Technical Report Documentation Page

1. Report No.	2. Government Accession Number	3. Recipient's Catalog No.
CG-D-07-00	ADA376017	

4. Title and Subtitle	5. Report Date
EVALUATION OF NIGHT VISION GOGGLES (NVG) FOR MARITIME SEARCH AND RESCUE: HH-65A SWEEP WIDTH VERIFICATION AND LASER ILLUMINATOR EVALUATION	October 1999
	6. Performing Organization Code: Project No. 1012.4.9

7. Author(s)	8. Performing Organization Report No.
K. Gross, H. Wallace, D. Larson, T. McClay	R&DC-231-99

9. Performing Organization Name and Address		10. Work Unit No. (TRAIS)
Analysis & Technology, Inc. P.O. Box 220 North Stonington, CT 06359-0220	U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340-6096	N/A
		11. Contract or Grant No.: DTCG39-94-D-E56616

12. Sponsoring Organization Name and Address	13. Type of Report & Period Covered
U.S. Department of Transportation United States Coast Guard Operations (G-O) Washington, DC 20593-0001	Final Report
	14. Sponsoring Agency Code: Commandant (G-OPR) U.S. Coast Guard Headquarters Washington, DC 20593-0001

15. Supplementary Notes

The R&D Center's technical point of contact is Dr. Keith Gross, (860) 441-2724, email: kgross@rdc.uscg.mil.

16. Abstract (MAXIMUM 200 WORDS)

The U.S. Coast Guard R&D Center conducted field tests to evaluate the search effectiveness of Coast Guard HH-65A helicopters equipped with night vision goggles (NVG). The purpose of the tests was to determine if the HH-65A's NVG search performance differed significantly from that of the Coast Guard HH-60J, and to assist the Coast Guard in deciding whether to continue to experiment with a near-infrared (IR), wide-area illuminator as an alternative to the aircraft's landing/hover lights.

Helicopters searched test ranges for small boats, life rafts, and mannequins. Analysts collected aircraft and target positions, target detection logs, and environmental and human factors data. Following reconstruction and analysis, sweep width data from the two aircraft were compared. No statistically significant differences in NVG search performance were found between the two aircraft. HH-65A data were combined with existing HH-60J data to produce updated sweep width tables incorporating additional illumination, environmental, and human factors conditions. Active illumination improved sweep width under all conditions tested. Low-intensity, near-IR illumination provided a small sweep width improvement over landing lights when whitecaps were present.

17. Key Words	18. Distribution Statement
search, search and rescue, night vision, night vision goggles, sweep width, life rafts, persons-in-water	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

19. Security Class (This Report)	20. Security Class (This Page)	21. No of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	142	

EXECUTIVE SUMMARY

1. Background

The U.S. Coast Guard R&D Center, Groton, CT, conducted three field experiments to evaluate the search performance of the Coast Guard's HH-65A helicopters equipped with Night Vision Goggles (NVG). The primary purpose of the experiments was to determine if the Coast Guard should develop unique NVG sweep width tables for the HH-65A, or use the tables developed for the Coast Guard HH-60J. Additionally, the R&D Center sought to determine whether to continue to experiment with a prototype near-infrared NVG illuminator developed under an earlier initiative, or to recommend that helicopter crews use the aircraft landing lights during NVG searches. The prototype illuminator generated energy using two 15-watt (9-watt output) near-IR (808-nanometer wavelength) lasers. The lasers were coupled to lenses mounted on a platform protruding from the left rear aircraft door. The lenses projected a large elliptical area on each side of the aircraft. Finally, the R&D Center used the additional data from the HH-65A tests, along with improved statistical techniques, to update the existing helicopter NVG sweep width tables.

2. Experimental Approach

To simulate real-world maritime search conditions, the R&D Center set up target ranges containing pre-positioned small boats, life rafts, and mannequins, whose locations were known only by the test team. NVG-equipped helicopter crews performed parallel-track and creeping-line searches, while an onboard data collector time-tagged and recorded the crews' target detections, along with various environmental and human factors parameters. Following each field test, analysts used target position logs, aircraft position logs, and environmental records to reconstruct each search. From that reconstruction, analysts determined, for a range of search conditions, the probability that a crew member would see each target type as the helicopter flew by at any given range. Analysts then constructed a series of Probability of Detection (POD) graphs, which plotted the aircraft's closest point of approach while passing each target versus the probability of the target being detected at that range. After mathematically smoothing the curves, they computed the integral of POD as a function of lateral range over all possible lateral range values. The result was sweep width, *W*, a measure of search effectiveness, for that particular target under the search conditions. *W* is used herein to compare the search performance of the HH-65A with that of the HH-60J, and the performance achieved with the experimental illuminator with that achieved using aircraft landing lights. Because no data exist for the HH-60J that would allow the two aircraft to be compared under illuminated conditions, only non-illuminated data were used for this comparison.

3. Observations

The following observations were made during the field tests. While they are not based on scientific analysis of the data, they may have implications for training, doctrine, or aircraft modifications.

- "Credit card"[1] windows in pilots' doors interfere with NVG search effectiveness.
- The HH-65A's Traffic Collision Avoidance System (TCAS) display causes glare and reflections within the cockpit.
- Reflective tape is highly visible when illuminated by landing lights or the illuminator.
- Whitecaps are distracting and annoying.
- Fatigue seems to play a major factor in crew's alertness after about 4 hours on task.
- Crews initially said that backscatter from the illuminator beam was distracting, but became less critical when they witnessed how effective it was against retro-reflective targets.
- Moderate rain is very distracting when illumination is used.
- Inexperienced crews have trouble distinguishing targets from whitecaps, debris, etc.
- Backscatter from the landing/hover lights is not highly visible to the naked eye when aimed straight down. Backscatter becomes more prevalent as the lights are aimed farther out.
- Crews generally over-estimate target distances.

4. Conclusions

The following conclusions were drawn based on statistical analysis of the field test data.

- The sweep widths for the HH-65A and the HH-60J are not statistically different, but the HH-65A appears to have a slightly better sweep width as a result of a higher probability of detecting targets close to the aircraft's flight path.
- Active illumination improves sweep width for Person(s) in the Water (PIWs) under all conditions encountered during these tests. Under extremely bright moon conditions with excellent visibility, active illumination may not improve sweep width for life raft and skiff targets. Low-intensity, near-infrared illumination seems to provide a small improvement in sweep width over the aircraft landing lights when whitecaps are present.
- The use of three searchers (two pilots and one crewman), a common practice when the HH-65A first became NVG compatible, results in sweep widths that are roughly 80 percent of those achieved by a normal four-person crew.

5. Recommendations

- Though the HH-65A's sweep widths appear to be slightly better than those of the HH-60J, the difference is not statistically significant at high confidence levels. Therefore, the Coast Guard should use the same sweep width tables for both aircraft.

---

[1] A small window that can be manually opened. The frame around the window interferes with pilots' vision.

- To maximize search performance, search and rescue unit (SRU) helicopters should employ four searchers whenever possible.

- The effectiveness of searching for PIWs, outfitted with retro-reflective material, is enhanced by the use of artificial illumination. Even under high humidity conditions with backscatter, field test data indicate that retro-reflective material is visible to a greater extent when illumination is used.

- Searches for small boats and rafts benefit from the use of artificial illumination when the moon has about 50-percent or less face showing. Artificial illumination does not appear to increase (and may decrease) sweep width during very bright natural lighting conditions (near full-moon conditions). When humidity is high and backscatter is an annoyance, use of artificial illumination will normally improve probability of detection at shorter lateral ranges and may slightly reduce probability of detection at longer lateral ranges. Experimental results tend to indicate improved sweep widths with artificial illumination even when backscatter is an annoyance.

- The prototype near-IR illuminator seems to improve sweep width slightly under whitecap conditions. The effect cannot be proven with the quantity of data taken to date and is not significant at a 68-percent confidence level. The effect is not strong enough to justify continued prototype development. The Coast Guard should continue to monitor technological improvements from the research conducted by other services and retest if significant technological advancements occur.

- Parachute flares provide additional illumination, but the Coast Guard would have to develop operational doctrine for deploying patterns of flares to provide sufficient light in the immediate search area to benefit NVG-equipped SRUs. Not enough data were available to justify any solid conclusions. Expended (hence invisible) flares drifting into the search area may create an unacceptable risk to airborne SRUs. If further research into flare drop tactics is desired, coordination with Canadian authorities is recommended.

- The appendix B procedure to calculate sweep width should be considered as the basis of new NVG sweep width tables to be placed either in the National Search and Rescue Manual or in the Coast Guard Addendum.

- The Coast Guard should consider an aggressive campaign to educate the maritime community on the benefits of using retro-reflective material to increase target visibility during night search and rescue operations.

- Due to the night visibility improvement of PIWs wearing PFDs with retro-reflective material, the Coast Guard should consider mandating the use of retro-reflective material on all PFDs.