U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Aviation Rulemaking Committee Charter

Effective Date: 10/05/12

SUBJECT: Section 318 Night Vision Goggles Feasibility Study

1. **PURPOSE.** This charter creates the Aviation Rulemaking Committee (ARC) for the Section 318 Night Vision Goggles Feasibility Study according to the Administrator's authority under Title 49 of the United States Code (49 U.S.C.) 106(p)(5). This charter also outlines the committee's organization, responsibilities, and tasks.

2. **BACKGROUND.** This ARC is necessary to comply with Section 318 of the Federal Aviation Administration (FAA) Modernization and Reform Act of 2012 (the Act). Section 318 of the Act requires the Administrator to carry out a study on the feasibility of requiring 14 CFR part 135 air ambulance helicopter pilots to use Night Vision Goggles (NVG) during nighttime operations. The Act requires the Administrator to submit a report to Congress on the results of the study no later than February 14, 2013.

3. **OBJECTIVES AND TASKS OF THE ARC.** The ARC will provide a forum for the United States aviation community to discuss and provide recommendations to the FAA. The ARC will conduct a study on the feasibility of requiring pilots of helicopters providing air ambulance services under Title 14 Code of Federal Regulations (14 CFR) part 135, to use night vision goggles during nighttime operations. While conducting the study, the ARC will consider information from owners and operators of helicopters providing 14 CFR part 135 air ambulance services and aviation safety professionals to determine the benefits, financial considerations, and risks associated with requiring the use of NVGs.
   - **a.** The ARC will conduct a literature review and determine the benefits and risks associated with requiring the use of night vision goggles considering the following:
     1. Human and environmental factors (e.g., effects of eye pathologies on NVG use, fatigue, effects of recurrent use on human performance, effects of prolonged NVG use on color vision, effects on loss of dark adaptation and transition to night vision, lighting, weather, and terrain).
   - **b.** The ARC will determine the benefits, financial considerations, and risks associated with requiring the use of night vision goggles considering the following:
     1. Obstacle lighting (LED vs. incandescent bulbs);
     2. Airport, hospital, and helipad lighting (LED vs. incandescent bulbs);
     3. Operational criteria for use (Risk assessment, safety analyses, costs associated with go/no-go based on NVG availability);
     4. Operational criteria for use (Specific language in the operations rules (14 CFR parts 135 and 91), updated operations specification paragraphs in 8900.1);
     5. Dispatch protocol (What dispatch and operations continuation considerations need to be addressed, how long will it take, and are there resources to support the effort?);
     6. Helicopter medical personnel using NVGs to assist with NVG-aided flight into unimproved landing sites;
     7. Second crewmember using NVGs to assist with NVG-aided flight into unimproved landing sites;

8. Assess single-crew pilot only (no other occupants using NVG) operations into unimproved landing zones;
9. Single pilot vs. dual pilot operations;
10. Operational requirements for single pilot operations;
11. Aircraft Make/Model specific NVG currency requirements/endorsements (§§ 61.57, 135.293);
12. Effects on rural communities (If there is one helicopter in a given region that has an NVG component become inoperable, and the mission could have been completed unaided, did the mandate prevent the mission from being completed?);
13. Minimum Equipment List Considerations (How does mandating NVG operations at night affect the Master Minimum Equipment List and the operator's Minimum Equipment List?);
14. Autopilot requirements (Is an autopilot or some sort of stabilization system needed?);
15. Requiring pilot currency for instrument flight (Instrument Meteorological Conditions (IMC)) if NVGs are used (§135.207);
16. Size and scope of operation. (What are the effects of operator size and the geographic scope of the operations relative to operating with NVG?);
17. Effect on operational control;
18. NVG maintenance and aircraft configuration control;
19. Prior adverse operator experience with Night Vision Imaging Systems (NVIS) and mitigations used;
20. NVIS operational usage patterns and policy for use during nighttime operations (continuous vs. intermittent use during night operations as defined in 14 CFR 1.1: "*Night* means the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.");
21. The known causes of civil NVG accidents worldwide;
22. Assess 14 CFR 135.207 requirements while using NVGs (Evaluate increased requirement for NVG inadvertent IMC recovery procedures); and
23. FAA approval of NVGs (approval methods to include NVG manufacturers and NVIS STC holders).

Recommendation Report. The ARC will make recommendations on the feasibility of requiring pilots of helicopters providing air ambulance services under 14 CFR part 135, to use night vision goggles during nighttime operations.

The ARC will submit a final report detailing recommendations no later than 2 months from the effective date of the charter.

4. ARC PROCEDURES.

a. The ARC advises and provides written recommendations to the Associate Administrator for Aviation Safety, and acts solely in an advisory capacity. Once the ARC recommendations are delivered to the Associate Administrator for Aviation Safety, it is within her discretion to determine when and how the report of the ARC is released to the public.

b. The ARC may propose additional tasks as necessary to the Associate Administrator for Aviation Safety for approval.

c. The ARC will submit a report detailing recommendations within 2 months from the effective date of this charter. The chair of the ARC sends the recommendation report to both the Associate Administrator for Aviation Safety and the Director of the Office of Rulemaking.

d. The ARC may reconvene following the submission of its recommendations for the purposes of providing advice and assistance to the FAA, at the discretion of the Associate Administrator for Aviation Safety, provided the charter is still in effect.

5. ARC ORGANIZATION, MEMBERSHIP, AND ADMINISTRATION. The FAA will set up a committee of members of the aviation community. Members will be selected based on their familiarity with NVG, analysis, and regulatory compliance. Membership will be balanced in viewpoints, interests, and knowledge of the committee's objectives and scope. ARC membership is limited to promote discussion. Active participation and commitment by members will be essential for achieving the ARC objectives. Attendance is essential for continued membership on the committee. When necessary, the ARC may set up specialized work groups that include at least one ARC member and invited subject matter experts from industry and government.

This ARC will consist of members from:

Industry:

- Air Methods Corporation (QMLA)
- Air Evac EMS, Inc. (EVCA)
- Metro Aviation (HDNA)
- Med Trans Corporation (M3XA)
- Stat Medevac (E3MA)
- Tristate Careflight (IFJA)
- Classic Helicopters (JAPA)
- Travis County EMS (LEUA)
- Halo Flight, Inc. (H7FA)

FAA:

- AFS, Flight Standards Service
- AAM, Office of Aerospace Medicine
- ANG-C1, Human Factors Research & Engineering Division
- ANG-E261, Airport Safety R & D Section
- AAS-100, Office of Airport Safety & Standards – Airport Engineering Division
- ASW-300, Aerospace Medical Division – Aerospace Medical, ASW
- ASW-100, Southwest Region – Aircraft Certification Service, Rotorcraft Directorate
- AVP-200, Office of Accident Investigation and Prevention – Safety Analytical Services Division
- APO, Aviation Policy and Plans

The Associate Administrator for Aviation Safety is the sponsor of the ARC and will select an industry chair(s) from the membership of the ARC and the FAA designated Federal official for the ARC. The FAA participation and support will come from all affected lines-of-business.

a. The ARC sponsor is the Associate Administrator for Aviation Safety who:
   1. Appoints members or organizations to the ARC, at the sponsor's sole discretion;
   2. Receives all ARC recommendations and reports; and
   3. Provides administrative support for the ARC, through the Flight Standards Service.

b. Once appointed, the industry chair(s) will:

1. Coordinate required committee and subcommittee (if any) meetings in order to meet the ARC's objectives and timelines;
2. Provide notification to all ARC members of the time and place for each meeting;
3. Ensure meeting agendas are established and provided to the committee members in a timely manner;
4. Ensure meetings minutes are kept; and
5. Perform other responsibilities as required to ensure the ARC's objectives are met.

6. **COST AND COMPENSATION.** The estimated cost to the Federal Government for the Section 318 Night Vision Goggles Feasibility Study ARC is approximately $40,000 annually. All travel costs for government employees will be the responsibility of the government employee's organization. Non-government representatives, including the industry co-chair, serve without government compensation and bear all costs related to their participation on the committee.

7. **PUBLIC PARTICIPATION.** ARC meetings are not open to the public. Persons or organizations outside the ARC who wish to attend a meeting must get approval in advance of the meeting from a committee chairperson or designated federal official.

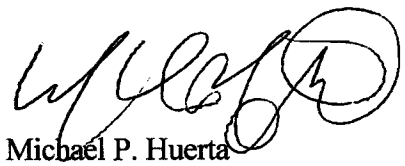
8. **AVAILABILITY OF RECORDS.** Consistent with the Freedom of Information Act, Title 5, U.S.C., section 522, records, reports, agendas, working papers, and other documents that are made available to or prepared for or by the committee will be available for public inspection and copying at the FAA Headquarters, Flight Standards Service, AFS-1, 800 Independence Avenue, SW, Washington, DC 20591. Fees will be charged for information furnished to the public according to the fee schedule published in Title 49 of the Code of Federal Regulations, Part 7.

   You can find this charter on the FAA Web site at:
   http://www.faa.gov/regulations_policies/rulemaking/committees/documents/.

9. **DISTRIBUTION.** This charter is distributed to director-level management in the Office of the Associate Administrator for Aviation Safety, the Office of Aviation Policy and Plans, and the Office of Rulemaking.

10. **EFFECTIVE DATE AND DURATION.** This ARC is effective upon issuance of this charter. The ARC will remain in existence for 12 months unless sooner suspended, terminated, or extended by the Administrator.

The effective date of this charter is October 5, 2012.



Michael P. Huerta
Acting Administrator

A REPORT FROM THE AVIATION RULEMAKING COMMITTEE FOR THE SECTION 318 NIGHT VISION GOGGLES FEASIBILITY STUDY TO THE FEDERAL AVIATION ADMINISTRATION

Results of Study on Feasibility of Requiring 14 CFR Part 135 Air Ambulance Helicopter Pilots to Use Night Vision Goggles during Nighttime Operations

November 14, 2012

Prepared for:

Associate Administrator for Aviation Safety
Federal Aviation Administration
Washington, DC

TABLE OF CONTENTS

LETTER TO ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY

November 14, 2012

Ms. Margaret Gilligan
Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Dear Ms. Gilligan:

The Aviation Rulemaking Committee (ARC) for the Section 318 Night Vision Goggles (NVG) Feasibility Study was established on October 5, 2012 to comply with the Federal Aviation Administration (FAA) Modernization and Reform Act of 2012 (the "Act"), which requires the Administrator to carry out a study of the feasibility of requiring 14 CFR part 135 air ambulance helicopter pilots to use NVG during nighttime operations. The FAA tasked the ARC to conduct the feasibility study and consider information from owners and operators of helicopters providing 14 CFR part 135 air ambulance services and aviation safety professionals to determine the benefits, financial considerations, and risks associated with requiring the use of NVG.

The NVG ARC conducted the feasibility study, reviewed the results (including deliberation of the considerations set forth in its charter), and developed its recommendation. The members prepared this final report in accordance with the charter.

After careful consideration of the present operating environment and its limitations, as well as current FAA certification and surveillance resources, the NVG ARC recommends against rulemaking that would impose a requirement on pilots of helicopters providing air ambulance services under 14 CFR part 135 to use NVG during nighttime operations.

On behalf of the members, it has been a pleasure to participate on the ARC and assist the FAA in conducting the feasibility study. We appreciate the FAA's willingness to coordinate with the helicopter air ambulance community to address issues of concern to the industry and ensure the safest possible operating environment. The ARC would be happy to provide additional support as you prepare the report to Congress in order to meet the objectives of Section 318 of the Act.

Sincerely,

Chris Bassett, Industry Chair
Air Methods

William Tom Shergalis, Designated Federal Official
General Aviation & Commercial Division (AFS-800)
Federal Aviation Administration

EXECUTIVE SUMMARY

On October 5, 2012, the Administrator of the Federal Aviation Administration (FAA) established the Aviation Rulemaking Committee (ARC) for the Section 318 Night Vision Goggles (NVG) in order to assist the FAA in conducting the feasibility study required by section 318 of the FAA Modernization and Reform Act of 2012 (Public Law 112-95) ("the Act"). In mandating the study, Congress directed the Administrator to consult with owners and operators of helicopters providing air ambulance services to determine the benefits, financial considerations, and risks associated with requiring the use of NVG. The ARC has completed its review and submits this report for consideration by the Administrator in the preparation of the FAA Report to Congress on the results of the feasibility study.

Methodology

The ARC conducted a study on the feasibility of requiring pilots of helicopters providing air ambulance services under Title 14 Code of Federal Regulations (14 CFR) part 135, to use NVG during nighttime operations. In addition to their own operational experience with NVG, the members had the benefit of FAA participants and subject matter experts (SME) as it undertook this effort. The feasibility study consisted of two primary components: (1) a literature review and (2) a review of the considerations set forth in the charter establishing the ARC. The scope of the feasibility study was limited to the single question of whether or not to mandate the use of NVG for helicopter air ambulance operators during nighttime operations.

Literature Review

The initial focus of the literature review was limited to human and environmental factors, but the ARC expanded the scope of the review to include additional documents including regulations, guidance material, and National Transportation Safety Board (NTSB) resources.

At the outset of the literature review, the FAA assessed a number of reports and studies on the impact of NVG on pilot workload, and presented the results of this effort to the ARC. The members built on this foundation with a detailed review of the NTSB reports and recommendations, including accident and incident reports that were often cited by members of Congress when calling for further study of helicopter air ambulance operations. The ARC also noted the FAA guidance promulgated in response to the NTSB recommendations to date. After studying the NTSB materials, the members noted the lack of clarity in the data regarding NVG as a probable cause in accidents/incidents, as well as the inconsistent fashion in which such accidents/incidents are classified as controlled flight into terrain (CFIT) or inadvertent entry into instrument meteorological conditions (IMC) and subsequent loss of control in flight.

The members reviewed the current regulations applicable to helicopter air ambulance operations and identified several areas for further review, as a mandate to use NVG could result in significant decrease in emergency medical services. The ARC also discussed the pending final rule—Air Ambulance and Commercial Helicopter Operations, Part 91 Helicopter Operations, and Part 135 Aircraft Operations; Safety Initiatives and Miscellaneous Amendments Final Rule

("Helicopter Air Ambulance Final Rule"), which was proposed on October 12, 2010.[1] Industry stakeholders anticipate the final rule will be issued in the near future.

In reviewing the corresponding guidance material, the members reiterated their concern that certain guidance documents regarding equipment certification, operator certification, and operational authorization would require further review in the context of a requirement versus a recommendation to use NVG during nighttime operations. They were also concerned with relief from dispatch prohibitions in the event the technology is inoperable. In light of the proposed requirements for helicopter terrain awareness and warning system (HTAWS) and radio altimeters (in the Helicopter Air Ambulance Final Rule), the members noted the FAA should review current regulations and guidance to allow for the continued operation of aircraft in a limited timeframe should one of these devices become inoperable. The ARC completed the literature review and compiled an index of all of the documents it reviewed.

Review of Considerations

In formulating the ARC's objectives and tasks, the FAA developed a series of considerations to facilitate the members' discussions and assist the members in considering the question at hand. The members deliberated and discussed the 24 considerations set forth in the Charter. FAA SMEs provided additional information and research to support the ARC's efforts to evaluate each consideration, and the members reached consensus on their discussion of each consideration. In conducting this portion of the study, the members documented several concerns and issues that ultimately resulted in the ARC's recommendation.

The ARC determined that additional aeromedical research is necessary to determine the impact of and long-term consequences of NVG usage by flight crew. They also raised a similar concern about additional study necessary to ascertain the scope of the adverse effects on NVG of certain types of lighting used by airports/heliports/hospitals. The members also discussed training requirements and whether additional requirements are necessary to enhance the safety of NVG operations. The members emphasized that operational requirements applicable to nighttime operations do not need to be increased when such operations are conducted with NVG. The current regulatory requirements applicable to nighttime operations are also applicable to NVG operations, and the members noted that additional regulations would not necessarily enhance safety.

In addition to the equipment relief issues previously discussed, the ARC also addressed the level of current FAA resources available to review applications for modification of aircraft and certification of night vision imaging systems (NVIS) equipment and NVG. The members were reluctant to recommend a mandate in the current oversight environment where the FAA does not have sufficient resources to handle the level of certification and surveillance activity. The ARC documented lack of FAA resources as one of its primary concerns. The members also studied single-pilot operations and the requirement to have a second (flight or medical) crewmember during operations into unimproved landing sites. The ARC recommended further review of this requirement. Finally, the members discussed the significant economic impact that a requirement would have on small (and especially rural) operators and the likely outcome that many aircraft would be unable to operate at night if NVG use is mandated.

[1] 75 FR 62640.

Feasibility Study

The ARC concluded its feasibility study after completing the literature review and thorough discussion of the considerations in the Charter.

Results of Feasibility Study

The members agreed that NVIS are an extremely effective safety intervention in the night visual flight rules (VFR) environment, but they had significant concerns about the ramifications of a requirement to use NVG. They noted that, in general, there are greater risks when operating at night than during the day, but NVG can mitigate many of these risks when properly used and integrated into the operation. The members also noted the proper use of NVG can greatly enhance the safety of night operations, but there are hazards associated with improper use and integration of NVIS and NVG.

Although current NVG technology is not a substitute for daylight, the goggles significantly improve many of the limitations of unaided night vision. When used properly, NVG can dramatically increase the safety of night flying. However, the members emphasized that there are certain circumstances during which NVG are not always safe during nighttime operations because NVG do not provide adequate imagery under all lighting conditions, scene contrast, and atmospheric conditions. The ARC noted that the narrow scope of the question for study made it difficult to consider recommending the mandate, as the language in section 318 of the Act would require NVG use during all nighttime operations, which could result in an unsafe operating environment.

Additional Considerations for the FAA

In reviewing its findings after conducting the feasibility study, the ARC noted the voluntary implementation of NVIS and integration of NVG by helicopter air ambulance operators. The members also identified several areas for further review by the FAA. The additional areas of study resulted from the discussion regarding the considerations set forth in the NVG ARC Charter, as well as the analysis conducted by the ARC during the literature review. In the process of formulating its recommendation, the ARC suggested that the FAA should consider further review of the question of whether to mandate NVG use during nighttime operations after the Helicopter Air Ambulance Final Rule is promulgated.

The additional considerations submitted to the FAA involve questions focused on equipage, operational authorization/limitations, and FAA certification/surveillance resources. The ARC suggests the FAA undertake a review of these issues before further discussion regarding a requirement to use NVG that would take the decision-making ability away from the operator (and the pilot).

NVG ARC Recommendation

The ARC reached consensus on its recommendation after concluding its feasibility study, which was comprised of a literature review and a discussion of 24 considerations developed by the FAA to facilitate the ARC's deliberative process.

After careful consideration of the results of the feasibility study, the ARC was not prepared to recommend additional requirements in the current regulatory environment and in light of

insufficient resources to support FAA certification and surveillance activities. The ARC recommended against rulemaking that would impose a requirement on pilots of helicopters providing air ambulance services under 14 CFR part 135 to use NVG during nighttime operations.

Conclusion

The ARC unanimously agreed that use of NVG during nighttime operations enhances safety, but the members were not prepared to recommend taking the decision-making ability regarding the use of NVG away from operators (and their pilots) by mandating the use of NVG during nighttime operations. The ARC felt that safety is ensured in an environment where well-trained pilots can conduct a risk assessment and determine the course of action that mitigates the risks of nighttime operations, including the use of NVG. The members also noted the need for additional FAA resources to address the increased certification and surveillance workload that would result from such a requirement.

The members did not recommend a requirement to use NVG during nighttime operations, but they did document areas for further study by the FAA. The ARC noted its support of FAA efforts to allocate sufficient resources to NVIS certification, operator certification, and NVG operational authorizations. Finally, the ARC encouraged further collaboration between industry stakeholders and the FAA to determine the most effective regulatory environment for helicopter air ambulance operators.

1.0 NIGHT VISION GOGGLES AVIATION RULEMAKING COMMITTEE

On February 15, 2012, the President signed the FAA Modernization and Reform Act of 2012 (the "Act").[2] Pursuant to section 318 of the Act, the Federal Aviation Administration (FAA) chartered the Aviation Rulemaking Committee (ARC) for the Section 318 Night Vision Goggles (NVG) Feasibility Study on October 5, 2012. [3] The ARC conducted a study on the feasibility of requiring pilots of helicopters providing air ambulance services under Title 14 Code of Federal Regulations (14 CFR) part 135, to use NVG during nighttime operations.[4] While conducting the study, the ARC considered information from owners and operators of helicopters providing 14 CFR part 135 air ambulance services, aviation safety professionals, and FAA subject matter experts (SME) to determine the benefits, financial considerations, and risks associated with requiring the use of NVG.

The nine members of the ARC were selected by the FAA to represent parties directly affected by the issues, i.e., 14 CFR part 135 helicopter air ambulance operators currently authorized to conduct NVG operations. ARC membership included three members representing large air ambulance operators, three members representing medium-size air ambulance operators, and three members representing small air ambulance operators to ensure a balance in viewpoints and opinions.[5] The ARC's composition also allows the members to discuss the impact of a mandate to use NVG from the perspective of similarly situated operators and understand the unique burden, challenges, and foreseeable issues in mandating the use of NVG from each member's perspective. The ARC members, FAA participants, and ARC program support are listed in Appendix A.

In accordance with the Charter, the ARC will remain in effect until October 4, 2013, unless sooner suspended, terminated, or extended by the Administrator. The Associate Administrator for Aviation Safety (AVS-1) is the ARC sponsor. The ARC may reconvene following the submission of its report to advise and assist the FAA, at the discretion of AVS-1, provided the NVG ARC Charter is still in effect.

The ARC has completed its feasibility study, and this report provides the results and its recommendation consistent with the Charter, which enables the Administrator to meet its reporting requirements to Congress as directed by the Act.

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[2] FAA Modernization and Reform Act of 2012 (Public Law 112-95).
[3] *See* Aviation Rulemaking Committee Charter: Section 318 Night Vision Goggles Feasibility Study (October 5, 2012) (the "Charter").
[4] *Night vision goggle operation* means the portion of a flight that occurs during the time period from 1 hour after sunset to 1 hour before sunrise where the pilot maintains visual surface reference using night vision goggles in an aircraft that is approved for such an operation. 14 CFR 61.1(a)(14).
[5] The FAA used the following size standard in selecting members for the ARC: small (1–14 aircraft), medium (15–50 aircraft), and large (over 50 aircraft).

2.0 BACKGROUND

This chapter discusses background information relevant to the ARC's methodology, the scope of the ARC's feasibility study, the development of the ARC's recommendations, and the organization of this report and its content.

2.1 Overview

The Act directed the FAA to conduct a feasibility study on requiring the use of NVG by helicopter air ambulance operators during nighttime operations.

2.1.1 Congressional Review

The National Transportation Safety Board (NTSB) documented 12 accidents (eight involving fatalities) and 29 fatalities resulting from helicopter air ambulance accidents during calendar year 2008. [6] As a result, the NTSB held a public hearing on February 3 – 6, 2009 to examine safety issues concerning the helicopter air ambulance industry.

Shortly after the NTSB hearing, on April 22, 2009, the House of Representatives Transportation and Infrastructure Committee Aviation Subcommittee conducted a hearing on helicopter air ambulance safety.[7] The committee heard testimony by the Department of Transportation (DOT), the FAA, the NTSB, and the U.S. Government Accountability Office (GAO) as well as industry representatives and air ambulance operators. The GAO testimony primarily addressed the conclusions from a study conducted by GAO in 2007.[8]

Based on testimony given during the NTSB hearing and findings from recent helicopter air ambulance accidents, the NTSB found the FAA needed to take action to prevent additional accidents, including improved pilot training; collection and analysis of flight, weather, and safety data; development of a low-altitude airspace infrastructure; and the use of dual pilots, autopilots, and night vision imaging systems (NVIS). The NTSB released several recommendations related to helicopter air ambulance operations in 2009. In 2010, the FAA adopted a number of initiatives to address the NTSB Recommendations, including promoting technology such as NVG, terrain awareness and warning systems (TAWS), and radar altimeters.[9]

Upon further review by Congress and in response to the NTSB findings and recommendations, the NVG feasibility study was incorporated as section 313 in the original bill (H.R. 658) introduced in the House of Representatives on February 11, 2011. The feasibility study was not included in the original Senate Bill (S.223), but it was

[6] NTSB Safety Recommendation A-09-87 through -96 (September 24, 2009).
[7] The hearing was called for after the September 28, 2008 crash of an emergency air medical flight near Washington, D.C. *See* Press Release: Republican Leaders Call for Hearing on Air Ambulance Flight Safety (October 2, 2008).
[8] *See* GAO, Aviation Safety: Potential Strategies to Address Air Ambulance Safety Concerns 1 (2009) (testimony is based primarily on GAO's February 2007 study on air ambulance safety). *See also,* GAO, Aviation Safety: Improved Data Collection Needed for Effective Oversight of Air Ambulance Industry, GAO-07-353 (Feb. 21, 2007).
[9] *See* Fact Sheet – FAA Initiatives to Improve Helicopter Air Ambulance Safety (October 7, 2010).

mandated by Congress in section 318 of the Act. In addition to the feasibility study required by section 318 of the Act, several statutory revisions relating to air ambulance operations were also enacted.[10]

2.1.2 FAA Aviation Rulemaking Committee

The ARC was chartered to comply with section 318 of the Act, which requires the Administrator to carry out a study on the feasibility of requiring 14 CFR part 135 air ambulance helicopter pilots to use NVG during nighttime operations.

In conducting the feasibility study, reviewing the results, and formulating its recommendation, the ARC wanted to ensure that it properly considered the benefits, financial considerations, and risks associated with requiring the use of NVG, as well as the current allocation of FAA resources to helicopter air ambulance certification and surveillance.

A draft of this report was provided by ARC members to the Air Medical Operators Association (AMOA) which was not a member of the ARC. AMOA is a trade association representing 14 CFR part 135 certificate holders that conduct emergency medical services. AMOA's comments have been incorporated into this report by approval of the ARC members.

The FAA tasked the ARC to submit its recommendations to the Administrator through its sponsor, AVS-1, by December 5, 2012. This report satisfies the ARC's mandate under the Charter, and the Administrator is required to submit the Agency's Report to Congress by February 14, 2013.

2.2 Methodology and Scope

Section 318 of the Act requires the Administrator to carry out a study on the feasibility of requiring helicopter air ambulance pilots to use NVG during nighttime operations. Because the scope of the study was narrowed to the single question of whether or not to mandate the use of NVG, the ARC primarily concentrated on the literature review conducted by the FAA and a discussion of the considerations set forth in the NVG ARC Charter in order to conduct the study.

2.2.1 Meetings

The ARC held two meetings during the course of its feasibility study. The initial meeting was on October 11, 2012 in Washington, DC to review the considerations set forth by the NVG ARC Charter; and the second meeting was held on November 2, 2012 in Washington, DC to review the results of the feasibility study, finalize the ARC's recommendation, and develop the final report.

[10] *See* the Act, Section 306 (which incorporates amendments to 49 U.S.C. adding § 44730, Helicopter air ambulance operations and § 44731, Collection of data on helicopter air ambulance operations).

2.2.2 Presentations

During the ARC's feasibility study, the members had the benefit of reviewing information presented by FAA participants and SMEs. The ARC considered the information contained in the following presentations in formulating its recommendation:

- Civil Use of Night Vision Goggles: Aeromedical and Human Factors Concerns – Presented by: Dr. G.J. Salazar, Southwest Regional Flight Surgeon (ASW-300)
- Night Vision Goggles: A review of the regulations, guidance, and training – Presented by: Jon Prater and Tom Shergalis, General Aviation & Commercial Division, Airmen Certification and Training Branch (AFS-810)
- Single-Pilot Night Vision Goggle Rotorcraft Operations: Examination of: Pilot Workload, Task Performance, and Out-the-Window Scan – Presented by: Robert Joslin, Aircraft Certification Service, Aircraft Engineering Division (AIR-100)
- Obstruction & Heliport Lighting – Presented by: Tom Mai, Office of Airport Safety and Standards, Airport Engineering Division (AAS-100)
- Night Vision Imaging Systems: NVIS and NVG Maintenance – Presented by: Kevin Morgan, Aircraft Maintenance Division, General Aviation Branch (AFS-350)

2.2.3 Literature Review

The ARC conducted a comprehensive literature review of relevant studies, reports, and documents as part of the feasibility study, which the members consulted in the development of the ARC's recommendation. A complete list of the documents examined during the literature review is incorporated at Appendix E of this report. The methodology used during the literature review is set forth in chapter 4.0 of this report.

2.3 Organization of this Report

This report has seven chapters and six appendices organized as follows:

- Chapter 1.0 presents information on the ARC's composition and task.
- Chapter 2.0 discusses the ARC's specific tasking, as well as the methodology and scope of the feasibility study conducted by the ARC in order to develop its recommendation.
- Chapter 3.0 incorporates an overview of helicopter air ambulance operations and the use of NVG.
- Chapter 4.0 discusses the literature review conducted by the ARC as part of the feasibility study.
- Chapter 5.0 presents the ARC's review of the 24 considerations set forth in the NVG ARC Charter.
- Chapter 6.0 presents the ARC's recommendation and further questions for consideration by the FAA.

- Chapter 7.0 contains the ARC's conclusion on its recommendation regarding the requirement for pilots of helicopters providing air ambulance services under 14 CFR part 135, to use NVG during nighttime operations.
- Appendix A lists the NVG ARC members, FAA participants, and ARC program support.
- Appendix B contains a list of acronyms used in this report.
- Appendix C contains a copy of the NVG ARC Charter.
- Appendix D contains a copy of Section 318 of the Act.
- Appendix E includes a comprehensive list of the studies, recommendations, and documents examined as part of the literature review, and consulted during the ARC's discussion of the considerations discussed in this report.
- Appendix F includes a glossary of definitions relevant to helicopter air ambulance operations.

3.0 HELICOPTER AIR AMBULANCE OPERATIONS

Helicopter air ambulance operators must comply with the 14 CFR requirements applicable to air carriers in general, including 14 CFR parts 21, 27, 29, 43, 61, 91, and 97; and air ambulance operators in particular, which are contained in 14 CFR part 135. The unique demands of helicopter air ambulance operations require special crew training and aircraft modifications, including the addition of medical equipment. Helicopter air ambulance operators address the demands of their operating environment through several risk control measures—the use of risk assessment procedures, safety management systems (SMS), operational control centers, and other safety devices and tools. Helicopter air ambulance operations are conducted under the most stringent visual flight rules (VFR) weather minimums, which are higher than the VFR weather minimums for other air carrier and rotorcraft operations.

During helicopter air ambulance operations, pilots often fly into an unimproved landing site in order to pick up an ill or injured patient. These operations are often performed at night where NVG provide a significant enhancement.

3.1 NVIS and NVG Equipment

NVIS are an aid to night VFR flight. The NVIS refers to the integration of all elements required to successfully and safely use NVG while operating an aircraft. While NVG-enhanced vision is not equivalent to daytime vision, NVG enhance safety during nighttime operations and mitigate the risks associated with such flight operations. The pilot can easily maintain VFR flight in the event NVG is lost or degraded by reverting to unaided flight. The design of the NVG system permits the operator to fly with his/her corrective lenses, maintaining 20/20 visual acuity for viewing instruments, checklists and charts under the goggles.[11]

[11] *See* RTCA/DO-275 at ¶ 1.6.2.

NVG are a head-mounted, lightweight, self-contained binocular system consisting of two independent monocular assemblies. A monocular contains the electro-optical components that gather the available light, amplify that light and present that light to a single eye. Each monocular assembly contains one or more intensifier channels. NVG contain a filter:

- Class A: Refers to NVG in which a 625nm minus blue objective lens filter has been incorporated. This term also can refer to the NVIS lighting designed for use with NVG that contain a class A filter.
- Class B: Refers to NVG in which a 665nm minus blue objective lens filter has been incorporated. This term also can refer to the NVIS lighting designed for use with NVG that contain a class B filter.
- Modified Class B: Refers to NVG in which a modified Class B filter has been incorporated. The filter has been modified with a notch or band-pass feature for the purpose of passing a small amount of energy in the green wavelengths. This allows for the operator to view fixed head-up display (HUD) symbology with the NVG.

RTCA, Inc. ("RTCA") is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues. RTCA's recommendations are used by the FAA as the basis for policy, program, and regulatory decisions. RTCA developed and published the Minimum Operational Performance Standards (MOPS) for NVG in RTCA/DO-275. Technical Standard Order (TSO)-C164 for NVIS was published by the FAA on September 30, 2004. The approval for NVIS installation can only be accomplished through the type certificate (TC), amended TC, or Supplemental Type Certification (STC) process.

3.2 Civil Aircraft Operations

NVG are designated an "appliance," which means the FAA must certify the equipment under 14 CFR part 21. In addition, civil helicopter operators must receive FAA authorization to use NVG pursuant to the traditional 14 CFR part 135 certification process. Specifically, an operator seeking operational authorization for NVG operations must obtain certification for aircraft lighting, the equipment itself, and the operator's NVG training program.

Requiring FAA certification and approval of NVG prior to use helps ensure the goggles are used safely and are properly integrated into aircraft operations. To become certified to use NVG, operators must modify the aircraft on which the NVG will be used so the aircraft is properly equipped to integrate NVG safely into operations. For example, the cockpit lighting must be modified so that it is NVG compatible. Modification of aircraft can only be accomplished through the FAA's certification process for issuing a TC, amended TC, or STC.

In addition, a helicopter air ambulance operator must also modify its General Operations Manual (GOM) to include NVG-specific operational procedures, and all pilots and crewmembers who will use NVG must receive appropriate training.

3.3 Operational Authorization

The contribution of helicopter air ambulance operators to the nation's medical infrastructure is important. However, from an operational standpoint, it is a commercial aviation activity performed by an air carrier, which must be conducted in accordance with certain safety standards. To meet this requirement, each risk must be identified, assessed, and managed to ensure the risk is mitigated, deferred, or accepted within appropriate operational regulations and standards.

For example, the regulatory requirements for environmental lighting for night helicopter air carrier operations and the associated minimums are contained in 14 CFR part 135, subpart D. The pilot is responsible for determining which level of lighting is expected or observed along a flightpath and what minimums apply. The lighting level in one area may not always be the same. For example, the same area may have different lighting levels at different times of year.[12]

The FAA issues Operations Specifications (OpSpecs) for air ambulance operators that authorize emergency medical services (EMS) operations. OpSpecs are issued by the Principal Operations Inspector (POI), at the Certificate Holding District Office (CHDO) with jurisdiction over the operator/certificate holder. The following sections review the OpSpecs paragraphs that are generally issued to a helicopter air ambulance operator authorized to use NVG.

3.3.1 OpSpecs Paragraph A021, Helicopter Emergency Medical Services (HEMS)/Air Ambulance Operations—Helicopter

OpSpecs Paragraph A021 authorizes operators to conduct helicopter air ambulance operations in compliance with certain specifications or limitations. These specifications set forth when and where a particular operator may conduct operations. Specifically, Paragraph A021 lists the Class G (uncontrolled) airspace conditions (e.g., day/night and weather limitations), area (e.g., local/cross-country), ceiling, and visibility in which the particular certificate holder may conduct air ambulance operations. In addition, Paragraph A021 specifies different ceiling and visibility minimums for these conditions and areas when operating in mountainous and non-mountainous areas. Each specific combination of conditions and areas is listed in Paragraph A021.

3.3.2 OpSpecs Paragraph A050, Helicopter Night Vision Goggle Operations

OpSpecs Paragraph A050 authorizes the use of NVG by 14 CFR part 135 operators in accordance with the limitations and provisions specified.

3.3.3 OpSpecs Paragraph D093, Helicopter Night Vision Goggle Operations (HNVGO) Maintenance Program

OpSpecs Paragraph D093 is issued to operators authorized to conduct HNVGO under the limitations and provisions of 14 CFR part 135 and current OpSpecs Paragraph A050 using specific approved aircraft. Paragraph D093 includes the aircraft registration

[12] For additional information on high and low lighting conditions, *see* FAA Order 8900.1, Volume 4, Chapter 5, Section 3.

number, serial number, and make, model, and series (M/M/S) of the aircraft, as well as the name of the maintenance document with the current revision number/letter for the NVIS. Paragraph D093 also lists the maintenance document(s) for the NVG with the current revision number/letter must be listed in the table.

3.4 Use of NVG

The proper use of NVG can greatly enhance the safety of night operations, but there are hazards associated with improper use and integration. The certification process, including the training requirements, ensures safety in NVG operations. Operators must also evaluate the benefits of NVG use against the cost of acquiring, maintaining, and training pilots and other crewmembers to use them. In the end, whether it makes sense for an operator to obtain FAA authorization to use NVG depends on its particular operational circumstances, specifically whether it engages in night flying.

When used properly, NVG can dramatically increase the safety of night flying. Although currently NVG do not allow people to see as well at night as they do during the day, the goggles significantly improve many of the limitations of unaided night vision. In general, there are greater risks when operating at night than during the day, but NVG can mitigate many of these risks when properly used and integrated into the operation. However, it is important to note there are certain circumstances when NVG are not always safe during nighttime operations (i.e., well-lit urban areas). NVG do not always provide adequate imagery under all lighting conditions, scene contrast, and atmospheric conditions during nighttime conditions.

Visual acuity at night is significantly diminished from daytime levels. Visual acuity refers to the clearness of vision and the ability to distinguish details and shapes, usually measured in comparison with what a normal eye sees from 20 feet away. During the day, normal visual acuity with or without corrective lenses is considered 20/20. At night unaided, it degrades to 20/200 (or less).[13] This means it is more difficult to see the terrain and obstacles. Use of NVG allows users to see the terrain as well as obstacles to a much greater degree than during unaided night vision. Under ideal conditions, visual acuity with newer technology NVG can increase to up to approximately 20/25.[14]

While ceiling and visibility significantly affect safety in night VFR helicopter air ambulance operations, lighting conditions also have a significant effect on safety. Even in conditions which, by visibility and ceiling, are determined to be visual meteorological conditions (VMC), the ability to identify unlighted or low contrast objects and terrain at night may be compromised. The ability to find these objects and terrain is the "seeing condition." The seeing condition is related to the amount of natural and man-made lighting available, as well as the contrast, reflectivity, and texture of surface terrain and obstruction features. In order to conduct operations safely, seeing conditions must be accounted for in the planning and execution of night VFR helicopter air ambulance operations.

[13] *See* USAF Special Report, AL-SR-1992-0002, "Night Vision Manual for the Flight Surgeon," written by Robert E. Miller II, Col, USAF, (RET) and Thomas J. Tredici, Col, USAF, (RET).
[14] Gladstone, K. "Night Vision: The Need for Training." *FrontLine Defence*, 7:3, 42-43.

Industry representatives believe that NVG technology is the single most effective device for safety enhancement due to the fact that it allows the pilot to visually identify terrain and obstructions at night in all phases of flight. Air medical helicopter operations are performed at low altitudes and are often performed into and out of unimproved landing areas. Where other technologies can only offer benefit during the en route phase of flight, NVIS can provide significant safety benefits during the en route, landing, and take-off phases of flight.

In a recent survey of air medical operators conducted by AMOA, eleven 14 CFR part 135 certificate holders reported that of the nearly 731 aircraft in their combined fleets (representing over 90% of the air helicopters currently operated in air medical services in the United States) nearly all of those helicopters are currently operating with NVG. This is a significant increase considering that at the time the NTSB encouraged the use of NVG in 2006 the prevalence of that technology in the fleet was estimated at less than 5%.[15] The ARC noted the following data, as provided by AMOA:

- In 2008, approximately 60% of the helicopter air ambulance fleet was equipped with NVIS systems; six of the 11 fatal accidents in that year occurred at night in VFR conditions.

- In 2011, approximately 90% of the helicopter air ambulance fleet was equipped with NVIS technology; the only fatal air medical accident occurred in daylight conditions.

The ARC concurred that the statistics illustrate the continued confidence, based on experience, by helicopter air ambulance operators that NVG are an extremely effective safety intervention in the night VFR environment. The ARC further noted that the statistics illustrate the noteworthy commitment of helicopter air ambulance operators to enhance safety ahead of any regulatory pressure to do so and at considerable costs, as implementation of an NVIS is several times the cost of other recommended technology enhancements. Air medical services continue to be the leading segment in the development and application of this important technology in the civil aviation sector. ARC members believe the safety benefit of NVG is evident in the dramatic decrease of controlled flight into terrain (CFIT) accidents in the helicopter air ambulance community from the beginning of industry-wide implementation in 2006.

3.5 NVG Training

An operator may satisfy the FAA's NVG training requirements in one of two ways: (1) by creating an internal training program; or (2) by sending personnel who will be using NVG to a certified training school (certified under 14 CFR parts 135 and 141) for initial and recurrent training. If an operator chooses to have an internal training program, the operator must receive FAA approval for its training program by meeting certain requirements.

[15] *See* AMOA Comments on Docket Number FAA-2010-0982 (January 10, 2011). (Notice of Proposed Rulemaking: Air Ambulance and Commercial Helicopter Operations, Part 91 Helicopter Operations, and Part 135 Aircraft Operations; Safety Initiatives and Miscellaneous Amendments Final Rule.)

The operator's NVG approved training program must include ground training and flight training segments that will allow the pilot to conduct the particular type of operation safely and adequately.

In order to maximize the potential of a positive outcome for all NVG operations, a second trained and NVG-equipped person/crewmember may be required to use the goggles for certain operations (e.g., landing at an unimproved landing site). This second person need not be qualified as a pilot but should be trained to properly conduct airspace surveillance using night vision goggles. In many cases, the second person is a member of the medical crew. The most effective location for the second NVG equipped person is on the side of the aircraft opposite the pilot.[16]

3.6 Continued Airworthiness and Maintenance

The operator is required to conduct checks, inspections, and maintenance on the NVIS lighting installed on the aircraft and the NVG assembly to satisfy the continued airworthiness requirements. The NVG assembly consists of the helmet mount, binocular assembly, and power source assembly. Checks, inspections, and maintenance of the helmet mount, the wiring harness, and the associated hardware, must be in accordance with the manufacturer's recommended maintenance program.

To ensure the reliability of NVG and associated equipment, as well as the safety of flight operations, an operator must adhere to the Instructions for Continued Airworthiness (ICA) developed by the manufacturer and the STC holder. These ICA will be referenced in OpSpecs Paragraph D093, which details the maintenance requirements for NVG. The manufacturer's recommended maintenance program becomes mandatory when it is reviewed/approved by the FAA and listed on the operator's OpSpecs Paragraph D093.

4.0 LITERATURE REVIEW

This chapter discusses the literature review initially conducted by the FAA and continued by the ARC in accordance with Paragraph 3(a) of the NVG ARC Charter. The initial focus of the literature review under the Charter was human and environmental factors; however the ARC expanded the scope of the literature review to include regulations, guidance material, and NTSB resources. A comprehensive list of the NVG research and studies, NTSB reports and recommendations, regulations related to helicopter air ambulance operations and HNVGO, and FAA guidance material consulted as part of the review is incorporated in Appendix E of this report.

4.1 NVG Pilot Workload-Related Research

In conducting its literature review, the FAA assessed a number of reports and studies on the impact of NVG on pilot workload. The summary in this section is a representative sample of

[16] *See* RTCA/DO-268 at ¶ 5.

peer-reviewed research published over the last 15 years on pilot workload (dependent variable) with reduced field-of-view (FOV) (independent variable), which is characteristic of rotorcraft operations using NVG. Pilot workload is not directly measurable; however, the generally accepted measurable surrogates for pilot workload are head and eye movement and task performance. The consensus of the informed literature is that there is an increase in pilot workload and decreased pilot task performance with decreasing FOV. The results and conclusions of key studies are summarized below:

4.1.1 Field-of-View Effects on Pilot Performance in Flight

The Covelli et. al. (2010) laboratory experiment manipulated the pilot's field-of- view with a vision restriction device worn by pilots flying a Bell 206 simulator, representative of an air ambulance helicopter.[17] Flight performance, which was measured primarily by runway alignment error and vertical track error, was examined. Results indicated a significant and quantifiable change in visual scan pattern, head movement, and flight control performance as the field-of- view was sequentially decreased. As field-of-view decreased, the average visual scan pattern changed to focus less out-the-window (OTW) and more on the instruments inside the cockpit.

4.1.2 Effects of Field-of-View on Pilot Performance in Night Vision Goggles Flight Trials

The Jennings and Craig (2000) study examined pilot performance in low level helicopter flight while the pilots were wearing NVG with 40 degrees, and 52 degrees fields-of-view.[18] The pilots flew a standardized hover maneuver in a Bell 206 helicopter, representative of an air ambulance helicopter, under simulated night conditions with both subjective and objective measures of task performance obtained. The study concluded that pilots flew with higher workload and less precision as FOV decreased, as measured by subjective Cooper-Harper ratings and objective data of altitude, and lateral and longitudinal station keeping errors.

4.1.3 Effects of In-flight Field-of-View Restriction on Rotorcraft Pilot Head Movement

The Kasper et. al. (1997) experiment examined the effect of restricting visual field-of-view on rotorcraft pilot head movement during actual flights in an instrumented light military helicopter while wearing a FOV restrictor.[19] Test data indicated that as FOV decreased, the pilots tended to move their heads more to ensure adequate outside references were available to control the aircraft. However at very narrow FOVs the compensation was insufficient and pilot task performance deteriorated.

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[17] Covelli, J., Rolland, J., Proctor, M., Kincaid, P., & Hancock, P. (2010). Field-of-View Effects on Pilot Performance in Flight. *The International Journal of Aviation Psychology*, 20:2, 197-219.

[18] Jennings, S. & Craig, G. Effects of field-of-view on pilot performance in night vision goggles flight trials: preliminary findings, *Proc. SPIE* 4021, Helmet- and Head-Mounted Displays V, 335 (June 23, 2000); doi:10.1117/12.389163.

[19] Kasper, E., Haworth,L., Szoboszlay, Z., King, R., & Halmos, Z. (1997). *Effects of in-flight field-of-view restriction on rotorcraft pilot head movement.* Proceedings from the Society of Photo-Optical Instrumentation Engineers (SPIE) 3058, 34. DOI:10.1117/12.276658.

4.2 NTSB Reports and Recommendations

The ARC reviewed the NTSB reports and recommendations that served as the basis for the Congressional mandates in the Act. In 1988, the NTSB conducted a safety study of commercial EMS helicopter operations, which evaluated 59 helicopter air ambulance accidents and resulted in the NTSB issuing 19 safety recommendations.[20] The majority of the recommendations to the FAA were closed as a result of the issuance of Advisory Circular (AC) 135-14A, Emergency Medical Services/Helicopter (EMS/H), which is still in effect.[21] This AC addresses equipment, training, crew resource management (CRM), decision-making, flight-following procedures, weather minimums, and the development of safety programs for helicopter air ambulance flights operating under 14 CFR 135; however, it does not address NVG or HNVGO.

In the late 1990s and early 2000s, the helicopter air ambulance industry experienced significant growth and the number of accidents began to rise. As a result of the increase in EMS accidents, the NTSB conducted a special investigation in January 2006 that analyzed 41 helicopter EMS and 14 airplane EMS accidents that had occurred in the previous three years. The NTSB adopted the *Special Investigation Report on Emergency Medical Services Operations*.[22] The NTSB identified the following recurring safety issues in the report:

- Less stringent requirements for EMS operations conducted without patients on board;
- A lack of aviation flight risk evaluation programs for helicopter EMS operations;
- A lack of consistent, comprehensive flight dispatch procedures for EMS operations; and
- No requirements to use technologies such as TAWS and NVIS to enhance EMS flight safety.

In the report, the NTSB issued six findings including the following two, which address nighttime operations:[23]

- The use of TAWS would enhance the safety of EMS flight operations by helping to prevent CFIT accidents that occur at night or during adverse weather conditions.
- If used properly, NVIS could help EMS pilots identify and avoid hazards during nighttime operations.

Finally, the special report included four recommendations to the FAA. The recommendations included a requirement to install TAWS, but no recommendations specific to NVIS.[24]

[20] NTSB, *Commercial Emergency Medical Service Helicopter Operations, Safety Study* (NTSB/SS-88/01) (Washington, DC: 1988). (The NTSB classifies a helicopter air ambulance accident as one in which the accident flight involved an aircraft dedicated to or configured for air medical operations and piloted by an EMS crew.)
[21] *See* AC 135-14A, Emergency Medical Services/Helicopter (EMS/H) (June 20, 1991).
[22] NTSB, *Special Investigation Report on Emergency Medical Services Operations* (NTSB/SIR-06/01) (Jan. 25, 2006).
[23] *See* NTSB/SIR-06/01, NTSB Conclusions (Findings 5 and 6).

Immediately following adoption of the 2006 special investigation report, the number of helicopter air ambulance accidents decreased. In calendar year 2006, three fatal helicopter air ambulance accidents occurred with a total of five fatalities. In calendar year 2007, there were two fatal helicopter air ambulance accidents with a total of seven fatalities, but in calendar year 2008, there were eight fatal helicopter air ambulance accidents, with a total of 29 fatalities, which was the deadliest year on record for helicopter air ambulance operations. As a result of this increase in fatal accidents involving helicopter air ambulance operations, the NTSB placed the issue of helicopter air ambulance safety on its *Most Wanted List of Transportation Safety Improvements* on October 28, 2008, and also conducted a four-day public hearing to critically examine safety issues concerning this industry. (*See* section 2.1.1 of this report.)

As a result of the hearing, the NTSB identified the following safety issues: pilot training; collection of flight operations data; use of flight recording devices and data; SMS; weather information; use of autopilots or dual pilots; NVIS; reimbursement rate structures.[25] The NTSB released the following recommendation, which was specific to NVIS, to the FAA:

> Require helicopter emergency medical services operators to install night vision imaging systems and require pilots to be trained in their use during night operations. [26]

The ARC noted the FAA continues to address the NTSB recommendations relating to helicopter air ambulance operations, and specifically related to NVIS. The ARC also noted the FAA addressed the Congressional mandates related to NVIS and air ambulance operations.[27]

4.3 Title 14 CFR

In conducting the feasibility study, the ARC also reviewed the current regulations applicable to helicopter air ambulance operations and NVG, as set forth below. The members also noted that further review would be necessary after the FAA promulgates the Air Ambulance and Commercial Helicopter Operations, Part 91 Helicopter Operations, and Part 135 Aircraft Operations; Safety Initiatives and Miscellaneous Amendments Final Rule, which is anticipated in the near future (hereafter referred to as "Helicopter Air Ambulance Final Rule").[28]

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[24] *See* NTSB/SIR-06/01, NTSB Recommendations to FAA A-06-12 to A-06-15. (Recommendation A-06-15: Require EMS operators to install terrain awareness and warning systems on their aircraft and to provide adequate training to ensure that flight crews are capable of using the systems to safely conduct EMS operations.)
[25] *See* NTSB: Public Meeting as of September 1, 2009, Four Safety Recommendation Letters Concerning Helicopter Emergency Medical Services.
[26] NTSB Recommendation A-09-95 (September 24, 2009).
[27] *See* the Act, Sections 306 and 318.
[28] 75 FR 62640, Notice of Proposed Rulemaking: Air Ambulance and Commercial Helicopter Operations, Part 91 Helicopter Operations, and Part 135 Aircraft Operations; Safety Initiatives and Miscellaneous Amendments Final Rule (October 12, 2010).

4.3.1 14 CFR Part 1

- 1.1 – *Night* means the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time.

4.3.2. 14 CFR Part 43

Maintenance of the NVG appliance should be performed in accordance with the manufacturer's maintenance manual or other instructions acceptable to the Administrator as required by the STC. (*See* 14 CFR 43.13 – Performance rules (general) and 14 CFR 43.16 – Airworthiness limitations.)

4.3.3 14 CFR Part 61

- 61.1(b)(13) – *Night vision goggles* means an appliance worn by a pilot that enhances the pilot's ability to maintain visual surface reference at night.
- 61.1(b)(14) – *Night vision goggle operation* means the portion of a flight that occurs during the time period from 1 hour after sunset to 1 hour before sunrise where the pilot maintains visual surface reference using night vision goggles in an aircraft that is approved for such an operation.
- 61.31(k) – Type rating requirements, additional training, and authorization requirements: Additional training required for night vision goggle operations.
- 61.51(b)(3)(v) – Pilot logbooks: Logbook entries: Conditions of Flight: Use of night vision goggles in an aircraft in flight, in a flight simulator, or in a flight training device.
- 61.51(k) – Pilot logbooks: Logging night vision goggle time.
- 61.57(f) – Recent flight experience: Pilot in command: Night vision goggle operating experience.
- 61.57(g) – Recent flight experience: Pilot in command: Night vision goggle proficiency check.
- 61.195(k) – Flight instructor limitations and qualifications: Training for night vision goggle operations.

4.3.4 14 CFR 91

- 91.205(h) – Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements: Night vision goggle operations.

4.3.5 14 CFR 135

- 135.207 – VFR: Helicopter surface reference requirements.
- 135.271– Helicopter hospital emergency medical evacuation service (HEMES).
- Subpart J—Maintenance, Preventive Maintenance, and Alterations. (*See* 135.411 – Applicability.)

4.3.6 Helicopter Air Ambulance Final Rule

Under the Helicopter Air Ambulance Final Rule, additional requirements may be imposed on helicopter air ambulance operations that essentially create the equivalent of a requirement to use NVG during nighttime operations. The Notice of Proposed Rulemaking (NPRM) was published on October 12, 2010, and industry expects the FAA to issue the final rule in the near future.[29]

In addition to requirements applicable to all 14 CFR part 135 aircraft operations and 14 CFR part 91 helicopter operations; the proposed rule included operating requirements and equipage that would specifically impact air ambulance operations. The proposed rule includes provisions that would:

- Require helicopter pilots to demonstrate competency in recovery from inadvertent instrument meteorological conditions.
- Require all commercial helicopters to be equipped with radio altimeters.
- Change definition of "extended over-water operation," and require additional equipment for these operations.
- Require air ambulance flights with medical personnel on board to be conducted under 14 CFR part 135, including flight crew time limitation and rest requirements.
- Require certificate holders with 10 or more helicopter air ambulances to establish operations control centers.
- Require helicopter air ambulance certificate holders to implement pre-flight risk-analysis programs.
- Require safety briefings for medical personnel on helicopter air ambulances.
- Amend helicopter air ambulance operational requirements to include VFR weather minimums, instrument flight rules (IFR) operations at airports/heliports without weather reporting, procedures for VFR approaches, and VFR flight planning.
- Require the pilot in command to hold an instrument rating.

[29] 75 FR 62640 (October 12, 2010).

- Require equipage with a helicopter terrain awareness and warning system (HTAWS), and possibly light-weight aircraft recording systems (LARS).

4.4 Regulatory Guidance

The ARC reviewed several regulatory guidance documents while conducting its feasibility study. The members reviewed current guidance regarding certification/approval of the NVG and aircraft modification(s), as well as guidance related to operational authorization (including internal guidance which is directive for FAA personnel and advisory guidance published for industry stakeholders).

4.4.1 NVIS Certification/Equipment Approval: The ARC reviewed guidance documents relevant to NVG certification, including:

- TSO-C164, Night Vision Goggles (09/30/2004).
- RTCA/DO-268, Concept of Operations, Night Vision Imaging System for Civil Operators (03/27/2001), which describes the concept of operations supporting the implementation of aviation NVIS technology into the NAS by civilian aviation operators.
- RTCA/DO-275, Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment (10/12/2001), which contains MOPS for the aviation NVIS used to supplement night VFR operations.
- RTCA/DO-295, Civil Operators' Training Guidelines for Integrated Night Vision Imaging System Equipment (10/19/2004), which presents training guidance that has been generated from lessons learned by agencies having many years of experience in the training and operational application of NVIS.
- AC 27-1B CHG 3, Certification of Normal Category Rotorcraft (9/30/2008).
- AC 29-2C CHG 3, Certification of Transport Category Rotorcraft (9/30/2008).
- FAA Order 8130.21G CHG 1, Procedures for Completion and Use of the Authorized Release Certificate, FAA Form 8130-3, Approval Tag (04/14/2010).
- Master Minimum Equipment List (MMEL) Policy Letter (PL)-77, Cockpit and Instrument Lighting Systems (July 5, 2012), which provides standardized MMEL requirements for Cockpit/Flight Deck/Flight Compartment and Instrument Lighting Systems. This PL also includes a reference to operators with NVG systems.
- MMEL PL-127, Night Vision Imaging Systems (NVIS) (June 07, 2010), which provide standardized Master Minimum Equipment List (MMEL)

requirements for operations of NVIS modified aircraft with inoperative NVIS lights, cracked, or missing filters.[30]

4.4.2 Inspector Guidance: The ARC reviewed the current inspector guidance published by the FAA Flight Standards Service (AFS) regarding certification and surveillance of NVG for use by helicopter air ambulance operators, including:

- Order 8900.1, Volume 3, Chapter 19, Section 6, Flight Training Curriculum Segments, Uses of GPS in CFIT Avoidance, which provides guidance regarding the use of NVG to reduce the risk of CFIT accidents.
- Order 8900.1, Volume 4, Chapter 5, Section 1, Background and Definitions, which contains background information on air ambulance operations.
- Order 8900.1, Volume 4, Chapter 4, Section 2, Authorizations for 14 CFR Part 135 Air Ambulance Services, which incorporates guidance regarding the certification of air carriers (or new applicants) for an air ambulance authorization.
- Order 8900.1, Volume 4, Chapter 5, Section 3, Air Ambulance Service Operational Procedures, which addresses the evaluation of an operator's administrative, preflight, in-flight, emergency, and post flight procedures.
- Order 8900.1, Volume 4, Chapter 5, Section 4, Air Ambulance Operations Training Programs, which contains guidance for evaluating a training program for flight crew and medical personnel in air ambulance operations.
- Order 8900.1, Volume 4, Chapter 5, Section 5, Operational Risk Assessment Programs for Helicopter Emergency Medical Services, which provides guidance on risk assessment programs for helicopter air ambulance operators.
- Order 8900.1, Volume 4, Chapter 7, Section 4, Night Vision Imaging Systems, which is used by principal operations inspectors (POI), principal maintenance inspectors (PMI), and principal avionics inspectors (PAI) when evaluating a 14 CFR part 135 operator's request for use of NVG.
- Order 8900.1, Volume 4, Chapter 9, Section 1, Perform Field Approval of Major Repairs and Major Alterations, Figures 4-66 through 4-68, which incorporates guidance for the field approval process, including approval of NVG.
- Order 8900.1, Volume 6, Chapter 11, Section 22, Conduct Night Vision Imaging System Evaluation Inspection, which incorporates guidance for evaluating an operator's NVIS to include NVG and maintenance documents for aircraft operated under 14 CFR parts 91, 133, 135, 137, and 141.

[30] PL-127 is designated as MMEL Global Change (GC) 156.

4.4.3 Advisory Guidance for Operators: The ARC reviewed a number of advisory documents published by the FAA as a resource for helicopter air ambulance operators, including:

- Information for Operators (InFO) 11004 Enhanced Flight Vision System (EFVS), Enhanced Vision Systems (EVS), and Night Vision Goggles (NVG) compatibility with Light-Emitting Diodes (LEDs) at airports and on obstacles (2/15/11).
- Safety Alert for Operators (SAFO) 10022, Maintenance of Night Vision Imaging Systems (NVIS) (12/15/10).
- SAFO 06001, Helicopter Emergency Medical Services (HEMS) Operations (1/28/06).

5.0 FACTORS CONSIDERED BY THE ARC

This chapter provides a discussion of factors considered by the ARC in developing its recommendations. The members deliberated and discussed the 24 considerations set forth in the NVG ARC Charter. Each consideration, as mandated in Paragraph 3 of the Charter, is set forth below immediately followed by the ARC's consensus after study of and discussion about the consideration. FAA SMEs provided additional information and research to support the ARC's efforts to evaluate each consideration as part of the feasibility study.

5.1 NVG ARC Charter Paragraph 3(a) Consideration

In accordance with paragraph 3(a) of the Charter, the ARC conducted a literature review to determine the benefits and risks associated with requiring the use of NVG considering the factor discussed in this section. The consideration discussed by the ARC is set forth below.

5.1.1 Human and environmental factors (e.g., effects of eye pathologies on NVG use, fatigue, effects of recurrent use on human performance, effects of prolonged NVG use on color vision, effects on loss of dark adaptation and transition to night vision, lighting, weather, and terrain)

In considering this factor, the members discussed testing for night vision and the lack of reliability prevalent with such tests. Any test of night vision would be measurement of the subject's unaided vision. In addition, the members noted there is no predictive test in the current flight physical to determine if someone would be a successful user for NVG, and there is no screening tool for someone getting a flight physical. The ARC reached consensus on the need for further aeromedical study of the effects of NVG use on vision, as well as the long-term impact of NVG use.

5.2 NVG ARC Charter Paragraph 3(b) Considerations

In accordance with the paragraph 3(b) of the Charter, the ARC conducted a feasibility study to determine the benefits, financial considerations, and risks associated with requiring the use of

NVG considering the 23 factors discussed in this section. Each consideration discussed by the ARC is set forth below.

5.2.1 Obstacle lighting, including the differences between LED versus incandescent bulbs

See Section 5.2.2 below.

5.2.2 Airport, hospital, and helipad lighting, including the differences between LED versus incandescent bulbs

The members considered items 5.2.1 and 5.2.2 together. The members discussed the need for additional research and future evaluation regarding obstacle and airport/hospital/heliport lighting. The members also noted that this LED lighting is not an item the FAA can address, as Congress has to empower the FAA to deal with alternate lighting specifications. The ARC further noted the need to review these considerations when the draft Engineering Brief (EB) for aviation obstruction and ground lighting visibility with NVIS, which is currently under development by AAS-100, is published. The members understand the proposed EB will provide information about the interaction of LEDs used for both obstruction and aviation ground lighting with NVIS onboard both rotary and fixed wing aircraft.

5.2.3. Operational criteria for use including risk assessment, safety analyses, and costs associated with go/no-go based on NVG availability

The members considered this factor and felt that NVG should be part of any operational risk assessment. The members also discussed the importance of factoring in the currency and experience of the pilot(s), and crewmembers, using the goggles as part of the risk score. The members noted that NVG are considered an appliance and they generally agreed that it should be up to the pilot whether or not to use the tool. The members also discussed the costs to the operator, communities, and hospitals when a go/no go decision is made, as well as how to measure the costs. However, the members discussed certain regulatory equipment requirements (under 14 CFR 91.205) that significant impact of NVG usage (i.e., radar altimeter). The ARC recommended a revision of 14 CFR 91.205(h) (7), and subsequent regulations, related to the NPRM, prior to requiring the use NVG during all nighttime operations to ensure that equipment issues can be addressed.

5.2.4 Operational criteria for use, including consideration of specific language in the operations rules (14 CFR parts 135 and 91) and updated OpSpecs (with the associated guidance in Order 8900.1)

The members discussed current operational criteria for use and the need to review certain regulatory provisions as part of the discussion to construct a requirement. Specifically, the members cited 14 CFR 135.207, as NVG were not in use when the rule was written. The members also discussed the pending Helicopter Air Ambulance Final Rule, which would add requirements prior to issuance of OpSpecs Paragraph A050. The members suggested the FAA review and revise 135.207 to address aided night flight. In addition, the members recommended further review of any additional regulatory requirements after promulgation of the Helicopter Air Ambulance Final Rule.

5.2.5 Dispatch protocol, including consideration of the dispatch and operations continuation considerations that need to be addressed, how long will it take, and whether there are resources to support the effort

The members discussed this consideration in the context of flight release issues that arise when a flight starts daytime, and it becomes nighttime during the flight. The ARC also debated issues involved with unaided flight versus aided flight. The members noted that risk analysis has been sufficient to address issues of weather and determinations of acceptable levels of risk. The members also discussed whether "dispatch" is the correct terminology. For non-NVG users, dispatch and risk assessment would be significantly affected and they would experience lots of process change and cost. The members recommended further review after promulgation of the Helicopter Air Ambulance Final Rule.

5.2.6 Helicopter medical personnel using NVG to assist with NVG-aided flight into unimproved landing sites

The members discussed the restriction on the requirement to have a second (flight or medical) crewmember during operations into unimproved landing sites. The members noted that single pilot operations should be allowed without the requirement for a second (flight or medical) crewmember. They also suggested further review of the requirement for NVG use under 300 feet (unless there is a second crewmember using goggles), which is sometimes included in the limitations listed in the Rotorcraft Flight Manual Supplement (RFMS) or STC. The members noted that switching from aided to unaided flight can be a detriment to safety in certain circumstances.

Several members noted that while the FAA indicated a willingness to look at revisions to STCs in order to remove the limitation, there has been no measurable progress toward this goal from the policy division level. The members also noted the process for obtaining an STC amendment is still time consuming, and this would definitely raise a cost issue for smaller companies. The members agreed the FAA should review and consider repealing this requirement and systematically amending the affected STCs. However, the ARC also raised concerns about how long it might take to amend the STCs under current FAA policies and procedures (which can take several months, and in some cases, over one year). Under current procedures, any modification to the aircraft that involves equipment installed in accordance with the STC necessitates a full review of the STC as part of the process for considering a request to amend the STC. In addition to the length of time, the review process can sometimes yield additional equipage modification requirements for the operator. The members emphasized the significant costs associated with modifying the aircraft—including equipment and installation expenses, as well as the costs associated with the delay in obtaining the STC (or STC amendment).

5.2.7 Second crewmember using NVG to assist with NVG-aided flight into unimproved landing sites

See Section 5.2.9 below.

5.2.8 Assessment of single-crew pilot only operations into unimproved landing zones, with no other occupants using NVG

See Section 5.2.9 below.

5.2.9 Single pilot vs. dual pilot operations

The members discussed items 5.2.7 through 5.2.9 together. The members also discussed the underlying question regarding the safety of single-pilot operations. The members agreed that single-pilot operations are not unsafe. They also noted that in a dual pilot operation, both pilots would be subject to any rule or mandate. A requirement for two pilots would have a huge impact on the community. For example, if there is a two-pilot requirement and one pilot is not current, the flight cannot be conducted. The members felt that a two-pilot requirement is not a safety enhancement and would only have a negative impact on many communities.

5.2.10 Operational requirements for single pilot operations

In reviewing this consideration, the members discussed what, if any, operational requirements are appropriate if single pilot operations with NVG are permitted. The members did not feel that any changes are required to existing regulations. The members did not want to mandate a requirement and limit the pilot's decision-making ability. The members felt the decision regarding how many pairs of goggles to have on hand should remain a company-level decision.

5.2.11 Aircraft Make/Model specific NVG currency requirements/endorsements

The members reviewed 14 CFR 61.57 and 14 CFR 135.293 at the outset of the discussion. The members concurred that an aircraft make/model specific NVG currency requirement/endorsement is not necessary. The current requirement (category and class) is sufficient. The training program usually has a transition program (similar to a differences module) to address this issue. The members do not advocate a 14 CFR 135.293 requirement specific to aircraft make/model and note that an NVG check, as currently required, is sufficient. The members suggested the FAA review whether it may be appropriate to add certain NVG-specific tasks to the applicable Practical Test Standards (PTS) in the future.

5.2.12 Effects on rural communities

The members discussed the significant impact on rural communities if a requirement is mandated, especially with regard to equipment and training costs. The debated the following scenario: If there is one helicopter in a given region that has an NVG component become inoperable, and the mission could have been completed unaided, could mandate prevent the mission from being completed? A reduction in service would certainly result for some communities. The ramifications of a mandate require careful consideration, as many communities would be left without essential services.

5.2.13 Minimum Equipment List (MEL) Considerations

The members addressed how mandating NVG operations at night would affect the MMEL and the operator's MEL. In considering this factor, the members discussed

MMEL PL-127, and noted that a change to 14 CFR would override the PL. The members were reluctant to suggest a regulatory change without assurance that PL-127 would be modified and remain in effect. The ARC suggested the FAA develop appropriate safety measures for the other newly required equipment that operators can employ in the event of equipment failure, at least in a limited timeframe, to allow that aircraft to proceed safely. In addition, the members reiterated their suggestion to review the current equipage requirements under 14 CFR 91.205(h) and the importance of preserving the PL. Further, the members noted MEL issue would arise in any equipment proposal, and they suggested the FAA issue a policy letter, similar to PL-127 concerning NVIS MMELs to allow inspectors to address MEL changes in a more timely fashion.

The ARC also discussed the proposed requirements for HTAWS and radio altimeters in the Helicopter Air Ambulance Final Rule. They were concerned with relief in the event the technology fails and suggested the FAA review current regulations and guidance to allow for the continued operation of aircraft in a limited timeframe should one of these devices fail. The combined operation of the additional equipment should easily allow for the continuance of safe flight operations within a reasonable timeline for repair and return to service.

5.2.14 Autopilot requirements

The members addressed the question of whether an autopilot or some sort of stabilization system is needed. The members discussed and determined that an autopilot/stabilization system is not required, as it would shut down too many operations. They further noted that no additional autopilot requirements are necessary for aided flight and stressed their concern with ensuring that operational and equipage requirements for aided flight remain the same as operational and equipage requirements for unaided flight.

5.2.15 Requiring pilot currency for instrument flight

The members reviewed this consideration and debated whether changes are needed to training and currency requirements for NVG pilots. The members concurred that IFR currency should not be required, and the requirements should be the same whether the pilot is using goggles or not.

5.2.16 Size and scope of operation

In considering this factor, the ARC addressed the effects of operator size and the geographic scope of the operations relative to operating with NVG. The members noted the impact of integrating NVG into a current operation (or requesting authorization to use NVG as part of the initial certification process) is significant, regardless of the size of the operator. New NVG operators will experience substantial costs for the goggles and helicopter modifications, even before training is conducted.

5.2.17 Effect on operational control

The ARC discussed how a mandate would affect operational control. The members concurred that a requirement to use NVG would not impact operational control. They noted that mandating the use of NVG would necessitate integrating procedures that go hand-in-hand with dispatch and the other issues. While new guidance would be

necessary if the requirement is mandated. The members noted no measurable effect on operational control, as currently, it is a scalable issue.

5.2.18 NVG maintenance and aircraft configuration control

During the discussion of this consideration, the ARC raised significant concerns about the impact if NVG use is mandated. The members questioned whether the FAA is prepared to respond to the STC paperwork/applications. They also raised concerns about how the FAA will ensure the guidance is consistent with the current requirements. For example, there is guidance published today that differs from the guidance that was in place at the time many STCs was issued. The members also noted that if the new Helicopter Air Ambulance Final Rule requires a certain equipage (i.e. HTAWS), the new equipment may not be compatible with NVG. It could take a prohibitively long time to amend the STC, which would ground the aircraft if NVG use is mandated. The members felt it is important to ensure that FAA resources can be allocated to ensure efficient processing of STC amendments and other certification issues before considering a mandate regarding NVG use.

5.2.19 Prior adverse operator experience with NVIS and mitigations used

In discussing this consideration, the ARC did not identify any specific adverse operator experiences with NVG use. Instead, they emphasized the concerns raised regarding FAA certification/surveillance resources and equipment requirements. In addition to the concerns raised in this report regarding the certification process, the members noted that new operators would have an adjustment period while they integrated NVG into the operation. The members discussed the importance of reviewing the training conducted for FAA personnel regarding NVG to ensure the agency is able to conduct certification and surveillance in accordance with a standardized methodology.

5.2.20 NVIS operational usage patterns and policy for use during nighttime operations

In reviewing this factor, the ARC debated continuous versus intermittent use of NVG during night operations. The members discussed the current regulatory definition of "night" and raised concerns about the language used by Congress to define the scope of this study under the Act.[31] If NVG use is mandated from one hour after sunset to one hour before sunrise, it can create unsafe situations. For example, NVG are not necessary in high light city urban environments. The members raised concerns about how safety could be adversely impacted. (i.e., certain instrument approaches do not need goggles—some are proceed visually and some are proceed VFR (short VFR)). A mandate would be problematic under these circumstances and extensive study on the benefits versus determents would be necessary, as defining an exact timeframe for mandating NVG use (e.g., during nighttime operations) does not lend itself to rulemaking.

[31] 14 CFR 1.1. (*Night* means the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.)

5.2.21 The known causes of civil NVG accidents worldwide

In discussing this consideration, the ARC conducted a review of civil NVG accident/incident reports and discussed the lack of clarity in the data regarding NVG as a probable cause in accidents/incidents, as well as the inconsistent fashion in which such accidents/incidents are classified as CFIT or inadvertent entry into instrument meteorological conditions (IMC) and subsequent loss of control in-flight. The members noted that a search of the NTSB accident database yields 27 accident/incident reports that mention NVG.[32] The NTSB listed NVG as a causal factor in one accident. The NTSB listed NVG as a significant contributing factor in four accidents.[33] Further study or research would be appropriate to review the accident reports and develop a standardized methodology for investigating accidents involving the use of NVG.

5.2.22 Assess 14 CFR 135.207 requirements while using NVG

In reviewing this factor, the ARC evaluated an increased requirement for NVG inadvertent IMC recovery procedures. The members discussed and concurred on the need for adding a "third condition" (acknowledging aided night flight, as distinguished from unaided night flight) to the rule to account for VFR surface reference requirements during nighttime aided flight that ties to the 14 CFR part 61 definition.

5.2.23 FAA approval of NVG

The members reviewed the approval for operators using NVG, NVG manufacturers, and NVIS STC holders. The ARC discussed whether industry should move toward one standard of goggles (Class A or Class B filter). Currently, the TSO speaks to Class B-filter. The discussion continued as to whether the FAA should mandate a particular type of filter or maintain the current system of allowing, unless required by STC, operators to choose the type of filter they will use. The members discussed the pros and cons of A and B filters, as well as the impact of standardization. RTCA developed the standard for a goggle with a Class B filter. The FAA came out with TSO that picked up that standard (the FAA notes that Class B filter is the correct standard to deal with color.) The members also raised concerns about new requirements affecting existing operators. The members concurred that industry stakeholder would be open to a methodology for simplification and a requirement to identify the goggles (e.g., a placard indicating which class filter). However, the ARC was careful to state that industry is not ready for standardization, and operators currently using NVG would have to be accommodated before implementation of any requirement related to NVG equipment.

[32] The members queried the NTSB Aviation Accident Database and Synopses (www.ntsb.gov/aviationquery/) for reports involving helicopter accidents/incidents that mentioned "night vision goggles" or "night vision goggle" or NVG. The members further narrowed the results by eliminating reports involving public aircraft, as well as reports where NVG were mentioned as being used by individuals other than pilots/crewmembers on the helicopter involved in the accident/incident (i.e., other pilots flying in the area).

[33] In reviewing the 27 (26 accident and one incident) reports, the members noted that in addition to the four accident reports that listed as a significant contributing factor, two additional accident reports indicated NVG were present but the investigation was unable to determine if the pilot was using the NVG at the time of the accident; therefore, NVG may have been a contributing factor in the accident.

6.0 ARC RECOMMENDATION

This chapter discusses the results of the feasibility study and the ARC's recommendation based on the literature review and feasibility study.

6.1 Results of Feasibility Study

As discussed in chapter 5.0 of this report, the ARC had significant concerns regarding the feasibility of requiring the pilots of helicopters providing air ambulance services under 14 CFR part 135 to use NVG during nighttime operations at this time, in light of the current regulations and insufficient resources to support FAA certification and surveillance activities.

After conducting the feasibility study, the members reached consensus on the safety benefits associated with the use of NVG; however, they also noted significant areas of concern for further study and consideration by the FAA, as noted below.

6.2 Additional Considerations for the FAA

In developing its recommendation, the ARC noted that while it is not prepared at this time to recommend a regulatory requirement be added to 14 CFR part 135 mandating the use of NVG during all helicopter air ambulance nighttime operations, the members strongly support further effort on the part of the FAA to address a series of additional considerations and areas of study.

Upon consideration of the numerous issues raised with NVG operations, the ARC recommends the FAA undertake a review of the following questions and considerations in the near future:

- How many civil helicopter accidents that occurred at night would have been mitigated by the use of NVG?
- How is the cause of a helicopter air ambulance accident classified in relation to NVG use?
- What additional requirements are imposed on operators by the Helicopter Air Ambulance Final Rule?
- What kind of training do FAA inspectors and engineers receive on NVG certification and operations?
- Can definitions related to NVG operations (14 CFR 61.1 (13) and (14)) be sufficiently revised/updated during the rulemaking process to ensure the decision-making ability of the pilot is not hampered by a regulatory requirement to use NVG during night operations?
- How does the FAA plan to address equipage/equipment requirements (14 CFR 91.205(h)) in the context of a requirement to use NVG during all nighttime operations?
- Is a comprehensive review of regulations (14 CFR parts 21, 27, 29, 43, 61, 91, 97, and 135) and inspector guidance (i.e., FAA Order 8900.1) necessary to ensure that NVG

usage is accounted for in the regulatory framework? (For example, 14 CFR 135.207 was promulgated before widespread NVG-usage.)

- Can the FAA develop consistent, published certification standards for initial NVIS installation and compatibility with subsequent cockpit modifications?

- How does the FAA ensure the consistent application of rules governing NVG implementation? How does this assurance apply to the changing technological capability of NVG and enhanced vision products?

- How could the FAA account for pilot discretion regarding the use of NVG if a requirement is mandated?

- How does the FAA plan to address the current policy requiring a second crewmember on NVG under certain STCs/RFMS in light of the safety case demonstrating the requirement is unnecessary?

- How can FAA ensure the timely availability of inspector resources to allow for certification of new operators, as well as the required level of oversight for current operators, without interruption of existing NVG operations?

- How does the FAA allow for the continued operation of NVG in cockpits that undergo frequent changes and equipment updates? (If the FAA mandates NVG, current policy regarding the absolute filtration of cockpit lighting needs to be addressed to recognize the enhanced capabilities of modern NVG products.)

6.3 Recommendation

The ARC members reached consensus on the safety benefits and risk mitigation associated with the use of NVG by helicopter air ambulance pilots. The ARC also reached consensus on its concerns with mandating additional regulatory requirements on helicopter air ambulance operators. The members raised a threshold question as to whether the helicopter air ambulance industry should be subject to further rulemaking until the Helicopter Air Ambulance Final Rule is promulgated and implemented. The ARC further noted all of its members currently use NVG, which is consistent with the widespread implementation of NVG by industry. Many helicopter air ambulance operators work to ensure night operations are conducted aided, when NVG are available for use. However, the members also agreed that not all environments are suitable for continuous NVG use, so the technology should be available for use at the pilot's discretion.

After careful consideration of the results of the feasibility study, under the current regulations, and in light of current FAA certification and surveillance resources, the ARC is not prepared to recommend rulemaking that would impose a requirement on pilots of helicopters providing air ambulance services under 14 CFR part 135 to use NVG during all nighttime operations.

7.0 CONCLUSION

The ARC conducted the feasibility study mandated by section 318 of the Act. The members developed and agreed to the recommendation presented in this report. The ARC notes the recommendation in this report is based on the results of the feasibility study. The members discussed their concerns at the outset of the study and conducted the literature review and discussion of various considerations presented in the Charter. The ARC unanimously agreed that use of NVG during nighttime operations enhances safety, but the members were not prepared to recommend taking the decision-making ability regarding the use of NVG away from operators (and their pilots) at this time. The ARC felt that safety is ensured in an environment where well-trained pilots can conduct a risk assessment and determine the course of action that mitigates the risks of nighttime operations, including the use of NVG.

In discussing the considerations set forth in the Charter, the members documented support for their recommendation against a regulatory requirement to use NVG during nighttime operations. The also identified several areas for further study and consideration by the FAA, which are outlined in section 6.2 of this report. The members further noted that any requirement mandating the use of NVG during all nighttime operations would need to be carefully reviewed, as there are several situations (operating environments) that arise during nighttime operations during which the use of NVG would not be appropriate. While in many operating environments NVG offer risk mitigation, in some cases they do not mitigate risk and may even increase risk based on the operating environment.

As discussed in section 6.3 of this report, the ARC has concerns regarding additional regulatory requirements on helicopter air ambulance operators that would require the use of NVG in light of the current regulatory environment and the level of FAA certification and surveillance resources. The members further noted industry support for FAA efforts to increase and effectively deploy current resources.

The ARC members appreciated the opportunity to work with the FAA in conducting the feasibility study and developing its recommendation against a regulatory requirement to use NVG during all nighttime operations. While the ARC was not prepared to recommend a requirement after conducting the feasibility study and reviewing the results, the members look forward to continuing the dialogue. The ARC cited industry collaboration with the FAA as the best method to define the safest operating practices and establish an effective regulatory environment for helicopter air ambulance operators. The members completed this report and emphasized industry willingness to participate in future FAA efforts to study NVG equipment and operations.

APPENDICES

APPENDIX A: NVG ARC MEMBERS & FAA PARTICIPANTS

Members

Mr. Chris Bassett, Industry Chair
Air Methods

Mr. William Tom Shergalis, Designated Federal Official
Aviation Safety Inspector, General Aviation & Commercial Division (AFS-800)
Federal Aviation Administration

Air Evac EMS Inc.
Mr. Tony Bonham

Classic Helicopters
Mr. Matt Stein

HALO Flight, Inc.
Mr. Tom Klassen

Med-Trans Corporation
Mr. Brian Foster

Metro Aviation, Inc.
Mr. Jim Catlett

Stat MedEvac
Mr. John Kenny
Mr. Bill Martin

Travis County EMS
Mr. Willy Culberson

TriState CareFlight, LLC
Mr. Matt Rielly

FAA Participants

Mr. Larry Buehler (AFS-200)

Mr. Jose Castedo (APO-300)

Dr. Thomas Chidester (AAM-500)

Mr. Clark Davenport (ASW-100)

Mr. James Fee (AVP-200)

Mr. Donald Gallagher (ANG-E261)

Ms. Anne M Godfrey (ASW-170)

Mr. Dean Griffith (AGC-220)

Dr. Carla Hackworth (AAM-510)

Mr. Dan Herschler (ANG-C1)

Mr. Robert Joslin (AIR-100)

Mr. Thomas Mai (AAS-100)

Dr. Andy Mead (AAM-500)

Mr. Kevin Morgan (AFS-300)

Dr. Brian Pinkston (AAM-400)

Mr. Jon Prater (AFS-800)

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ARC Program Support

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Ms. Lisa Harig
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APPENDIX B: ABBREVIATIONS & ACRONYMS

Abbreviation/Acronym	Definition
14 CFR	Title 14 of the Code of Federal Regulations
AAM	Federal Aviation Administration Office of Aerospace Medicine
AAS	Federal Aviation Administration Airport Engineering Division
AAS-100	Federal Aviation Administration Airport Engineering Division
AC	Advisory Circular
AFS	Federal Aviation Administration Flight Standards Service
AGC	Federal Aviation Administration Office of the Chief Counsel
AIR-100	Federal Aviation Administration Aircraft Certification Service, Aircraft Engineering Division
AFS-350	Federal Aviation Administration Aircraft Maintenance Division, General Aviation Branch
AFS-810	Federal Aviation Administration General Aviation & Commercial Division, Airmen Certification and Training Branch
AMOA	Air Medical Operators Association
ANG	Federal Aviation Administration Office of NextGen
APO	Federal Aviation Administration Office of Aviation Policy and Plans
ARC	Aviation Rulemaking Committee
ASW	Federal Aviation Administration Flight Standards Service Southwest Region
ASW-300	Southwest Regional Flight Surgeon
AVP	Federal Aviation Administration Office of Accident Investigation & Prevention
AVS-1	Associate Administrator for Aviation Safety
CFIT	Controlled Flight into Terrain
CHDO	Certificate Holding District Office
CNS/ATM	Communications, Navigation, Surveillance, and Air Traffic Management

Abbreviation/Acronym	Definition
CRM	Crew Resource Management
DOT	Department of Transportation
EB	Engineering Brief
EFVS	Enhanced Flight Vision System
EVS	Enhanced Vision
EMS	Emergency Medical Services
EMS/H	Emergency Medical Services/Helicopter
FAA	Federal Aviation Administration
FOV	Field-of-View
GAO	Government Accountability Office
GC	Global Change
GOM	General Operations Manual
GPS	Global Positioning System
HEMS	Helicopter Emergency Medical Services
HNVGO	Helicopter Night Vision Goggle Operations
HTAWS	Helicopter Terrain Awareness and Warning System
HUD	Head-up Display
ICA	Instructions for Continued Airworthiness
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
InFO	Information for Operators
LARS	Light-weight Aircraft Recording Systems
LED	Light-Emitting Diode
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List

Abbreviation/Acronym	Definition
M/M/S	Make, Model, and Series
MOPS	Minimum Operational Performance Standards
NextGen	Next Generation Air Transportation System
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
NVG	Night Vision Goggles
NVIS	Night Vision Imaging Systems
OpSpecs	Operations Specifications
OTW	Out-the-Window
PAI	Principal Avionics Inspector
PGL	Program Guidance Letter
PL	Policy Letter
PMI	Principal Maintenance Inspector
POI	Principal Operations Inspector
PTS	Practical Test Standards
RFMS	Rotorcraft Flight Manual Supplement
RTCA	RTCA, Inc.
SAFO	Safety Alert for Operators
SMS	Safety Management System
STC	Supplemental Type Certificate
TAWS	Terrain Awareness and Warning System
TC	Type Certificate
TSO	Technical Standard Order
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

APPENDIX C: NVG ARC CHARTER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Aviation Rulemaking Committee Charter

Effective Date: 10/05/12

SUBJECT: Section 318 Night Vision Goggles Feasibility Study

1. **PURPOSE.** This charter creates the Aviation Rulemaking Committee (ARC) for the Section 318 Night Vision Goggles Feasibility Study according to the Administrator's authority under Title 49 of the United States Code (49 U.S.C.) 106(p)(5). This charter also outlines the committee's organization, responsibilities, and tasks.

2. **BACKGROUND.** This ARC is necessary to comply with Section 318 of the Federal Aviation Administration (FAA) Modernization and Reform Act of 2012 (the Act). Section 318 of the Act requires the Administrator to carry out a study on the feasibility of requiring 14 CFR part 135 air ambulance helicopter pilots to use Night Vision Goggles (NVG) during nighttime operations. The Act requires the Administrator to submit a report to Congress on the results of the study no later than February 14, 2013.

3. **OBJECTIVES AND TASKS OF THE ARC.** The ARC will provide a forum for the United States aviation community to discuss and provide recommendations to the FAA. The ARC will conduct a study on the feasibility of requiring pilots of helicopters providing air ambulance services under Title 14 Code of Federal Regulations (14 CFR) part 135, to use night vision goggles during nighttime operations. While conducting the study, the ARC will consider information from owners and operators of helicopters providing 14 CFR part 135 air ambulance services and aviation safety professionals to determine the benefits, financial considerations, and risks associated with requiring the use of NVGs.
   a. The ARC will conduct a literature review and determine the benefits and risks associated with requiring the use of night vision goggles considering the following:
      1. Human and environmental factors (e.g., effects of eye pathologies on NVG use, fatigue, effects of recurrent use on human performance, effects of prolonged NVG use on color vision, effects on loss of dark adaptation and transition to night vision, lighting, weather, and terrain).
   b. The ARC will determine the benefits, financial considerations, and risks associated with requiring the use of night vision goggles considering the following:
      1. Obstacle lighting (LED vs. incandescent bulbs);
      2. Airport, hospital, and helipad lighting (LED vs. incandescent bulbs);
      3. Operational criteria for use (Risk assessment, safety analyses, costs associated with go/no-go based on NVG availability);
      4. Operational criteria for use (Specific language in the operations rules (14 CFR parts 135 and 91), updated operations specification paragraphs in 8900.1);
      5. Dispatch protocol (What dispatch and operations continuation considerations need to be addressed, how long will it take, and are there resources to support the effort?);
      6. Helicopter medical personnel using NVGs to assist with NVG-aided flight into unimproved landing sites;
      7. Second crewmember using NVGs to assist with NVG-aided flight into unimproved landing sites;

Initiated By: AFS-800

8. Assess single-crew pilot only (no other occupants using NVG) operations into unimproved landing zones;
9. Single pilot vs. dual pilot operations;
10. Operational requirements for single pilot operations;
11. Aircraft Make/Model specific NVG currency requirements/endorsements (§§ 61.57, 135.293);
12. Effects on rural communities (If there is one helicopter in a given region that has an NVG component become inoperable, and the mission could have been completed unaided, did the mandate prevent the mission from being completed?);
13. Minimum Equipment List Considerations (How does mandating NVG operations at night affect the Master Minimum Equipment List and the operator's Minimum Equipment List?);
14. Autopilot requirements (Is an autopilot or some sort of stabilization system needed?);
15. Requiring pilot currency for instrument flight (Instrument Meteorological Conditions (IMC)) if NVGs are used (§135.207);
16. Size and scope of operation. (What are the effects of operator size and the geographic scope of the operations relative to operating with NVG?);
17. Effect on operational control;
18. NVG maintenance and aircraft configuration control;
19. Prior adverse operator experience with Night Vision Imaging Systems (NVIS) and mitigations used;
20. NVIS operational usage patterns and policy for use during nighttime operations (continuous vs. intermittent use during night operations as defined in 14 CFR 1.1: "*Night* means the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.");
21. The known causes of civil NVG accidents worldwide;
22. Assess 14 CFR 135.207 requirements while using NVGs (Evaluate increased requirement for NVG inadvertent IMC recovery procedures); and
23. FAA approval of NVGs (approval methods to include NVG manufacturers and NVIS STC holders).

Recommendation Report. The ARC will make recommendations on the feasibility of requiring pilots of helicopters providing air ambulance services under 14 CFR part 135, to use night vision goggles during nighttime operations.

The ARC will submit a final report detailing recommendations no later than 2 months from the effective date of the charter.

4. **ARC PROCEDURES.**
   a. The ARC advises and provides written recommendations to the Associate Administrator for Aviation Safety, and acts solely in an advisory capacity. Once the ARC recommendations are delivered to the Associate Administrator for Aviation Safety, it is within her discretion to determine when and how the report of the ARC is released to the public.
   b. The ARC may propose additional tasks as necessary to the Associate Administrator for Aviation Safety for approval.
   c. The ARC will submit a report detailing recommendations within 2 months from the effective date of this charter. The chair of the ARC sends the recommendation report to both the Associate Administrator for Aviation Safety and the Director of the Office of Rulemaking.

d. The ARC may reconvene following the submission of its recommendations for the purposes of providing advice and assistance to the FAA, at the discretion of the Associate Administrator for Aviation Safety, provided the charter is still in effect.

5. ARC ORGANIZATION, MEMBERSHIP, AND ADMINISTRATION. The FAA will set up a committee of members of the aviation community. Members will be selected based on their familiarity with NVG, analysis, and regulatory compliance. Membership will be balanced in viewpoints, interests, and knowledge of the committee's objectives and scope. ARC membership is limited to promote discussion. Active participation and commitment by members will be essential for achieving the ARC objectives. Attendance is essential for continued membership on the committee. When necessary, the ARC may set up specialized work groups that include at least one ARC member and invited subject matter experts from industry and government.

This ARC will consist of members from:

Industry:
- Air Methods Corporation (QMLA)
- Air Evac EMS, Inc. (EVCA)
- Metro Aviation (HDNA)
- Med Trans Corporation (M3XA)
- Stat Medevac (E3MA)
- Tristate Careflight (IFJA)
- Classic Helicopters (JAPA)
- Travis County EMS (LEUA)
- Halo Flight, Inc. (H7FA)

FAA:
- AFS, Flight Standards Service
- AAM, Office of Aerospace Medicine
- ANG-C1, Human Factors Research & Engineering Division
- ANG-E261, Airport Safety R & D Section
- AAS-100, Office of Airport Safety & Standards – Airport Engineering Division
- ASW-300, Aerospace Medical Division – Aerospace Medical, ASW
- ASW-100, Southwest Region – Aircraft Certification Service, Rotorcraft Directorate
- AVP-200, Office of Accident Investigation and Prevention – Safety Analytical Services Division
- APO, Aviation Policy and Plans

The Associate Administrator for Aviation Safety is the sponsor of the ARC and will select an industry chair(s) from the membership of the ARC and the FAA designated Federal official for the ARC. The FAA participation and support will come from all affected lines-of-business.

a. The ARC sponsor is the Associate Administrator for Aviation Safety who:
   1. Appoints members or organizations to the ARC, at the sponsor's sole discretion;
   2. Receives all ARC recommendations and reports; and
   3. Provides administrative support for the ARC, through the Flight Standards Service.

b. Once appointed, the industry chair(s) will:

1. Coordinate required committee and subcommittee (if any) meetings in order to meet the ARC's objectives and timelines;
2. Provide notification to all ARC members of the time and place for each meeting;
3. Ensure meeting agendas are established and provided to the committee members in a timely manner;
4. Ensure meetings minutes are kept; and
5. Perform other responsibilities as required to ensure the ARC's objectives are met.

6. **COST AND COMPENSATION.** The estimated cost to the Federal Government for the Section 318 Night Vision Goggles Feasibility Study ARC is approximately $40,000 annually. All travel costs for government employees will be the responsibility of the government employee's organization. Non-government representatives, including the industry co-chair, serve without government compensation and bear all costs related to their participation on the committee.

7. **PUBLIC PARTICIPATION.** ARC meetings are not open to the public. Persons or organizations outside the ARC who wish to attend a meeting must get approval in advance of the meeting from a committee chairperson or designated federal official.

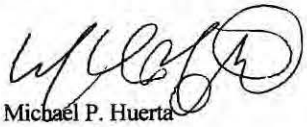
8. **AVAILABILITY OF RECORDS.** Consistent with the Freedom of Information Act, Title 5, U.S.C., section 522, records, reports, agendas, working papers, and other documents that are made available to or prepared for or by the committee will be available for public inspection and copying at the FAA Headquarters, Flight Standards Service, AFS-1, 800 Independence Avenue, SW, Washington, DC 20591. Fees will be charged for information furnished to the public according to the fee schedule published in Title 49 of the Code of Federal Regulations, Part 7.

   You can find this charter on the FAA Web site at:
   http://www.faa.gov/regulations_policies/rulemaking/committees/documents/.

9. **DISTRIBUTION.** This charter is distributed to director-level management in the Office of the Associate Administrator for Aviation Safety, the Office of Aviation Policy and Plans, and the Office of Rulemaking.

10. **EFFECTIVE DATE AND DURATION.** This ARC is effective upon issuance of this charter. The ARC will remain in existence for 12 months unless sooner suspended, terminated, or extended by the Administrator.

The effective date of this charter is October 5, 2012.



Michael P. Huerta
Acting Administrator

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APPENDIX D: FAA MODERNIZATION AND REFORM ACT OF 2012, SECTION 318

FAA Modernization and Reform Act of 2012 (P.L.112-95) § 318

SEC. 318. FEASIBILITY OF REQUIRING HELICOPTER PILOTS TO USE NIGHT VISION GOGGLES.

(a) STUDY.—The Administrator of the Federal Aviation Administration shall carry out a study on the feasibility of requiring pilots of helicopters providing air ambulance services under part 135 of title 14, Code of Federal Regulations, to use night vision goggles during nighttime operations.

(b) CONSIDERATIONS.—In conducting the study, the Administrator shall consult with owners and operators of helicopters providing air ambulance services under such part 135 and aviation safety professionals to determine the benefits, financial considerations, and risks associated with requiring the use of night vision goggles.

(c) REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the results of the study.

APPENDIX E: INDEX OF DOCUMENTS REVIEWED

The ARC reviewed the documents set forth in this Appendix in the preparation of this report.

1.0 Studies and Reports (General)

The members reviewed several presentations from Federal Aviation Administration (FAA) subject matter experts (SME) regarding research on night vision goggles (NVG) and pilot workload, as well as human factors, which included information from the following studies and reports:

- Parush, A., Gauthier, M., Arsenau, L., & Tang, D. (2011). The Human Factors of Night Vision Goggles: Perceptual, Cognitive, and Physical Factors. *Reviews of Human Factors and Ergonomics*, Vol. 7, 238-279. DOI:10.1177/1557234X11410392.

- Covelli, J., Rolland, J., Proctor, M., Kincaid, P., & Hancock, P. (2010). Field-of-View Effects on Pilot Performance in Flight. *The International Journal of Aviation Psychology*, 20:2, 197-219.

- Covelli, J. (2008). *Field-of-view effects on reflexive motor response in flight simulation*. Ph.D Dissertation, University of Central Florida. Retrieved from ProQuest Dissertations and Theses.

- Keller, M., Schnell, T., Lemos, K., Glaab, L., & Parrish, R. (2003, October). *Pilot performance as a function of display resolution and field of view in simulated flight using synthetic vision systems.* Paper presented at the 22nd Digital Avionics Systems Conference, Indianapolis, IN.

- Blumen I. and the UCAN Safety Committee. (November 2002). *A Safety Review and Risk Assessment in Air Medical Transport*. Supplement to the *Air Medical Physician Handbook*.

- Canning, A. (2000). *The effect of restricted field-of-view on locomotion tasks, head movements, and motion sickness*. Ph.D Dissertation, University of Central Florida. Retrieved from ProQuest Dissertations and Theses.

- Jennings, S. & Craig, G. (2000).Effects of field-of-view on pilot performance in night vision goggles flight trials: preliminary findings, *Proc. SPIE* 4021, Helmet- and Head-Mounted Displays V, 335 (June 23, 2000); doi:10.1117/12.389163.

- Kasper, E., Haworth,L., Szoboszlay, Z., King, R., & Halmos, Z. (1997). *Effects of in-flight field-of-view restriction on rotorcraft pilot head movement.* Proceedings from the Society of Photo-Optical Instrumentation Engineers (SPIE) 3058, 34. DOI:10.1117/12.276658

- Haworth, L., Szoboszlay, Z., Kasper, E., DeMaio, J., & Halmos, Z. (1996). *In-flight simulation of visionic field-of-view restrictions on rotorcraft pilot's workload, performance and visual cueing.* 52nd Annual Forum of the American Helicopter Society, Washington DC.

- Venturino, M., & Wells, M. J. (1990). Head movements as a function of field-of-view size on a helmet-mounted display. In D. Woods & E. Roth (Eds.), *Proceedings of the Human Factors Society 34th annual meeting* (pp. 1572–1576). Chicago, IL: HFES.

2.0 Congressional Testimony

The members reviewed transcripts of testimony by the following individuals before the House of Representatives Committee on Transportation and Infrastructure Committee, Aviation Subcommittee during the Oversight of Helicopter Medical Services Hearing, which took place on April 22, 2009:

- The Honorable Christa Fornarotto, Acting Assistant Secretary for Aviation and International Affairs, U.S. Department of Transportation (DOT)
- Mr. John Allen, Director, Flight Standards Service (AFS-1), FAA
- The Honorable Robert L. Sumwalt III, Member, National Transportation Safety Board (NTSB)
- Dr. Gerald Dillingham, Director, Physical Infrastructure Issues, U.S. Government Accountability Office (GAO)

3.0 GAO Reports

- GAO, Aviation Safety: Potential Strategies to Address Air Ambulance Safety Concerns 1 (2009) (testimony is based primarily on GAO's February 2007 study on air ambulance safety).
- GAO, Aviation Safety: Improved Data Collection Needed for Effective Oversight of Air Ambulance Industry, GAO-07-353 (Feb. 21, 2007).

4.0 NTSB Reports, Meetings & Recommendations

- NTSB, Special Investigation Report on Emergency Medical Services Operations (NTSB/SIR-06/01) (Jan. 25, 2006).
- NTSB, *Commercial Emergency Medical Service Helicopter Operations* (Safety Study NTSB/SS-88/01) (Washington, DC: National Transportation Safety Board, 1988).
- NTSB: Public Meeting as of September 1, 2009, Four Safety Recommendation Letters Concerning Helicopter Emergency Medical Services.
- NTSB/SIR-06/01, NTSB Recommendations to FAA A-06-12 to A-06-15.
- NTSB Recommendation A-09-95 (September 24, 2009).

- NTSB Accident/Incident Reports (including Synopsis, Factual Data Collection Report of Accident, and Brief of Accident) available in the NTSB Aviation Accident Database & Synopses (www.ntsb.gov/aviationquery/) and listed below by Date, Location, and Accident/Incident Number:

Date	Location	Accident/Incident Number
11/08/1994	Cameron, LA	CHI95FA035
03/12/1998	Quantico, WA	IAD98GA039
09/22/2001	Chico, CA	LAX01LA304
10/22/2001	Bartow, FL	MIA02GA011
12/16/2003	Okeechobee, FL	ATL04LA055
01/29/2005	Pilar, NM	DEN05LA053
04/21/2006	Nikiski, AK	ANC06TA047
11/02/2006	Kalispell, MT	SEA07FA014
11/07/2006	Harrisburg, PA	NYC07IA023
12/14/2006	Port Heiden, AK	ANC07FA007
12/03/2007	Whittier, AK	ANC08FA025
02/05/2008	South Padre Island, TX	DFW08FA062
02/08/2008	Valentine, TX	DFW08TA066
06/08/2008	Huntsville, TX	DEN08FA101
06/27/2008	Ash Fork, AZ	LAX08LA198
06/29/2008	Flagstaff, AZ	DEN08MA116A
06/29/2008	Flagstaff, AZ	DEN08MA116B
11/16/2008	Quitman, AR	CEN09TA060
02/22/2009	Cave Creek, AZ	WPR09LA125
06/24/2009	Morgantown, WV	ERA09CA367
08/17/2009	North Captiva Island, FL	ERA09LA464
11/04/2009	Globe, AZ	WPR10LA046
02/05/2010	El Paso, TX	CEN10FA113
03/25/2010	Brownsville, TN	ERA10MA188
08/31/2010	Walnut Grove, AR	CEN10FA509
05/03/2011	Camden, SC	ERA11LA278
04/29/2012	Hugo, OK	CEN12CA269

5.0 Title 14 of the Code of Federal Regulations (14 CFR) Parts

- 14 CFR Part 43
  - 43.13 − Performance rules (general).
  - 43.16 − Airworthiness limitations.

- 14 CFR Part 61
  - 61.1(b)(13) – *Night vision goggles* means an appliance worn by a pilot that enhances the pilot's ability to maintain visual surface reference at night.
  - 61.1(b)(14) − *Night vision goggle operation* means the portion of a flight that occurs during the time period from 1 hour after sunset to 1 hour before sunrise where the pilot maintains visual surface reference using night vision goggles in an aircraft that is approved for such an operation.
  - 61.31(k) − Type rating requirements, additional training, and authorization requirements: Additional training required for night vision goggle operations.
  - 61.51(b)(3)(v) − Pilot logbooks: Logbook entries: Conditions of Flight: Use of night vision goggles in an aircraft in flight, in a flight simulator, or in a flight training device.
  - 61.51(k) − Pilot logbooks: Logging night vision goggle time.
  - 61.57(f) − Recent flight experience: Pilot in command: Night vision goggle operating experience.
  - 61.57(g) − Recent flight experience: Pilot in command: Night vision goggle proficiency check.
  - 61.195(k) − Flight instructor limitations and qualifications: Training for night vision goggle operations.

- 14 CFR Part 91
  - 91.205(h) − Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements: Night vision goggle operations.

- 14 CFR Part 135
  - 135.207 − VFR: Helicopter surface reference requirements.
  - 135.271− Helicopter hospital emergency medical evacuation service (HEMES).
  - Subpart J—Maintenance, Preventive Maintenance, and Alterations. (See 135.411 − Applicability.)

- 75 FR 62640, Notice of Proposed Rulemaking: Air Ambulance and Commercial Helicopter Operations, Part 91 Helicopter Operations, and Part 135 Aircraft Operations; Safety Initiatives and Miscellaneous Amendments Final Rule (October 12, 2010).

6.0 Operations Specifications (OpSpecs)

- Paragraph A021, Helicopter Emergency Medical Services (HEMS)/Air Ambulance Operations—Helicopter
- Paragraph A050, Helicopter Night Vision Goggle Operations
- Paragraph D093, Helicopter Night Vision Goggle Operations (HNVGO) Maintenance Program

7.0 Regulatory Guidance

- Guidance Material Regarding NVIS Certification/Equipment Approval
  - Technical Standard Order (TSO)-C164, Night Vision Goggles (09/30/2004).
  - RTCA/DO-268, Concept of Operations, Night Vision Imaging System for Civil Operators (03/27/2001).
  - RTCA/DO-275, Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment (10/12/2001).
  - RTCA/DO-295, Civil Operators' Training Guidelines for Integrated Night Vision Imaging System Equipment (10/19/2004).
  - Advisory Circular (AC) 27-1B CHG 3, Certification of Normal Category Rotorcraft (9/30/2008).
  - AC 29-2C CHG 3, Certification of Transport Category Rotorcraft (9/30/2008).
  - FAA Order 8130.21G CHG 1, Procedures for Completion and Use of the Authorized Release Certificate, FAA Form 8130-3, Approval Tag (04/14/2010).
  - Master Minimum Equipment List (MMEL) Policy Letter (PL)-77, Cockpit and Instrument Lighting Systems (July 5, 2012).
  - MMEL PL-127, Night Vision Imaging Systems (NVIS) (June 07, 2010).

- Guidance Material published by AFS for inspectors:
  - Order 8900.1, Volume 3, Chapter 19, Section 6, Flight Training Curriculum Segments, which includes guidance regarding the use of NVG to reduce the risk of CFIT accidents.
  - Order 8900.1, Volume 4, Chapter 5, Section 1, Background and Definitions, which contains background information on air ambulance operations.
  - Order 8900.1, Volume 4, Chapter 4, Section 2, Authorizations for 14 CFR Part 135 Air Ambulance Services, which incorporates guidance regarding the certification of air carriers (or new applicants) for an air ambulance authorization.
  - Order 8900.1, Volume 4, Chapter 5, Section 3, Air Ambulance Service Operational Procedures, which sets forth the evaluation of an operator's administrative, preflight, in-flight, emergency, and post flight procedures, as well as additional information on high and low lighting conditions.

- Order 8900.1, Volume 4, Chapter 5, Section 4, Air Ambulance Operations Training Programs, which contains guidance for evaluating a training program for flight crew and medical personnel in air ambulance operations.
- Order 8900.1, Volume 4, Chapter 5, Section 5, Operational Risk Assessment Programs for Helicopter Emergency Medical Services, which provides guidance on risk assessment programs for helicopter air ambulance operators.
- Order 8900.1, Volume 4, Chapter 7, Section 4, Night Vision Imaging Systems, which is used by principal operations inspectors (POI), principal maintenance inspectors (PMI), and principal avionics inspectors (PAI) when evaluating a 14 CFR part 135 operator's request for use of NVG.
- Order 8900.1, Volume 4, Chapter 9, Section 1, Perform Field Approval of Major Repairs and Major Alterations, Figures 4-66 through 4-68, which incorporates guidance for the field approval process, including approval of NVG.
- Order 8900.1, Volume 6, Chapter 11, Section 22, Conduct Night Vision Imaging System Evaluation Inspection, which incorporates guidance for evaluating an operator's NVIS to include NVG and maintenance documents for aircraft operated under 14 CFR parts 91, 133, 135, 137, and 141.

- Guidance published by the FAA Flight Standards Service (AFS) for Helicopter Air Ambulance Operators:
  - AC 135-14A, Emergency Medical Services/Helicopter (EMS/H) (6/20/91).
  - Information for Operators (InFO) 11004 Enhanced Flight Vision System (EFVS), Enhanced Vision Systems (EVS), and Night Vision Goggles (NVG) compatibility with Light-Emitting Diodes (LEDs) at airports and on obstacles (2/15/11).
  - Safety Alert for Operators (SAFO) 10022, Maintenance of Night Vision Imaging Systems (NVIS) (12/15/10).
  - SAFO 06001, Helicopter Emergency Medical Services (HEMS) Operations (1/28/06).

- Guidance Material published by the FAA Airports Division (AAS) on Obstruction Lighting and Heliport Lighting Equipment
  - AC 150/5390-2C, Heliport Design (4/24/2012).
  - AC 150/5345-43G, Specification for Obstruction Lighting Equipment (9/26/2012).
  - Engineering Brief (EB) No. 67D, Light Sources other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures (March 6, 2012).
  - EB No. 87, Heliport Perimeter Lights for Visual Meteorological Conditions (January 13, 2012).
  - Program Guidance Letter (PGL) 12-02, Specifying LED Lighting on AIP-Funded Projects (March 5, 2012).

APPENDIX F: GLOSSARY

Aided Flight: Flight with night vision goggles (NVG) in an operational position. (Reference: RTCA/DO-268 at ¶ 2.4.2.)

Appliance: Any instrument, mechanism, equipment, part, apparatus, appurtenance, or accessory, including communications equipment, that is used or intended to be used in operating or controlling an aircraft in flight, is installed in or attached to the aircraft, and is not part of an airframe, engine, or propeller. (Reference: 14 CFR 1.1.)

Class A: NVG in which a 625nm minus blue objective lens filter has been incorporated. This term also can refer to the night vision imaging system (NVIS) lighting designed for use with NVG that contain a class A filter. (Reference: RTCA/DO-275 at ¶ 1.8.)

Class B: NVG in which a 665nm minus blue objective lens filter has been incorporated. This term also can refer to the NVIS lighting designed for use with NVG that contain a class B filter. (Reference: RTCA/DO-275 at ¶ 1.8.)

Field of View (FOV): Unaided FOV covers an elliptical area that is approximately 120° lateral by 80° vertical, whereas the field of view of current Type I NVG systems is nominally 40° and is circular. Both the reduced field of view of the image and the resultant decrease in peripheral vision can increase the operator's susceptibility to misperceptions and illusions. Proper scanning techniques should be employed to reduce the susceptibility to misperception and illusions. (Reference: RTCA/DO-295 at ¶ 4.1.1.2.1.6.)

Modified Class B: NVG in which a modified Class B filter has been incorporated. The filter has been modified with a notch or band-pass feature for the purpose of passing a small amount of energy in the green wavelengths. This allows for the operator to view fixed Head-up display (HUD) symbology with the NVG. (Reference: RTCA/DO-275 at ¶ 1.8.)

Monocular: A monocular contains the electro-optical components that gather the available light, amplify that light and present that light to a single eye. Each monocular assembly contains one or more intensifier channels. (Reference: RTCA/DO-275 at ¶ 1.8.)

Night: The time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time. (Reference: 14 CFR 1.1.)

Night Vision Goggles (NVG): A head-mounted, lightweight, self-contained binocular system consisting of two independent monocular assemblies. (Reference: RTCA/DO-275 at ¶ 1.8.)

Night Vision Imaging System (NVIS): The integration of all elements required to successfully and safely use NVG while operating an aircraft. (Reference: RTCA/DO-275 at ¶ 1.8.)

NVIS Operation: A night flight wherein the pilot maintains visual surface reference using NVG in an aircraft, which is NVIS approved. (Reference: RTCA/DO-268 at ¶ 2.4.)

Unaided Flight: A flight without NVG or a flight with NVG in a non-operational position. (Reference: RTCA/DO-268 at ¶ 2.4.2.)

Unimproved Landing Site: Any site that is not an airport, heliport, or other FAA-approved landing site (also referred to as an unimproved landing area). (Reference: RTCA/DO-295 at ¶ 2.5.1.)