HUMAN FACTORS ISSUES FOR CIVIL AVIATION USE OF NIGHT VISION GOGGLES

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HUMAN FACTORS ISSUES
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BACKGROUND

The Federal Aviation Administration (FAA), in response to requests from civil aviation rotorcraft operators, has undertaken the task of determining requirements for the use of night vision imaging systems (NVIS) in civil aviation operations. The FAA enlisted the support of two organizations to assist in this effort: 1) The RTCA, Inc., a non-profit corporation formed to advance the art and science of aviation for the benefit of the public, and 2) Ames Research Center of the National Aeronautics and Space Administration (NASA Ames Research Center.

The RTCA formed Special Committee 196 (SC-196) Night Vision Goggle (NVG) Appliances & Equipment on 8 November 1999 to assist the FAA in this effort, as documented in the Terms of Reference for SC-196 (RTCA, Inc., 1999). The RTCA SC-196 is composed of representatives from industry, the military services, FAA, and NASA and has worked since its inception to develop the documentation required to support this technology transfer. According to the SC-196 Terms of Reference, "Night Vision Goggle Equipment is an emerging technology that will enhance the safety margin of civil rotorcraft and small airplane operations" (RTCA, 1999, p. 1). The SC-196 has been meeting in plenary sessions since November 1999 with the goal of developing the documentation necessary to transition the use of night vision imaging systems (NVIS), and specifically night vision goggles (NVGs), from the military aviation sector to the civil aviation sector. The purpose of the meetings has been to develop three specific documents required by RTCA as part of the transition process. The documents are the Concept of Operations (CONOPS), the Minimum Operational Performance Standards (MOPS), and the Training Guidance document.

In addition to the support provided by the RTCA, the FAA, through a statement of work to NASA Ames Research Center, obtained aviation human factors support from NASA during the period from September 2000 to September 2001 for the transition of NVGs into the civilian sector. NASA was tasked to support the FAA in three areas: 1) to participate in SC-196, 2) to conduct a survey of current and near term NVG devices and equipment suitable for civilian operations, and 3) to document human factors issues related to the use of NVGs in civil flight operations and recommend solutions or research needed for the resolution of unresolved issues. Reports in support of Task 1 took the form of briefings of NVG issues at each SC-196 meeting. A final report for Task 2 NVG Equipment Survey was prepared as a stand-alone document. This report is the final report for Task 3 Documentation of Human Factors Issues.

During the development of the CONOPS, MOPS, and Training Documents by SC-196, issues were raised that required resolution. Some issues were resolved within individual working groups, others were brought forward to the entire committee. RTCA documents are developed using the method of consensus. To be approved for release, a document

must have unanimous approval of all committee members. The RTCA process requires SC-196 to brief the issues and the resolution status of each one as part of the document approval process.

NASA and its contractor PLRA were directed by the FAA statement of work to attend the SC-196 plenary meetings with the task of both contributing technically to the document development as well as to identify and formally track the issues raised during the process. An issue tracking form was developed to capture and track the issues. The issues that crossed working group boundaries or those that the working groups could not solve internally were documented using this form. The status of issue resolution for each of these was formally briefed at each plenary session. These issues are numbered 1 to 16 in this Final Report. Other major issues that were addressed within individual working groups are also included in this report and are numbered 17 to 32. These issues were not documented on an issue tracking sheet and did not have a tracking number assigned. They are included in this report to document the decision process and rationale used for issue resolution. The body of this report consists of a summary of each of these thirty-two issues in a standard format.

ISSUE NUMBER: 1

DATE: 6-1-00

ISSUE TITLE: Instrument flight experience requirements for NVG operations.

ISSUE DESCRIPTION: Mr. Baxter, representing Bell Helicopter, felt that the following requirements stated in the Concept of Operations (CONOPS) document concerning instrument experience and currency are too strict: (1) Instrument currency check flight required in the last 12 months; (2) 30 hrs instrument training required if pilot does not have an instrument ticket.

ISSUE DISCUSSION: The following points and recommendations were offered during discussion of this issue. NVG flight requires diligent cross check of flight instruments even under the best ambient conditions. Instrument familiarity and recent use are considered vitally important to safe NVG flight operations. The instrument experience requirement can be satisfied by amending the CONOPS to read as follows: (1) Instrument ticket is recommended but not required. No instrument currency check is required. Pilot must show instrument proficiency during NVG training. (2) Reduce the total hours required for instrument training for those with no instrument ticket from 30 hrs to 15-20 hours. No actual comparative NVG flight performance data from instrument versus non-instrument rated pilots was available.

ISSUE STATUS: Resolved 9-14-00 with available information

ISSUE RESOLUTION: Resolved on 9-14-00 by group discussion. Deleted the requirement for an instrument ticket holder to have completed an instrument currency check in the past 12 mos. NVG training will include instrument procedures associated with inadvertent IMC. The decision was made not to change the 30 hour training requirement for a non-instrument rated pilot. The 30 hours is in line with the requirements to apply for an instrument rating and many of these hours can be accomplished concurrently.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: The contribution of instrument flying skills to successful performance during night VFR with NVGs has not been systematically studied. Comparative research using civilian pilots who are instrument rated and not instrument rated and who have varying levels of instrument flight experience would provide useful data to refine these requirements.

SOURCE DOCUMENTS: Federal Aviation Regulations and Aeronautical Information Manual 2000 (FAR/AIM 2000).

ISSUE NUMBER: 2

DATE: 6-1-00

ISSUE TITLE: NVG Instructor qualifications. Who is qualified to provide NVG training?

ISSUE DESCRIPTION: CONOPS discussions at the plenary session in Ft Worth determined that only an NVG qualified instructor should be allowed to provide NVG training. Workgroup 5 participants in Washington, D.C. concluded that a company standardization and training pilot for commercial operations could administer NVG training to company pilots provided that the training pilot had received training and had been signed off by a qualified NVG instructor.

ISSUE DISCUSSION: The following points and recommendations were made during discussion of this issue. Company training pilots are already limited to giving training only within their own company. Allowing a company standardization and training pilot to give NVG training would be acceptable because the training pilot has received training and a checkout from a qualified instructor and the training program must be approved by the FAA before training is conducted with company pilots.

ISSUE STATUS: Resolved 6-1-00

ISSUE RESOLUTION: Company training pilots can give training only within their own company. This solution was agreed upon on 1 June 2000.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: CONCEPT OF OPERATIONS: Night Vision Imaging System for Civil Operators.

ISSUE NUMBER: 3

DATE: 6-1-00

ISSUE TITLE: Minimum crew for off-site landings.

ISSUE DESCRIPTION: What should the minimum crew requirements be to clear the aircraft and land at an off-site, i.e.unsurveyed, landing zone? This issue addresses the potential need for additional crewmembers to clear the tail and other parts of the aircraft of obstructions when landing at an unsurveyed area that the crew had not previously landed in. The potential risk of not being able to adequately clear the aircraft when flying single pilot must be recognized.

ISSUE DISCUSSION: A remote area is a site that does not qualify as an airport, heliport or vertiport as defined per applicable regulations. Remote area landing sites do not have the same features as a heliport, so extra care must be given to visually locating any obstacles that may be in the approach/departure path. Consideration should be given to employing additional personnel to scan the opposite side or in back of the helicopter due to the pilot's limited field of view and field of regard. Applicable landing area lighting requirements must be complied with. Although there is additional cost for each additional crewmember, there is a large safety benefit to be gained, particularly for single pilot operations. The requirements as stated in the Concept of Operations set the minimum crew requirements based on aircraft type certificate and the aircraft operation being performed. The employment of additional personnel to scan for obstacles is left as a judgment for the pilot and operator, to be supported by the NVG training process.

ISSUE STATUS: Resolved 9-14-00

ISSUE RESOLUTION: Resolved by Plenary Group agreement on 9-14-00 as follows: The minimum crew for all maneuvers to include off-site landings remains as written in the Concept of Operations (CONOPS). The CONOPS states the minimum crew for NVG operations is the higher of either the minimum crew specified by the aircraft type certificate or the minimum crew required for the aircraft operation being performed. It also states that during remote area operations, consideration should be given to employing additional personnel to scan for obstacles. Situations where more than the minimum crew is recommended will be addressed in the Training Document and the NVG Pilot Handbook.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: Federal Aviation Regulations and Aeronautical Information Manual 2000 (FAR/AIM 2000) and the CONCEPT OF OPERATIONS: Night Vision Imaging System for Civil Operators.

ISSUE NUMBER: 4

DATE: 6-1-00

ISSUE TITLE: Secondary lighting system requirements as addressed by the MOPS.

ISSUE DESCRIPTION: Is ANVIS compatible secondary lighting (emergency lighting) required if a backup lighting system is required for that aircraft?

ISSUE DISCUSSION: It was decided during the Plenary session in Washington, D.C., on September 14, 2000, that this was a requirements issue and therefore should be resolved by Working Group 3.

ISSUE STATUS: Resolved 9-14-00

ISSUE RESOLUTION: IAW the FARs, there is an FAA requirement for secondary lighting in helicopters operating under Part 135 during unaided night flight. Workgroup 3 decided that if the aircraft has been modified for NVG compatible lighting, and secondary lighting is required for that aircraft by regulation, then that secondary lighting must be also NVG compatible. This requirement will be stated in the MOPS.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: Federal Aviation Regulations and Aeronautical Information Manual (FAR/AIM 2000).

ISSUE NUMBER: 5

DATE: 6-2-00

ISSUE TITLE: Windshield/window distortion and resolution issues.

ISSUE DESCRIPTION: Good definitions are needed in the MOPS and CONOPS for the following terms: Reflectivity, IR transmissivity, and angle of incidence as applied to the optical characteristics of aircraft windscreens. It is also necessary to determine the extent of any visual distortion or loss of resolution that could be encountered in NVG flight operations due to the effects of these parameters. The potential effects of windshield anti-ice on NVG resolution must also be determined.

ISSUE DISCUSSION: There are two issues presented above that require resolution. First, there is a need for good definitions of the above terms for inclusion in the MOPS and CONOPS. Secondly, it is necessary to determine the effects of the above parameters on NVG resolution. The FARs do not address these issues except for subjective pilot determination of whether they may adversely affect flight. Additional research will be required to determine the effects on NVG operations. As of November, 2000, the terms reflectivity and IR transmissivity and angle of incidence were not defined in the MOPS CH-1. NVG distortion caused by the use of windshield anti-ice has been reported as a problem in aircraft with anti-ice systems imbedded in the windscreen such as the Bell 212, 412, 214, and 222, and possibly the Augusta 109. Some distortion is common in aircraft that use embedded anti-ice even without goggles. However, data needs to be collected to determine if the problem is worse with NVGs. If it is a problem, it should be addressed in the MOPS as a potential restriction.

ISSUE STATUS: Partially resolved. Reference the first issue, additional definitions were added to the MOPS Appendix C Glossary. As of July 2001, “reflectivity” had been defined but not “IR transmissivity” nor “angle of incidence”. Reference the second issue, recognizing the potential for problems associated with transmissivity, reflectivity and other characteristics of aircraft windscreens, a maintenance inspection was written into the MOPS Chapter 5 (Continued airworthiness) that would require a determination to be made concerning these potential problems with the windscreen. In addition, the MOPS now requires that a flight test be accomplished that would look for specific problems involving the windscreen, specifically with windshield de-ice and other equipment turned on. However, research is still required to determined the end-to-end resolution with NVGs while looking through the windscreen. It is known that certain aircraft canopies may block out up to 70% of the near IR energy required by the NVGs which measurably affects visual performance. The affects of scratched or crazed canopies on NVGs must also be quantified.

ISSUE RESOLUTION and DATE: Partially resolved.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Research is needed on the effects on optical distortion and resolution of representative values of windscreen

reflectivity, IR transmissivity, angle of incidence, and state of repair with reference to scratching and crazing. Definitions are needed for IR transmissivity and angle of incidence.

SOURCE DOCUMENTS: Minimum Operational Performance Specification (MOPS).

ISSUE NUMBER: 6

DATE: 5-31-00

ISSUE TITLE: NVG Performance degradation when using a Class B filter.

ISSUE DESCRIPTION: Is NVG performance loss when using Class B filtering significant enough to warrant Class A filtering?

ISSUE DISCUSSION: CW5 Joe Roberts offered to provide supporting documentation from USAARL and Night Vision Labs. Data was to be presented to the General Committee for resolution. If Class A were determined as the minimum acceptable by the General Committee, the issue would be referred immediately to WG-2 and WG-3

ISSUE STATUS: Resolved 9-14-00 with available information

ISSUE RESOLUTION: CW5 Roberts provided a USAARL study that suggested that the performance degradation caused by the Class B filters is not significant enough to warrant specifying Class A filters. The Army's Night Vision Labs reportedly contends that there has not been extensive enough testing in a variety of conditions to come to this conclusion. Navy and Air Force research supports Class B as the minimum standard. The consensus of the plenary group is that extensive comparative evaluations have been completed by the Navy that show a slight energy loss from Class A to Class B, but that the loss is not significant enough to warrant Class A filters. The color accommodating attributes of Class B filters outweigh the energy loss. Therefore, Class B filters are specified as the minimum standard specified by the MOPS.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Future data may indicate an operationally significant energy loss under some conditions, and this may require revisiting this issue.

SOURCE DOCUMENTS: USAARL study of the effects of Class A filters on NVG performance, as reported verbally by CW5 Roberts. Navy determination that Class B filters are the standard for Navy cockpits.

ISSUE NUMBER: 7

DATE: 6-1-00

ISSUE TITLE: What is the maximum acceptable NVG performance degradation caused by the windscreen characteristics?

ISSUE DESCRIPTION: This issue was a call for any available technical information on the question of windscreen degradation of NVG performance.

ISSUE DISCUSSION: Dr. Lee Task from AFRL researched this issue and provided some data. He cited 12 different research papers that may assist in understanding this problem. Dr. Chuck Antonio offered to gather data on this subject. Additional research may be required starting with reading the references suggested by Dr. Task.

ISSUE STATUS: Partially resolved.

ISSUE RESOLUTION: The maximum degradation generally accepted by the Armed Services is 12%. This is determined by reading the Tri-Bar chart through the canopy using the goggles while the aircraft is in a darkened hanger and comparing the obtained resolution to that obtained under the same conditions except without looking through the canopy. This value 12% was accepted as the civil solution.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: The number 12% was accepted for civil use after being recommended by the Armed Service representatives. It would be wise to do some minimal research to determine the validity of this number. Research is required to determine the effects of values higher than 12% on pilot performance. Until that is done, 12% is a proven safe maximum limit. In addition, the studies recommended by Dr. Task should be reviewed for relevancy to the civil environment.

SOURCE DOCUMENTS: Verbal references from the Navy and Air Force representatives.

ISSUE NUMBER: 8

DATE: 6-1-00

ISSUE TITLE: What is the effect of windscreen anti-ice on NVG performance?

ISSUE DESCRIPTION: Does windshield anti-ice cause optical distortion during NVG operations? Is there any technical information on this subject? Mike Atwood, an NVG instructor pilot, reported that use of anti-ice systems that are imbedded in the windscreen will cause unacceptable distortion of the visual scene as seen through goggles when anti-ice is in use. Examples of aircraft with this type of windscreen anti-ice are the Bell 212, 412, 214ST, 222, and possibly the Augusta 109.

ISSUE DISCUSSION: This issue is indirectly referenced in the MOPS Section 4, Interference Effects, but is not specifically called out. That section recommends that anti-ice systems be flight checked along with the rest of the NVG cockpit modifications to determine the effects. Some imbedded anti-ice systems will cause windscreen distortion even without goggles. This issue will require research to determine how severe the problem is.

ISSUE STATUS: Partially resolved

ISSUE RESOLUTION: This was discussed at the January 2001 Plenary session in Washington DC. No one at the meeting could verify the problems stated by Mr. Atwood. It was felt that what he was describing was the normal distortion that would be experienced unaided. It was reportedly no better or worse with the goggles on. It was agreed that pilots of aircraft with windscreens that cause distortion should be aware of it and take the normal precautions that would be taken unaided, avoiding use of the anti-ice if possible. Additional research at some future date may be wise to better quantify whether this is an issue or not. Pilots must be aware of the limitations imposed by their individual aircraft on NVG use, and modify their flying to accommodate those limitations.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: It would be prudent to conduct at least a cursory examination of aircraft with imbedded anti-ice systems to determine the effects on visual scene distortion for both unaided and NVG-aided flight.

SOURCE DOCUMENTS: MOPS Section 4 and Section 5 which address windscreen distortion in general terms.

ISSUE NUMBER: 9

DATE: 9-7-00

ISSUE TITLE: Pilot vision requirements for NVG operations.

ISSUE DESCRIPTION: Pilots flying under FAR Part 91 only require a Class 3 flight physical. This allows the pilot to have uncorrected or corrected 20/40 vision and still be qualified to fly at night. NVGs have only been tested with pilots that have vision correctable to 20/20. The effect of allowing pilots with vision less than 20/20 to fly with NVGs is currently unknown. Likewise, the effect of color blindness on pilot performance with NVGs is unknown.

ISSUE DISCUSSION: The minimum of vision correctable to 20/20 comes directly from military requirements for their pilots. The FARs allow civilian pilots to fly at night with vision correctable to 20/40. Current goggles have resolutions no better than 20/40 under the best of night viewing conditions. It is not clear whether the effects of pilot vision at 20/40 and goggle resolution at 20/40 would be additive or not. Further research is required to determine the effects on pilot-goggle system resolution and on pilot performance for pilot vision that is not correctable to 20/20 or better. Similarly, the effects of various types of color blindness are not known. In the interim, the conservative solution would be for the CONOPS and the MOPS to state the minimum vision requirement for NVG operations as correctable to 20/20 vision with no allowance for color blindness.

ISSUE STATUS: Partially resolved 9-14-00

ISSUE RESOLUTION: The September 2000 plenary session recommended that 20/20 be the initial requirement. This requirement could then be relaxed if data from additional research supports less than 20/20 vision. The MOPS already requires 20/20 vision. The CONOPS (dated 25 Oct) lists 20/20 vision as an assumption under paragraph 1.3. Further research should be conducted to determine the actual minimum pilot vision requirements for NVG operations. See Issue 12 Minimum Visual Acuity Requirements.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Further research is recommended to determine the actual visual requirements for NVG flight. This would require ground and flight tests with a method for controlling the visual acuity of the test subject while measuring performance degradation on typical flight tasks. Ground tests to compare the visual resolution using NVGs under varying light levels and scene contents for color blind subjects and for subjects who are not color blind would be the recommended initial step in research on the effects of color blindness with flight tests to follow if supported by the ground data. See also Issue 12 Minimum Visual Acuity Requirements.

SOURCE DOCUMENTS: Federal Aviation Regulations and Aeronautical Information Manual (FAR/AIM 2000).

ISSUE NUMBER: 10

DATE: 9-7-00

ISSUE TITLE: NVG low light performance and testing.

ISSUE DESCRIPTION: The minimum requirements for NVIS in low light levels (ambient illumination) have been determined using relatively high illumination levels for testing. The test illumination level is selected based on that level at which the highest resolution is obtained. As a result, the standard for NVIS low light resolution is driven by the highest light resolution an NVIS device can attain. Depending on the gain of a particular NVIS system and its signal-to-noise ratio, the minimum illumination under which it can function and the associated resolution can vary considerably from one system to another. There is currently no good method for accurately testing low light performance. The Europeans do not want this high light level standard enforced because it is not a true designator of a minimum resolution standard.

ISSUE DISCUSSION: The minimum operating standard should include low illumination level testing in order to ensure increased performance and safety during low light conditions. The proposed solution is to 1) establish a high light level requirement that will ensure adequate low light performance; 2) determine method (s) of testing that will accurately determine low illumination level performance.

ISSUE STATUS: Partially resolved

ISSUE RESOLUTION: Since low light testing methods do not currently exist, the decision was made to continue using high illumination level testing standards that are in existence today and have been used for years to extrapolate the low light performance of NVIS. This solution is considered temporary until such time as a reliable low illumination performance test can be developed by industry or government. Further research is required in the area of low illumination resolution testing to make tests results repeatable.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Research must be conducted to develop and validate a reliable and repeatable low illumination testing method.

SOURCE DOCUMENTS: MOPS.

ISSUE NUMBER: 11

DATE: 9-13-00

ISSUE TITLE: Defining critical flight phases.

ISSUE DESCRIPTION: Critical phases of flight need to be defined for use in completing a risk hazard assessment. Examples of potential critical phases might be flight near the ground or obstacles, flight in reduced weather conditions, or flight in mountainous terrain.

ISSUE DISCUSSION: The goal of the risk hazard assessment is to be able to determine what the reliability of the NVIS should be during various phases of flight that have varying degrees of associated risk. There was a briefing presented to the SC-196 concerning the methodology for completing the functional hazard assessment. There was a lengthy discussion concerning the characteristics of a critical phase of flight which would result in an NVIS failure having catastrophic results. The group consensus was that a critical phase of flight would most likely be one that occurred close to obstacles or the ground, one occurring over mountainous terrain on a low illumination night, or one in which the weather conditions were conducive to potential inadvertent IMC. Critical phases of flight for NVGs would be similar to critical phases of flight for unaided night VFR since that is the mode the pilot would have to revert to in the case of NVG failure. During this discussion the question of whether NVGs are more prone to inadvertent IMC than night unaided flight was raised. It was agreed that loss of visual cues may occur more rapidly during aided flight vs. unaided flight. In point of fact, a better description would be that there is a certain level of visibility which is effectively worse for the unaided pilot than for the NVG-aided pilot. If the NVG-aided pilot does not recognize the visibility conditions and indicators leading up to this certain level and remain clear of them, it can appear to the pilot as though the visual cues have been lost more rapidly under NVGs compared to unaided flight. A recommended definition for a critical phase of flight would be any phase in which loss of NVGs would cause the pilot difficulty in maintaining visual reference to the ground. It was decided that WG-1 should define the critical phases of flight for NVGs.

ISSUE STATUS: Resolved

ISSUE RESOLUTION: This issue was addressed at the January 2001 Plenary session by Workgroup 1. Critical flight phases were defined as any phase of flight conducted in proximity to obstacles or terrain, or during conditions of reduce visibility approaching VFR minimums.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: CONOPS.

ISSUE NUMBER: 12

DATE: 11-09-00

ISSUE TITLE: Minimum visual acuity (VA) requirements.

ISSUE DESCRIPTION: This issue is a follow-on to Issue 9. The current NVG minimum operating standards for visual acuity of 20/20 vision are not based on human acuity requirements necessary to perform critical helicopter flight maneuvers while wearing NVGs. There is a need to define the minimum visual acuity required for critical rotorcraft flight maneuvers. The maneuvers considered as critical are a) hover and low airspeed; b) takeoff and landing; c) up-and-away flight.

ISSUE DESCRIPTION: Establish minimum visual acuity for the maneuvers listed above based on actual human performance requirements and recognized precision standards for the maneuvers. Perform flight tests to systematically vary visual acuity in flight and measure pilot performance. Faber, Haworth, Task, and Turpin were to collaborate on test methods and test matrix.

ISSUE STATUS: Testing was planned for FY 01-02. This plan is on hold awaiting funding.

ISSUE RESOLUTION: Unresolved

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Funds needed to conduct the required test.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 13

DATE: 11-08-00

ISSUE TITLE: Halo variance between different NVG tubes.

ISSUE DESCRIPTION: Presently, maximum halo size within an image intensifier tube is specified in the OMNI IV contract as a maximum diameter of 1.25 mm. Halo size is evaluated by manufacturers by introducing a point light source at the input and in the center of the image intensifier (I^2) tube field-of-view (FOV) and measuring the diameter of the resulting halo circle at the output of the image intensifier tube. Halo size variance within the FOV of the tube is not evaluated. Recent discoveries of halo variance within the military have resulted in further studies by the Army Night Vision Electronic Sensors Directorate (NVSED) with the intent of developing a maximum halo variance standard for industry by FY O2. The Army feels that halo variance between tubes in the same set of NVGs could cause an aviator to misinterpret the visual scene resulting in inappropriate control input. The Army does not want to engage in "tube matching" to pair image intensifiers with similar halo performance characteristics. Continued studies are ongoing to determine the significance of halo variance.

ISSUE DISCUSSION: SC-196 must consider this issue and coordinate with NVESD to determine possible courses of action. The point of contact at NVESD is Mr. Ed Bender. The MOPS should address this issue and be flexible enough to insert a requirement when this problem is better understood. Further research is required to understand the significance of halo variance. This will be incorporated in the MOPS when test data become available in 6 months to a year. There should be a mention of this phenomenon in the training document to make aviators aware of the issue.

ISSUE STATUS: The authors of the MOPS and CONOPS are now aware of this issue and will be looking for Army test results. Appropriate documents will be modified if and when additional information on this subject becomes available.

ISSUE RESOLUTION: Unresolved

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Further research is required to understand the possible effects of halo variance on pilot performance.

SOURCE DOCUMENTS: NVG OMNI IV specification.

ISSUE NUMBER: 14

DATE: 11-08-00

ISSUE TITLE: What is the basis for the minimum operational performance standard (MOPS)?

ISSUE DESCRIPTION: The MOPS definition is self explanatory. However, the basis for the specification is not clearly apparent. For instance, the MOPS performance requirements for NVGs do not state the basis for the requirements. Is the basis safety, manufacturers' capability, technology driven etc.? The basis for the MOPS should be identified and quantified where possible.

ISSUE DISCUSSION: The basis for each area of the MOPS should be stated and supported by quantifiable data.

ISSUE STATUS: Resolved

ISSUE RESOLUTION: The basis of the MOPS is to supplement night VFR flight operations. This question has been addressed in Chapter 1 of the MOPS.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: MOPS Chapter 1.

ISSUE NUMBER: 15

DATE: 11-08-00

ISSUE TITLE: Applicability of night vision imaging system (NVIS) requirements within the FARs.

ISSUE DESCRIPTION: Presently public use and military operators must comply with all FARs except those that are identified as applicable to civil aviation only. For example, military operators are required to comply with sunset to sunrise lighting requirements specified by the FARs unless a letter of exemption is issued by the FAA (which is common). Public use and military operators may not be able to comply with future NVIS requirements contained in the FARs, and they should not be held to them.

ISSUE DISCUSSION: The CONOPS must include language that makes it clear that NVIS requirements pertain to civil operators only.

ISSUE STATUS: Resolved

ISSUE RESOLUTION: This was made clear in the CONOPS with a modification of the "Purpose" paragraph. The FAA Chief of Flight Standards also stated that if a Notice of Proposed Rule Making concerning NVIS is published, it will be made clear that these requirements and information pertain only to civil aviation.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: N/A

SOURCE DOCUMENTS: CONOPS.

ISSUE NUMBER: 16

DATE: 02-06-01

ISSUE TITLE: Inspection of replacement windscreens

ISSUE DESCRIPTION: What additional inspections, if any, should be accomplished if a windscreen in a previously NVIS certified aircraft is replaced with a different part number windscreen, one that may have different characteristics than the windscreen used in the original certification? Within Chapter 5 (Airworthiness) of the MOPS, there is no requirement to retest the installed NVIS after installation of a replacement windscreen. There is a concern that if the original windscreen is replaced with a different part number or model of windscreen, the replacement windscreen may have different optical characteristics and this could affect the NVIS performance.

ISSUE DISCUSSION: Possible methods for resolving this issue were discussed. 1) A poll could be taken of all the members of the RTCA SC-196 to determine if there is a need to retest the complete NVIS after replacing the windscreen if the windscreen is a different model or part number than the original, or 2) A retest of the installed NVIS could be established as a special inspection after replacing a windscreen. Consideration should be given to the cost to the operator of conducting a periodic retest and to the availability of test equipment and resources.

ISSUE STATUS: Pending resolution at the July 01 plenary session.

ISSUE RESOLUTION: Unresolved.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Information from the SC-196 members related to this issue.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 17

ISSUE TITLE: Time limit for NVG Currency.

ISSUE DESCRIPTION: What should the recent flight experience requirements be for NVG flight? For night VFR flight carrying passengers the FARs require night VFR flight with at least three take-offs and three landings at least every 90 days in the same category, class and type (if applicable) aircraft. For IFR flight the FARs require instrument flight maneuvers to be flown at least every 6 calendar months. NVG flight is closer to night VFR than to IFR flight, suggesting a 90-day recency of flight requirement for NVGs. However, the Army uses 45 days due to the perishable nature of the skill required to fly with NVGs. The Army is gradually relaxing this requirement and is leaning toward a 90 day currency requirement based on aviator NVG experience.

ISSUE DISCUSSION: The minimum requirements for recency of NVG flight must be set to ensure safety at reasonable cost. For those pilots who fly under NVGs frequently, the currency issue is not a factor. A 90 day currency requirement for NVGs would match the existing currency requirements for acting as pilot in command (PIC) carrying passengers and for the special case of carrying passengers at night. This would be most efficient from a training schedule and cost perspective. A 45 day currency requirement would match current Army requirements. There is potentially a cost to the operator associated with lowering the number of days to anything less than 90 days. There is a perceived safety risk of making it as long as 90 days if it is true that NVG skills deteriorate faster than night VFR skills. The TSO approval for Rocky Mountain's use of NVGs specified a two calendar month currency requirement. There are to date insufficient data on civil NVG operations upon which to base a decision for civil operations, but the Army's rather large database tends to support a 90 day NVG currency requirement in place of their present 45 day requirement. For the present time, it was decided to use 2 calendar months as specified in the first FAA TSO issued for civil use of NVGs. This is midway between the ideal 90 day requirement and the Army's more stringent 45 day requirement, which may in the future be changed to 90 days.

ISSUE STATUS: Resolved with available information.

ISSUE RESOLUTION: The NVG recency of flight experience requirements stated in the CONOPS are 2 calendar months.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: If the Army does decide to change to a 90-day NVG currency requirement, this issue should be revisited and the data upon which the Army based its decision should be analyzed in the context of civil aviation NVG operations.

SOURCE DOCUMENTS: CONOPS.

ISSUE NUMBER: 18:

ISSUE TITLE: Radar Altimeter as minimum equipment.

ISSUE DESCRIPTION: Should a radar altimeter be required for NVG flight operations? The radar altimeter will potentially assist in preventing controlled flight into terrain under certain visual conditions and terrain environments. Night flight in featureless desert or mountainous terrain is demanding and would be aided by the use of a radar altimeter. However, not all flights or mission profiles require this instrument for added safety. The Army now requires a radar altimeter in all aircraft due to the extensive night flying and NVG flight involved in their warfighting mission. This was not always the case however. The Army flew NVGs in all types of terrain for nearly 20 years without requiring a radar altimeter. A radar altimeter may not be needed in all flight conditions and adds weight, requires precious panel space, and adds expense to getting an aircraft certified for NVG flight.

ISSUE DISCUSSION: There was a split vote on this issue. The majority of the CONOPS working group, spirited on by the Military contingent, felt that a radar altimeter should be required equipment. A smaller but no less vocal group, with major industry included, felt this should be optional.

ISSUE STATUS: Unresolved.

ISSUE RESOLUTION: The majority voted to include a radar altimeter as required minimum equipment for NVG cockpit certification. However, the RTCA process requires consensus to resolve issues. A requirement for a radar altimeter was included in the CONOPS and the MOPS but its ratification is in question.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Comparative controlled flight into terrain data is needed for aircraft equipped with radar altimeters and those without radar altimeters and flown under NVGs for various flight scenarios.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 19

ISSUE TITLE: Attitude Indicator Requirement.

ISSUE DESCRIPTION: Should an attitude indicator be required as part of the minimum equipment list for NVG flight?

ISSUE DISCUSSION: This question was prompted by the perception by some that NVG flight is done with a significant dependence on aircraft instruments for attitude awareness due to the potential illusions experienced using NVGs under certain ambient and terrain conditions. Also, some participants held the opinion that flight with NVGs make the pilot more prone to inadvertent IMC than unaided flight. For both of these reasons, their opinion was that an attitude indicator should be required as minimum equipment for NVG flight. The argument against this is that NVGs actually allow the pilot to see and avoid clouds that could not be detected unaided. In addition, since NVGs are merely an aid to VFR night flight, and an attitude indicator is not required for night helicopter operations, this should not be a requirement for NVG flight. An attitude indicator requirement is typically an issue only for older aircraft such as a Bell 47 that do not have an attitude indicator on the standard instrument panel. Adding an attitude indicator will add weight, take up panel space, and add cost to getting the aircraft cockpit certified for NVG flight. It was decided to require an attitude indicator as minimum equipment for NVG cockpit certification. This will only affect a small percentage of older aircraft. The risk mitigation was considered to be worth the added weight and expense.

ISSUE STATUS: Resolved with available information

ISSUE RESOLUTION: An attitude indicator is required by the CONOPS and MOPS as minimum equipment.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: The economic impact of requiring an attitude indicator for all aircraft conducting NVG flight was not available at the time this issue was resolved, nor was comparative data available on the probability of pilots entering inadvertent IMC conditions under unaided night VFR compared to NVG aided night VFR. Future data in these areas may require revisiting this issue.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 20

ISSUE TITLE: Purpose of the CONOPS and MOPS and the relationship between the two documents.

ISSUE DESCRIPTION: What is the relationship between the CONOPS and the MOPS? There was a lengthy discussion concerning the relationship between these two documents. Participants wanted the CONOPS to refer to the MOPS and Training Concept for additional detail concerning a subject to avoid lengthy discussions in the CONOPS of subjects that are covered in detail in the supporting documents. Another discussion centered around whether the CONOPS is considered a "requirements" document.

ISSUE DISCUSSION: A typical requirements document is written first, and is the document that all other documents such as the MOPS and Training Concept would cite as the controlling authority for their requirements. Additionally, Government requirements documents are normally written in a language that clearly specifies the performance that must be achieved by the system being developed to support the requirements, which in this case would be the Night Vision Imaging System (NVIS). The approach taken with the CONOPS differs in two respects. First, the CONOPS is not written in typical requirements language. It is written more as a conceptual vision of how NVGs will be used in the NAS. The only requirements language in the document resides in the pilot training and qualifications sections. Secondly, a requirements document is normally written first. In this case, the MOPS and the Training Document were written simultaneously with the CONOPS. If the CONOPS is a true requirements document, there should be direct traceability between the CONOPS and the MOPS and Training Documents. In reality, this is only partially true.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The CONOPS is not a pure requirements document. It is written as more of a vision concerning how NVIS will be implemented into the National Airspace System. The CONOPS can and should direct the reader to other documents for the details concerning a particular subject. It was agreed that there should be traceability between subjects covered in the CONOPS and those covered in the MOPS and training documents.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: CONOPS, MOPS, and Training Document.

ISSUE NUMBER: 21

ISSUE TITLE: Should an instrument rating be required for NVG training?

ISSUE DESCRIPTION: Should the applicant for an NVG qualification be required to have an instrument rating as a prerequisite to NVG training? The debate concerning this issue was very polarized.

ISSUE DISCUSSION: There is a perception by some that flying NVGs is very close to the same skills and procedures used for instrument flight. In addition, the chance of going inadvertent IMC is perceived by some to be increased over regular night unaided flight and therefore, there is a need for the skills that an instrument ticket provides to recover from this emergency. The argument presented by the other side is that the chance of inadvertent IMC decreases because the clouds are more visible. In addition, if the pilot has enough training and skill to demonstrate an inadvertent IMC recovery, then that is sufficient to mitigate the potential risk. A compromise position was reached to make an instrument rating optional but to require a minimum of instrument training beyond that which is required of pilots flying VFR.

ISSUE STATUS: Resolved with available information.

ISSUE RESOLUTION: Requirements for instrument experience were added to the CONOPS and the Training Document. The applicant must either have an instrument rating or have completed 30 hours of actual or simulated instrument flight time. Of this instrument flight training, at least 15 hours of that training must be from an authorized flight instructor in an actual aircraft of which 5 hours must be in the aircraft category for which the NVIS endorsement is being sought. Of this training, a maximum of 10 hours may be performed in an approved flight simulator or approved flight training device. Of this training, 10 hours must be done at night in an actual aircraft.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: The contribution of instrument flying skills to successful performance during night VFR with NVGs has not been systematically studied. Comparative research using civilian pilots who are instrument rated and not instrument rated and who have varying levels of instrument flight experience would provide useful data to refine these requirements.

SOURCE DOCUMENTS: FAR/AIM 2001 and the CONOPS document.

ISSUE NUMBER: 22

ISSUE TITLE: What pilot ratings are required as prerequisites for NVG training?

ISSUE DESCRIPTION: Should a commercial rating be a prerequisite for an NVG qualification? What should the minimum pilot rating be?

RECOMMENDED SOLUTION: The primary users of NVGs will initially be FAR Part 135 Commercial operators who have commercial licenses. Maintaining the higher standard will help ensure that only more experienced aviators qualify for the challenging NVG certification. Allowing private pilots to fly NVGs will add risk due to the greater potential for inexperienced applicants. That being said however, the guidance for writing the CONOPS, MOPS and training documents was to target the lowest common denominator which is the FAR Part 91 pilot holding a private certificate. It was concluded that the lowest pilot rating should be a private pilot certificate.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The lowest rating specified in the CONOPS and MOPS is that the applicant for an NVG logbook sign-off must have a private pilot certificate.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 23

ISSUE TITLE: Flight experience required for NVG training and currency

ISSUE DESCRIPTION: Should NVG training and currency be based on number of hours flown or number of specific tasks accomplished? Representatives from the commercial NVG training industry (Bell Helicopter) recommended 7-10 hours of NVG flight training as preparation for an NVG logbook sign-off. The NVG logbook sign-off should be based on proficiency and not just the number of hours. The SC-196 Training Workgroup recommended 5 hours minimum (proficiency based), which is supported by Rocky Mountain Helicopters (RMH) and the FAA personnel who certified the RMH pilots and aircraft.

ISSUE DISCUSSION: High levels of NVIS proficiency, along with a well-balanced NVIS experience base, will help to offset many of the visual performance degradations associated with night operations. NVIS experience is a result of proper training coupled with numerous NVIS operations. An experienced NVIS operator is acutely aware of the NVIS operational envelope and its associated operational effects, visual illusions and performance limitations. This experience base is gained (and maintained) over time through a continual, holistic NVIS training program which exposes the operator to NVIS operations conducted under various moon angles, percentage of available illumination, contrast levels, visibility levels, and varying degrees of cloud coverage. An operator should be exposed to as many of these variations as practicable during the initial NVIS qualification program. Continued exposure during the NVIS recurrent training will help strengthen and solidify this experience base.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The following was specified in the CONOPS document.

Pilot qualifications for an NVG logbook sign-off are as follows:

1. Have 20 hours of night unaided VFR flight.
2. Have at least 250 total hours of flight time as a pilot, of which 50 hours can be in an approved flight simulator or approved flight training device, that is representative of the aircraft category that will be used for NVIS training.
3. Have attended an NVIS training course that follows a syllabus recognized by the applicant's appropriate regulatory agency. This training can be conducted either by a qualified NVIS instructor or an authorized operator. This course should include a minimum of 5 separate flights, of not less than 1 hour per flight. All training must be conducted by an authorized NVIS instructor in an NVIS approved aircraft. Regardless of these minimum flight time requirements, proficiency in the designated flight maneuvers must be achieved.

In order to carry passengers the pilot must, within the preceding two calendar months:
1. Perform and log three area departure and arrival tasks using night vision goggles.

2. Perform and log three tasks of transitioning from aided night vision goggle flight to unaided flight without the use of night vision goggles and then back to aided night vision goggle flight.
3. Perform and log three takeoffs and landings using night vision goggles if the pilot is approved to use night vision goggles during the takeoff and landing phases of flight.
4. Perform and log three hovering tasks using night vision goggles if the pilot is approved to use night vision goggles during the hovering phase of flight.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: FAR/AIM 2000.

ISSUE NUMBER: 24

ISSUE TITLE: Inadvertent IMC while using NVGs.

ISSUE DESCRIPTION: Will the use of NVGs make the pilot more susceptible to entering inadvertent instrument meteorological conditions than unaided flight?

ISSUE DISCUSSION: Some believed that wearing NVGs would permit the pilot to get deeper into a reduced visibility situation before recognizing that situation compared to flying unaided. The opponents of this position state that NVGs will allow the pilot to see the restriction to visibility before entering whereas an unaided pilot would not be able to see it coming. The method for mitigating risk is to perform extensive weather planning and to stay alert for weather changes. The pilot who plans is not surprised by the weather. Even with thorough planning a risk of entering inadvertent IMC while flying with NVGs still exists. To help mitigate this risk, it is important to know how to recognize subtle changes to the NVG image that occur during entry into IMC conditions. Some of these include the onset of scintillation, loss of scene detail, and changes in the appearance of halos. It was decided to list in the CONOPS some ways to help reduce the potential for inadvertent flight into IMC conditions.

ISSUE STATUS: Resolved

ISSUE RESOLUTION: Information was provided in CONOPS on methods to help reduce the potential for inadvertent flight into IMC conditions.

1. Obtain a thorough weather brief (including pilot reports).
2. Be familiar with weather patterns in the local flying area.
3. Look beneath the NVG at the outside scene.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 25

ISSUE TITLE: NVG Power Supply Requirements.

ISSUE DESCRIPTION: There was a discussion concerning the power supply requirements for the NVGs. The U.S. design provides for a single primary and backup power supply for both image intensifier tube assemblies. The British design has a separate battery power supply for each image intensifier tube with no backup. This demonstrates a difference in fail-safe design philosophy. The MOPS as then drafted drove the designer toward the U.S. design solution.

ISSUE DISCUSSION: The MOPS should be rewritten to include the following design guidance. A battery power module must provide sufficient electrical power for operation of the binocular. The power module must include both primary and secondary sources. Each source must be capable of independently operating the binocular, and for equal duration. The power module may also include provisions to interface with an external power source. In this instance, the power module must supply uninterrupted power to the binocular in the event of failure of the external power source. A low-power indicator must signal the user to select the spare power module source when primary power is no longer sufficient to operate the binocular. The low-power indicator must be visible to the user.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The MOPS was rewritten to add design solution flexibility as described above into the design criteria.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 26

ISSUE TITLE: Daylight readability of cockpit instruments.

ISSUE DESCRIPTION: There was a lengthy discussion concerning daylight readability of the flight instruments. The discussion centered around the fact that many cockpits have daylight instrument readability problems due to factory design deficiencies. Some factory design cockpits may not meet the NVG daylight readability requirements. The NVG cockpit modification requires NVG aircraft to pass an instrument daylight readability test to get FAA approval of the cockpit modification. The main question was whether the daylight readability of the instruments has to be potentially better following the NVG modification than it was before the modification, i.e. better that the original manufacturers design.

ISSUE DISCUSSION: Two points were made relevant to this issue. The method for evaluating NVG daylight readability is a subjective evaluation so the results of the cockpit inspections may vary. When one adds a modification to a cockpit one assumes the potential additional requirement of having to improve one's cockpit to meet the standards governing the modification. There will be additional discussion on this topic and a more formal resolution forthcoming.

ISSUE STATUS: Interim resolution pending further discussion.

ISSUE RESOLUTION: As an interim, pending additional discussion, cockpits must meet the daylight readability criteria specified in the MOPS even if it means improving on the OEM's design.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Data on the extent of daylight readability problems with current cockpits and a more repeatable method for determining the acceptability of daylight readability for specific cockpits.

SOURCE DOCUMENTS: MOPS.

ISSUE NUMBER: 27

ISSUE TITLE: Windscreen transmissivity.

ISSUE DESCRIPTION: There was a big discussion concerning how cockpit canopy or windscreen transmissivity affects NVG performance. This issue was raised in various workgroup discussions in some form on three different occasions. Goggle performance can be significantly reduced by the see-through characteristics of the cockpit canopy and by the amount of near-IR energy that is allowed to pass through it. Total NVG performance is determined by a combination of several factors, which include human eye performance, goggle performance, cockpit lighting, canopy transparency, ambient lighting, and the visual scene.

ISSUE DISCUSSION: Mr. Loran Haworth volunteered to work on a formula to determine go-no-go criteria for the combination of all of the above contributing factors. The Air Force reported that the F-16 has a see-through problem with the canopy. It was reported that certain military windscreens have been measured to block up to 70% of the near-IR energy that comes into the NVG, resulting in a potentially significant degradation in goggle performance.

ISSUE STATUS: Unresolved.

ISSUE RESOLUTION: Cannot be resolved without further data.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Data is needed in the form of measured visual acuity degradation caused by the various factors discussed above. With these data an effort can be undertaken to develop a formula that will give total resultant visual acuity after all factors affecting visual acuity are considered, measured and assigned a value. Potentially a go no-go value could be determined that considers not only the resultant visual acuity but also takes into account the weather conditions and the degree of difficulty of the mission profile to be flown. A substantial research effort is needed to reach this goal.

SOURCE DOCUMENTS: None.

ISSUE NUMBER: 28

ISSUE TITLE: Minimum vision requirements for NVG qualification.

ISSUE DESCRIPTION: Vision requirements – civil vs. military. This issue is closely related to Issue 9 above. This subject was briefed by the FAA SW Region Flight Surgeon. The military requires all aviators to pass a Class I flight physical annually. The vision requirement is 20/20 vision (or correctable to 20/20), with color blindness not permitted. In addition, laser surgery to correct vision is not permitted. Civilians flying under Part 91 only require a Class III flight physical, taken every 24 months. To pass the physical, the pilot's vision requirements are allowed to be correctable to 20/40, and there are minimal tests for color blindness. Typical NVG resolution is approximately 20/40 or worse. If the goggle user starts with deficient vision in the 20/40 range, the impact could be significant. The actual results are not known but this could be an issue. Having said that, a person with 20/20 vision sees approximately 20/200 at night unaided so there will still be a benefit to using NVGs. Civilian pilots are allowed laser eye surgery to correct vision. Some patients report a permanent condition that causes lights to bloom or have a halo during unaided night vision following corrective laser surgery.

ISSUE DISCUSSION: If the goggle user starts with deficient vision in the 20/40 range, the cumulative impact could be significant. However, in the absence of data, any supposed cumulative effect is speculation. This is an issue the FAA must address. Since no data currently exist concerning the effects on NVG resolution of visual acuity of less than 20/20, the CONOPS and MOPS should at present hold to this more stringent requirement. Laser corrective surgery should not be allowed.

ISSUE STATUS: Interim solution implemented pending further data.

ISSUE RESOLUTION: The CONOPS and MOPS both specify visual acuity of 20/20 for NVG qualification. When data becomes available regarding NVG resolution and pilot performance with visual acuity less than 20/20, this issue should be revisited.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: Research and flight test must be done to quantify the effects of reduced visual acuity on NVG resolution and pilot performance.

SOURCE DOCUMENTS: FAR/AIM 2000.

ISSUE NUMBER: 29

ISSUE TITLE: Aircraft position lighting requirements.

ISSUE DESCRIPTION: Aircraft position lighting can affect NVG performance on certain aircraft. Films of the effects of standard, FAA approved position lights on an F-16 showed significant visual resolution degradation when looking off axis over the wing with position lights on, due to veiling glare. Shadowing and gain reductions were obvious. This problem does not seem as prevalent on helicopters where the position lights are typically aft of the cockpit and attached to the fuselage rather than a wing. There is reportedly an NVG compatible position light available on the market that meets FAA specifications. Military aircraft often turn position lights off while operating in MOAs. Civilian aircraft operating with NVGs however, will have to meet FAA requirements concerning external lighting.

ISSUE DISCUSSION: Position lights must meet the specifications outlined in the FARs. NVG compatible red, green, and white position lights are available on the market. If standard position lights are demonstrated to interfere with NVGs during external lighting tests conducted IAW the MOPS procedures, then NVG compatible lighting will have to be installed.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: NVG external lighting must comply with the FARs and with the criteria specified for external lighting in the MOPS.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: MOPS.

ISSUE NUMBER: 30

ISSUE TITLE: Minimum crew required for NVG operations.

ISSUE DESCRIPTION: What should the minimum number of crewmembers be for NVG operations? This issue is similar to Issue 3 concerning off-sight landings. Some feel that there should be two NVG qualified crewmembers in the cockpit for NVG operations. This is due to the reduced field of view of the NVGs and difficulty in clearing the skids and tail during confined area operations.

ISSUE DISCUSSION: The Army requires two qualified pilots, or a pilot and trained observer for NVG flights. Single pilot NVG operations are not permitted. The Navy and Air Force however, fly NVGs in single pilot aircraft. The extra crewmember required by the Army does reduce risk but the Army flight profiles are typically more difficult than a typical civilian operation. Requiring two qualified crewmembers would have a huge cost impact on many civil operators in both salary and training costs. It was decided that the minimum crew for night vision goggle operations shall be the higher of either the minimum crew specified by the aircraft type certificate or the minimum crew required for the aircraft operation.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The minimum crew for night vision goggle operations shall be the higher of either the minimum crew specified by the aircraft type certificate or the minimum crew required for the aircraft operation.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: FAR/AIM 2000.

ISSUE NUMBER: 31

ISSUE TITLE: Should permanent cockpit lighting installation be mandated or can temporary lighting be used?

ISSUE DESCRIPTION: One major industry NVG training school recommends that temporary NVG cockpit lighting installations should be allowed. These would be removable filters and area lights that could be clipped or velcroed in place for night operations and removed for day operations. This position was controversial in that the cockpit lighting working group is leaning toward requiring a more permanent lighting modification in order to be certified.

ISSUE DISCUSSION: The was concern that a temporary installation may lack configuration consistency from one flight to the next. The Air Force has developed temporary lighting kits for various training aircraft in the fleet. They seem to work well. Consistency is the big issue. The FAA will resist approving anything that is temporary and could be reinstalled differently each time and may not meet the original approved lighting criteria. It was decided that only permanent cockpit lighting be approved for NVG use. This will ensure consistency with the cockpit lighting criteria and testing.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: Permanently installed lighting is required.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: MOPS lighting section.

ISSUE NUMBER: 32

ISSUE TITLE: Instructor pilot qualifications.

ISSUE DESCRIPTION: What should the requirements be to qualify as an NVG instructor pilot?

ISSUE DISCUSSION: As a result of discussions, the following criteria for qualification as an NVG instructor pilot were recommended:

1. Holds a pilot certificate and flight instructor certificate with the applicable category and class rating for the aircraft in which the night vision goggle training is being given.
2. Holds a type rating, if a type rating is appropriate, on the flight instructor's pilot certificate for the aircraft in which the night vision goggle training is being given.
3. Is pilot in command qualified for night vision goggle operations, in accordance with the applicable regulations in the aircraft in which the night vision goggle training is being given.
4. Has logged at least one hundred night vision goggle operations as the sole manipulator of the controls.
5. Has logged at least twenty night vision goggle operations as sole manipulator of the controls in the category, class, and type (if class and type are appropriate) of the aircraft in which the night vision goggle training is being given.
6. Is current and qualified to act as a pilot in command in night vision goggle operations in accordance with the applicable regulations.

Has a logbook endorsement from the applicable regulatory agency authorized to provide that endorsement and that endorsement must state that the flight instructor is authorized to perform the night vision goggle pilot in command qualification and recency requirements checks.

ISSUE STATUS: Resolved.

ISSUE RESOLUTION: The criteria above were adopted and specified in the CONOPS and the Training Document.

INFORMATION NEEDED TO RESOLVE UNRESOLVED ISSUE: None.

SOURCE DOCUMENTS: FAR/AIM 2000.

SUMMARY

This report is a compilation of the major issues that were raised and discussed in the meetings of the RTCA Special Committee 196 (SC-196) Night Vision Goggle (NVG) Appliances & Equipment during the Committee's drafting of two documents that will assist the FAA in the implementation of requirements for the use of night vision imaging systems (NVIS) in civil aviation flight operations. The issues discussed herein were discussed by the SC-196 members as they drafted the two documents entitled, "Concept of Operations Night Vision Imaging System for Civil Operators" and "Minimum Operational Performance Standards (MOPS) for Integrated Night Vision Imaging System Equipment". In all, thirty-two major issues are documented here in a standard format that includes issue number, issue title, issue description, issue discussion, issue status, issue resolution, data needed to resolve unresolved issue, and applicable source documents. Of these, the first sixteen issues were issues that crossed SC-196 working groups and/or that were brought before the entire SC-196 in plenary session for resolution. The remainder of the issues, numbers seventeen through thirty-two, were discussed and resolved or partially resolved within a single working group. This report documents the issue resolution process that was used and the rationale used to resolve each issue or the additional information that is needed to resolve the unresolved issues.

The method used to resolve each issue was that of consensus of all SC-196 members who were present at the meeting at which a particular issue was resolved. In some cases there was considerable debate with diametrically opposing views based on differences in expert opinion among the committee members. In one instance, for Issue 18 Radar Altimeter as minimum equipment, consensus could not be reached. The majority of the members present voted to require that a radar altimeter be installed in any aircraft that is to be operated with NVGs. The issue was considered resolved by SC-196, however this is in contradiction to RTCA procedures. Therefore, in this report, the Issue 18 status is shown as unresolved.

Of the 32 issues, 20 were resolved, 5 were partially resolved, 2 received an interim resolution pending further discussion and data, and the remaining 5 issues were unresolved.

The issue resolution process relied heavily on the expert opinion of the industry, government, and military representatives who served as committee members. Discussions of the issues often raised points which could not be resolved on the basis of test data because such data either does not exist or was not available to the committee at the time that a resolution of the issue was made. In the case of ten issues, the issue was left unresolved or only partially resolved pending further information. For two issues an interim resolution was implemented pending further information.

Some of the 20 issues that were resolved were resolved on the basis of expert opinion only and in the absence of test data. It is reasonable to expect that when test data become available these issues should be revisited. Those issues which were resolved but without the benefit of test data and may be subject to modification if further data become

available are given an issue status of Resolved with Available Information. In all, five of the twenty resolved issues fell into this category of being resolved with available information.

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