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EVALUATION OF NIGHT VISION GOGGLES (NVG) FOR MARITIME SEARCH AND RESCUE (HH-3/HH-60 COMPARISON REPORT)

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15. Supplementary Notes
This report is the seventh in a series that will document the Improvement of Search and Rescue Capabilities (ISARC) Project at the U.S.C.G. R&D Center and thirty-third in a series of R&D Center reports dealing with Search and Rescue (SAR).

16. Abstract Eight experiments, including seven involving helicopters, have been conducted by the U.S. Coast Guard Research and Development (R&D) Center to evaluate night vision goggles (NVGs) for their effectiveness in detecting small targets at night. Three types of NVGs have been evaluated. The AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) was evaluated onboard U.S. Coast Guard HH-3F, CH-3E, and HH-60J helicopters, and HU-25C and RG-8A fixed-wing aircraft. The AN/PVS-5C and AN/PVS-7A NVGs were evaluated onboard U.S. and Canadian Coast Guard Search and Rescue Units (SRUs) in the 200-foot size range and onboard U.S. Coast Guard 41-foot utility boats (UTBs).

A total of 3029 target detection opportunities were generated during searches from helicopters for all the target types employed during the eight experiments. These data were first analyzed to determine whether a statistically significant difference existed in the detection performance of the HH-3/CH-3 and HH-60 helicopters. The data were then analyzed to determine which of 25 search parameters of interest exerted a statistically significant influence on target detection probability. Lateral range curves and sweep width estimates are presented for SRU/target type combinations that contained sufficient data to support this detailed analysis. Human factors data are presented and discussed.

No statistically significant differences exist in the data set between the detection performance of HH-3F/CH-3E and HH-60J helicopters. The data for these SRUs are combined and presented as one SRU type for sweep width analysis. NVGs proved to be an effective nighttime search aid for helicopter searches for small SAR targets. The addition of chemical lights to unlighted targets can improve detection performance. Preliminary results on a small data subset indicate that energizing the HH-60J nose light significantly increases target detection probability for unlighted PIWs.

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UNCLASSIFIED	UNCLASSIFIED		

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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
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oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
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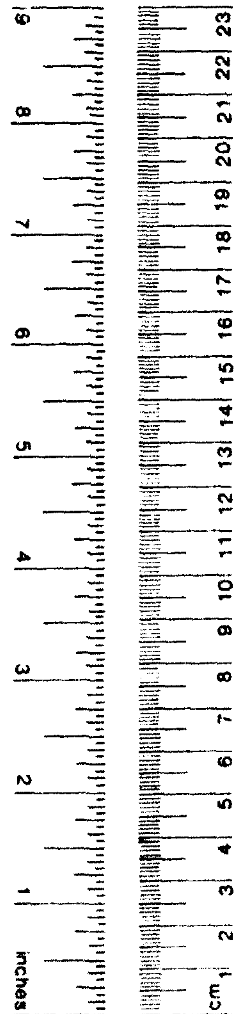
*1 in = 2.54 (exactly).



Approximate Conversions from Metric Measures

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cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
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m^3	cubic meters	1.3	cubic yards	yd^3
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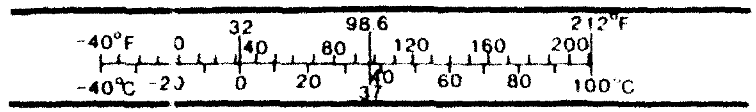

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EXECUTIVE SUMMARY

INTRODUCTION

1. Background

This report provides an analysis of seven experiments conducted to evaluate the AN/AVS-6 Aviators Night Vision Imaging System (ANVIS) for its effectiveness in the U.S. Coast Guard's maritime search and rescue (SAR) mission. The Night Vision Goggles (NVGs) were evaluated onboard HH-3F/CH-3E and HH-60J helicopters from Coast Guard Air Stations Traverse City, Michigan, Cape Cod, Massachusetts; Clearwater, Florida; and Aviation Training Center (ATC) Mobile, Alabama. Data were collected during seven 3-week experiments conducted in Fort Pierce, FL and Block Island Sound (off the Connecticut/Rhode Island/New York coasts). Coast Guard 41-foot utility boats (UTBs) participated in five of these experiments, and an eighth experiment has been performed in conjunction with the Canadian Coast Guard using ships in the 200-foot size range. These surface search and rescue units (SRUs) used both the AN/PVS-5C and AN/PVS-7A NVGs. During one experiment, HU-25C and RG-8A fixed-wing aircraft conducted searches with the ANVIS NVGs. These data are summarized in a previous report. This report discusses the detection performance of the HH-3F/CH-3E helicopters as compared to the detection performance of the HH-60J helicopter and will provide search guidance based on this evaluation.

These evaluations were conducted by the U.S. Coast Guard Research and Development (R&D) Center as part of the Improvement of Search and Rescue Capabilities (ISARC) Project.

2. ANVIS Description

The ANVIS NVGs are equipped with Generation III image intensifier tubes. All helicopter crew positions were provided with ANVIS NVGs on hinged helmet mounts. The NVGs restrict visual perception in several ways: field of view is restricted to 40 degrees; depth perception is severely inhibited; visual acuity is reduced to 20/40, at best; and the display is monochromatic (green). The ANVIS design allows limited, non-NVG peripheral vision.

3. Approach

Data were collected using operational Coast Guard search craft with crews that had received basic instruction in NVG use. Standard search patterns were used to search for randomly placed targets within assigned search areas. The search crews were not alerted to target locations.

A precision microwave tracking system (MTS) was used to monitor and record target and search craft positions. Target detections and human-factors data were logged by data recorders onboard each search unit. Environmental data were logged onboard a chartered workboat. An environmental data buoy was deployed in each exercise area to record winds, sea conditions, and air/water temperatures.

Data reconstruction was performed to determine which target opportunities resulted in detection and at what lateral range each opportunity, occurred. Raw data files were developed that included each target detection or missed opportunity, along with the values of 25 search parameters of interest for each target opportunity. These data were analyzed on a desktop computer using a variety of statistical techniques including binary, multivariate regression analysis. Lateral range versus target detection probability plots and sweep width estimates were developed for search conditions that were well represented in the data. The search parameters were analyzed for their significance at the 90-percent confidence level.

Human factors data were compiled and analyzed quantitatively where possible. Subjective comments by search unit crews and data recorders were synopsized and incorporated into the Conclusions and Recommendations of this report.

RESULTS AND CONCLUSIONS

1. Results

A combined total of 3029 target detection opportunities were generated from helicopters for the target types discussed in this report. Table 1 provides a summary of environmental and moon parameters for each target type.

Table 1. Range of Environmental and Moon Parameters Encountered

TARGET	ENVIRONMENTAL PARAMETERS									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
Small Boats	0 to 1	1.5 to 15	1 to 20	0 to 1.0	1.3 to 6.2	0 to 2	51 to 96	10.4 to 27.0	13.4 to 27.2	68 to 65	none to full
Rafts w/retro-tape	0 to 2	5 to 15	2 to 14	0 to 1.0	1.3 to 6.6	0 to 1	50 to 95	15.7 to 27.0	18.4 to 27.2	66 to 53	quarter to full
Rafts w/out retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.2	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	69 to 69	none to full
Unlighted PIWs w/retro-tape	0	4 to15	5 to 22	0	1.3 to 3.6	0 to 2	71 to 86	11.6 to 24.6	13.3 to 23.9	63 to 31	quarter to full
PIWs Strobe	0	3	15 to 17	1.0	2.3 to 2.6	1	82	11.5	13.6	30 to 16	half
PIW w/Red Safety Lights	0 to 3	15	5 to 15	1 to .9	2 to 4.3	0 to 1	61 to 86	22.2 to 26.0	22.0 to24.0	67 to 19	quarter to 3/4
PIW w/ Orange Chemical Wand	0	10 to 15	7 to 13	0 to .4	2.3 to 3.6	0 to 1	65 to 80	25.0 to 26.0	25.0 to 26.0	59 to 5	quarter to half
PIW w/Personnel Marker Light	0	15	5 to 10	.2 to .4	5.2 to 6.2	0	63 to 69	21.1 to 21.5	20.8 to 22.2	47 to 57	full

Where both SRU types searched for the same target type, data were analyzed to determine whether a statistically significant difference existed between the detection performance of the two SRU types. For the small boat, raft with retroreflective tape, and persons in the water (PIW) targets no significant difference existed at the 90-percent confidence level.

Lateral range plots and sweep width estimates were developed for each data set with sufficient data to support this detailed analysis. Sweep widths and NVG correction factors from daytime sweep width tables were calculated for each significant environmental condition in an SRU/target type combination. These are summarized in table 2.

An analysis of detections by crew position resulted in the following trends.

1. For all target types, the copilot position (left seat) made more detections than the pilot position (right seat) for all of the data sets. This difference is consistent across all target types and suggests a degraded pilot search capability that is due, in part, to the pilot having primary responsibility for flying the aircraft.

2. In the aft section of the helicopter the flight mechanic usually searched through an open door with a wide field of view and no glass to reflect light, and therefore made more detections overall than either the rescue swimmer position or the avionics position.

Table 2. Sweep Width Correction Factors for NVG Nighttime Searches by Helicopters

TARGET TYPE	SWEEP WIDTH (W) (nmi)	NIGHT CONDITIONS	DAYLIGHT CORRECTION CONDITIONS	CORRECTION FACTOR
Small Boats (15 to 25 feet)	0.9	visibility ≤ 8 nmi	Weather and aircraft speed	0.4
		visibility > 8 nmi		
	0.7	no moon	Weather and aircraft speed	0.2
	1.3	moon	Weather and aircraft speed	0.4
Life Rafts with Retroreflective Tape	0.6	no moon	Weather and aircraft speed	0.5
	0.9	moon	Weather and aircraft speed	0.5
Life Rafts without Retroreflective Tape	0.4	no moon	Weather and aircraft speed	0.3
	0.8	moon	Weather and aircraft speed	0.5
Unlighted PIW with Retroreflective Tape	0.3	H_S <= 3 feet	Weather and aircraft speed	2.0
	0.1	H_S > 3 feet	*	0.5
PIW with Green PML	N/A	all conditions	**	N/A
PIW with Red Safety Light	1.3	no moon	Aircraft speed	6.0
	0.3	moon	Aircraft speed	2.0
PIW with "Firefly" Strobe	N/A	all conditions	***	N/A

* A sweep width of 0.1 nmi was calculated for PIW targets in seas > 3 feet. NVG searches may be difficult to perform.

** NVGs should not be used when searching for a PIW with a green PML.

*** For strobe light equipped targets, set sweep width equal to the visibility or the distance to the visible horizon.

2. Conclusions

1. Glare from interior and exterior lights on the helicopter windows is a constant problem. On hazy or foggy nights, the reflection from the helicopter's exterior anti-collision lights made detection difficult (they caused a grainy affect with the NVGs, making it difficult to see targets at any distance).

2. The presence of a visible moon significantly enhanced the NVG detection performance against unlighted targets; however a bright moon or strong artificial lighting (i.e. shore lights) can inhibit detection performance for lighted targets against a dark background.

3. The presence of moon or artificial light within the field of view generally degrades the NVG detection performance against all targets.

4. Illumination of targets by a "Firefly" strobe light or similar device greatly improved NVG target detectability even in poor visibility.

5. Based on a small data set in well moon lighted conditions, energizing the HH-60J nose light at a dim setting greatly enhanced target detection performance.

RECOMMENDATIONS

1. Sweep width correction factor recommendations from the daytime sweep width tables for nighttime searches with NVGs are given in table 2. Corrections to daylight sweep width for fatigue, SRU speed, and weather should be applied where indicated in the table.

2. Search patterns should be oriented to minimize the time spent searching toward bright light sources. The major axis of a parallel search and the minor axis of a creeping line search should be oriented so the aircraft nose or tail is pointed at the major light source.

3. Mariners and life raft/safety device manufacturers should be notified of the improved detection performance achieved when searching for lighted targets, and they should be encouraged to use lights on items that may end up as search objects.

4. Crews on helicopters conducting NVG searches should, weather permitting, search with the cabin windows and cabin door open thereby eliminating reflective glass glare.

5. Mariners should be advised not to energize chemical lights until a possible rescue unit is visible or audible to them because of the rapid decline in intensity of the chemical lights with time.

6. The Coast Guard HH-65A helicopter should be evaluated to determine its usefulness during NVG searches.

7. Sources of NVG-compatible illumination should be evaluated on surface and air SRUs, particularly against targets that are not equipped with lights. These targets should include those both with and without retroreflective materials.

8. Additional information should be gathered to support conclusions about HH-60J search performance made in this report. Specifically, and in order of preference:

   - Unlighted PIW targets with significant wave heights below 3 feet,
   - Small boat and life raft data with significant wave heights below 3 feet, and
   - PIW targets illuminated with either the red safety light or "Firefly" strobe light.

ACKNOWLEDGMENTS

The authors would like to thank the many individuals from the numerous Coast Guard units that participated in this research effort. During the seven field experiments involving helicopters, nearly 200 people participated actively as lookouts, observers, and staff. In particular, we would like to acknowledge the personnel from the following units, without whom the operational field experiments would not have been possible; Air Station Traverse City, Air Station Cape Cod, Air Station Miami, Air Station Clearwater, ATC Mobile, Station Fort Fierce, FL, Station Montauk, NY, Station New London, CT, and Station Point Judith, RI. We extend our special thanks to the personnel from the Watch Hill Lighthouse Keepers Association, Station Fort Pierce, FL, and Aids to Navigation Team New Haven, CT, for providing logistical support during the field experiments. The crews of the R/V Osprey, R/V Uconn, M/V Big "D", and F/V Quranbaug Queen deserve recognition for their assistance in target and environmental buoy deployments/recoveries during the experiments.

We also extend our appreciation for the services provided by Mr. A. Allen, LCDR M. Lewandowski, and Mr. T. Parker in preparation and deployment services for the environmental buoy; Mr. M. Couturier and Mr. D. Brennan for Command and Control operations during the field tests; Mr. G. Reas for his expertise in servicing and maintaining the electrical equipment and the night vision goggles; Mr. S. Ricard, Mr. R. Marsee, Mr. D. Raunig, Mr. C. Oates, and Mr. T. Noble who provided field and target support.

We would like to acknowledge the advice and critical review provided by Dr. David Paskausky during the planning and analysis phases of these experiments.

We would also like to thank the many other personnel from the Coast Guard R&D Center, and Analysis & Technology, Inc., who supported this research effort.

CHAPTER 1
INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This report documents the U.S. Coast Guard Research and Development (R&D) Center evaluation of night vision goggles (NVGs) for search and rescue (SAR) missions. Eight experiments have been conducted in support of this evaluation: four in Fort Pierce, Florida; three in Block Island Sound off the Connecticut/Rhode Island/New York coasts; and one on Canso Bank, Nova Scotia.

This report is the sixth in a series of reports that provide information to the Coast Guard on the effectiveness of NVGs during SAR missions. Data were collected from operational Coast Guard search and rescue units (SRUs) for target types that can be expected to be search objects during actual SAR missions. Data on several environmental factors were collected and examined to determine the affect of the factors on the NVG-equipped lookout detection performance. Analyses were conducted on SRU/target data sets for which sufficient data were collected. Reference 1 presents the results of analyses conducted on the data collected during the first seven experiments.

This evaluation of NVGs is part of the R&D Center Improvement of Search and Rescue Capabilities (ISARC) Project. The project objectives are to improve the detection of SAR related objects through improved techniques of drift prediction, visual search, electronic search, and search planning. Other objectives are to improve estimates of the probability of search success, to develop improved SAR techniques and equipment, and to improve post mission analysis. Specific objectives of the NVG evaluations are to:

1. Establish the nighttime SAR capabilities of operational Coast Guard SRUs equipped with NVGs,

2. Develop operationally realistic sweep widths that search planners can use to represent Coast Guard nighttime search effectiveness under a variety of environmental and lighting conditions, and

3. Provide specific guidance on which search techniques should be employed during nighttime searches.

1.2 AN/AVS-6 NIGHT VISION GOGGLE DESCRIPTION

The AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) was evaluated onboard the HH-3F/CH-3E and HH-60J helicopters. The ANVIS NVGs shown in figure 1-1 are helmet-mounted and are designed for use onboard helicopters. These NVGs are designed for use in a broad range of night illumination conditions, including starlight and overcast. They amplify available light to produce a green monochromatic image of the nighttime scene. Because ambient light level varies, the NVG image quality varies; too much or too little light can cause poor image quality.

The ANVIS NVGs have two Generation III image intensifier tubes incorporated into a hinged binocular assembly that can easily be flipped up or down by the aviator. Adjustments for diopter correction, range focus, interpupillary separation, vertical positioning, fore-aft positioning (eye relief), and tilt positioning can be made to suit the individual wearer..

When in use (down position), the binocular assembly is offset from the eyes to allow limited non-NVG peripheral vision. The eyes can also be focused beneath the goggles to view instruments and controls. The ANVIS NVGs are limited to a 40-degree field of view. Peak spectral response is achieved between wavelengths of 0.65 and 0.90 microns and includes visible light from yellow through red and a portion of the near-infrared spectrum. Incorporated into the ANVIS is a "minus blue" instrument light filter that eliminates wavelengths smaller than 0.625 microns (yellow). An automatic brightness control adjusts rapidly to changing illumination conditions. These NVGs severely inhibit depth perception and reduce visual acuity to no better than 20/40.

The ANVIS NVGs used during the R&D Center experiments were manufactured by ITT Electro-Optics Division, Litton Electron Devices, and Varian Corporation. Detailed ANVIS specifications and the principles of operation can be found in references 2 and 3.

Figure 1-1. AN/AVS-6 ANVIS Night Vision Goggles

1.3 EXPERIMENT DESCRIPTIONS

A total of eight experiments, including seven involving helicopters, have been conducted in support of the NVG evaluation effort. The first six established sweep widths for the HH-3E/CH-3E (herein after termed H-3), 41-foot Utility Boats, and 210-foot size vessels. The seventh experiment provided a 1-week performance comparison under similar conditions for the H-3 against the HH-60J (herein after termed H-60), HU-25C, and RG-8A. This seventh experiment indicated the HH-60 and HH-3 may perform similarly during NVG searches. The eighth experiment was conducted to obtain sufficient data on the H-60 to allow a comparison of H-3 and H-60 performance and establish a basis for combining data collected for these SRU types. Reference 1 provides details concerning the dates and locations of the first seven experiments. Sections 1.3.1 through 1.3.6 provide details of NVG experiment setup and conduct.

1.3.1 Participants

All NVG data used in this evaluation were collected during experiments controlled by the Surveillance Systems Branch of the U.S. Coast Guard R&D Center. The R&D Center Project and Test Managers arranged for the primary logistics support. R&D Center personnel were responsible for maintaining a liaison between all Coast Guard and contractor participants and for maintaining top-level control of all experiment communications and data collection activities.

The prime contractor for the Coast Guard was Analysis & Technology, Inc. (A&T). A&T prepared test plans, provided logistics planning support, installed Microwave Tracking System (MTS) equipment, coordinated data collection priorities, and provided data recorders onboard participating SRUs.

HH-3F, CH-3E, and HH-60J helicopters assigned to support these experiments. Air stations Traverse City, MI, Cape Cod, MA, and Clearwater, FL provided the H-3 helicopters. Aviation Training Center (ATC) Mobile, AL provided the H-60 helicopters. Only during the experiment conducted during the Spring of 1991 did two aircraft participate during the same experiment.

1.3.2 Exercise Areas

The exercise area for experiments conducted during the Spring of 1989, 1990, 1991, and 1992 was a 10- by 20-nmi area off the coast of Fort Pierce, FL centered at 27°32.6'N, 80°09.0'W along a major axis of 160 degrees magnetic. Figure 1-2 depicts the Fort Pierce exercise area and indicates the locations of land-based MTS components. SRUs were assigned specific search patterns within this area, which varied in size from 4- by 8-nmi to 10- by 15-nmi, depending on the target and SRU type.

The exercise area for experiments conducted during the Fall of 1989 and 1990 was a 10- by 20-nmi area in Block Island Sound off the CT/RI/NY coasts centered at 41°12.5'N, 71°48.0'W along a major axis of 090 degrees magnetic. Search patterns ranging in size from 4- by 5-nmi to 8- by 12-nmi were assigned in various parts of the exercise area. These search patterns were assigned according to target type, SRU type, and prevailing winds/seas. Figure 1-3 depicts the Block Island Sound exercise area and indicates the locations of land-based MTS components.

In both exercise areas, an operations center was established at the MTS master station location. The operations centers were equipped with all of the computer and communications equipment required to direct data collection activities and record target and SRU position information. These facilities, known as R&D Control, were located at the Sea Palms Condominiums in Fort Pierce during the Spring 1989, 1991, and 1992 experiments; at Watch Hill Light on Block Island Sound during the Fall 1989 and 1990 experiments; and at the Tiara North Condominiums in Fort Pierce during the Spring 1990 experiment. These locations are depicted in figures 1-2 and 1-3.

1.3.3 Targets

Nine types of search targets were used in the NVG evaluations. These targets included 18- and 21-foot small boats, five configurations of simulated persons in the water (PIW), and three configurations of life rafts.

The targets that were deployed without lights include PIW with retroreflective tape-equipped personal flotation devices (PFDs), 4- to 6-person life rafts with and without retroreflective tape, and 18- and 21-foot small boats. The retroreflective tape on the life rafts was applied in accordance with Safety of Life at Sea (SOLAS) specifications.

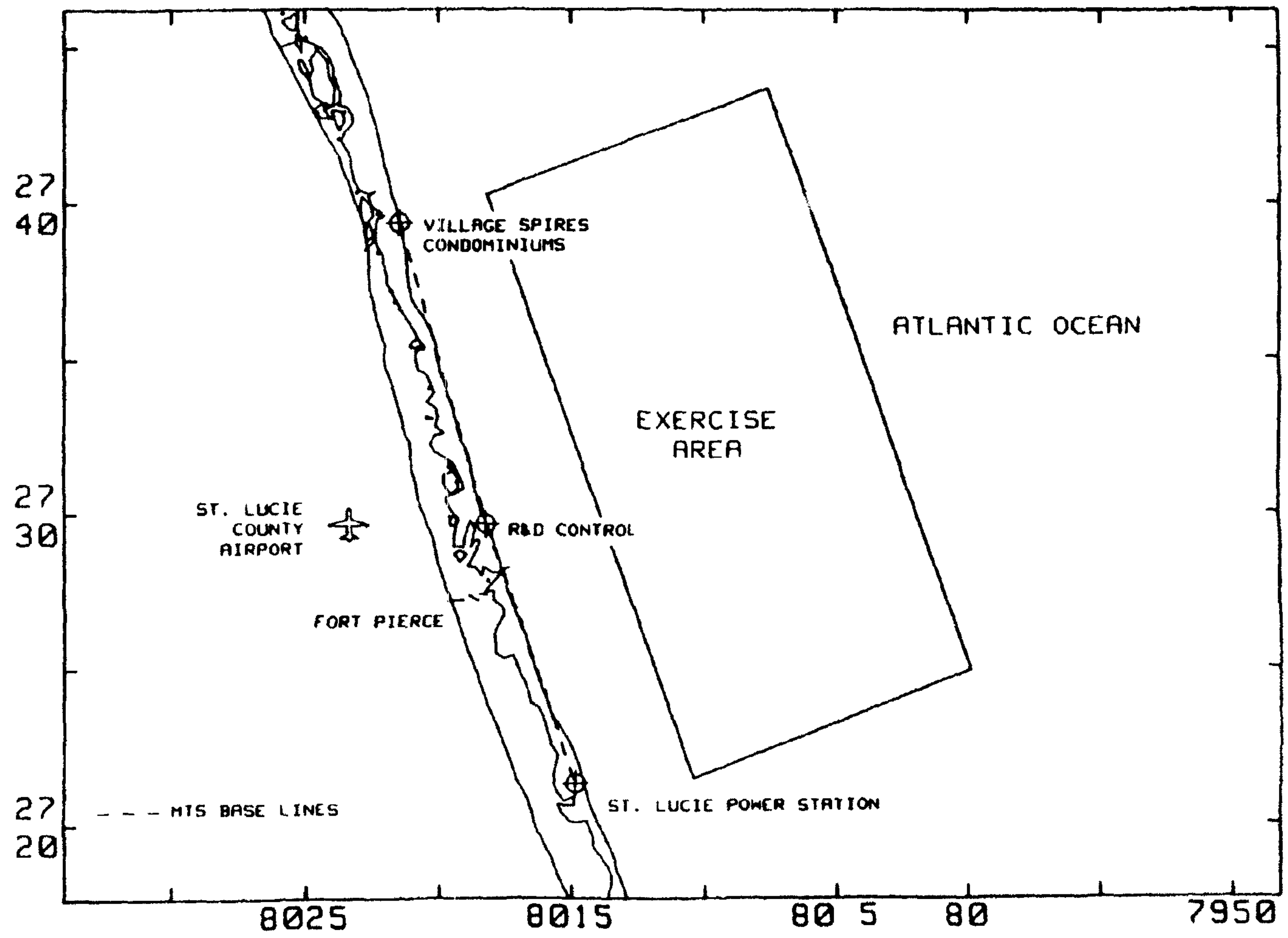


Figure 1-2. Fort Pierce Exercise Area

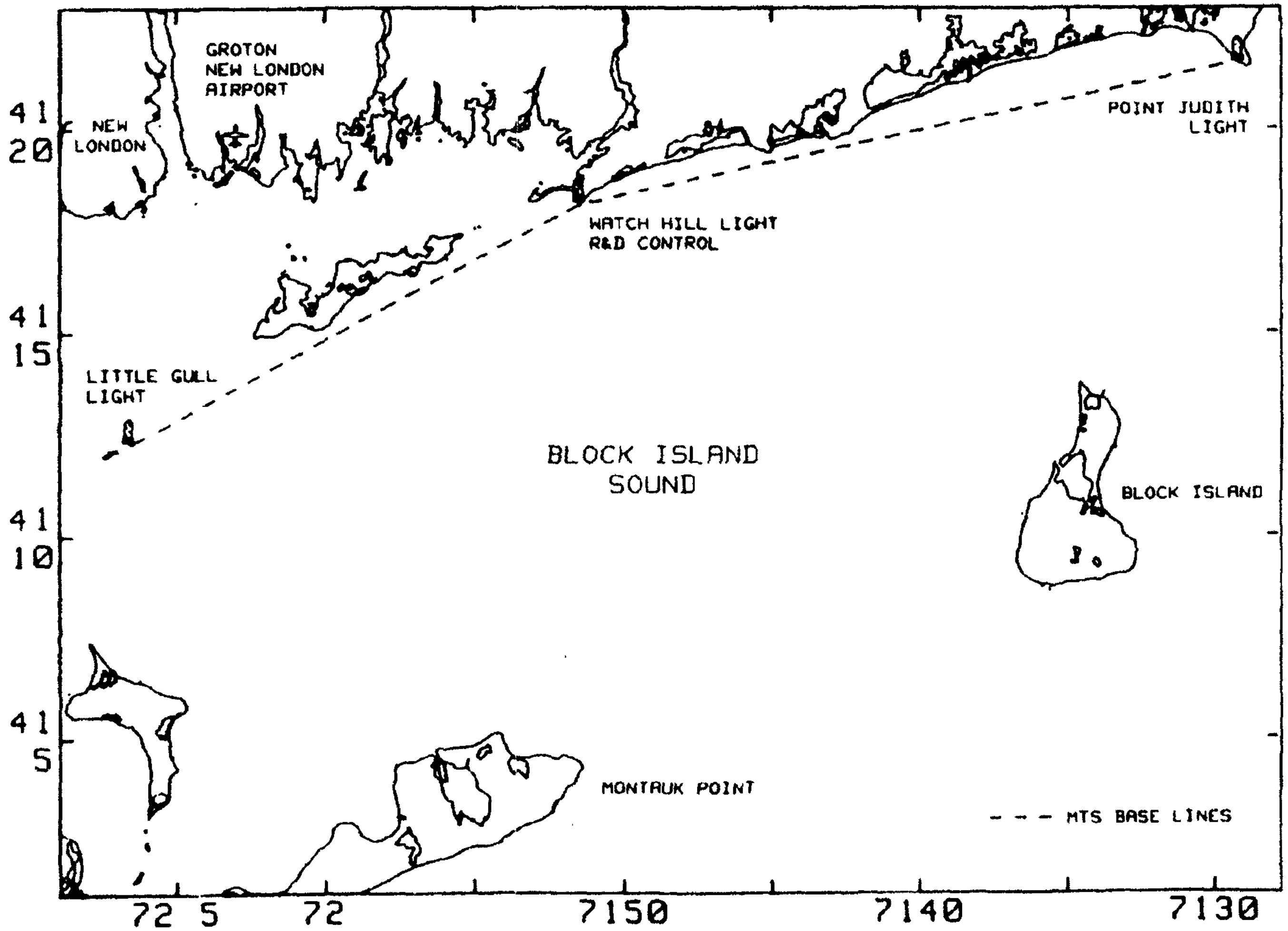


Figure 1-3. Block Island Sound Exercise Area

Some PIW targets were deployed with lights. During some H-3 searches PIW targets were deployed with either a military-issue, 1-second "Firefly" strobe or green, orange, or red chemical lights. The chemical lights were Cyalume devices manufactured by the American Cyanamid Corporation. The green light was a U.S. Coast Guard-issue personnel marker light (PML) (shown in figure 1-4A). The red light was a red safety light stick (shown in figure 1-4B). The orange light wands used appear the same as the red safety light stick and no picture is provided. The brightness of the red and green chemical lights was plotted in arbitrary units as a function of wavelength (see figure 1-5). Two aspects of figure 1-5 are noteworthy. First, most of the PML energy was eliminated by the minus-blue filter on the ANVIS NVGs. Only wavelengths longer than 625 nanometers were intensified by the ANVIS NVGs, making the PMLs nearly impossible to detect. Second, the brightness of both chemical lights diminished rapidly after activation. As a result, there was about a fivefold decrease in peak output after 1 hour. Brightness remained relatively stable for several hours after this time. No data have been obtained for the orange light wands; however, observed light output diminished more quickly than either the red or green chemical lights. Several lights dimmed to the extent that after approximately four hours no light could be seen.

During early experiments target types were not mixed. Once enough data were collected and analysis determined life raft and small boat targets were detected at similar ranges, these targets were deployed together unless rough seas prevented the deployment of the small boat targets. Table 1-1 provides the salient characteristics of targets deployed during these experiments. Figures 1-6 through 1-10 provide representative photographs of all targets.

1.3.4 Lookout Positions

The H-3 helicopters carried either four or five NVG-equipped lookouts. The lookouts included the pilot and copilot, an avionics operator searching through an enlarged window, a flight mechanic searching through the open door, and a rescue swimmer (when onboard) searching through a side window or out the open rear cargo door. The H-60 helicopter carried four NVG-equipped lookouts. The lookouts included the pilot and copilot, an avionics operator searching through an enlarged window, and a flight mechanic searching through the open door.

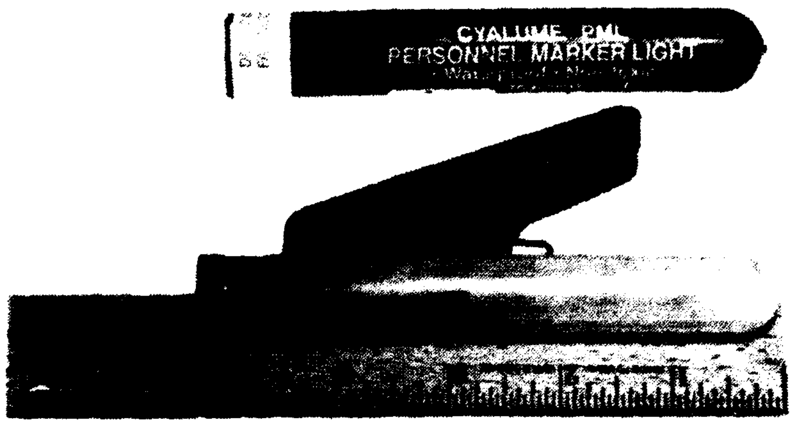


Figure 1-4A. Green Cyalume Personnel Marker Light

Figure 1-4B. Red Safety Light

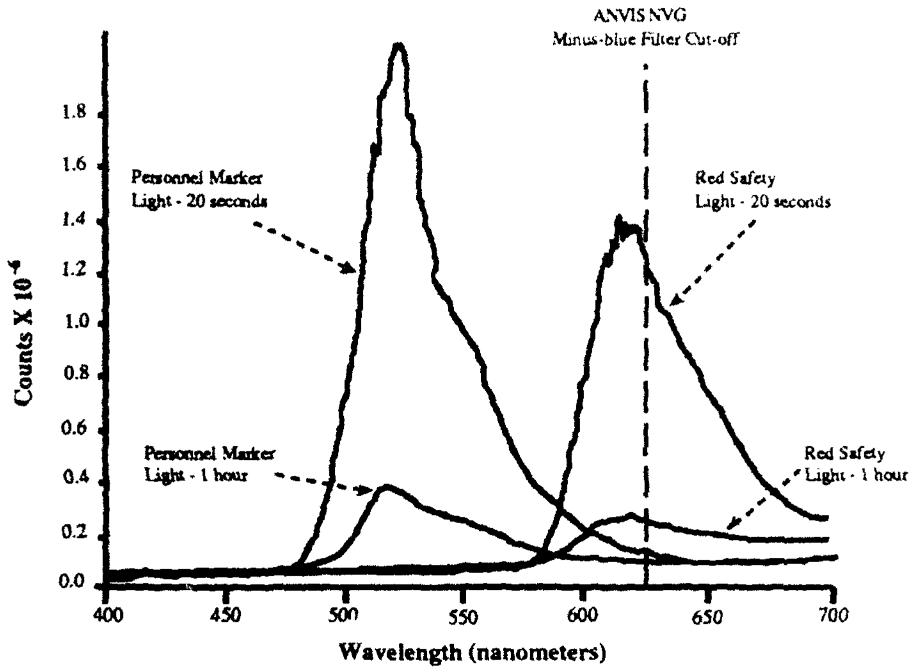


Figure 1-5. Brightness Versus Wavelength and Time for PML and Red Safety Light (U.S. Coast Guard R&D Center Laboratory Measurements)

Table 1-1. NVG Target Descriptions

TARGET	TARGET DESCRIPTION	DIMENSIONS length x beam x freeboard (feet)	PRINCIPAL MATERIAL
PIW *	Department store style mannequin w/type i PFD and retroreflective tape	1.5 x 1 x 1	Plastic
Six-person life raft	Switlik w/orange canopy	8.6 x 5.8 oval x 3.8 ht.	Rubber/ fabric
	Avon or Beaufort w/orange canopy†	7.2 dia. x 3.7 ht.	
	Dunlop w/orange canopy†	9 x 5.5 oval x 3.25 ht.	
Four-person life raft	Avon w/orange canopy†	6 dia. x 3.5 ht.	Rubber/ fabric
	Viking w/orange canopy†	5.5 square x 3.5 ht.	
Small boats	Rectangular white skiff w/console	18 x 7.5 x 1.6	Fiberglass
	Rectangular white skiff w/console, blue canvas bimini, and blue bow shelter canvas	21 x 7.7 x 1.6	

* *Equipped with PML, Orange Light Wand, or Red Safety Light* attached to the PFD with plastic tie wrap.
† Rafts were deployed with or without retroreflective tape.

Figure 1-6. Persons in the Water Target

Figure 1-7. Four-Person Life Raft With Retroreflective Tape Applied in Accordance With SOLAS Specifications

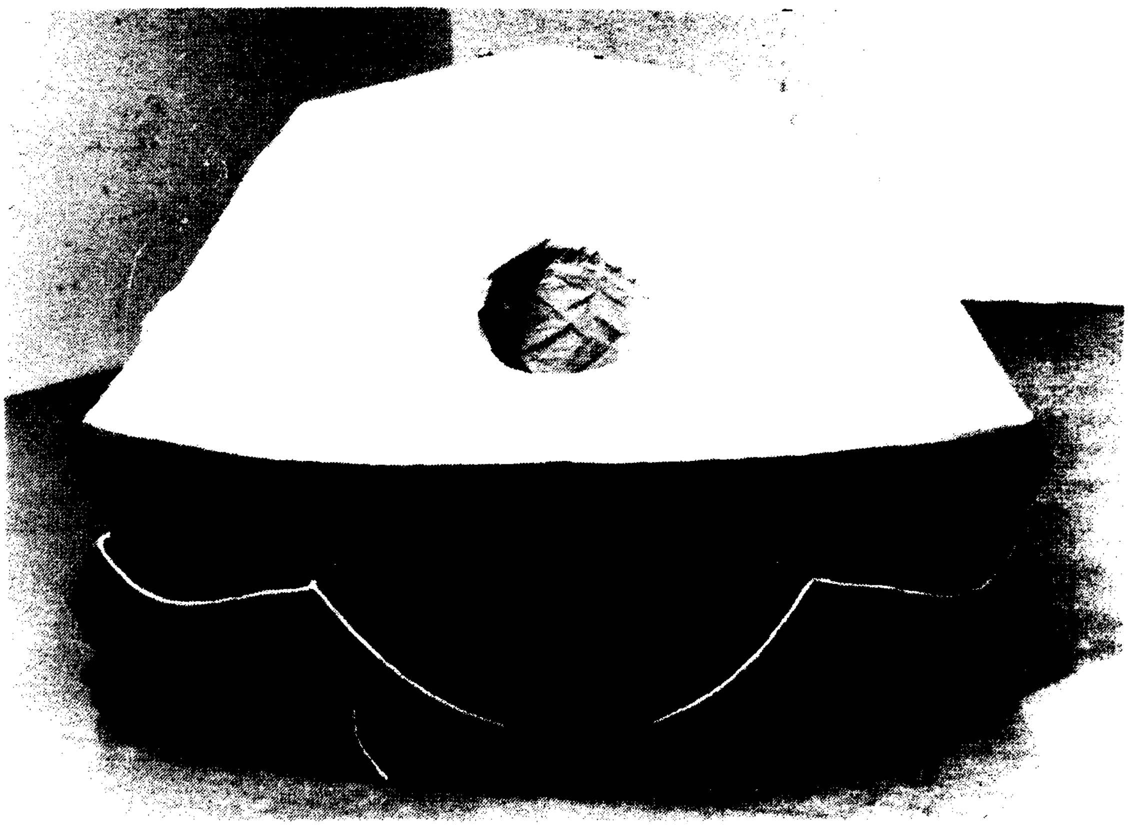


Figure 1-8. Six-Person Life Raft Target Without Retroreflective Tape

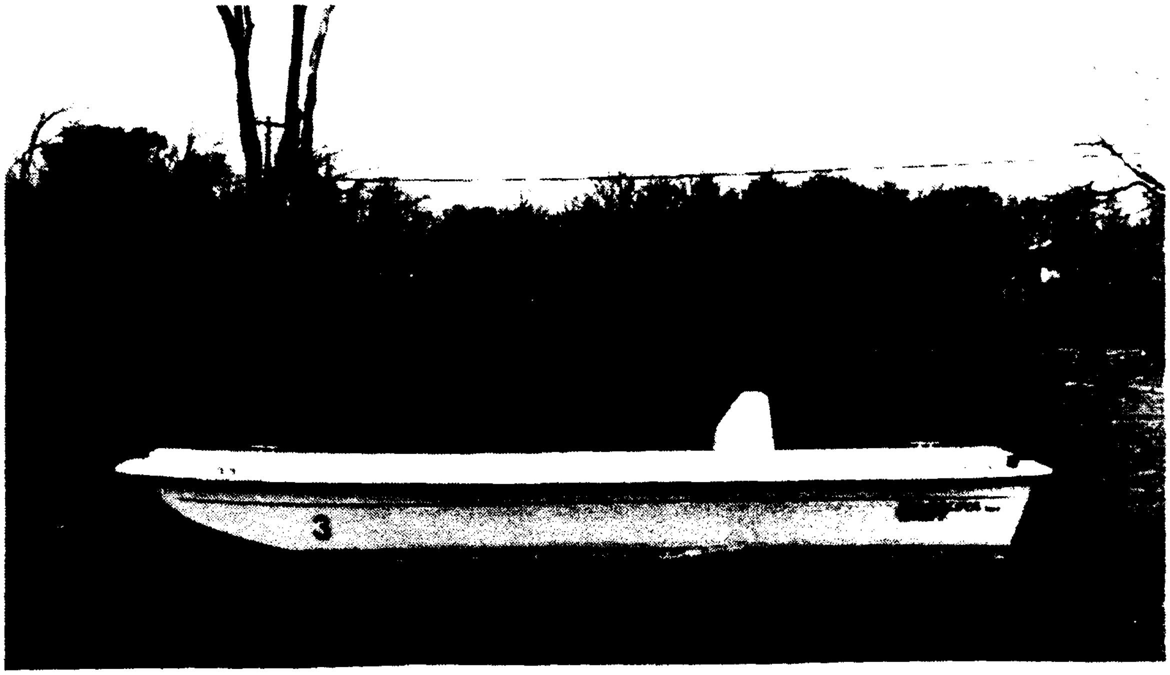


Figure 1-9. Eighteen-Foot Small Boat Target

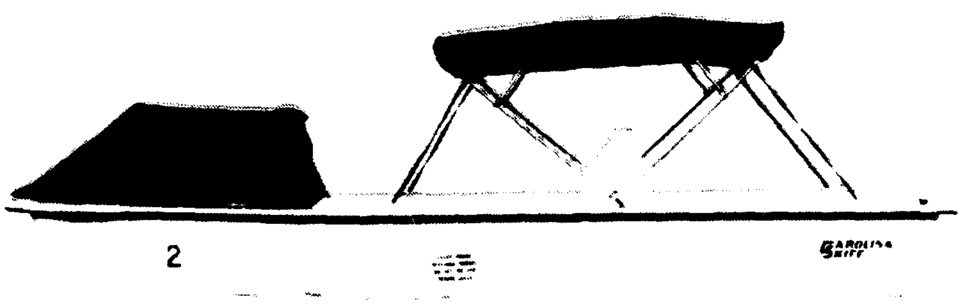


Figure 1-10. Twenty-One Foot Small Boat Target With Canvas

1.3.5 Experiment Design and Conduct

Detection data were obtained by conducting operationally realistic NVG searches using parallel search (PS) and creeping line search (CS) patterns, as defined in reference 4. Track spacing and search area dimensions were chosen to provide the maximum number of target detection opportunities at a variety of lateral ranges without producing multiple target distractions for the lookouts. The helicopters used a 1-nmi track spacing while searching for life rafts, lighted PIWs, and small boats and a 0.5-nmi track spacing while searching for unlighted PIWs. Figure 1-11 illustrates the type of search instructions that were provided to participating SRUs during the experiments. The helicopters searched at a 300-foot altitude and used a 90-knot ground speed for small boat and life raft targets and a 60-knot ground speed for PIW targets.

In the interest of realism, helicopter crews were composed of personnel from the normal complement of their respective air stations. With the exception of some of the helicopter pilots, most of the SRU crew members had little or no operational experience with NVGs. These experience and training levels are representative of what can currently be expected at many U.S. Coast Guard SAR facilities. The crews were encouraged to maintain motivational levels that would prevail during an actual SAR mission and to conduct operations as they normally would, with the exception that the SRU did not divert from the assigned search pattern for the purpose of confirming target sightings. Target confirmation was made through post experiment data analysis. Helicopter crew members wore the ANVIS NVGs while searching and used radar to avoid severe weather.

Targets were anchored within the search area each night and were seldom moved until recovered. SRU crews knew which target type(s) were deployed each night but were never told the target locations and did not know the exact number of deployed targets each night. Crews were told to report any sighting of an object that could conceivably be one of the search targets to an onboard data recorder.

Each night, a data recorder from the A&T field team accompanied each SRU to log target detections, human factors data, and crew comments. Crew information was recorded on the SRU Information Form (figure 1-12). Target detections, crew comments, and general observations were recorded on the NVG Detection Log (figure 1-13).

When a target was sighted, lookouts immediately relayed its relative bearing (as a "clock" position), its estimated range (expressed as a fraction of the distance to the horizon), and a brief description of its appearance to the data recorder. The data recorder then logged the detection time,

Geographic Analysis, Archiving & Display Station
Night Vision Goggles - Block Island Sound

Search Plan No. Creeping Line Search

Center: 41° 12.5 N 71°48 W AXES Major: 120/300°T Minor 030/210°T
START: 41° 11.22N 71°54.35W Right Length: 8.00 nm Track Spacing: 1.00 nm
Speed: 90 kts Time: 00:42 Width: 8.00 nm Track Miles: 63.00 nm
41°11.04 71°55.26 41°17.96 71°49.94 41°13.96 71°40.72 41°07.04
71°46.04

Waypoint	Latitude	Longitude	Course	Range	Cumulative Distance
1	41°11.22N	71°54.35W			
2	41°17.28N	71°49.70W	030°T	7 nm	7 nm
3	41°16.78N	71°48.55W	120°T	1 nm	8 nm
4	41°10.72N	71°53.20W	210°T	7 nm	15 nm
5	41°10.22N	71°52.05W	120°T	1 nm	16 nm
6	41°16.28N	71°47.40W	030°T	7 nm	23 nm
7	41°15.78N	71°46.24W	120°T	1 nm	24 nm
8	41°09.72N	71°50.90 W	210°T	7 nm	31 nm
9	41°09.22N	71°49.75W	120°T	1 nm	32 nm
10	41°15.28N	71°45.09W	030°T	7 nm	39 nm
11	41°14.78N	71°43.94W	120°T	1 nm	40 nm
12	41°08.72N	71°40.59W	210°T	7 nm	47 nm
13	41°08.22N	71°47.44W	120°T	1 nm	48 nm
14	41°14.28N	71°42.75W	030°T	7 nm	55 nm
15	41°13.78N	71°41.64W	120°T	1 nm	56 nm
16	41°07.72N	71°46.29W	210°T	7 nm	63 nm

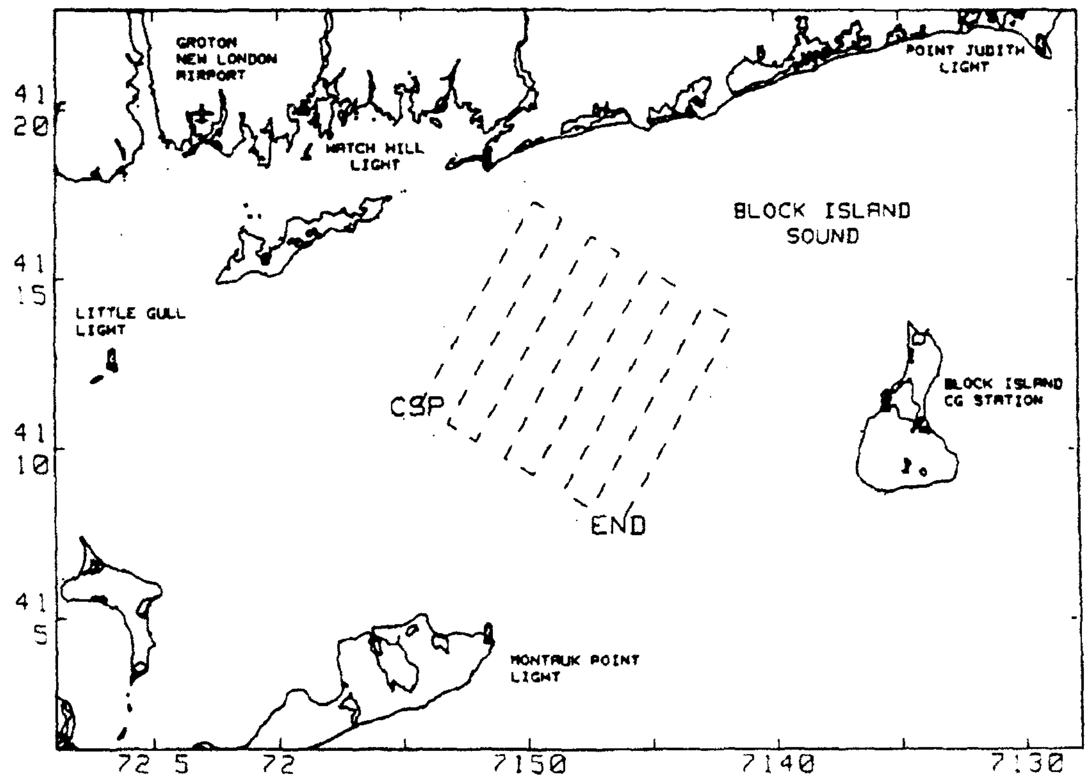


Figure 1-11. Example of Search Instructions Provided to Search and Rescue Units (Life Raft and Small Boat Targets)

SRU INFORMATION FORM

DATE ______________________ MTS TRANSPONDER CODE ______________________

SRU TYPE __________________ SERIAL NUMBER ____________________

COAST GUARD COMMAND ____

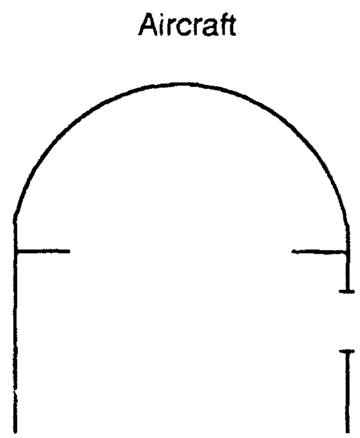
NAVIGATION INPUTS USED
(check all that apply)

TACAN ___ VOR/DME ___ INS ___ LORAN-C ____ RDF ___ RADAR ____ DEAD REC. ____

CREW NAMES

POSITION	NAME	RANK	FUNCTION	EXPERIENCE W/NVG (hr)
A				
B				
C				
D				
E				
F				

SKETCH (show positions)



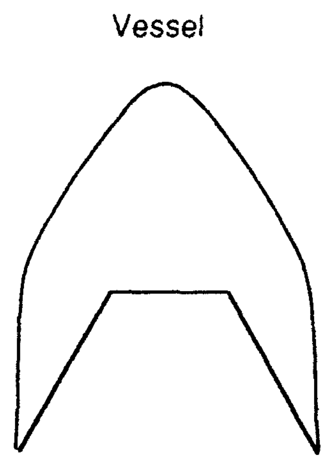


Figure 1-12. Search and Rescue Unit Information Form

NVG DETECTION LOG

AIRCRAFT/BOAT NO. ____________

TRANSPONDER CODE ____________

SEARCH END TIME ____________

SEARCH START TIME ____________

SEARCH DURATION ____________

DATE ____________

SEARCH SPEED ____________

ALTITUDE ____________

EVENT/ DETECTION NO.	TIME (HH:MM:SS)	SIGHTING RANGE (rel. to horiz.)	RELATIVE BEARING (deg/clock)	MOON VISIBLE? (Y/N)	SRU HEADING (deg T or M)	LOOKOUT/ POSITION	(visibility, precip., fog, target appearance, etc.)

RECORDER: ____________

Figure 1-13. Night Vision Goggle Detection Log relative bearing, range, moon visibility, SRU heading, lookout position, and remarks on the NVG Detection Log. Times were synchronized to the nearest second with the MTS computer clock so that detections could be validated during post experiment analysis of the logs and SRU track histories. The data recorders were instructed not to assist with the search effort in any way and did not wear NVGs while recording data.

On-scene environmental conditions were recorded on the Environmental Conditions Summary Form (figure 1-14) by an A&T technician onboard the chartered workboat. The Minimet^{tm} environmental buoy provided additional environmental data. The buoy relayed information to the R&D Control facility over a UHF-FM data link three times per hour. This information was also stored as a backup in an internal memory onboard the buoy.

Figure 1-15 is an example of the data messages received from the Minimet^{tm} buoy. Two of the three hourly messages relayed wind data, water temperature, and air temperature at 10 minutes and 40 minutes past the hour. At 30 minutes past the hour, wave spectrum data including significant wave height (H_S) were relayed. The buoy was the preferred environmental data source when duplicate sets of information (workboat and buoy) were available.

1.3.6 Tracking and Reconstruction

Target locations and SRU positions were monitored using an automated MTS consisting of a Motorola Falcon 492 system controlled by a Hewlett-Packard desktop computer. The controlling software system was developed by the R&D Center to provide real-time positioning and tracking with search reconstruction accurate to better than 0.1 nmi. A mobile MTS transponder was installed on the workboat for use in target positioning and on each SRU so that a track history of each search pattern could be generated. SRU positions were recorded continuously by the MTS, displayed in real time on a computer screen at R&D Control, and recorded on a microcomputer hard disk every 10 to 30 seconds. Target positions were recorded by obtaining an MTS fix on the workboat while deploying and recovering each target, thus verifying that each target position was unchanged. A more detailed description of this system can be found in reference 5.

In the Fort Pierce exercise area, the tracking system recorded the range from a transponder to the MTS master unit located at the top of a high-rise condominium building in Fort Pierce. The tracking system also recorded the range from a transponder to the two relay stations (located on a meteorological tower at the Florida Power and Light Company, St. Lucie Plant, and at the Village Spires condominiums in Riomar). These locations are depicted in figure 1-2. In the Block Island

ENVIRONMENTAL CONDITIONS SUMMARY

REPORTING UNIT ____________ DATE ____________

TIME			CLOUD COVER (tenths)	MOON VISIBLE (Y/N)	VISIBILITY (nmi)	WEATHER DESCRIPTION (clear, rain, fog, etc.)	SEA STATE			RELATIVE HUMIDITY (%)	AIR TEMP (C)	WATER TEMP (C)
	TRUE SPEED (knots)	TRUE DIRECTION (deg M)					H_S *	WHITE CAPS (N/S/M)	SWELL DIR (deg M)			
**METHOD OF MEASUREMENT												

*Significant wave height.

**Note: Method may be scientific (anemometer, radar, psychrometer, etc.) or an estimate. Indicate method used to measure each parameter.

OBSERVER: ____________________

Figure 1-14. Environmental Conditions Summary Form

Z901MET 890927 21 10 045 129 045 045 086 059 178 121 153 259800 439209 00
Buoy #901 - Met. Data - 27 Sep 1989 / 21:10:00
    Vector Wind Speed: 4.5 mps (8.75 knots)
    Vector Wind Direction: 129°M
    Average Wind Speed: 4.5 mps (8.75 knots)
    Average Azimuth Reading: 45°M
    Average Vane Reading: 86°M
    Wind Gust: 5.9 mps (11.47 knots)
    Water Temperature: 17.8°C (64°F)
    Air Temperature: 12.1°C (53.8°F)
    Battery Voltage: 15.3 volts
    Loran Time Delays: 25980 / 43920.9 S/N: 0 C/S: 0
    Latitude/Longitude: 41°12.171'N / 71°47.905'W

1 Z901WAV 890927 21 087 110 104 095 112 113 126 175 174 206 204 239 246
2 Z901WAV 890927 21 239 223 204 206 198 189 193 196 168 189 171 187 205
3 Z901WAV 890927 21 224 241 255 251 245 250 001 004 009
Buoy #901 - Wave Data
    Record #1 - Wave Spectral Values 1 to 13 - 27 Sep 1989 / 21:30:00
      087 110 104 095 112 113 126 175 174 206 204 239 246
    Record #2 - Wave Spectral Values 14 to 26 - 27 Sep 1989 / 21:30:00
      239 223 204 206 198 189 193 196 168 189 171 187 205
    Record #3 - Wave Spectral Values 27 to 32 - 27 Sep 1989 / 21:30:00
      224 241 255 251 245 250
    Scaling Factor: 1
    Significant Wave Height: .4 m (1.3 ft)
    Maximum Wave Period: .9 sec

Z901MET 890927 21 40 051 115 051 045 072 062 178 118 158 259800 43209 00
Buoy #901 - Met. Data - 27 Sep 1989 / 21:40:00
    Vector Wind Speed: 5.1 mps (9.91 knots)
    Vector Wind Direction: 115°M
    Average Wind Speed: 5.1 mps (9.91 knots)
    Average Azimuth Reading: 45°M
    Average Vane Reading: 72°M
    Wind Gust: 6.2 mps (12.05 knots)
    Water Temperature: 17.8°C (64°F)
    Air Temperature: 11.8°C (53.2°F)
    Battery Voltage: 15.8 volts
    Loran Time Delays: 25980 / 43920.9 S/N: 0 C/S: 0
    Latitude/Longitude: 41°12.171'N / 71°47.905'W

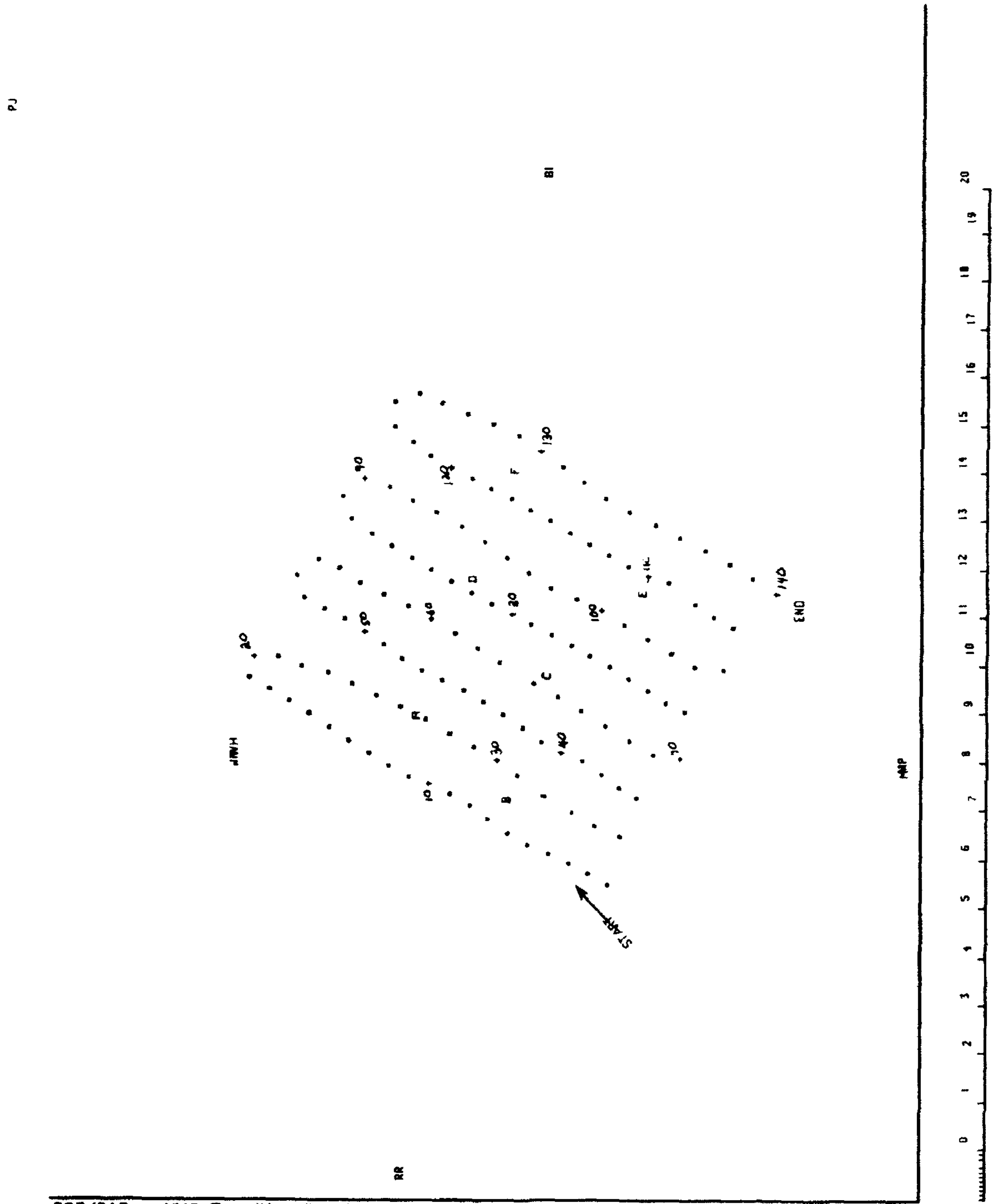
Figure 1-15. Minimet[tm] Environmental Data Buoy Message Formats

Sound exercise area, the tracking system recorded the range from a transponder to the MTS master unit located at Watch Hill Light and from a transponder to the two primary relay stations (located at Little Gull Light and Point Judith Light). These locations are depicted in figure 1-3.

Search tracks and target locations were reconstructed by using the recorded target and SRU position data to generate an accurate geographic representation on hard-copy plots. Figures 1-16 is an MTS-generated reconstruction plot of an actual search that was conducted during the second Block Island Sound experiment. Target positions are plotted using identifying letters, and the SRU track is identified by dots and plus signs. Plotting the SRU position marks created a trackline history for each search craft. Each position mark is associated with a known time on a hard-copy printout that accompanied the plot. Figure 1-16 depicts the CH-3E helicopter execution of the search instructions that were shown in figure 1-11.

Analysts used the tracking system plots and NVG Detection Logs to determine which targets were detected and which were missed during each leg of an SRU search pattern. Normally, a target was considered an opportunity for detection on any given search leg if the SRU passed it within a distance of 1.5 times the maximum lateral range of detection. This rule, although somewhat arbitrary, provided sufficient data to identify an asymptotic limit to the NVG lateral range curve (to be discussed in section 1.4) without adding a large number of meaningless (very long-range) target misses to the data set.

If a logged target report could be correlated with the position of a particular target, it was considered a detection. Analysts performed this correlation by using the time of a given detection in the NVG Detection Log to locate the search craft on the hard-copy tracking system plot. The range and bearing information for the reported detection was then compared to target positions on the tracking system plot. At this point, a detection/nondetection determination was made. A miss was recorded for any target detection opportunity that could not be correlated with a logged detection report on a particular search leg. An accurate lateral range measurement was then recorded for each detection or miss from the closest point of approach (CPA) for each target on each leg. These detections and misses, along with associated search parameters and environmental conditions, were compiled into computer data files for analysis. Data files for this experiment are listed in the appendix to this report.



POD/SAR - NVG Test #3 - Fall 1989 - Block Island Sound
CG9691 (Traverse City, MI CH-3E) - Search 1 - 23 Oct 1989

Figure 1-16. MTS Plot of a Typical Helicopter Search

1.3.7 Range of Parameters Tested

A total of 25 potentially significant search parameters were recorded for each valid target detection opportunity. The parameters can be broadly classified as relating to the target, the SRU, the environment, ambient light, and human factors. The search parameters and their units of measure are as follows.

PARAMETER	UNIT OF MEASURE (See the data Appendix for the description of the numbers in parentheses)	
Target-Related		
1. Target Type/Target Subtype	Life Rafts (2):	with retroreflective tape (-1)
		without retroreflective tape (0)
	Small Boats (1):	18-foot without canvas (0)
		21-foot with canvas (1)
	PIW (3):	unlighted (0)
		strobe (9)
		red safety light (1)
		green PMLs (-1)
2. Lateral Range*	Nautical Miles	
SRU-Related		
3. NVG Type	Helicopters:	AN/AVS-6
4. Search Speed	Knots	
5. Search Altitude	Feet	
Environment-Related		
6. Precipitation Level	None (0)/light (1)/moderate (2)/heavy (3)	
7. Visibility	Nautical Miles	
8. Wind Speed	Knots	
9. Cloud Cover	Tenths of sky obscured	

*See section 1.4.1 for definition.

PARAMETER (Cont'd)	UNIT OF MEASURE (Cont'd)
10. Significant Wave Height	Feet
11. Whitecap Coverage	None (0)/ light (1)/ heavy (2)
12. Relative Wave Direction	Wave fronts traveling into (1)/away from (-1)/across (0) line-of-sight to target at SRU's CPA (if target missed) or at time of detection
13. Relative Humidity	Percent
14. Air Temperature	Degrees Celsius
15. Water Temperature	Degrees Celsius
Ambient Light-Related	
16. Relative Azimuth of Artificial Light	Light source located along (1)/away from (-1)/across (0) line-of-sight to target at SRU's CPA (if target missed) or at time of detection
17. Artificial Light Level	Rural (0)/suburban (1)/urban (2)
18. Moon Elevation	Degrees above or below the horizon
19. Moon Visible (from SRU)	yes (1)/no (0)
20. Relative Azimuth of the Moon	Moon (visible or not) located along (1)/away from (-1)/across (0) line-of-sight to target at SRU's CPA (if target missed) or at time of detection
21. Moon Phase	None, 1/4, 1/2, 3/4, full
Human Factors-Related	
22. Lookout Position†	Location onboard SRU
23. Lookout ID†	Individual identifier
24. Lookout NVG Experience†	Hours
25. Time on Task	Hours (actually searching)

†Items 22 through 24 were recorded for detections only.

A total of 111 individual lookouts have participated onboard helicopters during these experiments. NVG experience ranged from 0 to 758 hours and time-on-task ranged up to 5.7 hours on the longest searches conducted here.

The range of environmental and moon parameters encountered over the seven experiments is summarized in table 1-2.

1.4 ANALYSIS APPROACH

1.4.1 Measure of Search Performance

Sweep width (W) is the primary performance measure used by SAR mission coordinators to plan searches. Because this NVG evaluation is intended to support improved Coast Guard SAR mission planning, sweep width was chosen as the measure of search performance to be developed during data analysis. Sweep width is a single-number summation of a more complex range/detection probability relationship. Mathematically,

$$W = \int_{-\infty}^{+\infty} P(x)\,dx$$

where

W = Sweep Width

x = Lateral range (i.e., CPA) to targets of opportunity (see figure 1-17), and

$P(x)$ = Target detection probability at lateral range x.

Figure 1-18 shows a typical P(x) curve as a function of lateral range. In this figure, x is the lateral range of detection opportunities.

Conceptually, sweep width is the numerical value obtained by choosing a value of lateral range that is less than the maximum detection distance such that scattered targets that are detected beyond the chosen value of lateral range are equal in number to those which are closer than the chosen value of lateral range that are missed. Figure 1-19 (I and II) illustrates this concept of sweep width. The number of targets missed inside the distance W is indicated by the shaded portion near the top middle of the rectangle (area A); the number of targets sighted beyond

Table 1-2. Range of Environmental and Moon Parameters Encountered

TARGET	ENVIRONMENTAL PARAMETERS									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
Small Boats	0 to 1	1.5 to 15	1 to 20	0 to 1.0	1.3 to 6.2	0 to 2	51 to 96	10.4 to 27.0	13.4 to 27.2	-68 to 65	none to full
Rafts w/Retro-tape	0 to 2	5 to 15	2 to 14	0 to 1.0	1.3 to 6.6	0 to 1	50 to 95	15.7 to 27.0	18.4 to 27.2	-66 to 53	quarter to full
Rafts w/out Retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.2	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	69 to 69	none to full
Unlighted PIWs w/Retro-tape	0	4 to 15	5 to 22	0	1.3 to 3.6	0 to 2	74 to 86	11.6 to 24.0	13.3 to 23.9	63 to 31	quarter to full
PIW w/Strobe	0	3	15 to 17	1.0	2.3 to 2.6	1	82	11.5	13.6	30 to 46	half
PIW w/Red Safety Lights	0 to 3	15	5 to 15	.1 to .9	2 to 4.3	0 to 1	61 to 86	22.2 to 26.0	22.0 to 24.0	67 to 19	quarter to 3/4
PIW w/Orange Chemical Wand	0	10 to 15	7 to 13	0 to .4	2.3 to 3.6	0 to 1	65 to 80	25.0 to 26.0	25.0 to 26.0	59 to 5	quarter to half
PIW w/Personnel Marker Light	0	15	5 to 10	.2 to .4	5.2 to 6.2	0	63 to 69	21.1 to 21.5	20.8 to 22.2	47 to 57	full

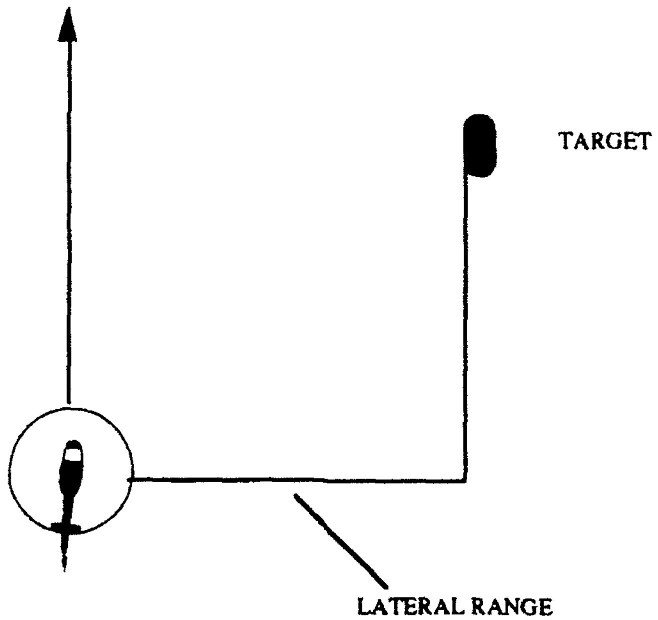


Figure 1-17. Definition of Lateral Range

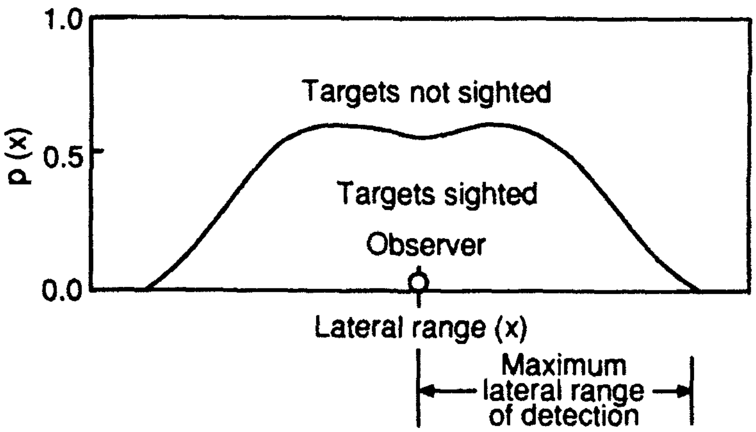


Figure 1-18. Relationship of Targets Detected to Targets Not Detected

the distance W out to the maximum detection range (MAX. R_d) is indicated by the shaded portion at each end of the rectangle (areas B). Sweep width is defined as the lateral range where the number of targets missed equals the number of targets sighted (area A = sum of areas B). A detailed mathematical development and explanation of sweep width can be found in reference 6

1.4.2 Analysis of Search Data

Three primary questions were addressed in this analysis of NVG detection data.

1. Which of the 25 search parameters (identified in section 1.3.7) exerted significant influence on the detection performance of the SRUs against the target types tested?

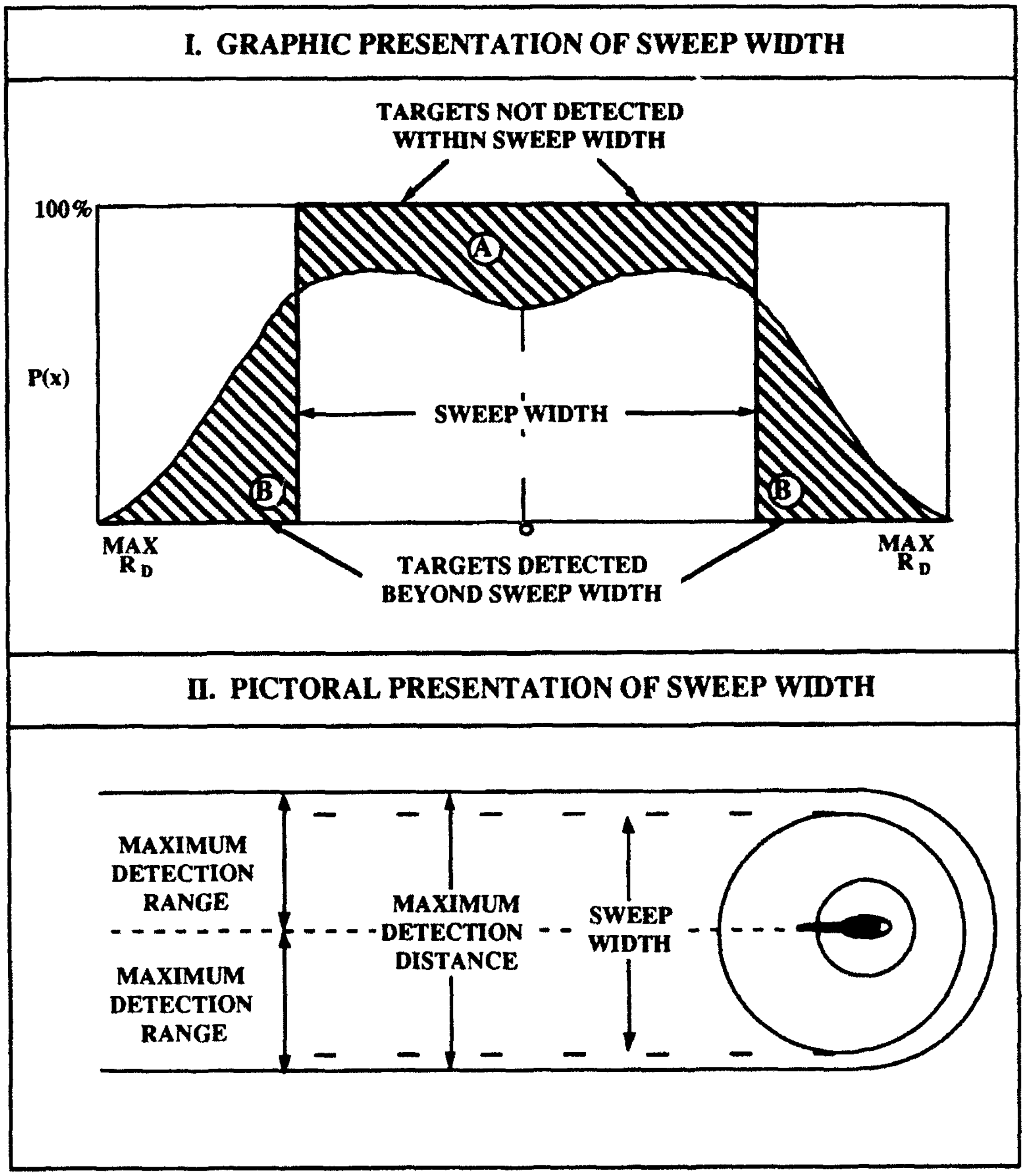


Figure 1-19. Graphic and Pictorial Presentation of Sweep Width

2. What are the NVG sweep width estimates for various combinations of significant parameters identified in question 1?

3. What guidance for NVG use onboard U.S. Coast Guard SRUs can be developed based on the quantitative analysis performed in question 1 and the subjective comments and observations obtained from experiment participants?

1.4.2.1 Development of Raw Data

After each experiment, the tracking system plots and NVG detection logs were used (as described in section 1.3.6) to determine which SRU-target encounters were valid detection opportunities and which of those opportunities resulted in successful target detections. The analyst listed each target detection opportunity on a raw data sheet along with a detection/miss indicator. Values for the 25 search parameters listed in section 1.3.7 were obtained for each detection opportunity that was listed by consulting appropriate logs and environmental data buoy messages. A separate raw data sheet was completed for each search conducted by each SRU. The contents of these raw data sheets were entered into computer data files on an Apple Macintosh IIcx computer using spreadsheet software and then stored on magnetic disk. A separate data file was constructed for each SRU for each night it participated in data collection. Hard copies of the spring 1992 data files are provided in appendix B of this report. One data file was created for each SRU/target type combination to be evaluated. These raw data files served as input to all subsequent data sorting and statistical analysis routines used for this evaluation.

1.4.2.2 Data Sorting and Statistics

Once the raw data files were entered into the computer and verified, basic statistics were obtained to characterize the data sets. A commercial statistics and graphics software package purchased from SYSTAT, Inc. was used to perform this phase of the data analysis.

Various SYSTAT routines were used to produce simple statistics, histograms, and scatter plots showing the range of search parameter values and the combinations present in each data set. The minimum, maximum, mean, and standard deviation values for each search parameter contained in the data sets were obtained to determine the range of search conditions represented in each data set. Histograms showing the distribution of values for various parameters of interest were created to determine which search conditions were well-represented within each data set and which were not. Scatter plots of search parameter combinations that are well represented in each data set were also produced.

After the data sets were characterized in this manner, logistic multivariate regression analysis was used to determine which search parameters exerted a significant influence on NVG detection performance and to develop lateral range curves from which NVG sweep widths could be computed.

1.4.2.3 LOGIT Multivariate Regression Model

Multivariate logistic regression models have proven to be appropriate analysis tools for fitting U.S. Coast Guard visual search data where the dependent variable is a discrete response (e.g., detection/no detection). The detection data from this NVG evaluation were analyzed using a commercially-available software package from SYSTAT, Inc., called LOGIT. LOGIT is an add-on module to the SYSTAT standard statistical analysis and graphics software package.

The LOGIT regression model is useful in quantifying the relationship between independent variables, x_i, and a probability of interest, R (in this case the probability of detecting a target). The independent variables can be continuous (e.g., range, wave height, wind speed) or discrete [e.g., moon visible or not (1 or 0)]. The logistic regression model has proved to be an effective means of identifying statistically significant search parameters and of quantifying their influence on the target detection probability versus lateral range relationship. This functional relationship, commonly referred to as the lateral range curve, provides a basis for computing sweep widths.

The equation for target detection probability that is used in the logistic regression model is

$$R = \frac{1}{1 + e^{-\lambda}}$$

where

R = target detection probability for a given searcher - target encounter,

λ = $a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + ... + a_n x_n,$

a_i = fitting coefficients (determined by computer program), and

x_i = independent variable values.

The method of maximum log-likelihood is employed in the logistic regression model to optimize values of the coefficients a_i. A detailed theoretical development of the logistic regression analysis methodology is given in reference 7.

A logistic regression model has the following advantages over other regression models and statistical methods.

1. The logistic regression model implicitly contains the assumption that $0 \leq R \leq 1.0$; a linear model does not contain this assumption unless it is added, significantly increasing the computational load.

2. The logistic regression model is analogous to normal-theory linear models; therefore, analysis of variance and regression implications can be drawn from the model.

3. The logistic regression model can be used to observe the effects of several independent or interactive parameters that are continuous or discrete.

4. A regression technique is better than nonparametric hypothesis testing, which does not yield quantitative relationships between the probability in question and the values of independent variables.

The primary disadvantages of a logistic regression model are:

1. For the basic logistic regression models, the dependent variable (R) must be a monotonic function of the independent variables. This limitation can sometimes be overcome by employing appropriate variable transforms.

2. The computational effort is substantial, requiring the use of relatively powerful computer resources.

With the advent of more powerful desktop computers, the capability exists to use them to perform multivariate logistic regression analyses on large data sets. The NVG detection data were analyzed on a Macintosh IIcx desktop computer using LOGIT. The LOGIT software (reference 8) uses the maximum log-likelihood method to fit a logistic curve to response data that can be broken down into discrete categories. The influence of various independent explanatory variables on a discrete-choice response can be determined using the LOGIT module. The significance of these explanatory variables as predictors of the response can be evaluated using the output t-statistics.

The LOGIT regression model was used interactively with each data set to arrive at a fitting function that contained only those search parameters found to exert a statistically significant influence on the target detection response. These fitting functions were then solved for representative sets of search conditions to generate lateral range curves. NVG sweep widths were computed from these lateral range curves.

1.4.2.4 Sweep Width Calculations

Sweep width, defined in section 1.4.1, is the measure of search performance used by U.S. Coast Guard search planners. Mathematically, the value of W is determined by computing the area under the lateral range curve. Before NVG sweep widths were computed for this report, the LOGIT analysis presented in section 1.4.2.3 was used with the data set for each SRU/target type combination. This analysis identified search parameters that exerted statistically significant influence on target detection probability. Histograms and scatter plots were then prepared to depict the distribution of the significant parameters identified within each data set. From these histograms and scatter plots, a determination was made as to how the raw experiment data could be sorted into subsets of substantial size. These subsets reflected distinct sets of search conditions. Lateral range curves and sweep widths were then computed for each data subset.

The preceding analysis procedure, and the subsequent process of generating lateral range curves and computing sweep widths, is illustrated in the following example using the helicopter data set for life raft (without retroreflective tape) searches.

STEP 1: Identification of Data Subsets. LOGIT analysis of this data set indicated that, in addition to lateral range, the moon visibility parameter exerted statistically significant influence on target detection probability. The distribution data relative to moon visibility were examined by generating a histogram depicting values of moon visible or moon not visible The histogram was then compared with a scatter plot of the distribution of moon visibility relative to the lateral range of each target detection opportunity. The evaluation of these plots indicated both subsets of data were well represented in the data set. The first set of search conditions was represented by moon not visible, and the second set of search conditions was represented by moon visible.

STEP 2: Generation of Lateral Range Curves. Two lateral range curve equations were generated by inputting the values of moon not visible or moon visible (0 or 1) to the LOGIT generated expression for target detection probability. The two distinct equations that resulted were then plotted for lateral range values between 0 and 2 nmi. This process yielded distinct plots of lateral range versus target detection probability; one for each moon condition as identified in step 1 above.

STEP 3: Calculation of Sweep Widths. Sweep width values were calculated for both sets of moon light conditions by integrating the applicable LOGIT expressions for target detection probability over the limits 0 to 2 nmi. The integral of the two-choice LOGIT function given in section 1.4.2.3 is:

$$A = \frac{1}{a_1} \ln \left(1 + e^{a_1 x_1 + c}\right) \Bigg|_{x_1 = 0 \text{ nmi}}^{x_1 = \text{ selected lateral range limit}}$$

where

A = Area under the LOGIT-fitted curve,

a_1 = Value of the lateral range coefficient determined by the LOGIT regression analysis,

x_1 = Lateral range, and

c = $a_0 + a_2 x_2 + a_3 x_3 + ... + a_n x_n$ for specified values of search parameters $x_2, x_3, ... x_n$. In this example n = 2 with a_2 representing the specified value of the moon visibility coefficient. The values for x_2 is the moon visibility value for each data set.

Sweep width is defined as two times the value of the area A computed above because searching occurs on both sides of the SRU; thus,

$$W = 2A.$$

The methods illustrated in the above example were used with all the SRU/target type combinations for which values of W were computed in this report. Integration limits were selected to include a lateral range interval from 0 nmi to a value well beyond the limits at which any detections were made during the experiments. These limits varied with each SRU/target type combination.

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CHAPTER 2
TEST RESULTS

2.1 INTRODUCTION

A combined total of 3029 target detection opportunities were generated during the eight NVG experiments. Two thousand two hundred and forty-eight from H-3 helicopters and 781 from H-60 helicopters. Table 2-1 summarizes the number of detection opportunities generated by each SRU type for each target type. Sufficient data were collected from each SRU type to permit evaluation of search performance against small boat, raft with retroreflective tape, and unlighted PIW targets. Section 2.2 presents the results of this comparative evaluation. No significant differences in search performance were found. Data for both SRU types are combined for a quantitative analysis of H-3/H-60 helicopter detection performance against each target type and are presented in section 2.3. Section 2.4 provides an evaluation of the human factors that were studied during the NVG experiments.

Table 2-1. Detection Opportunity Summary

TARGET TYPE	SRU TYPE	
	HH-3F/CH-3E	HH-60J
Small Boats	758	126
Life Rafts with Retroreflective Tape	380	321
Life Rafts without Retroreflective Tape	394	7
Unlighted PIWs with Retroreflective Tape	242	186
Unlighted PIWs with Helo Nose Light Energized	N/A	25
PIWs with Orange Chemical Light	N/A	116
PIWs with Red Chemical Light	232	N/A
PIWs with Personal Marker Light	90	N/A
PIWs with "Firefly" Strobe	152	N/A

2.2 COMPARATIVE DETECTION PERFORMANCE

Sections 2.2.1 through 2.2.3 present discussion and detailed analyses of the comparison of HH-3F/CH-3E and HH-60J search performance against small boat, life raft with retroreflective tape, and unlighted PIW targets. These data were evaluated using LOGIT regression analysis as described in chapter 1. A variable 'SRUTYPE' was added to each target detection opportunity to identify whether the opportunity occurred from an H-3 or H-60 helicopter. Analyses were conducted on the data sets using this variable to compare SRU detection performance. Environmental parameters except for significant wave height (H_S) are uniformly distributed over the combined data. Significant wave height experienced during H-60 searches is predominantly above 3-feet and H_S experienced during H-3 searches varies from about 1 foot up. An extract of each target data set was created to evaluate SRU search performance in overlaping H_S conditions.

2.2.1 Small Boats

Eight hundred and eighty-four detection opportunities exist in this data set, 758 from H-3 helicopters and 126 from H-60 helicopters. The mean value of H_S for H-3 searches is 2.6 feet and that for H-60 searches is 3.1 feet. The range of values experienced during H-3 searches encompasses all of the data collected during H-60 searches. Only 43 detection opportunities in the H-3 data set are excluded in this comparison.

Because both the extract of the overlapping data and the entire data set gathered searching for this target type are only different by 43 data points, the result of analyses is the same for both data sets. LOGIT regression analysis indicates that these SRU types performed similarly against small boat targets within a 99-percent confidence level.

2.2.2 Life Rafts with Retroreflective Tape

Seven hundred and one detection opportunities exist in this data set, 380 from H-3 helicopters and 321 from H-60 helicopters. The mean value of H_S for H-3 searches is 3.1 feet and that for H-60 searches is 4.0 feet. The range of values experienced during H-3 searches encompasses all of the data collected during H-60 searches. Only 11 detection opportunities in the H-3 data set are excluded in this comparison.

Because both the extract of the overlapping data and the entire data set gathered searching for this target type are only different by 11 data points, the result of analyses is the same for both data sets. LOGIT regression analysis indicates that these SRU types performed similarly against life raft with retroreflective tape targets within a 99-percent confidence level.

2.2.3 Simulated Persons in the Water

Four hundred and twenty-eight detection opportunities exist in this data set, 242 from H-3 helicopters and 186 from H-60 helicopters. The mean value of H_S for H-3 searches is 2.3 feet and that for H-60 searches is 3.9 feet. Of the 428 opportunities in this data set, 110 are in the region of overlapping H_S values.

In this data set, the extracted data is one quarter of the whole data set. LOGIT regression analysis conducted on the extracted data set indicates that there was no difference in SRU performance against the simulated PIW targets within a 90-percent confidence level. Similar analysis conducted on the entire data set indicates that there was no difference against these targets within a 99-percent confidence level.

Although no statistically significant difference was found in the detection performance of these two aircraft in this data set, no data exist for the H-60 helicopter in lower sea states (below 3 feet). Sections 2.3.4 and 2.4.1 show that the detection performance of the H-3 in the lower seas (below 3-feet) is much greater than that in higher seas (which both aircraft experienced during searches), and approximately 40-percent of those detections were made from the swimmer position (fifth position, which the H-60 does not carry). These facts, and the general comments made by H-60 crews about the discomfort of searching close to the aircraft, indicate that data collection from an H-60 in seas below 3-feet should be done to confirm or contradict the results shown here.

2.3 COLLECTIVE DETECTION PERFORMANCE

Section 2.2 presented a comparative analysis of the H-3 and H-60 helicopter detection performance. From the analysis conducted, there appears to be little difference in the detection performance of these SRUs while searching for the target types discussed. This section will extend the trend exhibited in those results to other target types. H-3 and H-60 data are combined for those target types where both SRU types conducted searches. Lateral range curve plots and sweep width estimates are provided for statistically significant search parameter combinations that are well represented in the raw data. The search parameter combinations selected using LOGIT regression analysis are used to identify the variables that were significant at the 90-percent confidence level. Raw data plots are presented for data subsets that do not have sufficient data to support meaningful sweep width analysis.

The lateral range plots in the following sections show the target lateral range from the SRU trackline along the horizontal axis and the target detection probability along the vertical axis. Figure 2-1 is an example of a lateral range curve plot. The figures expressed as ratios on the plots represent the number of target detections divided by the total number of target detection opportunities occurring within a particular lateral range interval. These ratios correspond to the target detection probability achieved within a particular lateral range interval. Each plotted probability is denoted by a diamond that is located along the horizontal axis at the average lateral range for all detection opportunities occurring within the applicable lateral range interval. A vertical bar through each diamond denotes the 90-percent confidence limits on the plotted detection probability. Fitted lateral range curves, where included, were generated using the LOGIT regression equation discussed in chapter 1 with statistically significant search variables. When a data set was found to contain statistically significant search variables in addition to lateral range, the mean values of these variables within the data set were used as the independent variable paramenters in the LOGIT equation. Each data subset plotted represents a unique combination of significant search variable values.

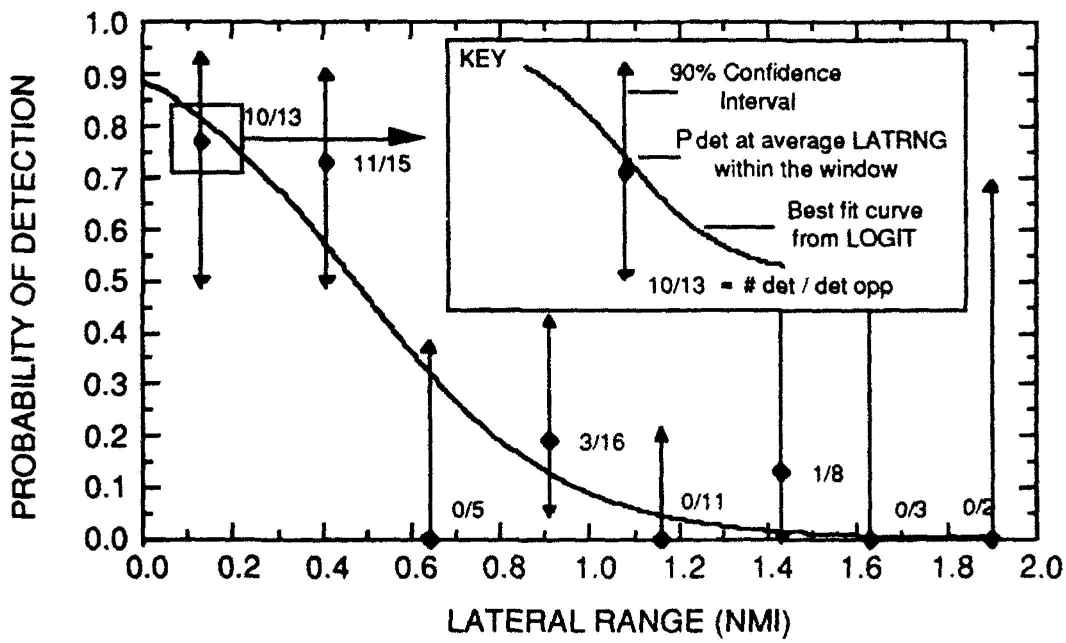


Figure 2-1. Example Lateral Range Curve Plot, 0.25 LATRNG Window

The presence of a natural or artificial light source within the field of view significantly degraded the detection capability of the NVG. The probability of detection decreased for small boat, life raft (with and without retroreflective tape), and PIW targets when the SRU was searching toward a visible moon or shore lights. For those data sets where this relationship existed at the 90-percent confidence limit in the LOGIT model, the relative azimuth parameter was eliminated from the LOGIT-fitted equation on the basis that search plans cannot be based on always searching away from a light source.

Time-on-task was evaluated for its affect on target detection performance. Although crews typically felt their performance deteriorated as the night progressed, in no target type data set was this parameter significant at the 90-percent confidence limit. In the data sets that included targets that were equipped with chemical illumination devices, time-on-task displayed its strongest affect; however, this is believed to be due to the decreased illumination provided by the chemical device over time.

2.3.1 Small Boats

Eight hundred and eighty-four target detection opportunities were generated for this target type data set. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by a combination of the lateral range, visibility, and moon visibility parameters.

After LOGIT analysis, the 884 detection opportunities in this data set were first sorted into 2 levels of visibility (vis <= 8 nmi and vis > 8 nmi); then the higher visibility data set was separated into moon visible and moon not visible. The lower visibility data set is not large enough to separate further. It can be expected that in lower visibility the illumination provided by the moon will be reduced. Each of the data subsets were then sorted into 0.25-nmi lateral range bins. These range bins extended from 0 nmi out to the maximum lateral range of each data subset. The raw data points were then plotted as shown in figures 2-2, 2-3, and 2-4.

The LOGIT-fitted lateral range curves shown in figures 2-2 through 2-4 were produced by solving the LOGIT regression model equation for the mean value of visibility and moon visibility in each data subset. Lateral range curves were generated over a 0- to 4-nmi lateral range interval for the higher visibility and moon visible data set and over a 0- to 2-nmi lateral range interval for the other data sets. Sweep width estimates of 1.3, 0.7, and 0.9 nmi were obtained by integrating the LOGIT fitted equations over the limits of 0 to the plot limit for figures 2-2 through 2-4 respectively.

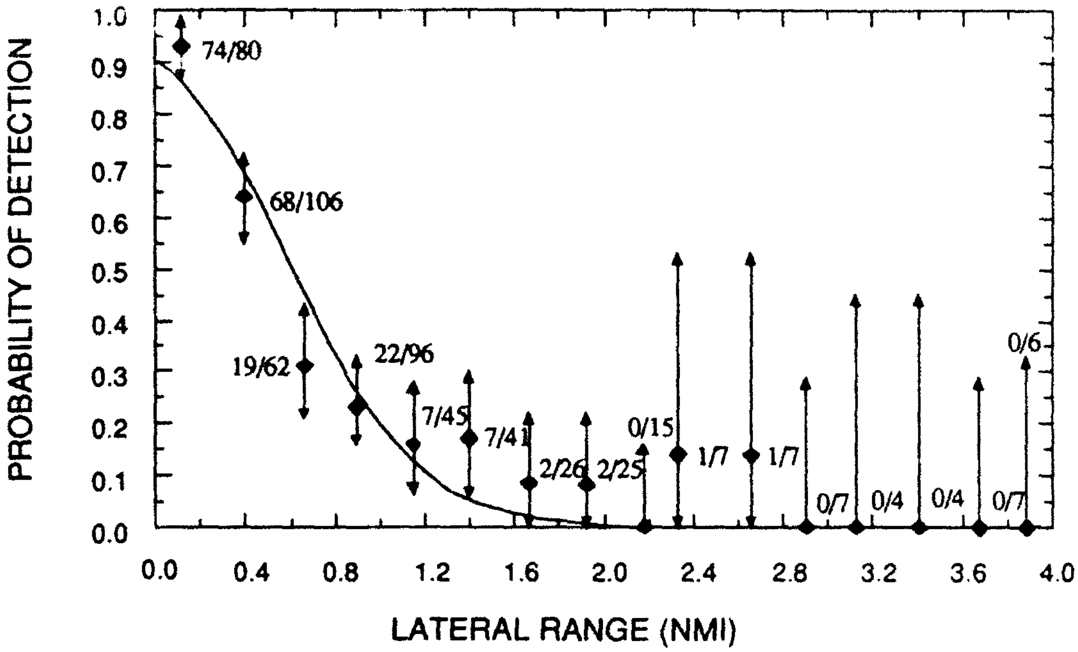


Figure 2-2. Helicopter Detection of Small Boats
(Visibility > 8 nmi and moon visible)

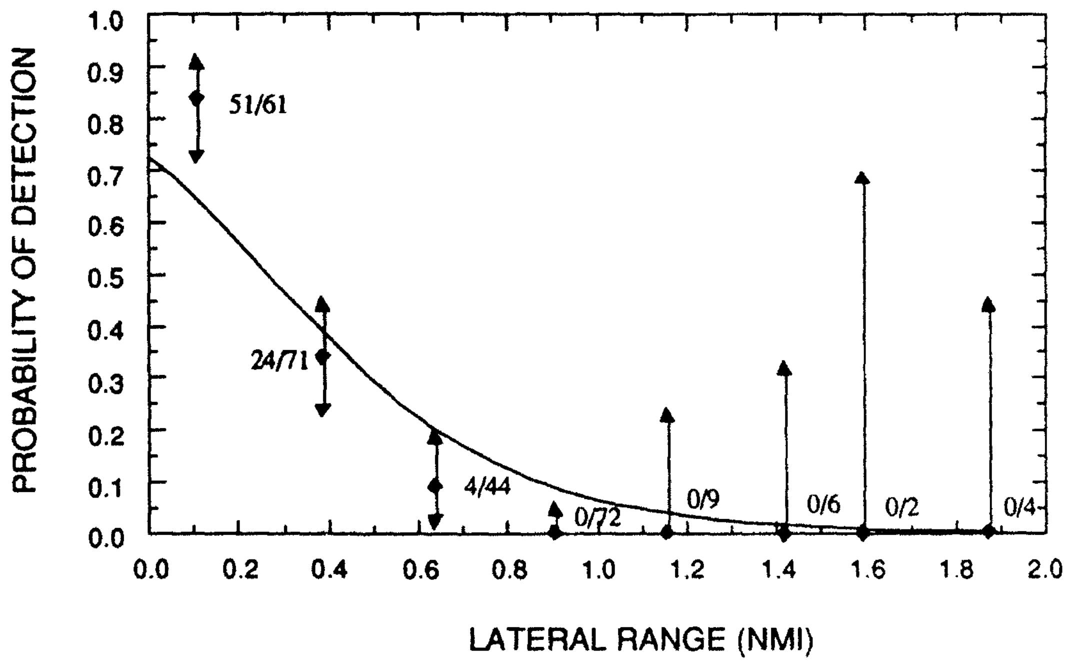


Figure 2-3. Helicopter Detection of Small Boats
(Visibility > 8 nmi and moon not visible)

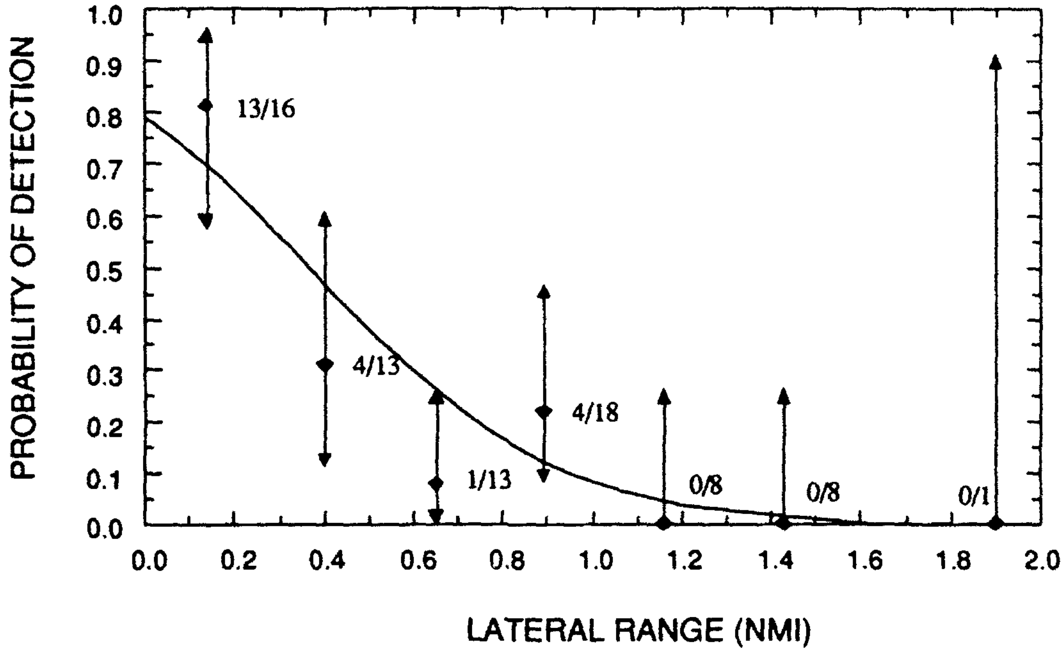


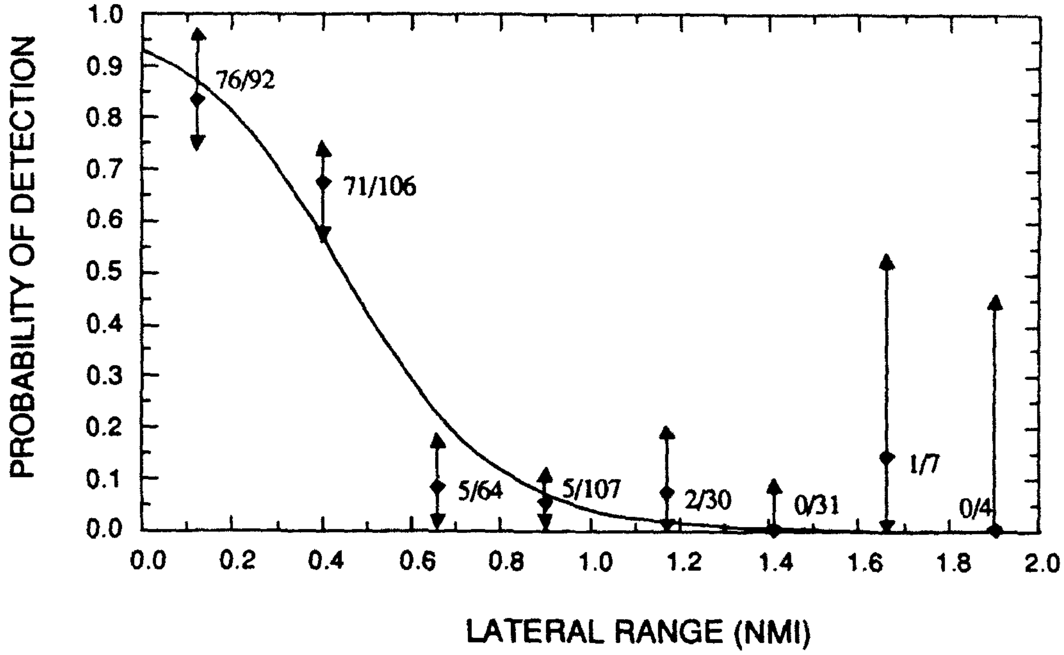
Figure 2-4. Helicopter Detection of Small Boats
(Visibility <= 8 nmi and all moon conditions)

2.3.2 Life Rafts With Retroreflective Tape

Seven hundred and one target detection opportunities were generated for this target type data set. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by a combination of the lateral range and moon visibility parameters.

After LOGIT analysis, the 701 detection opportunities in this data set were sorted into moon visible and moon not visible data sets. Both data subsets were then sorted into 0.25-nmi lateral range bins. These range bins extended from 0 to 2.0 nmi. The raw data points were then plotted as shown in figures 2-5 and 2-6.

The LOGIT-fitted lateral range curves shown in figures 2-5 and 2-6 were produced by solving the LOGIT regression model equation for moon visible and moon not visible. Lateral range curves were generated over a 0- to 2-nmi lateral range interval. Sweep width estimates of 0.9 and 0.6 nmi were obtained by integrating the LOGIT fitted equations over the limits of 0 to 2 for figures 2-5 and 2-6 respectively.



There are 13 missed detection opportunities beyond 2.0-nmi that are not included here.

Figure 2-5. Helicopter Detection of Life Rafts With Retroreflective Tape (moon visible)

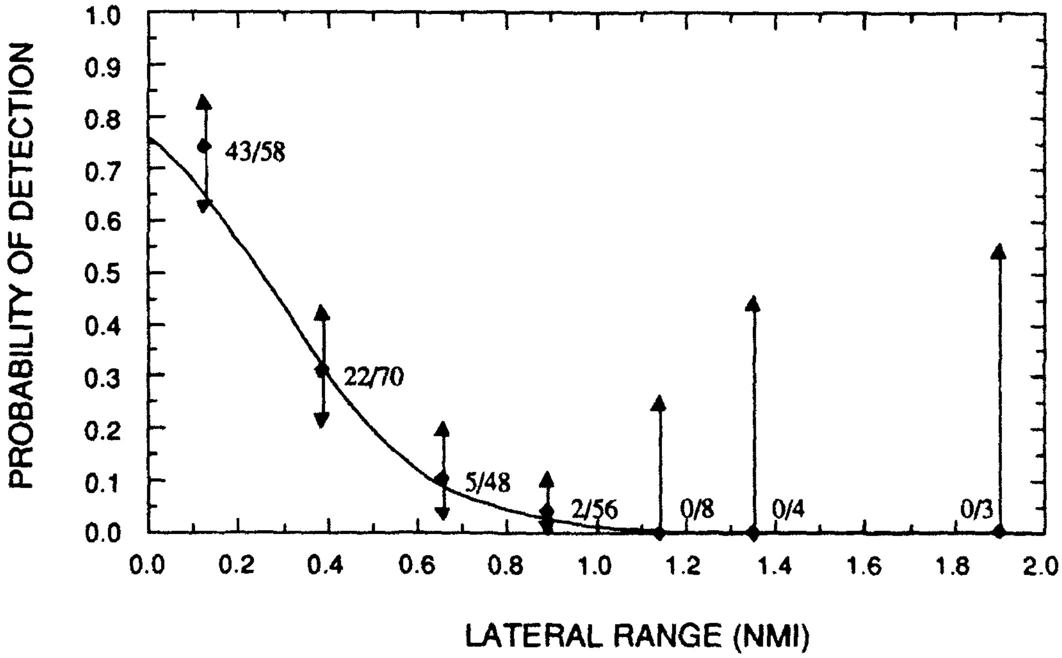


Figure 2-6. Helicopter Detection of Life Rafts With Retroreflective Tape (moon not visible)

2.3.3 Life Rafts Without Retroreflective Tape

Four hundred and one target detection opportunities were generated for this target type data set. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by a combination of the lateral range and moon visibility parameters.

After LOGIT analysis, the 401 detection opportunities in this data set were sorted into moon visible and moon not visible data sets. Both data subsets were then sorted into 0.25-nmi lateral range bins. These range bins extended from 0 to 2.0 nmi. The raw data points were then plotted as shown in figures 2-7 and 2-8.

The LOGIT-fitted lateral range curves shown in figures 2-7 and 2-8 were produced by solving the LOGIT regression model equation for moon visible and moon not visible. Lateral range curves were generated over a 0- to 2-nmi lateral range interval. Sweep width estimates of 0.4 and 0.8 nmi were obtained by integrating the LOGIT fitted equations over the limits of 0 to 2 for figures 2-7 and 2-8 respectively.

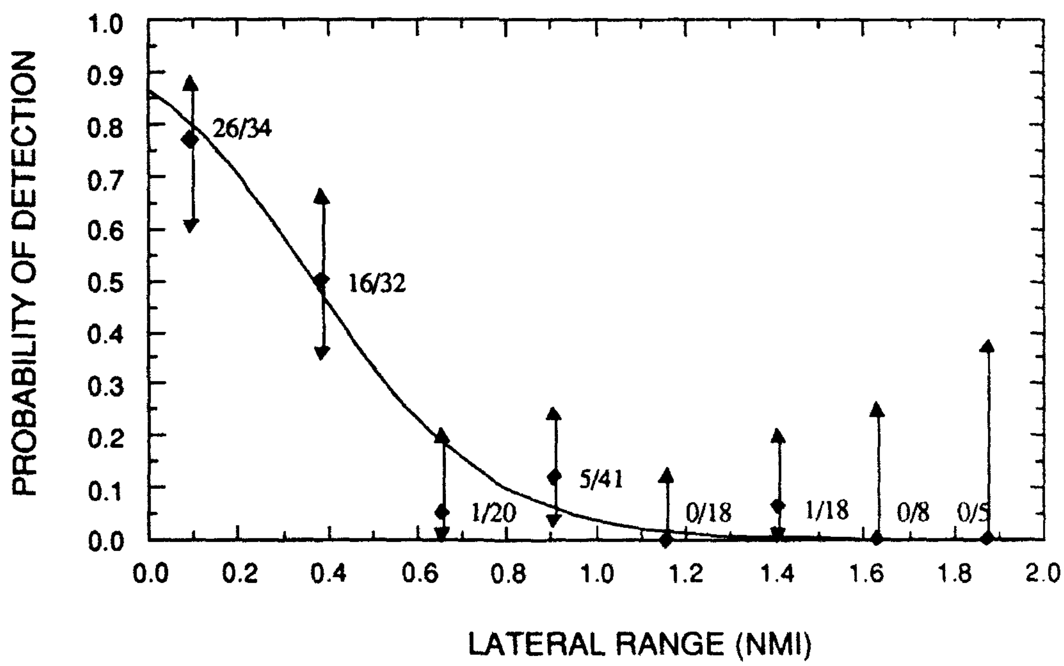


Figure 2-7. Helicopter Detection of Life Rafts Without Retroreflective Tape (moon visible)

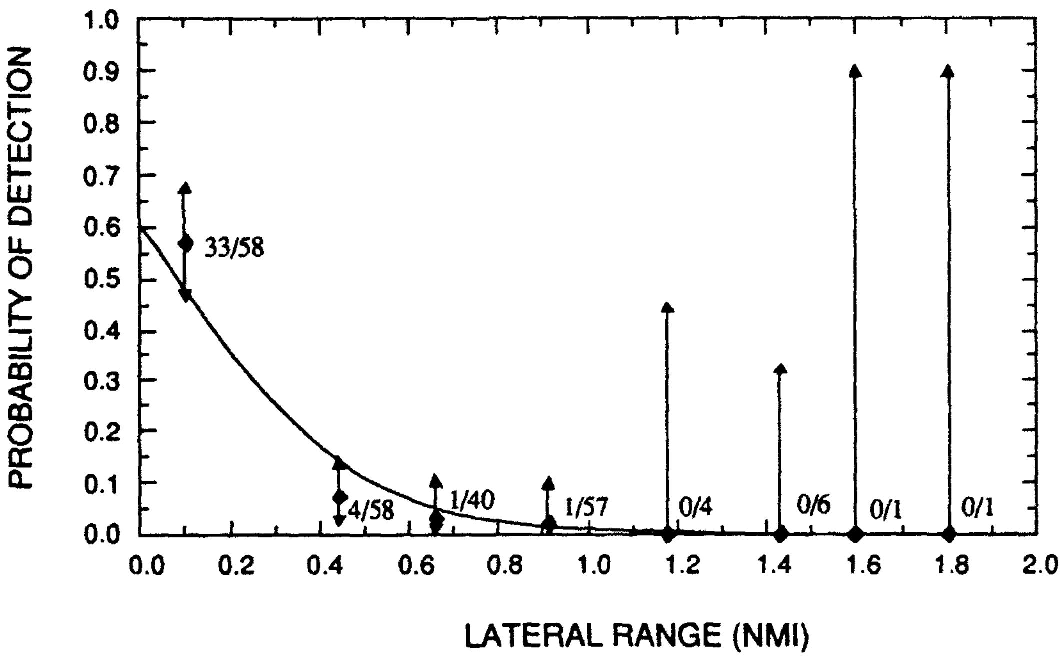


Figure 2-8. Helicopter Detection of Life Rafts Without Retroreflective Tape (moon not visible)

2.3.4 Unlighted Persons in the Water

Four hundred and twenty-eight target detection opportunities were generated for this target type data set. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by a combination of the lateral range and H_S parameters. In reference 1, visibility was found to have the largest affect on target detection probability; however, the large quantity of higher H_S data added during the H-60 searches in the spring of 1992 provided sufficient range and quantity to result in the use of H_S as the parameter most significantly affecting sweep width.

After LOGIT analysis, the 428 detection opportunities in this data set were sorted into H_S <= 3 feet and H_S > 3 feet data sets. Both data subsets were then sorted into 0.1-nmi lateral range bins. These range bins extended from 0 to 2.0 nmi. The raw data points were then plotted as shown in figures 2-9 and 2-10.

The LOGIT-fitted lateral range curves shown in figures 2-9 and 2-10 were produced by solving the LOGIT regression model equation by using the mean value of H_S in the $H_S <= 3$ feet and $H_S > 3$ feet data sets. Lateral range curves were generated over a 0- to 1-nmi lateral range interval. Sweep width estimates of 0.3 and 0.1 nmi were obtained by integrating the LOGIT fitted equations over the limits of 0 to 1 for figures 2-9 and 2-10 respectively.

In figure 2-9, the pronounced dip in target detection probability data at 0-nmi lateral range is likely due to these targets passing directly under the aircraft. The aft crew members did not have the opportunity to detect these targets, leaving only the pilots with a detection opportunity.

During the spring of 1992, an HH-60J helicopter conducted two searches for PIW targets with the nose light energized. Although the values for H_S in this small data set are above 3 feet, the detection probabilities achieved are similar to those achieved in the lower H_S ($H_S <= 3$ feet) data set. Figure 2-11 provides the probability of detection versus lateral range plot for these data.

No LOGIT-fitted lateral range curve has been developed for figure 2-11. Insufficient data exist to support generation of a LOGIT-fitted lateral range curve.

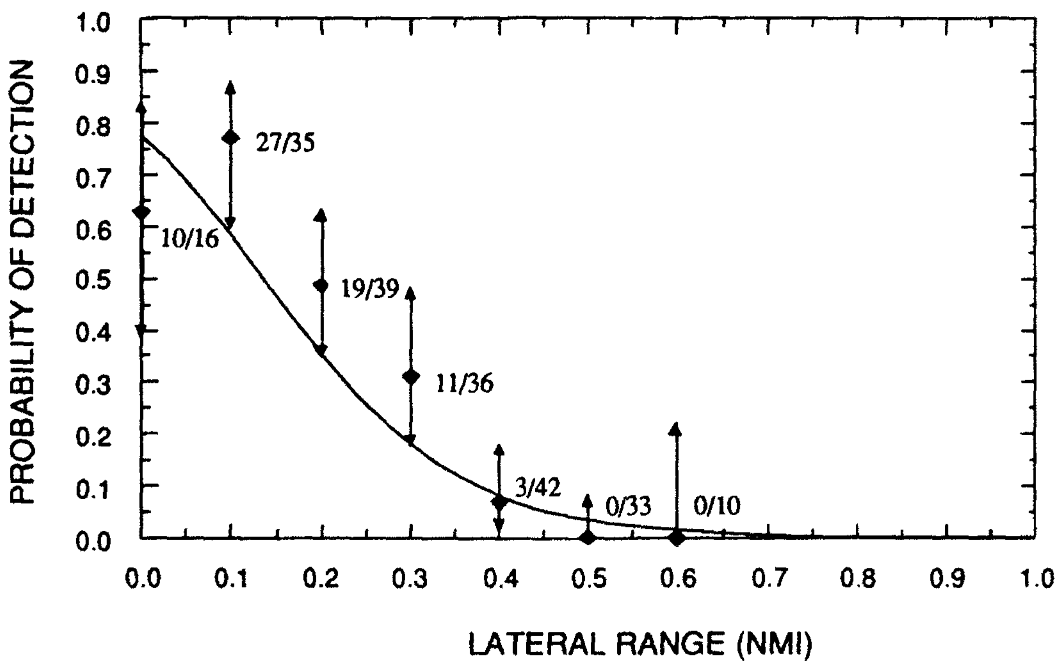


Figure 2-9. Helicopter Detection of Unlighted Persons in the Water ($H_S <= 3$ feet)

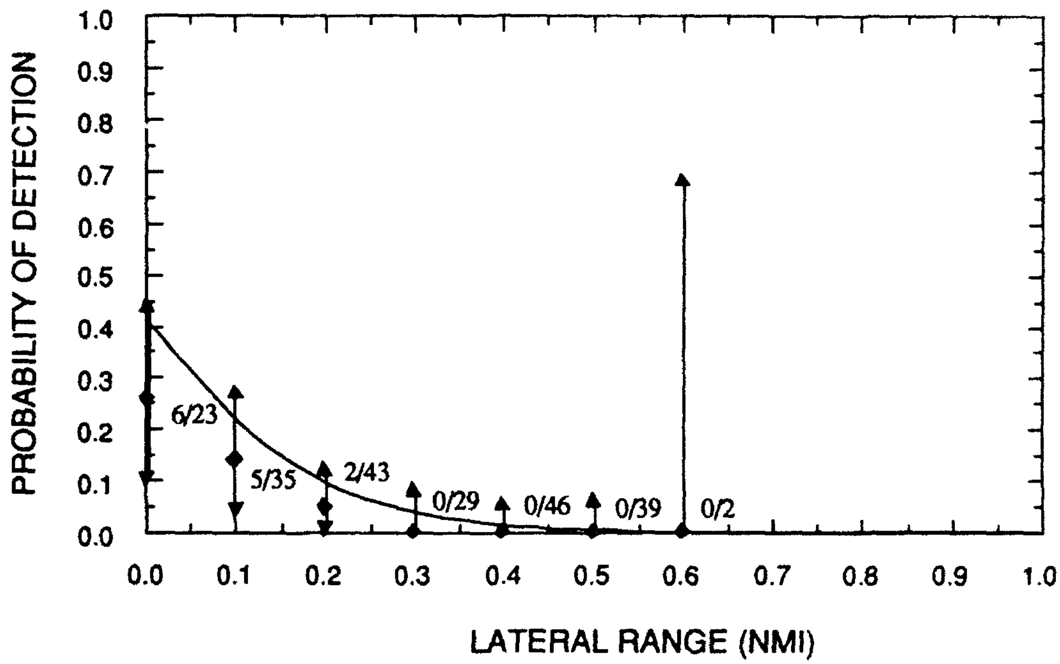


Figure 2-10. Helicopter Detection of Unlighted Persons in the Water
($H_S > 3$ feet)

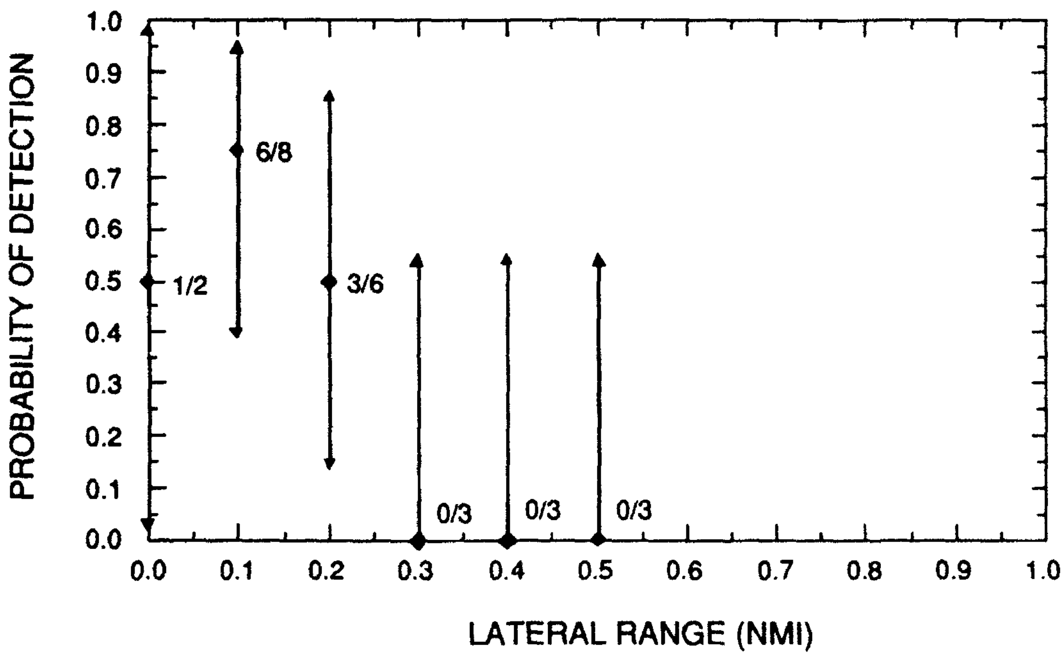


Figure 2-11. Helicopter Detection of Unlighted Persons in the Water
(HH-60J searches conducted with the nose light energized, $H_S > 3$ feet)

2.3.5 Persons in the Water With Red Safety Light

Two hundred and thirty-two target detection opportunities were generated for this target type data set. All of these data were collected from H-3 helicopters during the spring of 1990. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by a combination of the lateral range and moon visibility parameters. Although the relative azimuth of ambient lighting (looking toward shore versus away from shore) was found to have a significant effect on target detection probability, this parameter is not included in the LOGIT-fitted lateral range curve equation because searches cannot be planned to always search away from shore lights.

After LOGIT analysis, the 232 detection opportunities in this data set were sorted into moon visible and moon not visible data sets. Both data subsets were then sorted into 0.25-nmi lateral range bins. These range bins extended from 0 to 2.0 nmi. The raw data points were then plotted as shown in figures 2-12 and 2-13.

The LOGIT-fitted lateral range curves shown in figures 2-12 and 2-13 were produced by solving the LOGIT regression model equation for moon visible and moon not visible. Lateral range curves were generated over a 0- to 2-nmi lateral range interval. Sweep width estimates of 0.3 and 1.3 nmi were obtained by integrating the LOGIT fitted equations over the limits of 0 to 2 for figures 2-12 and 2-13 respectively.

The lateral range curves show a considerable decrease in overall probability of detection for moon visible data compared to the moon not visible data. The moon visible sweep width (0.3 nmi) was significantly less than moon not visible sweep width (1.3 nmi). In the moon visible data Hs was between 3.6 and 4.3 feet and this may have influenced the detection probability in this data downward.

Sweep width and probability of detection analysis of the two data subsets show that the presence of light, artificial or natural, severely degrades ANVIS NVG detection performance for this target type. The moonlight's relatively high intensity appeared to raise the sensitivity threshold of the ANVIS NVG detector tubes above the low-light intensity of the chemical lights. It is likely that shore lights were a distraction to the air crews when the lights were within the same field of view as the PIW targets. Sweep width was improved by over 140 percent when searching against a dark sky as opposed to a lighted shoreline.

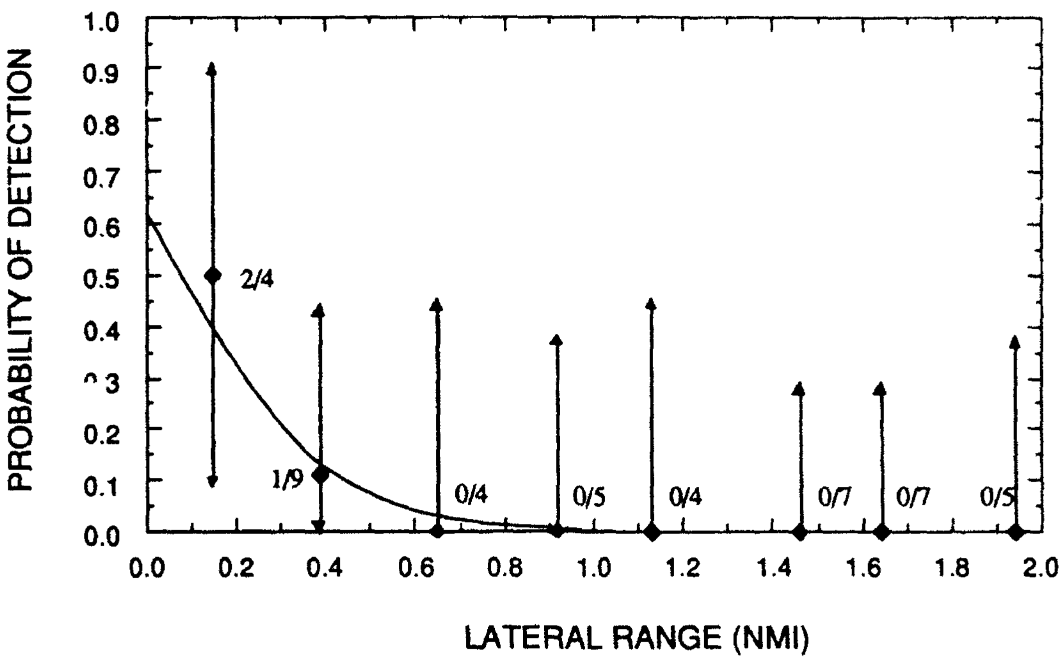


Figure 2-12. Helicopter Detection of Persons in the Water With Red Safety Lights (moon visible)

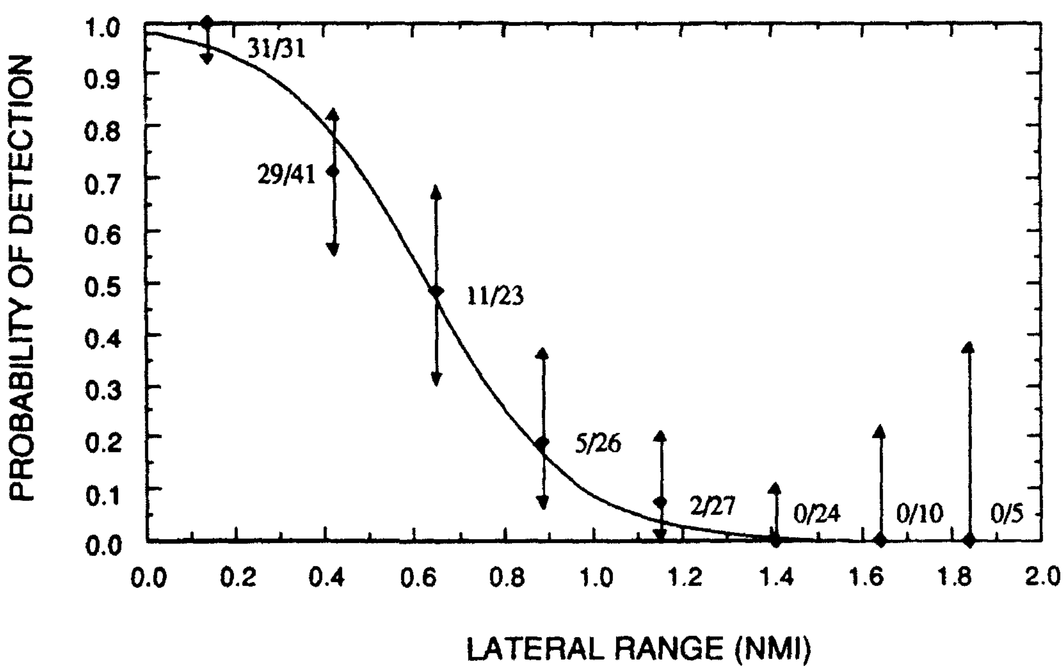


Figure 2-13. Helicopter Detection of Persons in the Water With Red Safety Lights (moon not visible)

2.3.6 Persons in the Water With Orange Chemical Light

One hundred and sixteen target detection opportunities were generated for this target type data set. All of the data were collected from an H-60 helicopter during the spring of 1992. LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within this data set could best be explained by lateral range alone.

After LOGIT analysis, the 116 detection opportunities in this data set were sorted into 0.1-nmi lateral range bins. These range bins extended from 0 to 1.0 nmi. The raw data points were then plotted as shown in figure 2-14.

No LOGIT-fitted lateral range curve has been developed for this data set. Insufficient data exist to support generation of a LOGIT-fitted lateral range curve.

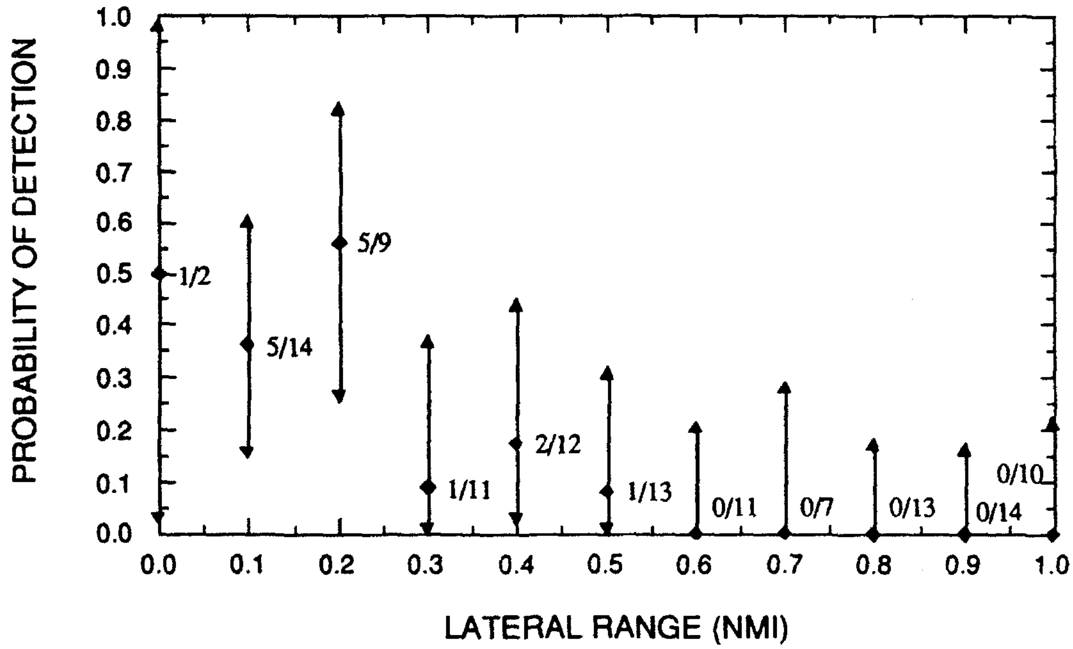


Figure 2-14. Helicopter Detection of Persons in the Water With Orange Chemical Lights

2.3.7 Persons in the Water With Green Personal Marker Light

PIW targets were deployed with Government-issue green PMLs on one night during the spring 1990 experiment. Although the PMLs emit very little light at wavelengths below the ANVIS 625-nanometer cutoff filter (see section 1.3.3), field testing of their detectability by NVGs was considered worthwhile because of their widespread use within the Coast Guard and other segments of the maritime community.

Of the 90 detection opportunities generated during the helicopter searches that night, only four detections were made. None of the detections involved sighting the chemical light itself through the NVGs. One detection was made with the naked eye while a pilot was looking beneath the ANVIS eyepiece to scan flight instruments. The remaining detections involved sighting of the retroreflective tape or the PIW's head through the ANVIS. All four detections were made at lateral ranges of less than 0.25 nmi. The raw data, sorted into 0.25-nmi lateral range bins, are plotted in figure 2-15. No lateral range curve was fit to the data.

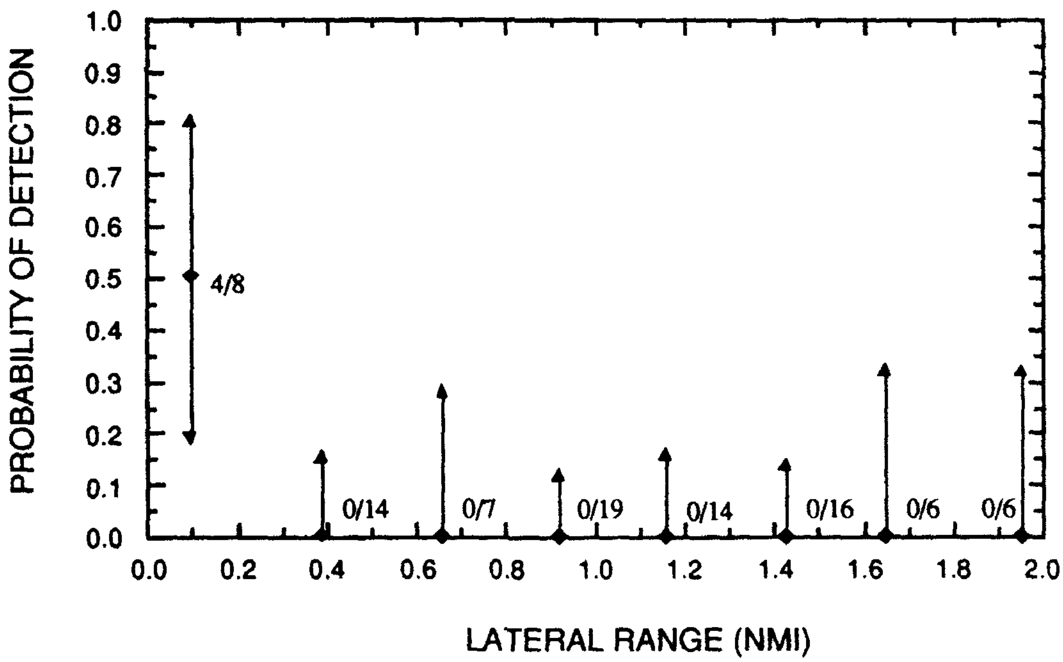


Figure 2-15. Helicopter Detection of Persons in the Water With Personal Marker Lights

2.3.8 Persons in the Water With "Firefly" Strobe Light

One hundred and fifty-two target detection opportunities were generated for this target type, and LOGIT analysis indicated that only lateral range was required to explain variations in target detection probability at the 90-percent confidence level. The influence of other search parameters could not be evaluated because all of the data were collected on a single night with negligible variation in search conditions.

Figure 2-16 provides a raw data plot and LOGIT-fitted lateral range curve for the helicopter/strobe data set. The raw data were sorted into eight, 0.5-nmi lateral range bins from 0 to 4 nmi. The lateral range curve was produced by solving the LOGIT regression model equation for lateral ranges from 0 to 5 nmi. A sweep width estimate of 3.5 nmi was obtained by integrating the fitted LOGIT probability equation over the limits 0 to 5 nmi. Given the relatively poor search conditions (visibility of 3 nmi) that prevailed on the night these data were collected, it is reasonable to expect that much larger helicopter/strobe sweep widths would be achieved in clear weather.

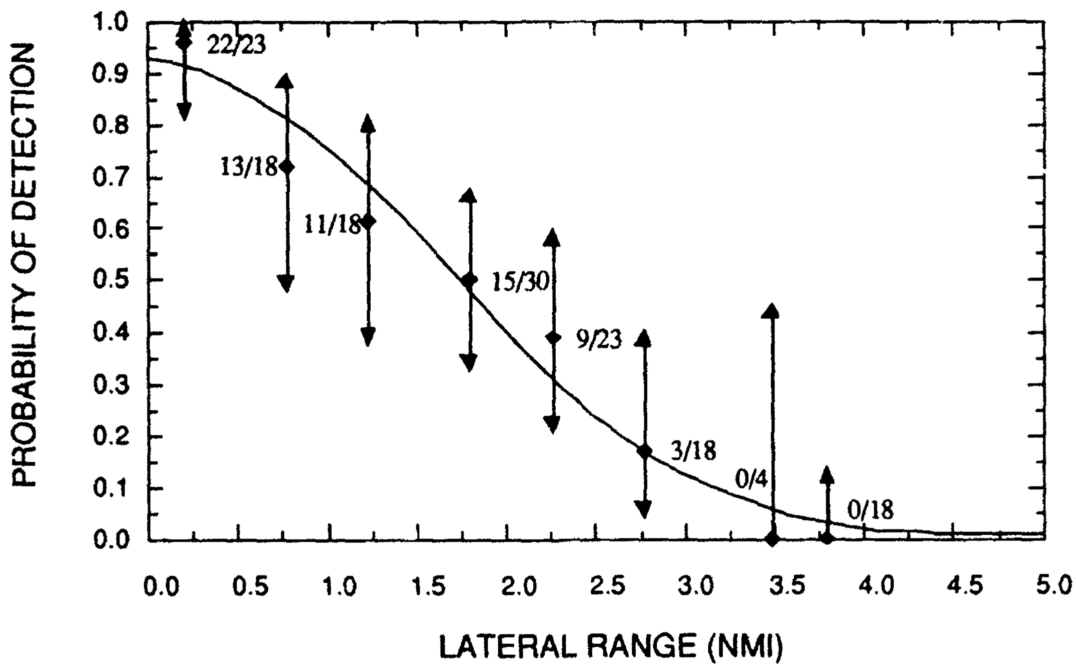


Figure 2-16. Helicopter Detection of Persons in the Water With "Firefly" Strobe Lights

2.4 HUMAN FACTORS

Sections 2.4.1 through 2.4.3 provide information that relates to the human factor aspects of conducting NVG-assisted searches in the marine environment. Section 2.4.1 provides quantitative data that detail where and from what crew positions NVG detections were made. Sections 2.4.2 and 2.4.3 summarize subjective comments and observations made by the SRU crews and members of the R&D Center test team.

2.4.1 Analysis of Detection by Position

Figure 2-17 depicts a breakdown of target detections by crew position and reported clock bearing for each SRU/data group. The circular diagrams on the left side of figure 2-17 show the distribution of initial target detections as a function of relative bearing (expressed in "clock" format). The silhouette diagrams on the right side of figure 2-17 show the distribution of initial target detections as a function of the crew positions. The number and location of lookouts varied with each aircraft. The H-3 helicopters operated with either four or five crew positions, and the H-60 helicopters operated with the full complement of four crew. The H-60 does not normally operate with a fifth crew member (designated swimmer). The only target type for which this fifth position was a major contributor to SRU target detection performance was the unlighted PIW target.

The information in figure 2-17 shows that the copilot position (left seat) made more detections than the pilot position (right seat). This is due in part to the fact that the pilot has the primary responsibility for the aircraft. However, the two aircraft incorporated in this data set show different trends in this aspect. The navigation responsibilities of the copilot in the H-60 helicopter are far more involved than those on the H-3 helicopter and the number of detections made from each position do not show as strong a relationship as for the H-3.

In the aft section of the helicopter, the flight mechanic usually searched through an open door with a wide field of view and no glass to reflect light and therefore made more detections overall than either the rescue swimmer position or the avionics position. The rescue swimmer position, which was not equipped with a seat on two of the H-3 helicopters, made substantially fewer initial detections than any other crew position. The swimmer confirmed many detections but was first to make a detection in only those instances shown.

During searches conducted for PIW targets, the swimmer made approximately 40-percent of all detections. Any decrease in search performance that may be experienced because the H-60 does not carry a rescue swimmer cannot be evaluated in this data because all of the data collected from H-60 helicopters was collected when H_S was above 3 feet.

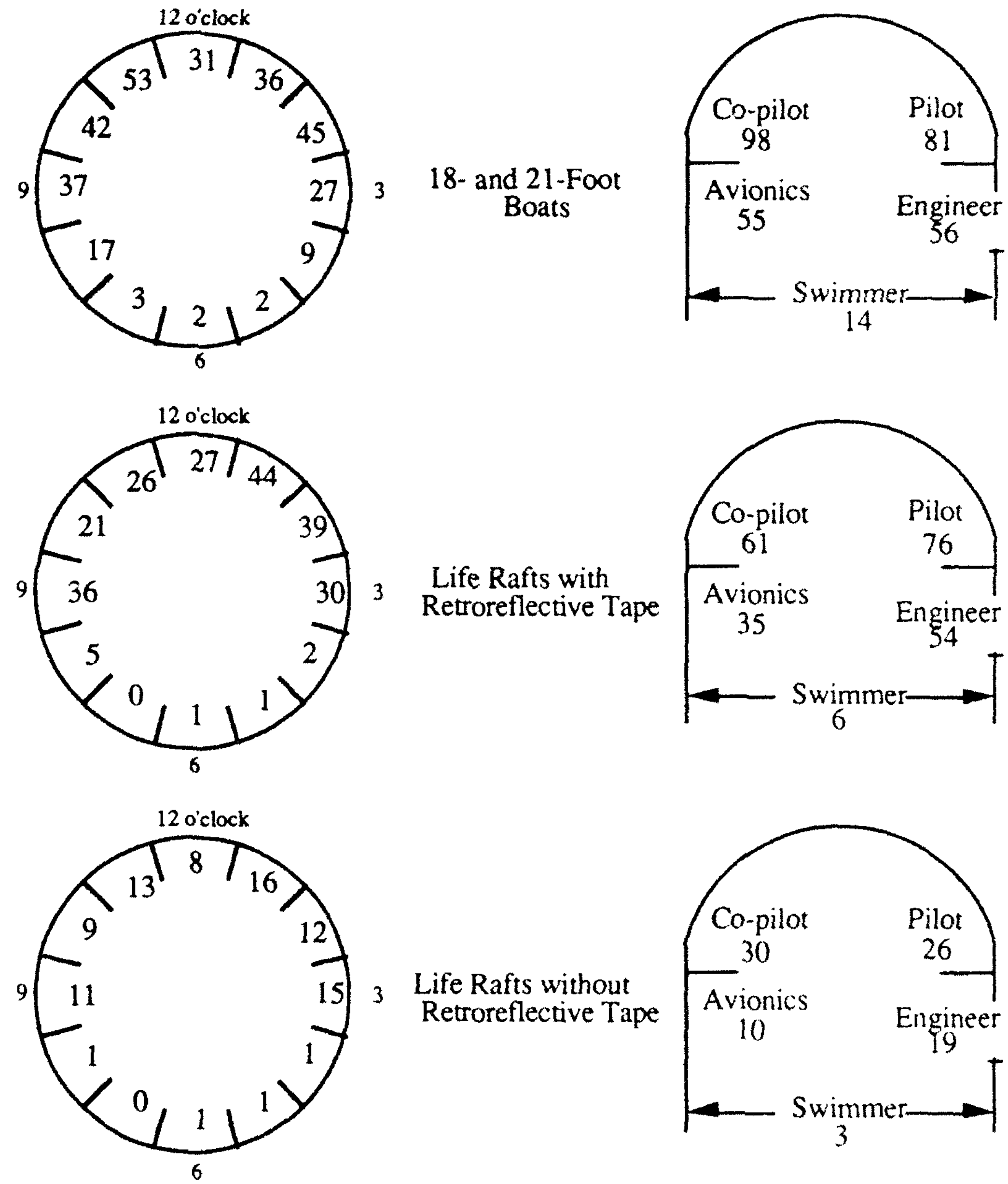


Figure 2-17. Total SRU Detections by Clock Bearing and Crew Position

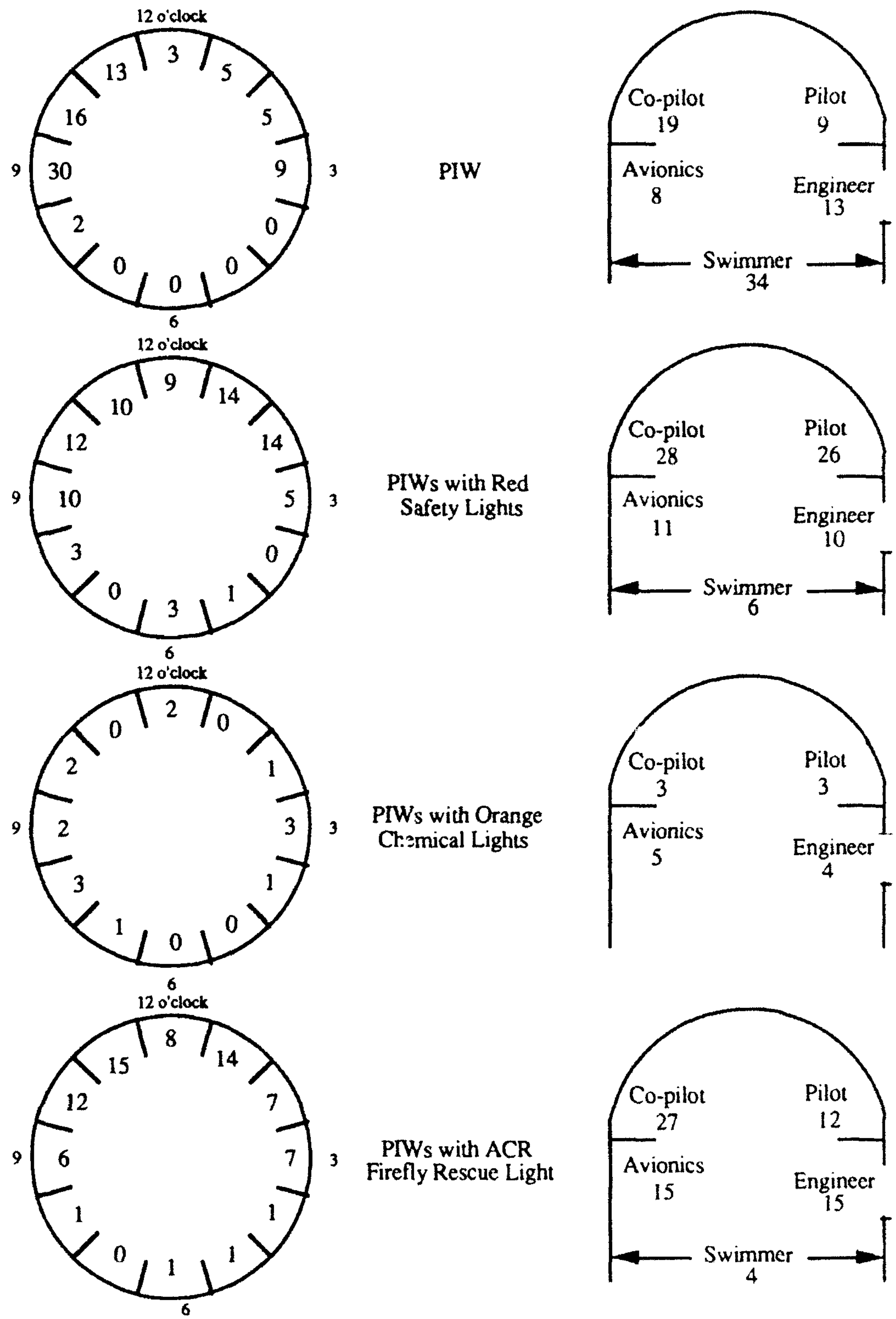


Figure 2-17. Total SRU Detections by Clock Bearing and Crew Position (Cont'd)

The clock-bearing data in figure 2-17 indicate that most of the detections were made between 9 and 11 o'clock on the port side and between 1 and 3 o'clock on the starboard side. A pronounced dip in detections consistently occurred dead ahead of the aircraft. This reflects the short range at which most NVG detections are made. The aircraft nose inhibits the close-in detection capability at 12 o'clock.

2.4.2 SRU Crew Comments Concerning NVG Use and Target Appearance

Subjective comments from the SRU crews concerning the comfort, ease-of-use, and effectiveness of the NVGs and their suitability for Coast Guard SAR operations were solicited each night by the data recorders. A summary of these comments is provided below.

2.4.2.1 Crew Comments Concerning NVG Use

1. Moonlight generally enhanced the lookouts' ability to detect targets at greater lateral ranges; however, looking into a low moon inhibited the lookouts' ability to detect any target.

2. A clear, bright moon can over drive the NVG tubes to the point that the automatic shutdown circuit will activate to prevent damage to the photo-reactive tube layers, and the NVGs will cut out. Even a partial moon can be a blinding light source when viewed through the NVGs. This is usually solved by not gazing toward bright lights.

3. When light sources from inside or outside the helicopter shine on the inside window surfaces, glare can become a problem for the NVG-equipped lookout. Perhaps the inside surfaces of the windows should be coated with anti-glare materials (much like the outside of the windows).

4. In periods of low ambient light, it was difficult to see outside the helicopter. The NVG display was black or grainy, and the H-3 instrument panel created too much glare on the windows. This was not evident in the H-60.

5. From the H-3 helicopter, the rotating beacon became more visible and hindered searching in hazy or foggy conditions. On a clear night, the H-3 lights helped

illuminate targets. From the H-60 helicopter, the nose light significantly increased target detection performance during searches for PIW targets.

6. Complaints of eye strain were common, especially after long sorties. Even 5-minute breaks seemed to help. Also, as the searches progressed, crews reported that NVG focus appeared to wander. After several hours, many crew members reported being unable to bring the NVGs back into focus.

7. Crews that were given the opportunity to view a target with the NVGs before commencing searches thought that it was helpful in familiarizing them with the target's appearance.

8. Some crews thought that it was helpful to fly near the shoreline and refocus the NVGs between searches.

9. One crew thought that a counterweight is needed on the back of the helmet to offset the NVG weight. The battery pack that now exists does not provide the appropriate weight. Another crew regularly used velcro-attached weights on the back of the helmet to offset the NVG weight.

10. Rough seas make it difficult to distinguish targets from waves and white caps.

11. Although crews from both helicopter types complained about discomfort and fatigue affecting their search performance, the comments from H-60 crews were directed more toward aircraft configuration than at NVG-comfort. Most H-60 crews thought the glare shield inhibited pilot and copilot searches forward of the aircraft, and the auxiliary fuel pod nearly eliminated the ability of the crew member in the avionics seat to search close to the aircraft.

2.4.2.2 Crew Comments Concerning Target Appearance

When detections were made, SRU crew members were encouraged to provide a description of target appearance . Table 2-2 lists these target descriptions by SRU and target type. The descriptions appear in the table in descending order of frequency for each SRU/target type combination.

Table 2-2. Summary of Target Appearance Descriptions

TARGET TYPE	SEARCH UNIT TYPE
Small Boats	Bright/white/light Boat/Skiff Open white boat Black/dark/dark w/canvas Boat w/canvas White w/dark bottom Round/oblong/square
Life Rafts without Retroreflective Tape	Raft Bright/white/light Light w/dark bottom Black/dark w/white top Black w/white reflection from the anti-collision light
Life Rafts with Retroreflective Tape	White/light Raft with tape Flashing with aircraft beacon Flashing triangle Glowing object White/round donut
Unlighted PIWs with Retroreflective Tape	Flash/glow Bright/white/light Reflective tape Bucket Person/head Not bright
PIWs with Strobe	None Sometimes confused with flashing aids to navigation
PIWs with Personall Marker Light (green cyalume)	Retroreflective tape, no chem light Target, saw chem light under goggles first Two reflective balls
PIWs with Red Safety Light	Dim steady glowing light Light in the water Bobbing A little light A chem light Blinking light Very bright light
PIWs with Orange Chemical Light	Steady spot - very dim Steady light White target Steady white cap Steady white light

2.4.3 Test Team Observations Concerning NVG Use

Data recorders logged subjective comments as time and opportunity permitted. These comments were sometimes similar in nature to the comments received from the SRU crews, but were made from a third-party viewpoint while not directly involved in the NVG search task. All of the data recorders were familiar with NVG characteristics and principles of operation. The data recorders also had at least 1 or 2 hours of experience using the NVGs while underway onboard an SRU or a workboat. Data recorder comments are summarized below.

1. The cockpit workload often drew the pilot and/or copilot off the NVGs for communications, instrument scans, and navigation computer adjustments. These distractions were usually brief but occurred frequently. Coverage of the search area with NVGs was probably less thorough than with daytime visual search due to this frequent scan shifting without the benefit of peripheral vision outside the cockpit.

2. Onboard the H-60 helicopter, the copilot sometimes spent up to half the search entering and adjusting waypoints in the navigation computer. Several times comments were made that they will be glad when software that will program the waypoints for them is installed.

3. Recurrent aircrew NVG training seems to vary between air stations. No standard non-pilot aircrew NVG training exists. Some crews spent time adjusting and focusing the NVGs prior to take off, while others would focus after takeoff. Most of the crews maintained good scanning techniques until late in the sortie.

4. Helicopter crew members, particularly those at the pilot, copilot, and avionics positions, noticed a glare from the light shining off the inside of the windows. Whether the light source was from inside the helicopter or external light shining into the helicopter, it hampered NVG search efforts.

5. Moonlight greatly improved the NVG image clarity and horizon definition. Increased air crew enthusiasm was evident under these conditions. Some crews actually transited to and from the search area at 300 feet to allow them to see objects as they would during the search.

6. H-60 pilots and copilots thought that the slower (60 knot) airspeed used during PIW searches made flying the aircraft much more difficult. Searching at this airspeed became intermittant at best.

CHAPTER 3
CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The following conclusions are based on the quantitative data analyses and subjective comments provided in chapter 2.

3.1.1 Comparative Evaluation

1. Reference 1 reported results that indicated that the HH-60J achieved detection probabilities that are not significantly different from those for the H-3 during the same time period. The results presented here for small boat, life raft with retroreflective tape, and PIW targets support that conclusion.

2. Data collected from HH-3F, CH-3E, and HH-60J helicopters are considered together, and sweep widths computed are valid for each SRU.

3.1.2 Search Performance of NVG-Equipped Helicopters

1. The presence of a visible moon significantly improved ANVIS NVG detection performance against small boat targets and life rafts with or without retroreflective tape.

    - The sweep width for small boat targets in low visibility or no moonlight conditions was half that in the moonlight conditions.

    - The sweep width for life raft targets without retroreflective tape, in no moonlight conditions, was half that in moonlight conditions .

- When retroreflective tape was added to life rafts, detection performance was substantially increased in no moonlight conditions, and the performance difference between the no moonlight and moonlight conditions was reduced. In moonlight conditions, there was no improvement in target detectability with the addition of the retroreflective tape. It appeared that at longer ranges, when the light received from the retroreflective tape was sufficiently weak in relation to the ambient light, targets were not easily distinguished from background noise within the NVG field of view. The search then became a search for the life raft rather than for the tape reflection.

2. When searching with no moonlight, the helicopter crews achieved no better detection performance against 4- and 6-person life rafts than they did against PIW targets in all moonlight conditions. Although much larger than the PIWs, these rafts were not equipped with retroreflective tape as were the PIW targets and were difficult to detect, especially when viewed against a lighted background or in low ambient light conditions.

3. Green Personal Marker Lights (PMLs) did not enhance the detectability of PIW targets when viewed through ANVIS NVGs. No ANVIS NVG detections of PIW targets with PMLs were made during a sortie that presented 90 opportunities for detecting these targets. The searches conducted through NVGs for these targets resulted in a much lower detection probability than for the PIW targets without PMLs. This is likely due to lookouts searching for a bright light rather than for the shape of a mannequin with just the PFD. The green PMLs are invisible through ANVIS NVGs.

4. When the moon was not visible, red safety lights significantly enhanced the detectability of PIWs when viewed through ANVIS NVGs. Sweep width was three times greater than that achieved for PIW targets with retroreflective tape on the PFD alone under moon-not-visible conditions. When the moon was visible, detection performance was comparable to levels achieved for PIW targets with retroreflective tape on the PFD alone.

5. Evaluation of the Orange Chemical Wand data gathered during the spring of 1992 indicated these chemical lights provided little assistance in night detectability. This is believed to be due to the extremely short time the majority of these lights remained illuminated.

6. The HH-3/CH-3 helicopter crews achieved detection probabilities against PIW targets that were comparable to the results for daylight visual search found in the National SAR Manual (see reference 4). The detectability of PIW targets was clearly enhanced by the retroreflective tape on the Type I PFDs. The tape reflected shore lights and/or the helicopters' anti-collision lights to produce flashes that were very distinct when viewed with the ANVIS NVGs.

7. During two searches on a well moon lighted night in the spring of 1992, energizing the HH-60 nose light increased detection performance significantly. Sweep widths calculated for unlighted PIW targets in sea conditions above H_S = 3 feet indicated that these searches would be difficult to conduct. By energizing the helicopter nose light detection performance similar to that in lower seas can be achieved.

8. One NVG-equipped helicopter crew achieved excellent search performance against "Firefly" strobe light targets under adverse search conditions. The NVG sweep width achieved in 3 nmi visibility was comparable to the National SAR Manual (reference 4) non-NVG searches for more powerful strobes in 5- to 20-nmi visibility.

9. Although search conditions were seldom ideal in terms of ambient light and sea conditions, the helicopters were able to mount viable search efforts against all target types.

3.1.3 General Conclusions

1. Glare from interior and exterior lights on the helicopter windows was a constant problem, especially on dark nights. On hazy or foggy nights, reflections from the helicopters' exterior anti-collision lights made detections difficult.

2. No obvious or consistent relationship between time on the search task and target detection probability was demonstrated in the test data. This result is surprising in light of the many SRU crew comments concerning eye fatigue and the physical discomfort experienced while wearing NVGs.

3. The presence of a visible moon significantly enhanced the NVG detection performance against unlighted targets; however, a bright moon or strong artificial lighting (i.e. shore lights) can inhibit performance against lighted targets..

4. The presence of the moon or artificial lights within the field of view generally degraded the NVG detection performance against all targets.

5. Illumination of targets by a "Firefly" strobe light (or similar device) greatly improved target detectability by NVGs, even in very poor visibility.

3.2 RECOMMENDATIONS

The following recommendations are offered concerning the employment, use, and further evaluation of NVGs in the Coast Guard SAR mission. These recommendations are based primarily on the quantitative data analyses and qualitative observations provided in this report and in reference 1. Consideration was also given to additional inputs provided by SRU crews, other Coast Guard sources, and Department of Defense (DOD) night-vision experts.

Daylight visual sweep widths, referenced in sections 3.2.1 and 3.2.2, are tabulated in reference 4. Fatigue, weather, and speed corrections are not to be applied unless specified below.

Search patterns should be oriented to minimize the time spent searching toward bright light sources. The major axis of a parallel search and the minor axis of a creeping line search should be oriented so the aircraft nose or tail is pointed at the major light source.

Crews on helicopters conducting NVG searches should, weather permitting, search with the cabin windows and cabin door open thereby eliminating reflective glass glare.

Mariners and raft/safety device manufacturers should be notified of the improved detection performance achieved when searching for lighted targets, and they should be encouraged to use lights on items that may end up as search objects.

Mariners should be advised not to energize chemical lights until a possible rescue unit is visible or audible to them because of the rapid decline in intensity of the chemical lights with time.

3.2.1 NVG Searches With Helicopters

Sweep width estimates for nighttime NVG searches using helicopters were calculated based on daylight visual sweep estimates from reference 4. The nighttime correction factors for the corrected daylight sweep width are listed in table 3-1.

Table 3-1. Sweep Width Correction Factors for NVG Nighttime Searches by Helicopters

TARGET TYPE	SWEEP WIDTH (W) (nmi)	NIGHT CONDITIONS	DAYLIGHT CORRECTION CONDITIONS	CORRECTION FACTOR
Small Boats (15 to 25 feet)	0.9	visibility $\leq$ 8 nmi	Weather and aircraft speed	0.4
		visibility > 8 nmi		
	0.7	no moon	Weather and aircraft speed	0.2
	1.3	moon	Weather and aircraft speed	0.4
Life Rafts with Retroreflective Tape	0.6	no moon	Weather and aircraft speed	0.5
	0.9	moon	Weather and aircraft speed	0.5
Life Rafts without Retroreflective Tape	0.4	no moon	Weather and aircraft speed	0.3
	0.8	moon	Weather and aircraft speed	0.5
Unlighted PIW with Retroreflective Tape	0.3	H_S <= 3 feet	Weather and aircraft speed	2.0
	0.1	H_S > 3 feet	*	0.5
PIW with Green PML	N/A	all conditions	**	N/A
PIW with Red Safety Light	1.3	no moon	Aircraft speed	6.0
	0.3	moon	Aircraft speed	2.0
PIW with "Firefly" Strobe	N/A	all conditions	***	N/A

* A sweep width of 0.1 nmi was calculated for PIW targets in seas > 3 feet. NVG searches may be difficult to perform.

** NVGs should not be used when searching for a PIW with a green PML.

*** For strobe light equipped targets, set sweep width equal to the visibility or the distance to the visible horizon.

3.2.2 Recommendations For Future Research

1. Additional information should be gathered to support the conclusions about HH-60J search performance made in this report. Specifically, and in order of preference:

   - Unlighted PIW targets with significant wave heights below 3 feet,
   - Small boat and life raft data with significant wave heights below 3 feet, and
   - PIW targets illuminated with either the red safety light or "Firefly" strobe light.

2. The Coast Guard HH-65A helicopter should be evaluated to determine its performance during NVG searches.

3. Sources of NVG-compatible illumination should be evaluated on surface and air SRUs, particularly against targets that are not equipped with lights. These targets should include those both with and without retroreflective materials.

REFERENCES

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5. Edwards, N. C.; Osmer, S. R.; Mazour, T. J.; and Hover, G. L., Factors Affecting Coast Guard SAR Unit Visual Detection Performance, Report No. CG-D-09-82, U.S. Coast Guard Research and Development Center and Analysis & Technology, Inc., August 1981.

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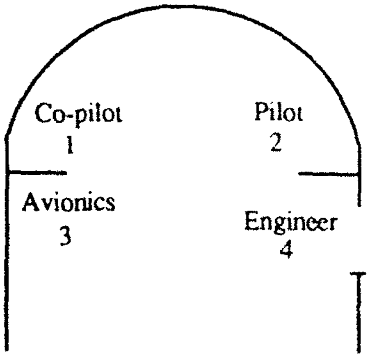
8. Steinberg, D., LOGIT: A Supplementary Module for SYSTAT, SYSTAT, Inc., November 1985.

KEY TO DATA APPENDIX

This appendix contains the raw data files for the U.S. Coast Guard NVG experiment conducted in the Spring of 1992. Each data file is labeled with the search unit tail number and the date on which the data were collected. The HH-60J helicopter used during this experiment was the CG-6007 from Air Training Center (ATC) Mobile, AL.

The data files are listed in chronological order. Each file record represents one search unit/target interaction and describes the target detection opportunity using 25 parameters of interest. The following is a key to the format of each record.

Item 1:	DET	Detection? (1 = yes, 2 = no)
Item 2:	LATRNG	Lateral range (nautical miles)
Item 3:	TOT	Time on task (hours)
Item 4:	PRECIP	Precipitation level (0 = none, 1 = light, 2 = moderate, 3 = heavy)
Item 5:	VIS	Visibility (nautical miles)
Item 6:	WDSP	Wind speed (knots)
Item 7:	CLDC	Cloud coverage (tenths of sky obscured)
Item 8:	HS	Significant wave height (feet)
Item 9:	WHCAPS	Whitecap coverage (0 = none, 1 = light, 2 = heavy)
Item 10:	SWDIR	Relative wave direction (1 = looking into oncoming waves, 0 = looking across the direction of wave travel, -1 = looking at the backside of the waves)
Item 11:	RELHM	Relative humidity (percent)
Item 12:	AIRTP	Air temperature (degrees Celsius)
Item 13:	WTTP	Water temperature (degrees Celsius)
Item 14:	RELAZ	Relative azimuth of artificial light (1 = looking into, 0 = looking across, -1 = looking away from)
Item 15:	LEV	Artificial light level (0 = rural, 1 = suburban, 2 = urban)
Item16:	ELEV	Moon elevation (degrees above (+) or below (-) the horizon)
Item 17:	MOONVIS	Moon visible from search unit (1 = yes, 0 = no)
Item 18:	MOONRA	Moon relative azimuth (1 = looking into, 0 = looking across, -1 = looking away from)
Item 19:	PHS	Moon phase (0 = none, .2, .5, .7, 1 = full)
Item 20:	SPD	Search speed (knots)
Item 21:	ALTTYPE	Search altitude or NVG type as listed below: • Helicopter data files - search altitude in feet;
Item 22:	POS	Position on search unit for detections or -9 for all missed targets. Position codes are shown below.



Item 23:	LO	Lookout identification number for detections or -9 for all missed targets.
Item 24:	EXP	Lookout experience with NVGs (hours) for detections or -9 for all missed targets.
Item 26:	CLOCK	Relative Bearing expressed in whole clock bearing
Item 25:	TYNO	Target type (1 = skiff target, 2 = life raft target, or 3 = person in the water (PIW)target)
Item 26:	SUBTY	Target subtype as listed below: • Skiff (0 = 18-foot skiff, 1 = 21-foot skiff) • Life Raft (0 = life raft without retroreflective tape, -1 = life raft with retroreflective tape) • PIW (0 = unlighted, 5 = with orange chemical light, and 9 = unlighted with helo nose light energized

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	0.2	0	0	15	16	5	3.9	1	0	67	24.6	23.9	-1	1	41	1	0	0.7	60	300	-9	-9	-9	-9	3	0
2	0	0	0	15	16	5	3.9	1	-1	67	24.6	23.9	0	1	41	1	-1	0.7	60	300	-9	-9	-9	-9	3	0
2	0.3	0.1	0	15	16	5	3.9	1	0	67	24.6	23.9	-1	1	42	1	0	0.7	60	300	-9	-9	-9	-9	3	0
2	0.2	0.2	0	15	16	5	3.9	1	0	67	24.6	23.9	1	1	42	1	0	0.7	60	300	-9	-9	-9	9	3	0
2	0	0.2	0	15	16	5	3.9	1	1	67	24.6	23.9	-1	1	43	1	1	0.7	60	300	-9	9	-9	-9	3	0
2	0.3	0.3	0	15	18	5	3.9	1	0	67	24.6	23.9	1	1	43	1	0	0.7	60	300	9	-9	-9	-9	3	0
2	0.2	0.4	0	5	18	5	3.9	1	0	67	24.6	23.9	-1	1	44	1	0	0.7	60	300	-9	9	-9	-9	3	0
2	0.2	0.5	0	15	18	5	3.9	1	0	67	24.6	23.9	-1	1	45	1	0	0.7	60	300	9	9	9	9	3	0
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2	0.5	0.7	0	15	18	5	3.9	1	0	67	24.6	23.9	1	1	46	1	0	0.7	60	300	9	9	-9	9	3	0
2	0.1	0.8	0	15	16	5	3.9	1	0	67	24.5	23.9	-1	1	46	1	0	0.7	60	300	9	9	9	9	3	0
2	0.5	0.9	0	15	16	5	3.9	1	0	67	24.5	23.9	1	1	47	1	0	0.7	60	300	9	-9	9	9	3	0
2	0.3	0.9	0	15	16	3	4.3	1	0	70	24.5	23.9	1	1	47	1	0	0.7	60	300	9	9	9	9	3	0
2	0.4	0.9	0	15	16	3	4.3	1	0	70	24.5	23.9	-1	1	47	1	0	0.7	60	300	-9	-9	-9	9	3	0
2	0.1	0.9	0	15	16	3	4.3	1	0	70	24.5	23.9	-1	1	47	1	0	0.7	60	300	9	-9	9	9	3	0
2	0.4	0.9	0	15	16	3	4.3	1	0	70	24.5	23.9	1	1	47	1	0	0.7	60	300	-9	-9	[illegible]	9	3	0
2	0.5	1	0	5	16	3	4.3	1	0	70	24.5	23.9	1	1	47	1	0	0.7	60	300	9	9	9	9	3	0
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2	0	1.1	0	15	16	3	4.3	1	1	70	24.5	23.9	0	1	48	1	1	0.7	60	300	-9	9	-9	9	3	0
2	0.3	0.8	0	15	16	5	3.9	1	0	67	24.6	23.9	-1	1	46	1	0	0.7	60	300	-9	9	9	9	3	0
2	0.3	1.2	0	15	16	3	4.3	1	-1	70	24.5	23.9	0	1	48	1	1	0.7	60	300	9	-9	9	9	3	0
2	0.1	1.3	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	48	1	1	0.7	60	300	9	9	9	9	3	0
2	0.1	1.4	0	15	17	3	4.3	1	-1	70	23.8	23.9	0	1	49	1	-1	0.7	60	300	-9	9	9	9	3	0
2	0.2	1.4	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	-1	0.7	60	300	-9	9	-9	9	3	0
2	0.4	1.4	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	-1	0.7	60	300	-9	-9	9	9	3	0
2	0.2	1.5	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	-9	9	9	3	0
2	0.4	1.5	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.5	1.5	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.5	1.6	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	-9	9	9	9	3	0
2	0.4	1.6	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.4	1.6	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.1	1.7	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.3	1.7	0	15	17	3	4.3	1	1	70	23.8	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.2	1.8	0	15	16	3	4.3	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.5	1.8	0	15	16	3	4.3	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.1	1.8	0	15	16	2	3.9	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.5	2	0	15	16	2	3.9	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	-9	9	3	0
2	0.2	2	0	15	16	2	3.9	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0	2.1	0	15	16	2	3.9	1	0	70	23.1	23.9	1	1	49	1	0	0.7	60	300	9	9	9	9	3	0
2	0.2	2.2	0	15	16	2	3.9	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.3	2.2	0	15	16	2	3.9	1	1	70	23.1	23.9	0	1	49	1	1	0.7	60	300	9	9	9	9	3	0
2	0.1	2.3	0	15	16	2	3.9	1	-1	70	22.9	23.8	0	1	49	1	1	0.7	60	300	9	9	1	9	3	0
2	0.2	2.3	0	15	16	2	3.9	1	1	70	22.9	23.8	0	1	49	1	1	0.7	60	300	9	9	1	9	3	0
2	0.3	2	0	15	12	2	3.3	1	0	70	22.9	23.8	1	1	47	1	0	0.7	60	300	9	9	1	9	3	0
2	0	2	0	15	12	2	3.3	1	1	70	22.9	23.8	0	1	47	1	0	0.7	60	300	9	9	1	9	3	0
2	0.4	2.1	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	47	1	0	0.7	60	300	9	9	1	9	3	0
2	0.2	2.1	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	47	1	0	0.7	60	300	9	9	1	9	3	0
2	0.1	2.2	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	46	1	0	0.7	60	300	9	9	1	9	3	0
2	0.5	2.2	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	46	1	0	0.7	60	300	9	9	1	9	3	0
2	0.5	2.3	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	46	1	0	0.7	60	300	9	9	1	9	3	0

CG-6007 MAY 13 1992 *(continued)*

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	0.4	2.3	0	15	12	0	3.3	1	0	82	22.9	23.8	1	1	46	1	0	0.7	60	300	-9	-9	-9	-9	3	0
1	0.1	2.4	0	15	13	0	3.3	1	0	72	22.2	23.7	-1	1	22	1	-1	0.7	60	300	4	507	2	9	3	0
1	0	2.7	0	15	13	0	3.3	1	1	72	22.1	23.7	0	1	19	1	0	0.7	60	300	1	501	16	9	3	0
1	0	2.8	0	15	13	0	3.3	1	-1	72	22.1	23.7	0	1	18	1	0	0.7	60	300	2	502	10	3	3	0
1	0	3	0	15	14	0	3.3	1	1	72	22.1	23.7	0	1	16	1	0	0.7	60	300	1	501	16	9	3	0
2	0.3	2.4	0	15	13	0	3.3	1	0	72	22.2	23.7	-1	1	23	1	-1	0.7	60	300	-9	-9	-9	-9	3	0
2	0.4	2.5	0	15	13	0	3.3	1	0	72	22.1	23.7	-1	1	22	1	-1	0.7	60	300	-9	9	-9	-9	3	0
2	0.5	2.5	0	15	13	0	3.3	1	0	72	22.1	23.7	1	1	21	1	1	0.7	60	300	9	9	-9	9	3	0
2	0.5	2.5	0	15	13	0	3.3	1	0	72	22.1	23.7	1	1	21	1	1	0.7	60	300	9	-9	9	9	3	0
2	0.5	2.6	0	15	13	0	3.3	1	0	72	22.1	23.7	-1	1	20	1	-1	0.7	60	300	-9	-9	9	-9	3	0
2	0.2	2.7	0	15	13	0	3.3	1	0	72	22.1	23.7	-1	1	20	1	-1	0.7	60	300	-9	9	-9	-9	3	0
2	0.2	2.8	0	15	13	0	3.3	1	0	72	22.1	23.7	-1	1	18	1	-1	0.7	60	300	-9	9	9	9	3	0
2	0.3	2.9	0	15	13	0	3.3	1	0	72	22.1	23.7	1	1	18	1	1	0.7	60	300	9	9	-9	9	3	0
2	0.2	3	0	15	14	0	3.3	1	0	72	22.1	23.7	1	1	16	1	1	0.7	60	300	-9	9	-9	9	3	0

EOF

CG-6007 MAY 16 1992

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0	0.3	0	10	13	7	4.3	1	0	79	24.6	24.3	1	1	10	1	0	1	60	300	1	502	22	9	3	0
1	0.1	0.8	0	10	13	7	4.3	1	0	79	24.7	24.3	1	1	15	1	0	1	60	300	1	502	22	8	3	0
1	0	0.9	0	10	13	7	4.3	1	-1	79	24.7	24.3	1	1	17	1	0	1	60	300	1	502	22	9	3	0
2	0.3	0	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	7	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0	0	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	7	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0	0.2	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	9	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.2	0.2	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	9	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.3	0.3	0	10	13	7	4.3	1	-1	79	24.6	24.3	1	1	10	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.5	0.4	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	11	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0	0.5	0	10	13	7	4.3	1	1	79	24.6	24.3	-1	1	11	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	0.7	0	10	13	7	4.3	1	-1	79	24.7	24.3	1	1	15	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.2	0.5	0	10	13	7	4.3	1	-1	79	24.7	24.3	1	1	12	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.5	0.5	0	10	13	7	4.3	1	-1	79	24.7	24.3	1	1	12	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.1	0.5	0	10	13	7	4.3	1	1	79	24.7	24.3	-1	1	12	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.5	0.6	0	10	13	7	4.3	1	1	79	24.7	24.3	-1	1	14	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.5	1	0	10	13	7	4.6	1	0	79	24.7	24.3	1	1	18	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.3	0.7	0	10	13	7	4.3	1	1	79	24.7	24.3	1	1	14	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.3	0.7	0	10	13	7	4.3	1	0	79	24.7	24.3	1	1	15	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1	0	10	13	7	4.3	1	0	79	24.7	24.3	1	1	17	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1	0	10	13	7	4.6	1	1	79	24.7	24.3	1	1	18	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1.2	0	10	13	7	4.6	1	0	79	24.7	24.3	1	1	19	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.2	1.1	0	10	13	7	4.6	1	0	79	24.7	24.3	1	1	19	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.1	1.2	0	10	13	7	4.6	1	1	79	24.7	24.3	-1	1	20	1	0	1	60	300	-9	-9	-9	-9	3	0
1	0.2	2.3	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	30	1	0	1	60	300	1	502	22	10	3	0
2	0.4	1.3	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	22	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0	1.3	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	22	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0	1.5	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	25	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.3	1.5	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	25	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1.5	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	24	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.2	1.6	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	25	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1.7	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	26	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0	1.8	0	10	14	7	4.6	1	0	87	24.5	24.3	0	1	27	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.2	1.8	0	10	14	7	4.6	1	0	87	24.5	24.3	0	1	27	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.2	1.8	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	27	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.4	1.8	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	27	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.1	2	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	28	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.5	2	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	28	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0	2	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	29	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.3	2.1	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	29	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.5	2.2	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	29	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.4	2.2	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	29	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.4	2.3	0	10	14	7	4.9	1	0	87	24.5	24.3	0	1	31	1	1	1	60	300	-9	-9	-9	-9	3	0
2	0.5	1.4	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	23	1	0	1	60	300	-9	-9	-9	-9	3	0
2	0.5	1.4	0	10	14	7	4.6	1	0	79	24.3	24.3	0	1	23	1	0	1	60	300	-9	-9	-9	-9	3	0
3	0.1	2.7	0	10	13	7	5.2	1	0	85	24.5	24.3	1	1	34	1	0	1	60	300	1	502	22	9	3	0
3	0.2	3.1	0	10	14	7	5.2	1	0	85	24.3	24.2	1	1	36	1	0	1	60	300	2	501	16	3	3	0
3	0.1	3.1	0	10	14	7	5.2	1	0	85	24.3	24.2	1	1	36	1	0	1	60	300	2	501	16	3	3	0
3	0.1	3.3	0	10	14	7	5.2	1	0	85	24.3	24.2	0	1	37	1	-1	1	60	300	2	501	16	2	3	0
3	0	3.5	0	10	14	7	5.2	1	0	85	24.3	24.2	0	1	37	1	1	1	60	300	2	501	16	9	3	0
3	0.1	3.5	0	10	14	7	5.2	1	0	90	24.3	24.2	1	1	37	1	1	1	60	300	4	509	15	2	3	0
[illegible]	0.3	2.5	0	10	14	7	4.9	1	1	87	24.5	24.2	1	1	33	1	0	1	60	300	-9	-9	-9	-9	3	0

CG-6007 MAY 16 1992 *(continued)*

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	0.4	2.7	0	10	13	7	5.2	1	1	85	24.5	24.3	-1	1	34	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.5	2.8	0	10	13	7	5.2	1	0	85	24.5	24.3	1	1	30	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.2	2.8	0	10	13	7	5.2	1	0	85	24.5	24.3	1	1	35	1	0	1	60	300	-9	9	-9	-9	3	6
2	0.4	2.9	0	10	13	7	5.2	1	0	85	24.5	24.3	-1	1	35	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.1	2.9	0	10	13	7	5.2	1	0	85	24.5	24.2	1	1	35	1	0	1	60	300	9	-9	-9	-9	3	6
1	0.1	3.2	0	10	14	7	5.2	1	1	85	24.3	24.2	-1	1	36	1	0	1	60	300	1	502	22	2	3	6
2	0.2	3.3	0	10	14	7	5.2	1	0	85	24.3	24.2	-1	1	37	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0	3.5	0	10	14	7	5.2	1	0	85	24.3	24.2	-1	1	38	1	0	1	60	300	-9	9	9	-9	3	6
2	0.4	3.4	0	10	14	7	5.2	1	1	85	24.3	24.2	-1	1	37	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.3	3.2	0	10	14	7	5.2	1	0	85	24.3	24.2	1	1	36	1	0	1	60	300	-9	-9	-9	-9	3	6
1	0.2	3.7	0	10	13	8	5.2	1	1	90	24.1	24.2	-1	1	38	1	0	1	60	300	1	502	22	9	3	6
1	0.2	3.8	0	10	13	8	5.2	1	-1	90	24.1	24.2	1	1	38	1	0	1	60	300	3	508	1	9	3	6
1	0.1	3.9	1	10	13	8	5.2	1	1	90	24.1	24.2	0	1	38	1	0	1	60	300	1	502	22	11	3	6
1	0.1	4.1	1	10	16	8	5.2	1	-1	90	23.3	24.2	1	1	39	0	0	1	60	300	4	509	15	3	3	0
2	0.3	3.5	0	10	13	7	5.2	1	1	90	24.1	24.2	-1	1	38	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.2	3.7	0	10	13	8	5.2	1	0	90	24.1	24.2	1	1	38	1	0	1	60	300	9	9	-9	-9	3	6
2	0.5	3.6	0	10	13	8	5.2	1	1	90	24.1	24.2	-1	1	38	1	0	1	60	300	-9	-9	-9	-9	3	6
2	0.1	3.9	1	10	13	8	5.2	1	-1	90	24.1	24.2	1	1	38	1	0	1	60	300	9	9	-9	-9	3	6
2	0.5	3.8	1	10	13	8	5.2	1	1	90	24.1	24.2	-1	1	38	1	0	1	60	300	9	-9	-9	-9	3	6
2	0.3	4	1	10	16	8	5.2	1	1	90	23.3	24.2	-1	1	39	1	0	1	60	300	9	9	9	-9	3	6
2	0.1	4.1	1	10	16	8	5.2	1	1	90	23.3	24.2	-1	1	39	0	0	1	60	300	9	9	9	9	3	0
2	0.1	4.1	1	10	16	8	5.2	1	1	90	23.3	24.2	-1	1	39	0	0	1	60	300	9	9	9	9	3	0

EOF

CG-6007 MAY 18 1992

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.1	0.1	0	15	12	0.2	4.6	1	0	80	24.3	24.5	-1	1	-3	0	0	0.7	90	300	3	510	12	8	2	-1
1	0.6	0.1	0	15	12	0.2	4.6	1	1	80	24.3	24.5	-1	1	-3	0	0	0.7	90	300	3	510	12	9	1	1
1	0.2	0.6	0	15	12	0.2	4.9	1	1	80	24.3	24.5	-1	1	2	0	0	0.7	90	300	3	510	12	9	2	-1
1	0.2	0.7	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	3	0	0	0.7	90	300	3	510	12	9	1	0
1	0.3	0.8	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	4	1	-1	0.7	90	300	3	510	12	10	2	-1
1	0.5	1.1	0	15	12	0.2	4.9	1	0	80	24.4	24.5	-1	1	7	1	0	0.7	90	300	4	513	6	2	2	-1
1	0.5	1.1	0	15	12	0.2	4.9	1	0	80	24.4	24.5	1	1	8	1	0	0.7	90	300	2	504	400	3	2	-1
1	0.3	1.4	0	15	12	0.2	4.6	1	0	78	24.4	24.5	0	1	10	1	0	0.7	90	300	2	504	400	1	2	-1
1	0.8	1.5	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	12	1	0	0.7	90	300	2	504	400	3	2	-1
1	0.2	1.5	0	15	12	0.2	4.6	1	0	78	24.4	24.5	1	1	12	1	0	0.7	90	300	2	504	400	2	2	0
2	1.8	0	0	15	12	0.2	4.6	1	1	80	24.3	24.5	-1	1	-4	0	0	0.7	90	300	-9	9	-9	-9	2	-1
2	2.3	0.1	0	15	12	0.2	4.6	1	1	80	24.3	24.5	1	1	-3	0	0	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.2	0.3	0	15	12	0.2	4.9	1	1	80	24.3	24.5	-1	1	-1	0	0	0.7	90	300	-9	-9	9	-9	2	-1
2	1.5	0.3	0	15	12	0.2	4.9	1	1	80	24.3	24.5	-1	1	-1	0	0	0.7	90	300	-9	-9	9	-9	1	0
2	0.3	0.3	0	15	12	0.2	4.9	1	-1	80	24.3	24.5	1	1	-1	0	0	0.7	90	300	9	-9	9	-9	1	1
2	0.6	0.4	0	15	12	0.2	4.9	1	-1	80	24.3	24.5	1	1	0	0	0	0.7	90	300	9	-9	-9	-9	2	1
2	1.4	0.4	0	15	12	0.2	4.9	1	1	80	24.3	24.5	-1	1	0	0	0	0.7	90	300	-9	-9	-9	9	2	1
2	0.5	0.4	0	15	12	0.2	4.9	1	1	80	24.3	24.5	-1	1	1	0	0	0.7	90	300	-9	-9	9	-9	2	-1
2	1.6	0.5	0	15	12	0.2	4.9	1	-1	80	24.3	24.5	1	1	1	0	0	0.7	90	300	9	-9	9	9	2	-1
2	1.1	0.5	0	15	12	0.2	4.9	1	-1	80	24.3	24.5	1	1	2	0	0	0.7	90	300	-9	9	-9	-9	1	1
2	0.7	0.5	0	15	12	0.2	4.9	1	1	80	24.3	24.5	1	1	2	0	0	0.7	90	300	-9	9	-9	9	1	0
2	0.6	0.7	0	15	12	0.2	4.9	1	1	80	24.4	24.5	1	1	3	0	0	0.7	90	300	9	9	-9	-9	2	-1
2	2.1	0.7	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	3	0	0	0.7	90	300	-9	9	-9	9	1	1
2	2.3	0.7	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	4	1	0	0.7	90	300	-9	-9	9	9	2	-1
2	2.4	0.8	0	15	12	0.2	4.9	1	1	80	24.4	24.5	-1	1	4	1	0	0.7	90	300	-9	9	9	9	2	1
2	1.4	0.8	0	15	12	0.2	4.9	1	1	80	24.4	24.5	1	1	4	1	0	0.7	90	300	9	-9	9	9	2	1
2	1.4	0.8	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	4	1	0	0.7	90	300	-9	9	9	9	2	1
2	1.1	0.9	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	5	1	0	0.7	90	300	9	9	9	9	1	0
2	1.5	0.9	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	5	1	0	0.7	90	300	9	9	9	9	2	1
2	2.2	1	0	15	12	0.2	4.9	1	-1	80	24.4	24.5	1	1	7	1	0	0.7	90	300	-9	9	9	9	1	0
2	2.4	1	0	15	12	0.2	4.9	1	1	80	24.4	24.5	-1	1	7	1	0	0.7	90	300	9	-9	9	9	2	1
2	2.3	1.1	0	15	12	0.2	4.9	1	1	80	24.4	24.5	1	1	7	1	0	0.7	90	300	9	-9	9	9	2	1
2	1.4	1.2	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	8	1	0	0.7	90	300	9	-9	9	9	2	1
2	1.5	1.3	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	9	1	0	0.7	90	300	9	-9	9	9	2	1
2	0.5	1.3	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	9	1	0	0.7	90	300	9	9	9	9	2	1
2	0.9	1.3	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	10	1	0	0.7	90	300	9	9	9	9	2	0
2	1.5	1.4	0	15	12	0.2	4.6	1	-1	78	24.4	24.5	1	1	11	1	0	0.7	90	300	-9	-9	9	9	2	1
2	2.4	1.5	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	11	1	0	0.7	90	300	-9	9	9	9	2	1
2	0.5	1.6	0	15	12	0.2	4.6	1	1	78	24.4	24.5	1	1	13	1	0	0.7	90	300	-9	9	9	9	2	1
2	1.5	1.6	0	15	12	0.2	4.6	1	1	78	24.5	24.5	1	1	13	1	0	0.7	90	300	9	9	9	9	2	1
2	1	1.7	0	15	12	0.2	4.6	1	1	78	24.5	24.5	1	1	14	1	0	0.7	90	300	9	9	9	9	2	0
2	[illegible]	1.7	0	15	12	0.2	4.6	1	1	78	24.5	24.5	1	1	14	1	0	0.7	90	300	9	9	9	9	2	1
[illegible]	0.4	2	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	20	1	1	0.7	90	300	4	513	6	2	2	1
[illegible]	0.2	2	0	15	12	0.1	4.3	1	1	78	24.4	24.4	1	1	20	1	1	0.7	90	300	2	504	400	1	2	1
[illegible]	0.4	2.3	0	15	12	0.1	4.3	1	-1	78	24.4	24.4	1	1	22	1	1	0.7	90	300	2	504	400	1	2	1
1	1.2	2.7	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	26	1	-1	0.7	90	300	2	504	400	3	2	1
[illegible]	0.1	2.7	0	15	12	0.1	4.3	1	1	78	24.4	24.4	1	1	26	1	0	0.7	90	300	1	503	160	12	1	1
[illegible]	0.6	2.8	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	27	1	0	0.7	90	300	3	510	12	10	1	0
[illegible]	0.1	2.8	0	15	13	0.1	4.3	1	1	78	24.3	24.4	1	1	27	1	0	0.7	90	300	2	504	400	1	2	0
[illegible]	1.4	2.9	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	28	1	1	0.7	90	300	2	504	400	2	1	0
[illegible]	0.2	3	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	29	1	0	0.7	90	300	1	503	160	10	2	1
[illegible]	[illegible]	3.2	0	15	13	0.4	4.3	1	0	78	24.3	24.4	1	1	30	1	-1	0.7	90	300	2	504	400	2	2	1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.4	3.3	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	31	1	-1	0.7	90	300	1	503	160	9	2	-1
2	1	1.8	0	15	12	0.2	4.6	1	0	78	24.5	24.5	0	1	18	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.4	1.8	0	15	12	0.2	4.6	1	0	78	24.5	24.5	0	1	18	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.5	1.9	0	15	12	0.2	4.6	1	0	78	24.4	24.4	0	1	19	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.2	1.9	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	19	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.8	2.1	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	20	1	-1	0.7	90	300	-9	-9	9	-9	2	-1
2	0.5	2.1	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	21	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.4	2.1	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	21	1	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.7	2.1	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	21	1	-1	0.7	90	300	-9	-9	-9	-9	2	1
2	2.4	2.2	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	22	1	-1	0.7	90	300	-9	-9	-9	-9	2	1
2	2.4	2.2	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	23	1	-1	0.7	90	300	-9	-9	-9	-9	2	1
2	1.2	2.3	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	23	1	-1	0.7	90	300	-9	-9	9	-9	2	1
2	1.5	2.4	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	24	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	0.9	2.5	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	25	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	2.4	2.5	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	25	1	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.8	2.5	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	25	1	1	0.7	90	300	-9	9	-9	-9	1	1
2	0.7	2.5	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	26	1	1	0.7	90	300	-9	-9	-9	-9	1	1
2	1.2	2.6	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	26	1	1	0.7	90	300	-9	-9	-9	-9	1	0
2	0.4	2.6	0	15	12	0.1	4.3	1	0	78	24.4	24.4	0	1	27	1	-1	0.7	90	300	-9	-9	9	-9	2	1
2	0.4	2.7	0	15	13	0.1	4.3	1	0	78	24.3	24.4	0	1	27	1	1	0.7	90	300	-9	-9	-9	-9	1	0
2	1.8	2.8	0	15	13	0.1	4.3	1	0	78	24.3	24.4	0	1	28	1	1	0.7	90	300	-9	-9	-9	-9	2	1
2	2.3	2.8	0	15	13	0.1	4.3	1	0	78	24.3	24.4	0	1	28	1	-1	0.7	90	300	-9	-9	9	9	2	-1
2	1	2.9	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	28	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	2.1	3	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	28	1	-1	0.7	90	300	-9	-9	9	9	1	1
2	1.7	3.1	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	29	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	0.8	3.1	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	29	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	2.1	3.2	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	30	1	-1	0.7	90	300	-9	9	-9	-9	2	1
2	1.2	3.3	0	15	13	0.4	4.3	1	0	78	24.3	24.4	0	1	31	1	1	0.7	90	300	-9	9	9	9	2	1
1	0.4	3.5	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	0	0.7	90	300	2	504	400	2	2	1
1	0.5	3.6	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	0	0.7	90	300	4	513	6	2	2	1
1	0.3	3.7	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	0	0.7	90	300	4	513	6	2	2	1
1	0.3	3.7	0	15	12	0.2	4.6	1	1	78	24.3	24.4	-1	1	38	1	0	0.7	90	300	2	504	400	1	2	1
1	1.6	3.7	0	15	12	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	-1	0.7	90	300	[illegible]	510	12	9	2	1
1	0.5	3.9	0	15	12	0.1	4.6	1	0	78	24.3	24.4	1	1	38	1	0	0.7	90	300	4	513	6	2	2	1
1	0.5	4.2	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	37	1	1	0.7	90	300	1	503	160	11	2	1
1	1.2	4.3	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	1	0.7	90	300	2	504	400	2	2	1
1	0.3	4.3	0	15	12	0.1	4.6	1	-1	78	24.2	24.4	1	1	36	1	0	0.7	90	300	4	513	6	2	1	1
1	0.7	4.4	0	15	12	0.1	[illegible]	1	0	78	24.2	24.4	-1	1	36	1	1	0.7	90	300	3	510	12	10	1	0
1	0.1	4.4	0	15	12	0.1	[illegible]	1	1	78	24.2	24.4	-1	1	36	1	0	0.7	90	300	2	504	400	1	2	0
1	0.3	4.6	0	15	12	0.1	4.5	1	0	78	24.2	24.4	-1	1	35	1	0	0.7	90	300	2	504	400	11	2	1
1	0.4	4.9	0	15	13	0.1	4.3	1	0	78	24.1	24.4	0	1	35	1	1	0.7	90	300	3	510	12	10	2	1
2	2.2	3.4	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	9	9	9	9	2	1
2	2.4	3.4	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	9	9	9	9	2	1
2	0.7	3.5	0	15	11	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	9	9	9	-9	2	1
2	1.6	3.7	0	15	12	0.2	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	-9	9	9	9	2	1
2	2	3.8	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	9	9	9	9	2	1
2	2.4	3.8	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	9	-9	9	9	2	1
2	2.4	3.9	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	38	1	1	0.7	90	300	-9	-9	9	9	2	1
2	1.5	3.9	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	-1	0.7	90	300	-9	9	9	9	2	1
2	1.5	4	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	9	9	-9	-9	2	1
2	0.6	4.1	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	-9	9	-9	9	2	1
2	2.4	4.1	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	-9	9	9	9	1	0
2	1.7	4.1	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	-9	9	9	9	1	1
2	0.7	4.1	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	9	9	9	9	1	1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	1.2	4.2	0	15	12	0.1	4.6	1	0	78	24.3	24.4	0	1	39	1	1	0.7	90	300	-9	-9	-9	-9	1	0
2	1	4.3	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	40	1	1	0.7	90	300	-9	-9	-9	-9	2	0
2	0.4	4.3	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	40	1	1	0.7	90	300	-9	-9	-9	-9	1	0
2	1.7	4.4	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	40	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	2.3	4.4	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.9	4.4	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	-1	0.7	90	300	-9	-9	-9	-9	2	0
2	0.8	4.5	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	-1	0.7	90	300	-9	-9	-9	-9	1	0
2	0.7	4.6	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	1	0.7	90	300	-9	-9	-9	-9	2	1
2	2.2	4.6	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	36	1	-1	0.7	90	300	-9	-9	-9	-9	1	1
2	1.6	4.6	0	15	12	0.1	4.6	1	0	78	24.2	24.4	0	1	35	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.8	4.7	0	15	13	0.1	4.6	1	0	78	24.1	24.4	0	1	35	1	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.2	4.7	0	15	13	0.1	4.6	1	0	78	24.1	24.4	0	1	35	1	1	0.7	90	300	-9	-9	9	-9	2	1
2	2.2	4.8	0	15	13	0.1	4.3	1	0	78	24.1	24.4	0	1	35	1	-1	0.7	90	300	-9	9	9	-9	2	1
2	1.2	4.9	0	15	13	0.1	4.3	1	0	78	24.1	24.4	0	1	34	1	1	0.7	90	300	-9	9	9	-9	2	-1

EOF

CG-6007 MAY 20 1992

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.1	0.1	0	15	11	7	3.6	1	1	72	24.6	24.7	-1	1	-34	0	1	0.7	90	300	2	503	160	1	2	-1
1	0.2	0.5	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-29	0	0	0.7	90	300	2	503	160	9	1	1
1	1	0.7	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-26	0	0	0.7	90	300	3	512	1	9	2	-1
2	0.3	0.1	0	15	11	7	3.6	1	0	72	24.6	24.7	0	1	-35	0	0	0.7	90	300	-9	-9	-9	-9	1	0
2	1.4	0.1	0	15	11	7	3.6	1	0	72	24.6	24.7	0	1	-35	0	0	0.7	90	300	-9	-9	-9	-9	2	-1
2	1.1	0.1	0	15	11	7	3.6	1	0	72	24.6	24.7	0	1	-34	0	0	0.7	90	300	-9	9	-9	-9	2	-1
2	0.5	0.2	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-33	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.7	0.2	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-33	0	0	0.7	90	300	-9	-9	-9	-9	1	0
2	0.2	0.3	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-32	0	0	0.7	90	300	-9	-9	-9	-9	1	0
2	0.7	0.3	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-32	0	0	0.7	90	300	-9	-9	-9	9	2	1
2	0.5	0.3	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-31	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.9	0.4	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-30	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.7	0.4	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-30	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	1	0.5	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-29	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.9	0.6	0	15	13	7	3.6	1	0	72	24.7	24.6	0	1	-27	0	0	0.7	90	300	-9	-9	-9	9	2	1
2	0.6	0.8	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-25	0	0	0.7	90	300	-9	-9	-9	9	1	1
2	1.2	0.8	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-24	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.4	0.9	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-24	0	0	0.7	90	300	9	-9	-9	9	2	1
2	0.4	1	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-23	0	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.3	1	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-22	0	0	0.7	90	300	-9	9	-9	9	2	1
2	0.7	1.1	0	15	11	7	3.6	1	0	72	24.7	24.7	0	1	-22	0	0	0.7	90	300	-9	9	9	9	2	1
1	0.5	1.3	0	15	11	3	3.6	1	1	78	24.6	24.6	-1	1	-3	0	1	0.7	90	300	1	503	400	10	2	1
1	0.3	1.6	0	15	11	3	3.6	1	0	78	24.6	24.6	-1	1	-1	0	0	0.7	90	300	2	511	1	3	1	0
1	0.3	1.7	0	15	11	3	3.6	1	0	78	24.6	24.6	-1	1	1	1	1	0.7	90	300	1	504	400	10	1	1
1	0.1	1.9	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	3	1	0	0.7	90	300	2	503	160	3	2	1
1	0.1	2.2	0	15	10	3	3.6	1	0	78	24.5	24.6	-1	1	6	1	0	0.7	90	300	2	504	400	1	2	1
1	0.5	2.3	0	15	10	3	3.6	1	0	78	24.5	24.6	0	1	8	1	1	0.7	90	300	1	503	160	11	1	1
1	0.2	2.4	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	8	1	0	0.7	90	300	4	511	1	3	2	1
1	0.3	2.5	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	10	1	0	0.7	90	300	2	504	400	3	1	0
1	0.2	2.6	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	11	1	-1	0.7	90	300	2	504	400	4	1	0
1	0.5	2.8	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	13	1	-1	0.7	90	300	3	512	1	9	2	1
2	0.5	1.5	0	15	11	3	3.6	1	1	78	24.6	24.6	-1	1	-2	1	0	0.7	90	300	9	-9	9	9	2	1
2	0.8	1.5	0	15	11	3	3.6	1	1	78	24.6	24.6	1	1	-1	1	0	0.7	90	300	9	9	9	9	2	1
2	0.3	1.7	0	15	11	3	3.6	1	-1	78	24.6	24.6	1	1	0	1	0	0.7	90	300	-9	9	9	9	2	0
2	0.1	1.8	0	15	11	3	3.6	1	0	78	24.6	24.6	0	1	2	1	0	0.7	90	300	-9	9	9	9	2	1
2	1	1.8	0	15	11	3	3.6	1	-1	78	24.6	24.6	1	1	2	1	0	0.7	90	300	9	9	9	9	2	1
2	0.8	1.8	0	15	11	3	3.6	1	-1	78	24.6	24.6	1	1	2	1	0	0.7	90	300	-9	-9	9	9	1	1
2	0.4	1.8	0	15	11	3	3.6	1	1	78	24.6	24.6	-1	1	2	1	0	0.7	90	300	-9	9	9	9	2	1
2	0.7	2	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	3	1	0	0.7	90	300	9	-9	9	9	1	0
2	0.7	2	0	15	10	3	3.6	1	1	78	24.5	24.6	1	1	4	1	0	0.7	90	300	9	9	9	9	2	1
2	0.3	2	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	4	1	0	0.7	90	300	9	9	9	9	2	1
2	0.4	2.2	0	15	10	3	3.6	1	1	78	24.5	24.6	1	1	6	1	0	0.7	90	300	9	9	9	-9	1	0
2	0.8	2.3	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	7	1	0	0.7	90	300	9	9	9	9	2	1
2	0.9	2.4	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	9	1	0	0.7	90	300	9	9	9	9	2	1
2	0.5	2.5	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	10	1	0	0.7	90	300	9	9	9	9	1	1
2	0.7	2.7	0	15	10	3	3.6	1	1	78	24.5	24.6	1	1	11	1	0	0.7	90	300	9	9	9	9	2	1
2	1.5	1.6	0	15	11	3	3.6	1	1	78	24.6	24.6	-1	1	1	1	0	0.7	90	300	-9	-9	9	9	2	1
2	1.5	2	0	15	10	3	3.6	1	1	78	24.5	24.6	1	1	4	1	0	0.7	90	300	9	9	9	-9	2	1
2	1.1	2.1	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	5	1	0	0.7	90	300	9	9	9	9	2	1
2	1.5	2.5	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	9	1	0	0.7	90	300	9	9	9	9	2	1
1	0.1	2.9	0	15	10	3	3.6	1	0	78	24.5	24.6	0	1	16	1	1	0.7	90	300	1	504	400	11	2	1
1	0.3	3.2	0	15	10	3	3.6	1	0	78	24.5	24.6	1	1	18	1	0	0.7	90	300	1	504	400	1	1	0
1	0.3	3.3	0	15	9	3	3.6	1	-1	78	24.4	24.6	1	1	20	1	0	0.7	90	300	4	511	1	3	1	0
1	0.1	3.3	0	15	9	3	3.6	1	0	78	24.4	24.6	0	1	20	1	0	0.7	90	300	2	503	160	12	1	1
1	0.3	3.4	0	15	9	3	3.6	1	0	78	24.4	24.6	0	1	21	1	0	0.7	90	300	1	504	400	1	2	1
1	0.1	3.5	0	15	9	3	3.6	1	0	78	24.4	24.6	-1	1	22	1	0	0.7	90	300	2	503	160	1	2	[illegible]

CG-6007 MAY 20 1992 (continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.5	3.6	0	15	9	3	3.6	1	-1	78	24.4	24.6	1	1	24	1	0	0.7	90	300	4	511	1	3	2	-1
1	0.1	3.8	0	15	9	3	3.6	1	0	78	24.4	24.6	0	1	25	1	0	0.7	90	300	1	504	400	12	2	-1
1	0.4	3.8	0	15	9	3	3.3	1	0	78	24.4	24.6	0	1	25	1	-1	0.7	90	300	1	504	400	11	1	0
1	0.6	3.9	0	15	9	3	3.3	1	0	78	24.4	24.6	-1	1	26	1	0	0.7	90	300	3	512	1	8	1	1
1	0.5	4.1	0	15	9	3	3.3	1	-1	78	24.4	24.6	1	1	28	1	-1	0.7	90	300	3	512	1	10	1	1
1	0.4	4.1	0	15	9	3	3.3	1	1	78	24.4	24.6	-1	1	28	1	0	0.7	90	300	4	511	1	3	1	0
1	0.2	4.2	0	15	9	3	3.3	1	-1	78	24.4	24.6	1	1	29	1	0	0.7	90	300	4	511	1	3	1	0
1	0.5	4.4	0	15	9	3	3.3	1	0	78	24.3	24.5	0	1	30	1	-1	0.7	90	300	1	504	400	11	2	1
2	0.7	3.1	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	18	1	0	0.7	90	300	-9	9	9	9	2	1
2	0.9	3.1	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	18	1	0	0.7	90	300	9	-9	-9	-9	1	1
2	0.4	3.4	0	15	9	3	3.6	1	-1	78	24.4	24.6	1	1	20	1	0	0.7	90	300	-9	-9	-9	9	2	1
2	1	3.6	0	15	9	3	3.6	1	1	78	24.4	24.6	-1	1	23	1	0	0.7	90	300	-9	9	-9	9	1	0
2	0.5	3.6	0	15	9	3	3.6	1	-1	78	24.4	24.6	1	1	23	1	0	0.7	90	300	-9	-9	-9	-9	2	1
2	1	3.9	0	15	9	3	3.3	1	-1	78	24.4	24.6	1	1	25	1	0	0.7	90	300	9	-9	-9	-9	1	0
2	0.6	3.9	0	15	9	3	3.3	1	-1	78	24.4	24.6	1	1	26	1	0	0.7	90	300	-9	9	-9	-9	2	1
2	0.1	4	0	15	9	3	3.3	1	1	78	24.4	24.6	-1	1	27	1	0	0.7	90	300	-9	9	-9	9	2	1
2	0.9	4.1	0	15	9	3	3.3	1	-1	78	24.4	24.6	1	1	27	1	0	0.7	90	300	-9	-9	-9	-9	2	1
2	0.9	4.3	0	15	9	3	3.3	1	1	78	24.3	24.5	-1	1	29	1	0	0.7	90	300	-9	-9	-9	9	2	-1
2	1.3	3.2	0	15	10	3	3.6	1	-1	78	24.5	24.6	1	1	19	1	0	0.7	90	300	9	-9	-9	9	2	-1
2	1.4	3.2	0	15	10	3	3.6	1	1	78	24.5	24.6	-1	1	19	1	0	0.7	90	300	9	-9	-9	9	2	1
2	1.4	3.3	0	15	9	3	3.6	1	1	78	24.4	24.6	-1	1	20	1	0	0.7	90	300	-9	9	-9	9	2	-1
2	1.5	3.4	0	15	9	3	3.6	1	-1	78	24.4	24.6	1	1	21	1	0	0.7	90	300	9	9	-9	9	2	1
2	1.5	3.6	0	15	9	3	3.6	1	1	78	24.4	24.6	-1	1	23	1	0	0.7	90	300	9	-9	9	-9	2	1
2	1.2	3.7	0	15	9	3	3.6	1	1	78	24.4	24.6	-1	1	24	1	0	0.7	90	300	-9	-9	9	9	2	1
2	1.5	4.1	0	15	9	3	3.3	1	1	78	24.4	24.6	-1	1	28	1	0	0.7	90	300	9	9	9	9	2	1

EOF

CG-6007 MAY 22 1992

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.4	0.2	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-42	0	1	0.7	90	300	2	504	306	2	2	-1
1	0.2	0.2	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-41	0	1	0.7	90	300	3	510	18	9	2	-1
1	0.2	0.3	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-40	0	1	0.7	90	300	2	504	306	2	2	-1
1	0.4	0.4	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-40	0	1	0.7	90	300	3	510	18	9	2	-1
1	0	0.6	0	15	14	6	5.2	1	0	68	24.6	25	0	1	-37	0	0	0.7	90	300	2	504	306	12	2	-1
2	0.3	0.1	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-43	0	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.3	0.2	0	15	15	6	5.9	1	-1	68	24.7	25	1	1	-42	0	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.6	0.2	0	15	15	6	5.9	1	-1	68	24.7	25	1	1	-42	0	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.7	0.3	0	15	15	6	5.9	1	-1	68	24.7	25	1	1	-41	0	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.6	0.4	0	15	15	6	5.9	1	-1	68	24.7	25	1	1	-39	0	-1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.8	0.5	0	15	15	6	5.9	1	1	68	24.7	25	-1	1	-38	0	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.8	0.5	0	15	14	6	5.9	1	-1	68	24.6	25	1	1	-38	0	-1	0.7	90	300	-9	-9	-9	-9	2	1
2	0.6	0.6	0	15	14	6	5.2	1	1	68	24.6	25	-1	1	-37	0	1	0.7	90	300	-9	-9	-9	9	2	1
2	0.5	0.7	0	15	14	6	5.2	1	-1	68	24.6	25	1	1	-36	0	-1	0.7	90	300	-9	-9	-9	-9	2	-1
1	0.4	0.9	0	15	13	6	5.2	1	1	68	24.6	25	1	1	32	0	1	0.7	90	300	3	510	18	9	2	-1
1	0.2	1	0	15	13	6	5.2	1	0	68	24.6	25	-1	1	-30	0	0	0.7	90	300	4	513	12	2	2	1
1	0.2	1	0	15	13	6	5.2	1	1	68	24.6	25	-1	1	-30	0	1	0.7	90	300	1	503	166	9	2	-1
2	0.3	0.8	0	15	14	6	5.2	1	1	68	24.6	25	-1	1	-33	0	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.4	0.8	0	15	14	6	5.2	1	1	68	24.6	25	-1	1	33	0	1	0.7	90	300	-9	-9	-9	-9	2	-1
2	0.3	0.9	0	15	14	6	5.2	1	-1	68	24.6	25	1	1	-32	0	-1	0.7	90	300	-9	-9	-9	9	2	-1
2	0.7	0.9	0	15	14	6	5.2	1	-1	68	24.6	25	1	1	-32	0	-1	0.7	90	300	-9	-9	9	-9	2	1
2	0.7	1	0	15	13	6	5.2	1	-1	68	24.6	25	1	1	31	0	-1	0.7	90	300	-9	-9	9	9	2	-1
2	0.6	1.1	0	15	13	6	5.2	1	-1	68	24.6	25	1	1	29	0	-1	0.7	90	300	-9	-9	-9	-9	2	1
2	1	1.1	0	15	13	6	5.2	1	1	68	24.6	25	-1	1	-29	0	1	0.7	90	300	-9	-9	-9	9	2	1
2	1	1.2	0	15	13	6	5.2	1	-1	68	24.6	25	1	1	28	0	1	0.7	90	300	-9	-9	-9	9	2	1
2	0.5	1.3	0	15	13	6	5.2	1	1	68	24.6	25	-1	1	27	0	1	0.7	90	300	-9	-9	-9	9	2	1
2	0.1	1.3	0	15	13	6	5.2	1	1	68	24.6	25	-1	1	26	0	1	0.7	90	300	-9	-9	9	-9	2	-1
2	0.7	1.4	0	15	13	6	5.2	1	-1	68	24.6	25	1	1	-25	0	-1	0.7	90	300	-9	9	9	9	2	1
1	0.2	1.5	0	15	13	3	5.6	1	0	77	24.5	24.9	1	1	-22	0	0	0.7	90	300	4	513	12	2	2	1
1	0.3	1.6	0	15	13	3	5.6	1	0	77	24.5	24.9	1	1	22	0	0	0.7	90	300	4	513	12	2	2	1
1	0.2	1.6	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	-21	0	1	0.7	90	300	1	503	166	9	2	1
1	0.3	1.7	0	15	13	3	5.6	1	0	77	24.5	24.9	-1	1	-20	0	0	0.7	90	300	2	504	306	2	2	1
1	0	2	0	15	13	3	5.6	1	0	77	24.5	24.9	0	1	17	0	0	0.7	90	300	2	504	306	12	2	1
2	0.6	1.6	0	15	13	3	5.6	1	-1	77	24.5	24.9	1	1	21	1	-1	0.7	90	300	9	-9	9	9	2	1
2	0.9	1.6	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	-21	0	1	0.7	90	300	-9	-9	-9	9	2	1
2	0.7	1.7	0	15	13	3	5.6	1	-1	77	24.5	24.9	1	1	21	0	-1	0.7	90	300	-9	9	9	9	2	1
2	0.4	1.8	0	15	13	3	5.6	1	1	77	24.5	24.9	-1	1	-20	0	1	0.7	90	300	-9	9	9	9	2	1
2	0.5	1.8	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	19	0	-1	0.7	90	300	-9	-9	9	9	2	1
2	0.7	1.9	0	15	13	3	5.6	1	-1	77	24.5	24.9	1	1	18	0	1	0.7	90	300	-9	-9	9	9	2	1
2	0.6	1.9	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	17	0	1	0.7	90	300	-9	9	9	9	2	1
2	1	2	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	17	0	-1	0.7	90	300	9	-9	9	9	2	1
2	0.5	2	0	15	13	3	5.6	1	1	77	24.5	24.9	1	1	16	0	1	0.7	90	300	9	9	9	9	2	1
1	0.1	2.1	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	2	0	0	0.7	90	300	4	513	12	3	2	1
1	0.1	2.6	0	15	11	3	5.2	1	-1	77	24.5	24.8	1	1	8	1	0	0.7	90	300	2	504	306	12	2	1
2	0.1	2.2	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	2	0	0	0.7	90	300	9	9	9	-9	2	1
2	0.9	2.2	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	3	0	0	0.7	90	300	-9	9	-9	9	2	1
2	0.8	2.3	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	3	0	0	0.7	90	300	-9	9	-9	9	2	1
2	0.5	2.3	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	4	0	0	0.7	90	300	9	9	-9	9	2	1
2	0.1	2.3	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	4	0	0	0.7	90	300	-9	9	9	9	2	1
2	0.8	2.4	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	4	0	0	0.7	90	300	-9	9	-9	9	2	1
2	0	2.4	0	15	11	3	5.2	1	1	77	24.5	24.8	1	1	5	0	0	0.7	90	300	-9	9	9	9	2	1
2	0.7	2.4	0	15	11	3	5.2	1	0	77	24.5	24.8	0	1	5	0	0	0.7	90	300	9	9	-9	9	2	1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.2	0.1	0	15	11	0	2.6	0	0	80	25.9	25.4	-1	1	-59	0	0	0.5	90	300	2	506	8	3	3	5
1	0.2	0.9	0	15	12	0	2.6	0	1	75	26	25.3	0	1	-53	0	0	0.5	90	300	3	515	100	8	3	5
2	1	0.1	0	15	11	0	2.6	0	0	80	25.9	25.4	0	1	-59	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.3	0.3	0	15	11	0	2.6	0	0	80	25.9	25.4	0	1	-58	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.9	0.3	0	15	11	0	2.6	0	0	80	25.9	25.4	0	1	-58	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.3	0.3	0	15	11	0	2.6	0	0	80	25.9	25.4	0	1	-58	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.8	0.4	0	15	11	0	2.6	0	0	80	25.9	25.4	0	1	-57	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.6	0.4	0	15	12	0	2.6	0	0	80	26	25.3	0	1	-57	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.1	0.5	0	15	12	0	2.6	0	0	80	26	25.3	0	1	-57	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.5	0.5	0	15	12	0	2.6	0	0	80	26	25.3	0	1	-56	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.9	0.8	0	15	12	0	2.6	0	0	80	26	25.3	0	1	-55	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.3	0.8	0	15	12	0	2.6	0	0	80	26	25.3	0	1	-54	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.8	0.8	0	15	12	0	2.6	0	0	75	26	25.3	0	1	-54	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.8	0.9	0	15	12	0	2.6	0	0	75	26	25.3	0	1	-53	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.3	1	0	15	12	0	3	0	0	75	26	25.3	0	1	-53	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.7	1.2	0	15	12	0	3	0	0	75	26	25.3	0	1	-51	0	0	0.5	90	300	-9	-9	-9	-9	3	5
2	0.4	1.3	0	15	12	0	3	0	0	75	26	25.3	0	1	-50	0	0	0.5	90	300	-9	-9	-9	-9	3	5
1	0.1	1.5	0	15	13	0	3	0	0	74	25.9	25.3	1	1	-41	0	-1	0.5	90	300	3	515	100	8	3	5
1	0.1	1.6	0	15	13	0	3	0	0	74	25.9	25.3	0	1	-40	0	0	0.5	90	300	1	505	100	8	3	5
2	0.8	1.4	0	15	11	0	3	0	0	74	26	25.3	-1	1	-43	0	1	0.5	90	300	-9	-9	-9	-9	3	5
2	0.4	1.5	0	15	13	0	3	0	0	74	25.9	25.3	1	1	-42	0	-1	0.5	90	300	-9	-9	-9	9	3	5
2	1	1.5	0	15	13	0	3	0	0	74	25.9	25.3	-1	1	-41	0	1	0.5	90	300	-9	-9	-9	-9	3	5
2	0.8	1.6	0	15	13	0	3	0	0	74	25.9	25.3	1	1	-40	0	-1	0.5	90	300	-9	-9	-9	9	3	5
2	0.6	1.7	0	15	13	0	3	0	0	74	25.9	25.3	-1	1	-40	0	1	0.5	90	300	-9	-9	-9	-9	3	5
2	0.9	1.7	0	15	13	0	3	0	0	74	25.9	25.3	-1	1	-39	0	1	0.5	90	300	-9	-9	9	-9	3	5
2	0.6	1.7	0	15	13	0	3	0	0	74	25.9	25.3	1	1	-39	0	1	0.5	90	300	9	-9	-9	9	3	5
2	1	1.8	0	15	13	0	3	0	0	74	25.9	25.3	1	1	-38	0	-1	0.5	90	300	9	-9	9	9	3	5
2	0.5	1.9	0	15	13	0	3	0	0	74	25.9	25.3	-1	1	-38	0	1	0.5	90	300	-9	-9	9	-9	3	5
2	0	2	0	15	10	0	3	0	0	74	25.6	25.3	0	1	-37	0	0	0.5	90	300	9	-9	-9	-9	3	5
2	1	2	0	15	10	0	3	0	0	74	25.6	25.3	1	1	-36	0	1	0.5	90	300	-9	9	9	9	3	5
2	0.2	2	0	15	10	0	3	0	0	74	25.6	25.3	-1	1	-36	0	1	0.5	90	300	9	9	9	9	3	5
2	0.6	2.1	0	15	10	0	3	0	0	74	25.6	25.3	1	1	-36	0	-1	0.5	90	300	-9	-9	-9	9	3	5
2	0.5	2.3	0	15	10	0	3	0	0	74	25.6	25.3	-1	1	-33	0	1	0.5	90	300	-9	-9	-9	9	3	5
2	0.6	2.4	0	15	10	0	3	0	0	69	25.6	25.3	1	1	32	0	-1	0.5	90	300	-9	-9	9	9	3	5
2	0.8	2.7	0	15	7	0	2.6	0	0	69	25.5	25.3	-1	1	-7	0	1	0.5	90	300	9	-9	9	9	3	5
2	0.4	2.7	0	15	7	0	2.6	0	0	69	25.5	25.3	-1	1	7	0	1	0.5	90	300	9	-9	9	9	3	5
2	0.5	2.8	0	15	7	0	2.6	0	0	68	25.5	25.3	1	1	-5	0	1	0.5	90	300	-9	-9	9	9	3	5
2	0.2	2.8	0	15	8	0	2.6	0	0	68	25.4	25.3	1	1	-5	0	-1	0.5	90	300	9	-9	-9	9	3	5
2	0.7	2.9	0	15	8	0	2.6	0	0	68	25.4	25.3	-1	1	-4	0	1	0.5	90	300	9	9	9	9	3	5
2	0.1	2.9	0	15	8	0	2.6	0	0	68	25.4	25.3	1	1	4	0	1	0.5	90	300	9	9	9	9	3	5
2	0.8	2.9	0	15	8	0	2.3	0	0	68	25.4	25.3	1	1	4	0	1	0.5	90	300	9	9	9	9	3	5
2	0.6	3	0	15	8	0	2.3	0	0	68	25.4	25.3	-1	1	-3	0	1	0.5	90	300	9	-9	9	9	3	5
2	0.9	3	0	15	8	0	2.3	0	0	68	25.4	25.3	-1	1	-3	0	1	0.5	90	300	-9	-9	9	9	3	5
2	0.5	3	0	15	8	0	2.3	0	0	68	25.4	25.3	1	1	-2	0	1	0.5	90	300	-9	9	9	9	3	5
2	0.4	3.2	0	15	8	0	2.3	0	0	68	25.4	25.3	-1	1	-1	0	1	0.5	90	300	9	9	9	9	3	5
2	0.1	3.3	0	15	8	0	2.3	0	0	68	25.4	25.3	-1	1	0	0	1	0.5	90	300	9	9	9	9	3	5
2	0.1	3.3	0	15	8	0	2.3	0	0	68	25.1	25.3	-1	1	1	0	1	0.5	90	300	9	-9	-9	9	3	5
2	1	3.4	0	15	8	0	2.3	0	0	68	25.1	25.3	1	1	2	0	1	0.5	90	300	9	9	9	9	3	5
2	0.7	3.5	0	15	8	0	2.3	0	0	68	25.1	25.3	1	1	3	0	-1	0.5	90	300	9	9	9	9	3	5
2	0.4	3.7	0	15	8	0	2.3	0	0	68	25.1	25.3	1	1	4	0	1	0.5	90	300	9	9	9	9	3	5
2	0.3	3.8	0	15	8	0	2.3	0	0	67	25.1	25.3	1	1	5	1	1	0.5	90	300	9	-9	-9	9	3	5

EOF

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
1	0.2	0.3	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	3	516	10	9	3	5
1	0.1	0.4	0	10	13	2	3.6	1	-1	79	26.1	25.7	1	1	-51	0	0	0.2	90	300	2	505	100	12	3	5
1	0	0.5	0	10	13	2	3.6	1	-1	79	26.1	25.7	1	1	-51	0	0	0.2	90	300	4	517	10	12	3	5
1	0.4	0.5	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	4	517	10	4	3	5
1	0.5	0.7	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-50	0	1	0.2	90	300	4	517	10	3	3	5
1	0.4	0.7	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-50	0	-1	0.2	90	300	1	506	14	10	3	5
2	0.9	0.1	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.5	0.2	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.9	0.2	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.5	0.3	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.9	0.3	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.8	0.4	0	10	13	2	3.3	1	0	79	26.1	25.7	0	1	-51	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.7	0.4	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-51	0	-1	0.2	90	300	-9	-9	9	-9	3	5
2	0.6	0.6	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-50	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.5	0.7	0	10	13	2	3.6	1	0	79	26.1	25.7	0	1	-50	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.7	0.8	0	10	13	2	3.6	1	0	79	26	25.6	0	1	-50	0	1	0.2	90	300	-9	-9	9	9	3	5
1	0.1	1	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-48	0	0	0.2	90	300	2	505	100	2	3	5
1	0.1	1.5	0	10	13	4	3.6	1	0	74	26	25.6	0	1	-45	0	0	0.2	90	300	1	506	14	10	3	5
2	0.6	0.9	0	10	13	2	3.6	1	1	74	26	25.6	-1	1	-48	0	0	0.2	90	300	-9	-9	-9	-9	3	5
2	0.4	1	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-48	0	0	0.2	90	300	-9	-9	-9	-9	3	5
2	0.7	1	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-48	0	0	0.2	90	300	-9	-9	-9	-9	3	5
2	0.8	1.1	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-47	0	0	0.2	90	300	-9	-9	-9	-9	3	5
2	0.5	1.1	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-47	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.8	1.2	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-47	0	0	0.2	90	300	-9	-9	9	-9	3	5
2	0.9	1.2	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-47	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.2	1.2	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-47	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.3	1.2	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-46	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.8	1.3	0	10	13	4	3.6	1	1	74	26	25.6	1	1	-46	0	0	0.2	90	300	-9	-9	9	9	3	5
2	1	1.4	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-46	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.3	1.4	0	10	13	4	3.6	1	1	74	26	25.6	-1	1	-45	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.2	1.4	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-45	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.6	1.5	0	10	13	4	3.6	1	-1	74	26	25.6	1	1	-45	0	0	0.2	90	300	-9	9	9	9	3	5
2	0.9	1.6	0	10	13	4	3.6	1	1	74	26	25.6	1	1	-45	0	0	0.2	90	300	-9	9	9	9	3	5
1	0.3	1.9	0	10	13	2	3.6	1	0	79	25.9	25.6	0	1	-40	0	-1	0.2	90	300	3	516	10	9	3	5
1	0.2	2.3	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-38	0	0	0.2	90	300	4	517	10	3	3	5
2	0.6	1.7	0	10	13	4	3.6	1	0	74	25.9	25.6	0	1	-43	0	0	0.2	90	300	9	9	9	-9	3	5
2	0.3	2	0	10	13	2	3.6	1	0	79	25.9	25.6	0	1	-41	0	0	0.2	90	300	-9	-9	9	-9	3	5
2	1	2	0	10	13	2	3.6	1	0	79	25.9	25.6	0	1	-41	0	0	0.2	90	300	9	-9	9	9	3	5
2	0.9	2	0	10	13	2	3.6	1	0	79	25.9	25.6	0	1	-41	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.8	2	0	10	13	2	3.6	1	0	79	25.8	25.6	0	1	-40	0	0	0.2	90	300	9	-9	9	9	3	5
2	0.1	2.1	0	10	13	2	3.6	1	0	79	25.8	25.6	0	1	-40	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.1	2.1	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-39	0	0	0.2	90	300	-9	9	9	-9	3	5
2	1	2.2	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-38	0	0	0.2	90	300	-9	-9	9	9	3	5
2	0.5	2.2	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-38	0	0	0.2	90	300	9	9	9	9	3	5
2	0.6	2.3	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-38	0	0	0.2	90	300	-9	9	9	9	3	5
2	0.5	2.3	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	38	0	0	0.2	90	300	9	9	9	9	3	5
2	0.4	2.4	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-37	0	0	0.2	90	300	9	9	9	9	3	5
2	0.7	2.4	0	10	13	2	3.3	1	0	79	25.8	25.6	0	1	-37	0	0	0.2	90	300	-9	9	9	-9	3	5
1	0.2	2.8	0	10	13	1	3.3	1	0	65	25.8	25.6	0	1	-30	0	0	0.2	90	300	3	517	10	7	3	5
2	0.4	2.5	0	10	11	2	3.3	1	1	65	25.8	25.6	-1	1	-34	0	1	0.2	90	300	-9	9	9	-9	3	5
2	1	2.5	0	10	11	2	3.3	1	1	65	25.8	25.6	1	1	-33	0	1	0.2	90	300	-9	-9	9	-9	3	5
2	0.1	2.6	0	10	11	1	3.3	1	1	65	25.8	25.6	-1	1	-32	0	1	0.2	90	300	9	9	9	9	3	5
2	0.3	2.6	0	10	11	1	3.3	1	1	65	25.8	25.6	1	1	-32	0	1	0.2	90	300	-9	9	9	9	3	5
2	0.8	2.6	0	10	11	1	3.3	1	-1	65	25.8	25.6	1	1	-32	0	1	0.2	90	300	-9	9	9	9	3	5
2	0.9	2.7	0	10	11	1	3.3	1	1	65	25.8	25.6	1	1	-32	0	1	0.2	90	300	9	-9	9	9	3	5
2	0.4	2.7	0	10	11	1	3.3	1	1	65	25.8	25.6	1	1	31	0	1	0.2	90	300	9	-9	9	9	3	5

CG-6007 MAY 27 1992 (continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	1	2.7	0	10	11	1	3.3	1	1	65	25.8	25.6	-1	1	-31	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.9	2.7	0	10	13	1	3.3	1	-1	65	25.8	25.6	1	1	-31	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.3	2.8	0	10	13	1	3.3	1	-1	65	25.8	25.6	1	1	-30	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.9	2.9	0	10	13	1	3.3	1	1	65	25.8	25.6	-1	1	-30	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.4	3	0	10	13	1	3.3	1	1	65	25.8	25.6	-1	1	-28	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.1	3	0	10	13	1	3.3	1	-1	65	25.8	25.6	1	1	-28	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.5	3.1	0	10	13	1	3.3	1	-1	65	25.8	25.6	1	1	-27	0	-1	0.2	90	300	-9	-9	-9	-9	3	5
[illegible]	0.1	3.2	0	10	13	1	3.3	1	1	65	25.8	25.6	-1	1	-27	0	1	0.2	90	300	-9	-9	-9	-9	3	5
2	0.9	3.2	0	10	13	1	3.3	1	-1	65	25.8	25.6	1	1	-26	0	-1	0.2	90	300	-9	-9	-9	-9	3	5

EOF

CG-6007 MAY 29 1992

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SLBTY
2	0.4	0.1	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	-32	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0	0	15	13	2	3.6	2	0	75	26	25.6	-1	1	-31	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0	0	15	13	2	3.6	2	0	75	26	25.6	-1	1	-31	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.2	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	-31	0	0	0	60	300	9	9	9	9	3	0
2	0.2	0.2	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	-32	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.3	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	-32	0	0	0	60	300	9	9	9	9	3	0
2	0.1	0.3	0	15	14	2	3.3	2	0	75	26	25.6	1	1	-32	0	0	0	60	300	9	9	9	9	3	0
2	0.2	0.3	0	15	14	2	3.3	2	0	75	26	25.6	1	1	-32	0	0	0	60	300	9	9	9	9	3	0
2	0.1	0.4	0	15	14	2	3.3	2	0	75	26	25.6	1	1	33	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.4	0	15	14	2	3.3	2	0	75	26	25.6	1	1	33	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.5	0	15	14	2	3.3	2	0	75	26	25.6	1	1	33	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.5	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	-35	0	0	0	60	300	9	9	9	9	3	0
2	0.2	0.7	0	15	14	2	3.3	2	0	75	26	25.6	1	1	36	0	0	0	60	300	9	9	9	9	3	0
2	0.5	0.8	0	15	14	2	3.3	2	0	75	26	25.6	1	1	36	0	0	0	60	300	9	9	9	9	3	0
2	0.1	0.9	0	15	14	2	3.3	2	0	75	26	25.6	1	1	37	0	0	0	60	300	9	9	9	9	3	0
2	0.4	0.9	0	15	14	2	3.3	2	0	75	26	25.6	1	1	37	0	0	0	60	300	9	9	9	9	3	0
2	0.1	1	0	15	14	2	3.3	2	0	75	26	25.6	-1	1	38	0	0	0	60	300	9	9	9	9	3	0
2	0.2	1.1	0	15	13	2	3.3	2	0	75	26	25.6	1	1	39	0	0	0	60	300	9	9	9	9	3	0
2	0.2	1.2	0	15	13	2	3.3	2	0	75	26	25.6	1	1	39	0	0	0	60	300	9	9	9	9	3	0
2	0.2	1.2	0	15	13	2	3.3	2	1	75	26	25.6	0	1	40	0	1	0	60	300	9	9	9	9	3	0
2	0.5	1.2	0	15	13	2	3.3	2	1	75	26	25.6	0	1	40	0	1	0	60	300	9	9	9	9	3	0
2	0.1	1.3	0	15	13	2	3.3	2	1	75	26	25.6	0	1	40	0	1	0	60	300	9	9	9	9	3	0
2	0	1.3	0	15	13	2	3.3	2	0	75	26	25.6	0	1	40	0	0	0	60	300	9	9	9	9	3	0
2	0.1	1.5	0	15	13	2	3.3	2	-1	75	26	25.6	0	1	41	0	1	0	60	300	9	9	9	9	3	0
2	0.5	1.6	0	15	13	2	3.3	2	1	75	26	25.6	0	1	41	0	1	0	60	300	9	9	9	9	3	0
2	0.4	1.6	0	15	13	2	3.3	2	-1	75	26	25.6	0	1	41	0	1	0	60	300	9	9	9	9	3	0
2	0.1	1.6	0	15	13	2	3.3	2	1	75	26	25.6	0	1	41	0	1	0	60	300	9	9	9	9	3	0
2	0.5	1.8	0	15	13	2	3.3	2	1	75	26	25.6	0	1	42	0	1	0	60	300	9	9	9	9	3	0
2	0.1	1.9	0	15	13	2	3.3	2	0	75	26	25.6	0	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.2	1.9	0	15	13	2	3.3	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.4	2	0	15	13	2	3.3	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.3	2	0	15	13	2	3.6	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.5	2.2	0	15	13	2	3.6	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.1	2.3	0	15	13	2	3.6	2	0	75	26	25.6	0	1	43	0	0	0	60	300	9	9	9	9	3	0
2	0.2	2.3	0	15	13	2	3.6	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.5	2.4	0	15	13	2	3.6	2	1	75	26	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.3	2.5	0	15	14	2	3.6	2	1	75	26.1	25.6	0	1	43	0	1	0	60	300	9	9	9	9	3	0
2	0.4	2.5	0	15	14	2	3.6	2	0	75	26.1	25.6	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.5	2.6	0	15	14	2	3.6	2	0	75	26.1	25.6	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.4	2.7	0	15	14	2	3.6	2	0	75	26.1	25.6	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.4	2.7	0	15	14	2	3.6	2	0	75	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.3	2.7	0	15	14	2	3.6	2	0	75	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.3	2.8	0	15	14	2	3.6	2	0	75	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0	2.8	0	15	14	2	3.6	2	0	75	26.1	25.7	0	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.4	2.8	0	15	14	2	3.6	2	0	75	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.3	2.8	0	15	14	1	3.9	2	0	83	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.4	2.9	0	15	14	1	3.9	2	0	83	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.5	2.9	0	15	14	1	3.9	2	0	83	26.1	25.7	1	1	42	0	0	0	60	300	9	9	9	9	3	0
2	0.1	3.1	0	15	14	1	3.9	2	0	83	26.1	25.7	1	1	41	0	0	0	60	300	9	9	9	9	3	0
2	0.2	3.1	0	15	14	1	3.9	2	0	83	26.1	25.7	1	1	41	0	0	0	60	300	9	9	9	9	3	0
2	0.2	3.2	0	15	12	1	3.9	2	0	83	26	25.6	1	1	40	0	0	0	60	300	9	9	9	9	3	0

CG-6007 MAY 29 1992 (continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	CLOCK	TYNO	SUBTY
2	0.2	3.3	0	15	12	1	3.9	2	0	83	26	25.6	1	1	-40	0	0	0	60	300	-9	9	-9	9	3	0
2	0.1	3.3	0	15	12	1	3.9	2	0	83	26	25.6	-1	1	-40	0	0	0	60	300	-9	9	9	9	3	0
2	0.3	3.5	0	15	12	1	3.9	2	0	83	26	25.6	1	1	-39	0	0	0	60	300	9	9	9	9	3	0
2	0.5	3.5	0	15	12	1	3.9	2	0	83	26	25.6	1	1	38	0	0	0	60	300	9	9	9	9	3	0
2	0.1	4.5	0	15	11	4	3.3	2	0	83	25.8	25.7	-1	1	-33	0	1	0	60	300	-9	9	9	9	3	0
2	0.4	3.5	0	15	12	1	3.9	2	0	83	26	25.6	1	1	39	0	0	0	60	300	9	9	9	-9	3	0
2	0.5	3.6	0	15	12	1	3.9	2	0	83	26	25.6	-1	1	39	0	0	0	60	300	9	9	9	9	3	0
2	0.4	3.6	0	15	12	1	3.9	2	0	83	26	25.6	1	1	38	0	0	0	60	300	-9	9	9	9	3	0
2	0.4	3.7	0	15	10	1	3.9	2	0	83	26	25.6	1	1	38	0	0	0	60	300	9	9	9	9	3	0
2	0.2	3.7	0	15	10	1	3.9	2	0	83	26	25.6	-1	1	-38	0	0	0	60	300	9	9	9	9	3	0
2	0	3.8	0	15	10	4	3.3	2	0	83	26	25.6	0	1	-38	0	0	0	60	300	9	9	9	9	3	0
2	0.3	3.8	0	15	10	4	3.3	2	0	83	26	25.6	1	1	37	0	0	0	60	300	-9	9	9	9	3	0
2	0.5	3.9	0	15	10	4	3.3	2	0	83	26	25.6	1	1	-37	0	0	0	60	300	9	9	9	9	3	0
2	0.4	3.9	0	15	10	4	3.3	2	0	83	26	25.6	1	1	36	0	0	0	60	300	9	9	-9	9	3	0
2	0.5	4	0	15	10	4	3.3	2	0	83	26	25.6	1	1	36	0	0	0	60	300	9	9	9	9	3	0
2	0.1	4.1	0	15	10	4	3.3	2	0	83	26	25.6	1	1	35	0	0	0	60	300	9	9	9	9	3	0
2	0.2	4.2	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	35	0	0	0	60	300	9	9	9	9	3	0
2	0.5	4.3	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	34	0	0	0	60	300	9	9	9	9	3	0
2	0.5	4.3	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	34	0	0	0	60	300	9	9	9	-9	3	0
2	0.5	4.4	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	34	0	0	0	60	300	9	9	9	9	3	0
2	0.3	4.4	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	33	0	0	0	60	300	9	9	9	9	3	0
2	0.5	4.7	0	15	11	4	3.3	2	0	83	25.8	25.7	1	1	32	0	0	0	60	300	9	9	9	9	3	0

EOF