of either sections of F-16 canopies that are coated and uncoated or of pieces of glass and plastic that will represent the range of transparency transmissions expected on military and civilian aircraft.

Since typical applicants may not have significant NVG evaluation experience relatively naïve subjects will be used in the final laboratory testing phase (Phase 2). All human testing is reviewed by the Wright-Patterson AFB Internal Review Board to insure proper standards are adhered to regarding treatment of human subjects.

Results: Literature search

Impact/Applications: none

Technology Transfer: none

Journal Articles: none

Books or Chapters: none

Technical Reports: none

Conference presentations/abstracts: none

Patents Issued or Pending: none

Honors: none

Related Projects: AFRL/HEC, because of its interest in the NVG visual acuity assessment area for military applications, will cost share this proposed effort on a 50/50 basis.

Project Title: Human Factors in Vertical Flight Simultaneous Non-interfering Operations (SNI) Literature Review

Primary Investigator: HSIAC Program Office, AFRL/HEC/HSIAC Bldg. 196, 2261 Monahan Way, WPAFB, OH (e-mail: David.Wourms@wpafb.af.mil)

FAA Sponsor Organization: AFS (POC: Hooper Harris)

Sponsor's Requirement Statement: To determine NAV performance of VFR helo pilots using IFR qualified GPS receivers. AFS needs to quantify helo pilot NAV performance for IFR and VFR pilotage which will allow the development of procedures to integrate within the national airspace system.

Research Project's Goal: develop a comprehensive understanding of (1) the extent of national and international human factors research directed toward vertical flight air crew performance especially dealing with flight and navigation instrumentation; (2) the most significant research along with its conclusions and recommendations; and, (3) the national and international vertical flight research resources available to include government labs, universities, and contractors.

Best Accomplishment: literature search

Project Summary: performed a literature search to investigate the area of human factors associated with vertical flight (or helicopter, rotorcraft, tilt-rotor) operations within the NAS

Scientific and Technical Objectives: The literature addressed three specific questions: (1) What would be considered the minimal flight instrumentation for safe VFR SNI helicopter operations, (2) What would be acceptable pilot performance skills and abilities to conduct such flights, and (3) What should be the minimum amount of protected airspace required for the VFR helicopter flying a SNI leg/route from a human performance standpoint?

Technical Approach: The literature search encompassed documents focused on control and display technology, pilot/operator performance, and airspace requirements. Using the strategy outlined in Attachment A, a literature search was conducted in the following government and commercial database resources: Aerospace Database, Compendex Defense, Technical Information Center (DTIC) Technical Reports (TR), Human Systems Information Analysis Center (HSIAC) in-house database, INSPEC, National Technical Information Service (NTIS), PsycINFO, Science Citations Index, Transportation Research Information Service (TRIS), NASA Technical Reports Server (NTRS), and World Wide Web Resources.

Results: The literature search revealed approximately 6000 citations and abstracts. At the FAA's request, there was no attempt by HSIAC analysts to edit the search results; only minimal formatting was undertaken to facilitate readability. The relevant public distribution material is compiled into Attachment B of this report. Material retrieved from copyrighted sources is found in an accompanying volume entitled, *Human Factors in Vertical Flight Simultaneous Non-interfering Operations (SNI), Volume II: Copyrighted Literature Search Results*.

Impact/Applications: none

Technology Transfer: none

Journal Articles: none

Books or Chapters: none

Technical Reports:

Wourms, D.F., Johnson, S.J., Ogden, J.A., and Metzler, T.R. (2001). Human Factors in Vertical Flight Simultaneous Non-interfering Operations (SNI), Volume I: Noncopyrighted Literature Search Results (HSAIC Technical Report # HSIAC-SS-2001-003), Wright Patterson Air Force Base, OH

Wourms, D.F., Johnson, S.J., Ogden, J.A., and Metzler, T.R. (2001). Human Factors in Vertical Flight Simultaneous Non-interfering Operations (SNI), Volume II: Copyrighted Literature Search Results, (HSAIC Technical Report # HSIAC-SS-2001-004), Wright Patterson Air Force Base, OH

Conference presentations/abstracts: none

Patents Issued or Pending: none

Honors: none

Related Projects: none

Appendix II

Human Factors General Aviation

Research Requirements

Research requirements exist in the AAR-100 interactive management database that allows program managers to track research requirements for each Federal Aviation Administration sponsor.

Requirement ID: 7

Sponsor Organization: ASW POC: Lorry Faber

Requirement Title: Head-up display for GA and rotorcraft

Funded Requirement:
- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: This research should provide guidance on best practices for Avionics manufacturers to design HUDs for civil aircraft and evaluation criteria for certification personnel. This is a critical project since there is very little regulatory guidance. Currently, some advisory material is attempting to be developed in the Transport Directorate, but very little consideration is being taken for small airplanes and rotorcraft. There are supplemental type certificates for implementation for HUDs in these aircraft and guidance would be helpful.

Background: Head-up Display (HUD), GA and rotorcraft: Literature review. Problems associated with civil and military GA rotorcraft HUD applications regarding conformal versus compressed formats offered by present manufacturers as well as issues of formatting and clutter, along with the use of highway-in-the-sky depictions on the HUD. Includes transition and training issues.

This research should provide guidance on best practices for Avionics manufacturers to design HUDs for civil aircraft and evaluation criteria for certification personnel. This is a critical project since there is very little regulatory guidance. Currently, some advisory material is attempting to be developed in the Transport Directorate, but very little consideration is being taken for small airplanes and rotorcraft. There are supplemental type certificates for implementation for HUDs in these aircraft and guidance would be helpful.

Output:

Regulatory Link:

Requirement ID: 8

Sponsor Organization: ASW POC: Lorry Faber

Requirement Title: Night vision goggle Certification Issues

Funded Requirement:
- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: This research will contribute to formulating an AC and Noticed for Proposed Rulemaking (NPRM) for civil operations for general aviation and rotorcraft for NVG certification and operations. Also, a Technical Standard Order is needed for the Night Vision Goggle equipment. There is currently no guidance for NVG's except for military specifications and regulations which may not be adequate for civil use. Two NVG civil certifications already exist for a FAR Part 27/29 rotorcraft flying under FAR Part 135 operations. There are other supplemental type certificate applications concerning NVG usage as well as waivers to the operating rules. Research and flight tests are required immediately so the appropriate regulatory statements are written and adopted.

Background:

Night vision goggle operational problems: Literature review and survey of existing issues. This need stems from recent approval for specific civilian use of NVG and the requirement to complete the RTCA SC-196 Minimum Operational Performance Standards. Examination of use in expected civilian operations as compared with military operational data to determine specific problems that may be associated with device use (CAMI proposed this examination originally in 1995). Also, determine minimum operational criteria for types of NVGs & NVG compatible aircraft lighting to be used, as well as training guidance for this equipment for civilian use. This research will contribute to formulating an AC and Noticed for Proposed Rulemaking (NPRM) for civil operations for general aviation and rotorcraft for NVG certification and operations. Also, a Technical Standard Order is needed for the Night Vision Goggle equipment. There is currently no guidance for NVG's except for military specifications and regulations which may not be adequate for civil use. Two NVG civil certifications already exist for a FAR Part 27/29 rotorcraft flying under FAR Part 135 operations. There are other supplemental type certificate applications concerning NVG usage as well as waivers to the operating rules. Research and potentially flight testing is required immediately so the appropriate regulatory statements are written and adopted.

Output: report

Regulatory Link:
Requirement ID: 19

Sponsor Organization: ASW POC: Lorry Faber

Requirement Title: Vertical Flight NVG Maintenance

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Research to establish AC for standard Human Factors inspection guidelines for an NVG component repair station. RTCA SC-196 recommends in their operational concept and Minimum Operational Performance Standards that NVG's shall be maintained through an FAA Repair Station. This station will perform daily maintenance according to the manufacturer's (FAA-approved) continued airworthiness instructions per technical standard order or supplemental type certificate.

Background: Research to establish AC for standard Human Factors inspection guidelines for an NVG component repair station. RTCA SC-196 recommends in their operational concept and Minimum Operational Performance Standards that NVG's shall be maintained through an FAA Repair Station. This station will perform daily maintenance according to the manufacturer's (FAA-approved) continued airworthiness instructions per technical standard order or supplemental type certificate.

Output:

Regulatory Link:

Requirement ID: 32

Sponsor Organization: AFS POC: Hooper Harris

Requirement Title: What is a too compelling and distracting flight display for Vertical Flight?

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: The purpose of the new project would be to define what that breakpoint is in displays. At what point do we have a "compelling" display that distracts the pilot resulting in reduced performance. This recommendation is also to head off a possible NTSB request based on accident results like the BK-117 in Florida in May. With the addition of FIS-B and ADS-B information to the cockpit like the Capstone project at what point do we say enough. Also, with the uniqueness of Vertical flight operations and the demographics of the pilot community's age and experience getting younger. These displays may have different effects on a minimally trained VFR helicopter pilot.

Background:

Output:

Regulatory Link:

Requirement ID: 33

Sponsor Organization: AFS POC: Hooper Harris

Requirement Title: Vertical Flight IFR approach lighting requirements

Funded Requirement:
- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Request a thorough literature review be done to sum up the recommended approach lighting standard. In turn, sum up the current issues that have not accounted for human factors concerns. Some examples of issues would include the following: what is needed for an approach lighting system for helicopters? What type of cueing should it support, roll, alignment, and rate of closure? What is the impact of approach ange on cueing? (i.e. 9 degrees or 12 degrees for a tiltrotor)? What is the impact of the look down angle in the flight deck for cueing? By defining all respective cues that could be addressed, then request a look at potential solutions for desired cueing.

Background: When WAAS and LAAS are realities in 2001 and 2002, the potential of precision approaches to heliports/vertiports will be high. Currently, the only approach lighting system that is approved for helicopters are HALS, that lack th appropriate cueing and look down angle for precision approach helicopter operations to a point. There have been several studies to date concerning the need for an approach lighting standard, however none have been done from a Human Factors standpoint (i.e. taken into account pilot workload and helicopter design). Request a thorough literature review be done to sum up the recommended approach lighting standard. In turn, sum up the current issues that have not accounted for human factors concerns. Some examples of issues would include the following: what is needed for an approach lighting system for helicopters? What type of cueing should it support, roll, alignment, and rate of closure? What is the impact of approach ange on cueing? (i.e. 9 degrees or 12 degrees for a tiltrotor)? What is the impact of the look down angle in the flight deck for cueing? By defining all respective cues that could be addressed, then request a look at potential solutions for desired cueing.

In turn, although this appears as an airport requirement, without this data it is undetermined if vertical flight aircraft needs to be limited by approach angle for IFR precision helicopter approaches based on human performance for lighting cueing.

Output:

Regulatory Link:

Requirement ID: 34

Sponsor Organization: AFS POC: Hooper Harris

Requirement Title: Simultaneous Non-interfering Operations - Quantify VFR Navigation Performance

Funded Requirement:

- FY01: Yes
- FY02: Yes
- FY03: Yes
- FY04: Yes

Requirement Statement: To determine NAV performance of VFR helo pilots using IFR qualified GPS receivers. AFS needs to quantify helo pilot NAV performance for IFR and VFR pilotage which will allow the development of procedures to integrate within the national airspace system.

Background: A major part of the future changes in the NAS to improve operations for helicopters will be the emergence of simultaneous Non-Interfering Operations (SNI) for VFR helicopters and fixed wing traffic (IFR and VFR). To achieve this Airspace Redesign, to what extent is the minimum amount of airspace needed to protect the VFR helicopter flying a SNI leg/route from a human performance standpoint. The proposed concept to be employed is based on satellite navigation technology. In turn, the amount of airspace that would be needed to protect the minimally equipped helicopter will be based on technology.

Human Factors questions include: To evaluate the relationship between pilotage and radio navigation. a) what are the ATC procedures that a helo VFR pilot should follow to optimize national airspace capacity? b) what is the amount of time the pilot fixates on landmarks versus GPS output. c) does the pilot fly the GPS needle? During VFR the pilot should use landmark references but the pilot may shift visual attention to the GPS which may adversely affect pilotage. c) does the GPS affect pilot scan?

Output: a report that recommends the minimum Required Navigation Performance (RNP) value for a VFR helicopter equipped with an IFR GPS. The minimum RNP value will help ATC develop procedures for VFR SNI routes.

Regulatory Link: This research request is directly linked to HR 1000 Section 103 of the Agency's performance plan. (Implementation of the infrastructure for helicopters and tiltrotors) and Administrator's 2001 Vertical Flight Policy Statement.

Requirement ID: 35

Sponsor Organization: AFS POC: Hooper Harris

Requirement Title: Low Speed helicopter/powered lift displays

Funded Requirement:
- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement:

Background: Helicopter/powered lift operations at low speed requires instrumentation which display information not normally found on conventional airplane instruments. One Avionics System is attempting certification of a system that indicates accuracy below 50 knots. Additional human factors research needs to be conducted to develop certification standards (pilot and aircraft) for these future avionics systems. These displays are integral to approvals for helicopters and tilt-rotors to conduct steep angle, de-accelerative GPS approaches to helo/vertiports, thereby exploiting the capabilities of GPS and DGPS for vertical flight.

Output:

Regulatory Link: This research is critical to the implementation of the infrastructure for helos and tiltrotos per HR-1000, section 103 of the agency's performance plan

Requirement ID: 36

Sponsor Organization: AFS POC: Hooper Harris

Requirement Title: Tiltrotor controls

Funded Requirement:
- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement:

Background: A new SFAR certification initiative will take place for the new aerodynamic design called the "tiltrotor aircraft". Much research has been dedicated to the tiltrotor design, but none concerning the human factors aspects of flight controls for civil and pilot certification. One particular control of interest is the nacelle tilt control. This control is new to all aerodynamic designs, and is the pilot control that changes the angle of the nacelle blades (propellers on the wings) to give the design aerodynamic thrust. It also enables the pilot to convert from "helicopter mode ", or t/o and landing mode, to "airplane mode". The aircraft companies have made many designs to look at proper pilot to aircraft interface...but do to many unknowns and funding the initiatives have been slowed way down.

Output:

Regulatory Link:

Requirement ID: 188

Sponsor Organization: ASW POC: Lorry Faber

Requirement Title: NVG resolution requirement

Funded Requirement:
- FY01: No
- FY02: Yes
- FY03: No
- FY04: No

Requirement Statement: This research will validate and expand the draft AC material in Part 27 and Part 29 concerning NVG certification for rotorcraft civil operations as well as the draft TSO concerning Night Vision Goggles. This material only suggests a minimum NVG resolution requirement that many European manufacturers and US civil operators are too stringent. The requirement was written because no data exists as to the existing acceptable resolution for human being for safe NVG flight. The requirement was a consensus decision based on NVG manufacturer statistics of current product use which did not include a wide variety of resolution levels. However, without this research there is uncertainty if another means may be safe to an overall NVG operation. This research is using the aid of the US military since they too have agreed that alternate methods need to be explored for cost and immediate implementation. Three NVG civil certifications already exist for a FAR Part 27/29 rotorcraft flying under FAR Part 135 operations, with more to follow. Research and potentially flight testing is required immediately so the appropriate alternate resolutions for NVGs can be justified when requested.

Background: This need stems from recent approval for specific civilian use of NVG and the recent completion of the RTCA SC-196 Minimum Operational Performance Standards. Examination of use in expected civilian operations as compared with military operational data to determine specific problems that may be associated with device use (CAMI proposed this examination originally in 1995). This research will contribute to formulating an AC and Noticed for Proposed Rulemaking (NPRM) for civil operations for general aviation and rotorcraft for NVG certification and operations. Also, a Technical Standard Order is needed for the Night Vision Goggle equipment. There is currently no guidance for NVG's except for military specifications and regulations which may not be adequate for civil use. Three NVG civil certifications already exist for a FAR Part 27/29 rotorcraft flying under FAR Part 135 operations. There are other supplemental type certificate applications concerning NVG usage as well as waivers to the operating rules. Research and potentially flight testing is required immediately so the appropriate regulatory statements are written and adopted.

Output: detection model; Regulatory Link:

Requirement ID: 189

Sponsor Organization: ASW POC: Lorry Faber

Requirement Title: NVG lighting requirement

Funded Requirement:
- FY01: No
- FY02: Yes
- FY03: Yes
- FY04: No

Requirement Statement: This research will validate and expand the draft AC material in Part 27 and Part 29 concerning NVG certification for rotorcraft civil operations. This material only suggests one means of compliance which many operators have complained is not cost effective and not the sole means. However, without this research there is uncertainty if another means may be safe to an overall NVG operation. This research is using the aid of the US military since they too have agreed that alternate methods needs to be explored for cost and immediate implementation. Three NVG civil certifications already exist for a FAR Part 27/29 rotorcraft flying under FAR Part 135 operations, with more to follow. The last certification effort had requested an unknown method to both the FAA and DoD. Research is required immediately so the appropriate alternate methods can be justified when requested.

Background: RTCA SC-196 Minimum Operational Performance Standards states a method of compliance for NVG lighting that is very similar to the method employed by the military. Many civilian operators, FAA test pilots and small manufacturers are concerned that this method is expensive and not necessarily the only method out there. However, due to lack of data, the current method is the only one proven to be safely employed as an effective evaluation process. The Committee agreed that this method will be cited in the document with a caveat that this is a recommendation only and that applicants applying for NVG certification has the right to not use this method if another method is appropriately documented and justified. As a result, many FAA and DoD are concerned that the alternate means of compliance that are suggested from applicants may not be totally proven to be safe. Most applicants (or small manufacturers) have limited budgets and therefore do not commit testing funds to R&D as other agencies might do. It is very difficult for the FAA to refute the data if the data is well justified for the small operation.

Output: report stating the results of repeatability testing for military accepted methodology and describing the alternative, inexpensive methodologies that provide the same results

Regulatory Link:

Appendix III

Human Factors Vertical Flight Fiscal Year Project Planning

FY02 Funded Projects

FY03 Proposed Projects

FY04 Proposed Projects

Human Factors Vertical Flight
FY02 Projects (contract dollars)

Project Title	Performer	Sponsor	Req ID
Discrimination Model To Predict Night Vision Goggle Target Detection	NASA Ames (Albert Ahumada)	ASW-100 (Lorry Faber)	188
Inexpensive Night Vision Imaging System Field Evaluation Methodology	WPAFB (Lee Task)	ASW-100 (Lorry Faber)	189
Field Validation of the Inexpensive Night Vision Imaging System	NAWC (Chuck Antonio) or WPAFB (Lee Task)	ASW-100 (Lorry Faber)	189
Determine NAV performance of VFR helicopter pilots using IFR qualified GPS receivers, RNP Measurement	Naval Postgraduate School (Rudy Darken), NASA Ames (Jeff Mulligan)	AFS-400 (Hooper Harris)	34

Human Factors Vertical Flight
FY03 Proposed Projects (contract dollars)

Project Title	Performer	Sponsor	Req ID
Field Validation of the Inexpensive Night Vision Imaging System	NAWC (Chuck Antonio) or WPAFB (Lee Task)	ASW-100 (Lorry Faber)	189
Determine NAV performance of VFR helicopter pilots using IFR qualified GPS receivers, RNP Measurement	Naval Postgraduate School (Rudy Darken), NASA Ames (Jeff Mulligan)	AFS-400 (Hooper Harris)	34

Human Factors Vertical Flight
FY04 Proposed Projects (contract dollars)

Project Title	Performer	**Sponsor**	**Req ID**
Determine NAV performance of VFR helicopter pilots using IFR qualified GPS receivers, RNP Measurement	Naval Postgraduate School (Rudy Darken), NASA Ames (Jeff Mulligan)	AFS-400 (Hooper Harris)	34