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Report No. CG-D-13-92

EVALUATION OF NIGHT VISION GOGGLES (NVG) FOR MARITIME SEARCH AND RESCUE

(JOINT CANADIAN/U.S. COAST GUARD EXPERIMENT)

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INTERIM REPORT

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NOTICE

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This report is the fifth 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-first in a series of R&D Center reports dealing with Search and Rescue.

16. Abstract

Three experiments were conducted in 1989 and three more were conducted in 1990 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 Aviators Night Vision Imaging System (ANVIS) NVG has been tested onboard U.S. Coast Guard HH-3 and CH-3 helicopters, and the AN/PVS-5C and AN/PVS-7A NVGs have been tested onboard U.S. Coast Guard 41-foot utility boats (UTBs) and a U.S. Coast Guard 210-foot medium endurance cutter and a Canadian Coast Guard 234-foot (71.5-meter) ship. During the fall 1990 experiment in the waters of Canso Bank off the coast of Nova Scotia, the medium endurance cutter and Canadian Coast Guard ship were employed in realistically-simulated search missions for 4- and 6-person lighted and unlighted life rafts with retroreflective tape. This interim report discusses the results of the Canso Bank experiment.

A total of 467 target detection opportunities were generated for the above mentioned target types during the Canso Bank experiment. These data were analyzed to determine which of 22 search parameters of interest exerted a statistically-significant influence on target detection probability. The analysis indicated that, on a surface vessel, target detection using NVGs was greater for lighted targets and that a lighted target could be detected out to the limits of visibility or the visual horizon whichever is less. Wind speed and wave height proved to be the search parameters which best described the effect of environmental factors on search performance. NVG performance was significantly greater when the lookout's view was not obstructed by glass.

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METRIC CONVERSION FACTORS

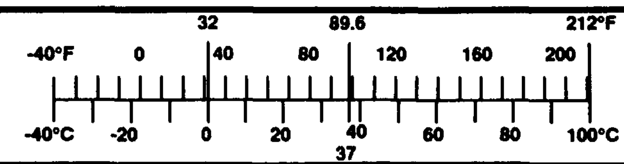
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	* 2.5	centimeters	cm
ft	feet	30.0	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
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000lb)	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
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
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	4.23	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35.32	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

INTRODUCTION

1. Background

This report provides a fourth interim evaluation of three types of night vision goggles (NVGs) for their effectiveness in the Coast Guard maritime search and rescue (SAR) mission. The NVGs were evaluated onboard HH-3 and CH-3 helicopters from Coast Guard Air Stations Traverse City, Michigan, and Cape Cod, Massachusetts; on 41-foot utility boats (UTBs) from Coast Guard Stations Fort Pierce, Florida, New London, Connecticut, Point Judith, Rhode Island, and Montauk, New York; and onboard a U.S. Coast Guard cutter and a Canadian Coast Guard ship. Data were collected during six 3-week experiments conducted in Fort Pierce, Block Island Sound (off the Connecticut/Rhode Island/New York coasts), and the North Atlantic Ocean on Canso Bank, Nova Scotia. This report will present analyses of NVG detection performance based on data that were obtained during the fall 1990 Canso Bank experiment. Target types evaluated in this report are 4-and 6-person lighted or unlighted orange and yellow canopied life rafts with retroreflective tape.

These NVG 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. The Canso Bank experiment was coordinated through the Canadian Coast Guard Office of SAR Research and Development and the Surveillance Systems Branch of the U.S. Coast Guard Research and Development Center. This research is ongoing, with an additional experiment and further data analyses planned for calendar year 1991.

2. NVG Descriptions

Two NVG models were evaluated during this experiment onboard two search and rescue units (SRUs). The AN/PVS-5C and AN/PVS-7A NVG are both equipped with Generation II-plus photodetectors and fixed headstrap mounts. Four lookout positions were used during NVG searches from the U.S. Coast Guard Cutter (USCGC) VIGOROUS (two bridge wings and two flying bridge). Two lookout positions inside the pilot house were used during searches from the Canadian Coast Guard Ship (CCGS) ALERT. Data were collected for the USCGC VIGOROUS in such a manner that bridge and flying bridge detection opportunities could represent distinct data sets.

Both NVG models restrict visual perception in several ways. They restrict the users to a 40-degree field of view, severely inhibit depth perception, reduce visual acuity to 20/40 at best, and provide a monochromatic (green) display. The AN/PVS-7A design allows limited non-NVG peripheral vision. The AN/PVS-5C design does not permit any peripheral vision.

3. Approach

Data were collected using operational Coast Guard search craft with crews who had received basic instruction in NVG use. Search patterns were generated to provide detection opportunities for the targets at a variety of lateral ranges within the search area. Search crews were not alerted to target locations in advance.

Global Positioning System (GPS) fixes were used to monitor and record target and search craft positions during the experiment. Target detections, environmental data, and human-factors data were logged by data recorders onboard each search unit. A wave rider data buoy was deployed within the exercise area to record significant wave height, wave period, and wave front direction.

Data reconstruction was performed to determine which detection opportunities resulted in a detection and at what lateral range each opportunity occurred. Raw data files were developed that included each target detection or miss along with the values of 22 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.

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 provided in this report.

RESULTS AND CONCLUSIONS

1. Results

A total of 467 detection opportunities were reconstructed from the Canso Bank experiment. Table 1 provides a breakdown of data quantities categorized by search unit and target type. No statistically significant difference was found to exist between detection performance from the VIGOROUS bridge and the VIGOROUS flying bridge. These data sets were combined to form one VIGOROUS data set.

Table 2 summarizes the range of search conditions represented in the data set. Lateral range curve plots and sweep width (W) estimates were developed for the following conditions. The values of W are presented under RECOMMENDATIONS.

a. Lighted Life Raft Targets. Four sets of search conditions described below.

(1) CCGS ALERT, wind speeds 2 to 19 knots,

(2) CCGS ALERT, wind speeds 20 to 35 knots,

(3) USCGC VIGOROUS, wind speeds 5 to 19 knots, or

(4) USCGC VIGOROUS, wind speeds 20 to 32 knots.

b. Unlighted Life Raft Targets. Two sets of search conditions described below.

(1) Significant wave height 3 to 5 feet, or

(2) Significant wave height 5.6 to 7.2 feet.

Table 1. Numbers of Target Detection Opportunities by SRU and Target Type

TARGET TYPE	SRU TYPE		
	USCGC VIGOROUS		CCGS ALERT
	BRIDGE	FLYING BRIDGE	
Unlighted 4- and 6-person Life Rafts with Retroreflective Tape	55	38	36
Lighted 4- and 6-person Life Rafts with Retroreflective Tape	113	100	125

An analysis of detections by crew position indicated the following trends.

a. Almost all detections of lighted targets were made on or forward of the beam. An area of concentrated detections exists between the 11 and 1 o'clock position from both vessels. This was primarily due to the fact that the crews were instructed to search in this area. Targets ahead of the vessel remain inside the visual horizon longer than targets on the beam.

b. Onboard the VIGOROUS, there were a higher number of detections made from the bridge wings than from the flying bridge. This difference occurred because flying bridge lookouts were not used during searches in very severe weather . On several occasions, the flying bridge lookouts were relocated to the bridge wings because of high winds. This explains the small discrepancies in the number of detections from the bridge wing and the flying bridge.

Table 2. Range of Environmental and Moon Parameters Encountered

SRU/ TARGET	ENVIRONMENTAL PARAMETERS								MOON	
	Precipitation Level	Visibility (nml)	Wind Speed (knots)	Cloud Cover (tenths)	Significant Wave Height (ft)	Whitecap Coverage	Relative Humidity (percent)	Air Temperature (deg. C)	Elevation (degrees)	Phase
VIGOROUS bridge/unlighted targets	0	4 to 12	4 to 28	0 to 1.0	3 to 7	0 to 2	56 to 93	3.9 to 12.8	11 to 71	Full moon
VIGOROUS bridge/lighted targets	0 to 3	0 to 10	5 to 32	0.2 to 1.0	3 to 9	0 to 2	58 to 100	7.2 to 15	-61 to 35	Quarter to three quarter moon
VIGOROUS flying bridge/unlighted targets	0	4 to 12	4 to 28	0 to 1.0	3 to 7	0 to 1	56 to 93	4.4 to 10.6	11 to 67	Full moon
VIGOROUS flying bridge/lighted targets	0 to 1	4 to 10	5 to 26	0.2 to 1.0	3 to 8	0 to 1	58 to 100	7.2 to 15	-64 to 35	Quarter to three quarter moon
ALERT/unlighted targets	0	2.5 to 15	3 to 34	0.1 to 1.0	3 to 7.2	0 to 2	48 to 94	3 to 12	7 to 70	Full moon
ALERT/lighted targets	0 to 1	1.5 to 15	2 to 35	0 to 1.0	3.1 to 9.8	0 to 2	59 to 100	3 to 15.5	-66 to 35	None to three quarter moon

2. Conclusions

a. General Conclusions

(1) Detection performance of NVGs was significantly increased when the target (4- to 6-person life raft) was equipped with a light.

(2) NVG detection performance (as measured by sweep width) was significantly greater when lookouts had a view unobstructed by glass (either through open bridge windows or by being stationed outside the pilot house). Glare and reflections of bridge lights appear to be a very significant source of distraction and fatigue while searching through the glass of closed bridge windows.

(3) No statistically significant difference was found for NVG-equipped lookouts searching from the VIGOROUS bridge or VIGOROUS flying bridge during the Canso Bank experiment.

(4) For the environmental conditions encountered on Canso Bank, worsening conditions nearly halve NVG detection performance (as measured by sweep width).

b. Search Performance of SRUs with NVG for Lighted Targets

(1) Results achieved during this experiment indicate that lighted targets are capable of being detected out to the limits of visibility or the visual horizon which ever is less.

(2) Environmental factors which affected SRU search performance while searching for these targets were best described by the wind speed parameter.

c. Search Performance of SRUs with NVG for Unlighted Targets

(1) Environmental factors which affected SRU search performance while searching for these targets were best described by the significant wave height parameter.

RECOMMENDATIONS

The following interim recommendations are added to those reported previously.

Daylight visual sweep widths for SRUs in the 200-foot size range do not exist in the National Search and Rescue Manual. Sweep widths are presented in nautical miles (nmi) and should be reviewed once the daylight visual portion of the Canso Bank experiment has been documented by the Canadian Coast Guard.

1. <u>NVG Searches for Lighted Life Raft Targets</u>.

   a. **CCGS ALERT, wind speeds 2 to 19 knots** - use 6.7 nmi.

   b. **CCGS ALERT, wind speeds 20 to 35 knots** - use 5.2 nmi.

   c. **USCGC VIGOROUS, wind speeds 5 to 19 knots** - use 11.1 nmi.

   d. **USCGC VIGOROUS, wind speeds 20 to 32 knots** - use 9.6 nmi.

2. <u>NVG Searches for Unlighted Life Raft Targets</u>

   a. **H_s 3 to 5 feet** - use 1.3 nmi.

   b. **H_s 5 to 7.2 feet** - use 0.6 nmi.

3. <u>General Recommendation</u>

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

4. Recommendations for Future Research

a. More NVG search performance data should be collected in moonlit conditions. References 1, 2, and 3 indicate that moonlight significantly affects detection capability and very limited quantities of moonlit data exist for SRUs in the 200-foot size data set.

b. NVG search performance data should be collected when weather conditions other than those experienced during this experiment could be expected. Specifically, warm nights with good visibility and no cloud cover were not experienced during this experiment. Low visibility conditions are also very limited in this NVG data set.

c. Additional large surface SRUs (such as (WPBs) and other .(WMECs)) should be evaluated for their NVG search performance.

d. 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 both retroreflective and non-retroreflective materials.

e. NVG detection performance from SRUs in the 200-foot range should be evaluated against additional target types (i.e. small craft).

ACKNOWLEDGEMENTS

The authors would like to acknowledge the strong support given to our data collection efforts by the officers and crew of both the CCGS ALERT and the USCGC VIGOROUS. Lookouts on both vessels put in long hours under difficult conditions to produce the data included in this report. The authors also wish to thank the other US and Canadian researchers involved. Reg Fitzgerald and his NORDCO, Ltd, team were instrumental in providing most of the logistical support for the experiment, the navigation system, and the analysis of the visual search results. Special thanks goes to those in the R&D Center field party: LT Mike Fisher and LTJG Kurt O'Brien from the R&D Center and Mr. Gary Hover and Mr. Steve Ricard from A&T, Inc.

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CHAPTER 1
INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This report is the fourth of a series that will document the U.S. Coast Guard Research and Development (R&D) Center evaluation of night vision goggles (NVGs) and other night vision devices for search and rescue (SAR) missions. To date, six experiments have been conducted in support of this evaluation. During 1989, one experiment was conducted in Fort Pierce, Florida and two experiments were conducted in Block Island Sound off the Connecticut/Rhode Island/New York coasts. Reference 1 presents an analysis of data collected during the first three experiments. During the spring of 1990, a fourth experiment was conducted in Fort Pierce. Analyses were conducted on SRU/target data sets for which additional data had been gathered and on new data sets. Reference 2 presents the results of those analyses. During the fall of 1990, a fifth experiment was conducted in Block Island Sound. Analyses were conducted on SRU/target data sets for which additional data had been gathered. Reference 3 presents the results of those analyses.

This report presents analyses performed on data obtained during a joint experiment by the Canadian Coast Guard and United States Coast Guard conducted on Canso Bank, Nova Scotia during the fall of 1990. During this experiment, two types of NVGs were evaluated onboard Canadian 234-foot (71.5m) ship and a U.S. Coast Guard 210-foot medium endurance cutter for their effectiveness in detecting 4-and 6-person lighted and unlighted life rafts with retroreflective tape applied.

This evaluation of night vision devices is part of the R&D Center Improvement of Search and Rescue Capabilities (ISARC) Project. ISARC project objectives are to improve search planning and execution, evaluate visual and electronic search methods, develop means to follow search area movement, and develop SAR models. Specific objectives of the night vision device evaluations are to:

1. Establish the night SAR capabilities of operational Coast Guard search and rescue units (SRUs) equipped with these devices, and

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

1.2 NIGHT VISION GOGGLE SYSTEM DESCRIPTIONS

The AN/PVS-5C and AN/PVS-7A NVGs shown in figures 1-1 and 1-2, respectively, are infantry-type NVGs designed to be worn with fixed headstrap mounts. The AN/PVS-5C goggles tested were Litton Model M-915A, incorporating two Generation II-plus image intensifier tubes and an available short-range infrared illuminator (not evaluated). The AN/PVS-7A goggles tested were Litton model M-972, incorporating a single Generation II-plus image intensifier, a short-range infrared illuminator (not evaluated), and a binocular lens assembly.

Both NVG models amplify available light to produce a green monochromatic image of the nighttime scene. Automatic brightness control is provided in both NVG models. As ambient light level varies, NVG image quality varies: Too much or too little light can cause poor image quality. Adjustments for diopter correction, range focus, interpupillary separation, tilt positioning, and fore-aft (eye relief) positioning are incorporated in both of these NVG models. The headstrap assemblies for both models adjust to fit the individual wearer. When used with the headstrap assemblies, peripheral vision is unavailable with the AN/PVS-5C, and restricted with the AN/PVS-7A. Both NVG models provide a 40-degree field of view (FOV), severely inhibit depth perception, and reduce visual acuity to no better than 20/40. Peak response is in the visible portion of the spectrum, with reduced amplification in the near-infrared to 0.86-micron wavelengths. More detailed specifications can be found in references 4 and 5.

The AN/PVS-7A NVGs were evaluated onboard the Canadian Coast Guard 234-foot (71.5m) Ship ALERT, and both the AN/PVS-5C and AN/PVS-7A NVGs were evaluated onboard the U.S. Coast Guard 210-foot Medium Endurance Cutter VIGOROUS.

Figure 1-1. AN/PVS-5C Night Vision Goggles

Figure 1-2. AN/PVS-7A Night Vision Goggles

1.3 EXPERIMENT DESCRIPTIONS

A total of six experiments have been conducted to date in support of the NVG evaluation effort. This document provides a summary of results obtained from the 23 October to 6 November 1990, 3-week experiment conducted in the waters on Canso Bank, Nova Scotia, Canada. Sections 1.3.1 through 1.3.6 provide detailed information concerning the experiment.

1.3.1 Participants

The Canso Bank NVG experiment was coordinated by Canadian Coast Guard SAR R&D Office, 344 Slater Street, Ottawa, Canada and the Surveillance Systems Branch of the U.S. Coast Guard R&D Center, 1082 Shennecossett Road, Groton, Connecticut. Canadian SAR R&D office and U.S. R&D Center Project and Test Managers arranged for primary logistics support for this test, handled liaison among all Coast Guard and contractor participants, and maintained top-level control of all experiment communications and data collection activities.

The U.S. Coast Guard Cutter (USCGC) VIGOROUS, and Canadian Coast Guard Ship (CCGS) ALERT operated as search platforms for the entire test, and the Canadian Coast Guard provided an ocean going buoy tender to deploy, maintain, and retrieve the life raft targets and a wave rider buoy.

The prime contractor for the U.S. Coast Guard was Analysis & Technology, Inc. (A&T) and the Prime contractor for the Canadian Coast Guard was NORDCO LTD. A&T and NORDCO prepared test plans, installed Global Positioning System (GPS) equipment and provided data recorders onboard participating SRUs. Targets were procured by both the Canadian and U.S. Coast Guards.

1.3.2 Exercise Area

The experiment was conducted on the Canso Bank off the coast of Nova Scotia, Canada. An array of 23 moorings was deployed within the 50-fathom contour on the Canso Bank with a wave rider buoy at the center. The mooring array was overlaid by an 18-by 25-nautical mile (nmi) search grid comprised of 36 waypoints which were alpha-numerically labeled. Figure 1-3 displays the location of the exercise area and figure 1-4 depicts an enlargement of the search area with target positions and grid array overlaid.

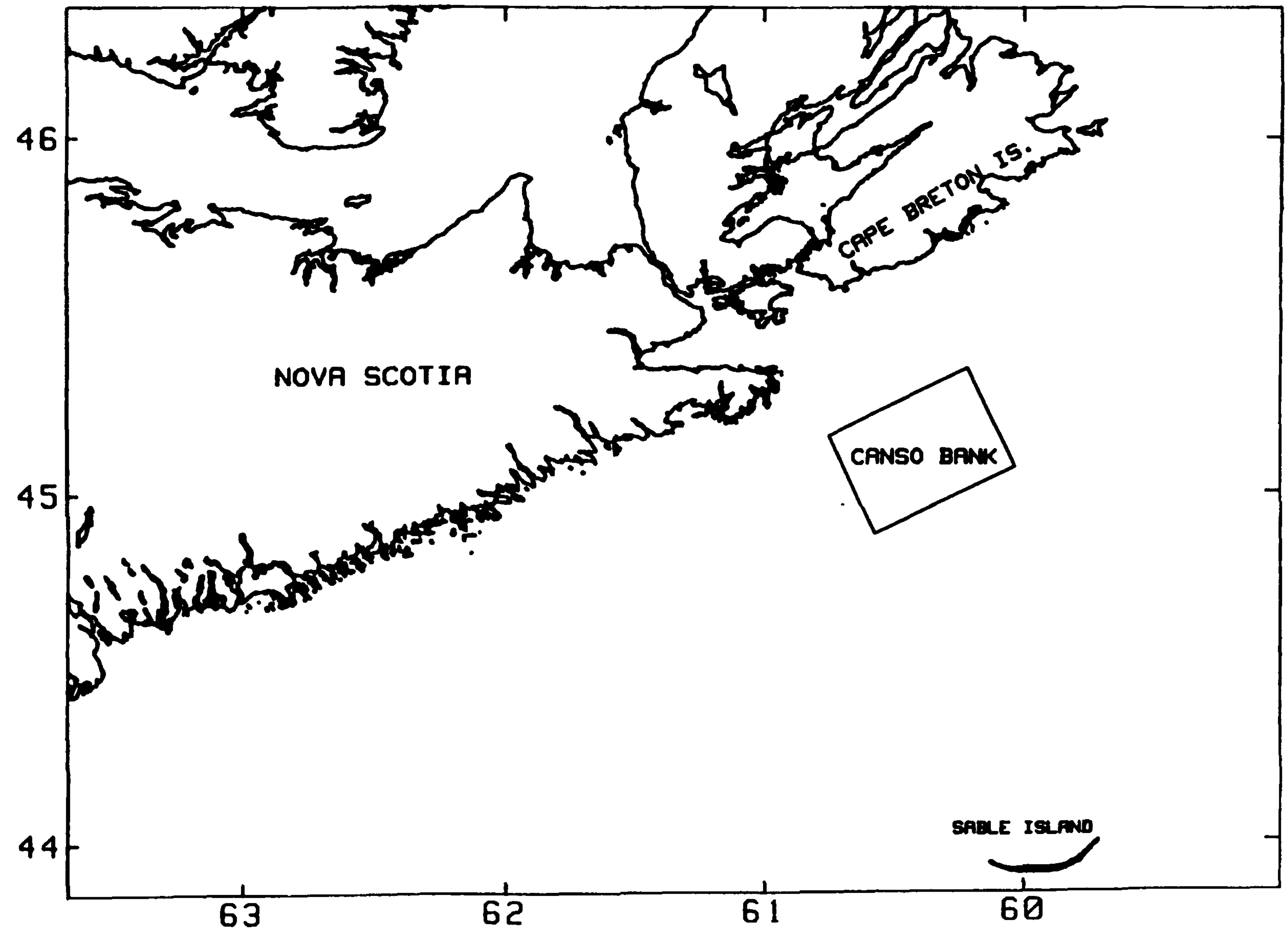

Figure 1-3. Canso Bank Exercise Area

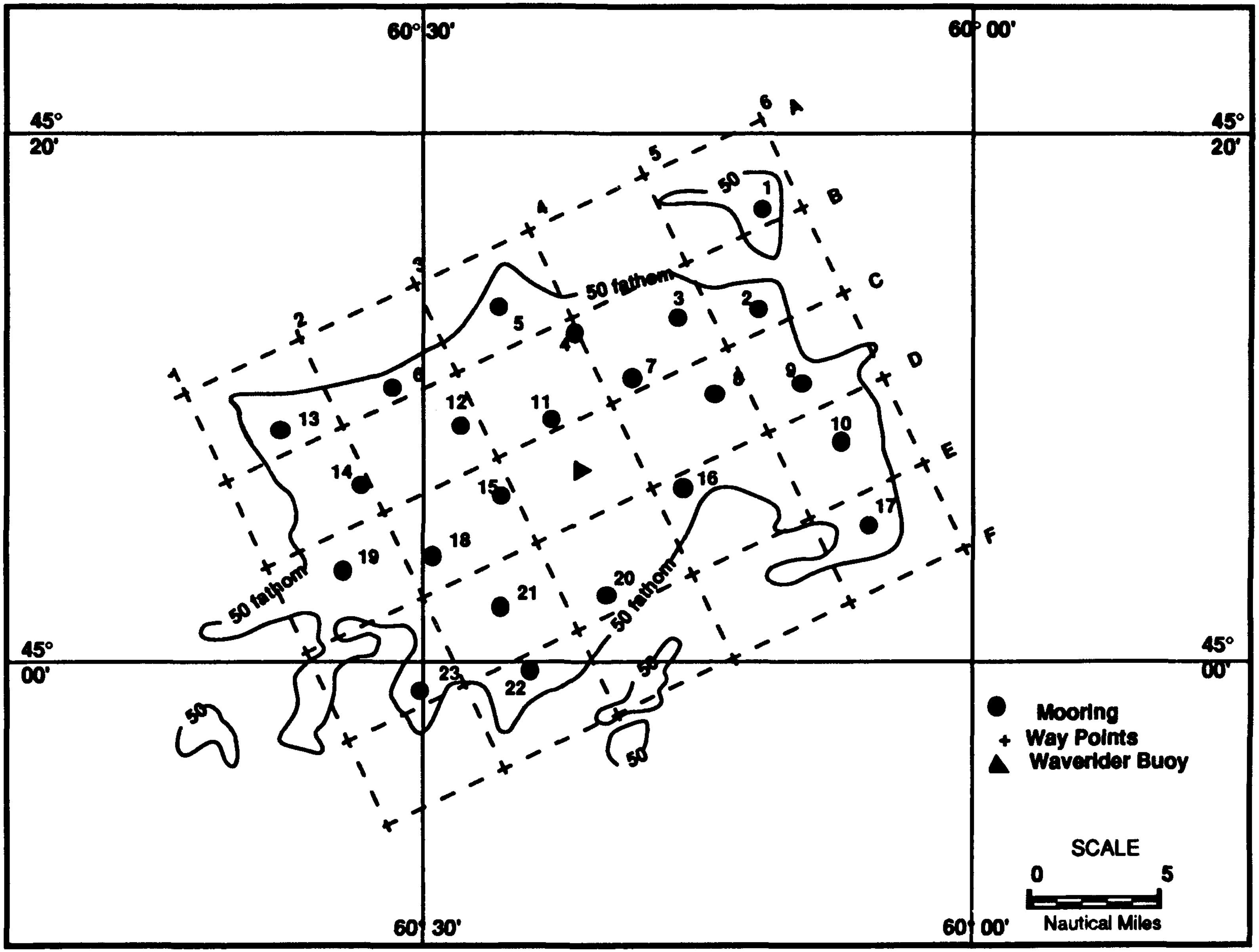

Figure 1-4. Canso Bank Exercise Area with Mooring Array and Search Grid

1.3.3 Targets

Four-and 6-person life rafts with retroreflective tape were equipped with a steady white light during the Canso Bank experiment. Some nights, raft lights were lighted. Other nights, raft lights were unlighted. Lighted and unlighted rafts were not mixed together as search targets. Throughout the 3-week experiment, targets were attached to the moorings in randomly selected combinations based on data collection priorities. Table 1-1 provides the salient characteristics of the raft targets deployed during the Canso Bank experiment. Figure 1-5 provides a representative photograph of a 4-person raft target.

Table 1-1. NVG Target Descriptions for the Canso Bank Experiment

TARGET TYPE	TARGET DESCRIPTION (quantity)	DIMENSIONS length x beam x freeboard (feet)	PRINCIPAL MATERIAL
6-person raft *	B.F. Goodrich w/orange canopy and retroreflective tape (5)	8.1 x 5.9 rectangular x 4 ht.	Rubber/ fabric
	B.F. Goodrich w/orange canopy and retroreflective tape (5)	8.4 dia. hexagon x 4.6 ht.	
	Dunlop/Beaufort w/orange canopy and retroreflective tape (1)	8.2 dia. hexagon x 4.2 ht.	
	Dunlop/Beaufort w/yellow canopy and retroreflective tape (2)	7.5 x 5.5 rectangular x 3.7 ht.	
4-person raft *	Dunlop/Beaufort w/yellow canopy and retroreflective tape (2)	6.6 pentagon x 3.8 ht.	Rubber/ fabric
	Dunlop/Beaufort w/orange canopy and retroreflective tape (9)	6.6 pentagon x 3.8 ht.	
	Canadian Dunlop/Beaufort w/orange canopy and retroreflective tape (1)	4.9 square x 3.3 ht.	

* Rafts were deployed with and without the lights turned on.

Figure 1-5. Four-Person Life Raft With Retroreflective Tape
Applied in Accordance With SOLAS Specifications

1.3.4 Experiment Design and Conduct

For the experiment conducted in Canadian waters, an 18-by 25-nmi search area was overlaid with a grid of 36 waypoints as described in section 1.3.2. Search patterns were created by selecting a combination of these waypoints that would result in a variety of target lateral ranges. Target density and weather factors had significant influence on the type of search pattern used. Early in the experiment, parallel searches were primarily used. Later in the experiment, a rough box was formed as a trackline for the search pattern. When both vessels searched on the same night, they would perform the same search with the second vessel following the first by approximately one half hour.

In the interest of realism, SRU crews were composed of personnel from the normal complement on their respective ships. Special training for the crews in the adjustment, care, and use of NVGs was usually limited to briefings and demonstrations by an A&T representative. Most SRU crewmembers had little or no operational experience with NVGs. The ALERT typically conducted searches with two lookouts in each watch section. Lookouts onboard the ALERT searched through open bridge wing windows from within the enclosed bridge. During severe weather, the widows were closed, and searches were conducted through the window glass. The VIGOROUS conducted searches with five crewmen in each watch section. Lookouts onboard the VIGOROUS searched from either the bridge wings or from the flying bridge. During severe weather VIGOROUS flying bridge lookouts were brought inside the enclosed portion of the bridge and more frequent reliefs of bridge wing lookouts were performed. VIGOROUS lookouts stood 4-hour watches and rotated among the four lookout positions and the helm position during the watch. ALERT lookouts were relieved by a new lookout every hour.

During this experiment, targets were attached to permanent moorings where they remained until either the Canadian Test Manager determined to move them or all targets were taken in because of weather conditions. The SRU crews were instructed to treat the data collection sorties as they would an actual SAR case. Crews were told to report any sighting of an object that could conceivably be one of the search targets to an onboard data recorder . 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 one key exception. In the interest of data collection efficiency, no diversions from the assigned search pattern were made by the SRUs for the purpose of confirming target sightings. Target confirmation was made through post-experiment data analysis.

Each night, a data recorder from the A&T field team logged human factors data, target detections, and crew comments. A second A&T observer assisted with data collection and was assigned to ensure the tracking system was properly maintaining a record of the vessel track. Crew information was recorded on the Lookout Information Form (figure 1-6). Target detections, crew comments, and general observations were recorded on the Visual Sighting Report Form (figure 1-7).

When a target was sighted, lookouts immediately relayed its relative bearing ("clock" method), 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, relative bearing, range, visibility of the moon, SRU heading, lookout position, and remarks on the NVG Detection Log. Times were synchronized to the nearest second with the tracking system computer 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. When lookouts searched from both the bridge and flying bridge, a concerted effort was made to prevent reported sightings at either the bridge/flying bridge level from alerting a lookout on the other bridge/flying bridge level. This permitted separate post-experiment analysis of NVG search performance capability from both locations.

During this experiment on-scene environmental conditions were recorded onboard both U.S. and Canadian Coast Guard ships by contractor personnel. A wave rider buoy also provided wave height, period, and direction information. Figure 1-8 depicts the Environmental Conditions Summary Form.

NORDCO

LOOKOUT INFORMATION FORM
SAR '90 DETECTION EXPERIMENT
CANSO BANK, N. S.

DATE ____________________ SEARCH TYPE ____________________

SRU ____________________ SEARCH NO. ____________________

LOCAL TIME	NAME	ID	RANK	LOCATION LEVEL (B/M/I)	LOCATION SIDE (P/S)	ACC TIME PER L/O (hr)	MED	REMARKS

Figure 1-6. Lookout Information Form

VISUAL SIGHTING REPORT FORM
SAR '90 DETECTION EXPERIMENT
CANSO BANK, N. S.

SEARCH NO. ____________ SEARCH TYPE __________ SRU ____________ DATE ____________

START TIME ____________ END TIME __________ DURATION __________ NVG. MODEL ____________

SIGHTING NO.	SIGHTING / TURN TIME	RANGE (nMI)	RELATIVE BRG (°)	SUN / MOON VISIBLE (Yes / No)	HEADING (° T)	LOOKOUT		CONFIRM MOORING NO.	REMARKS	OBS
						LOCATION	ID			

Figure 1-7. Visual Sighting Report Form

ENVIRONMENTAL DATA LOG
SAR' 90 DETECTION EXPERIMENT
CANSO BANK, N.S.

DATE ______________

SEARCH ______________

SRU ______________

LOCAL TIME	VIS (nm)	CLOUD COVER (tenths)	WX	TEMP (°C)		SHIP		APPRNT WIND		TRUE WIND		COMB SEA		SWELL	W.C. (NOAA)	ROLL		PITCH		REMARKS	OBS
				DRY	WET	HDG (°T)	SP (kt)	DIR (° REL)	SP (kt)	DIR (°T)	SP (kt)	HT (m)	PD (s)	DIR (°T)		AMPL (°)	PD (s)	AMPL (°)	PD (s)		

Figure 1-8. Environmental Conditions Summary Form

1.3.5 Tracking and Reconstruction

Target locations were monitored using GPS fixes (LORAN-C fixes were used for a back-up) which were correlated to account for differences in navigation units on each of the participating vessels. SRU positions were received continuously by the tracking system, displayed in real time on a CRT, and recorded every 20 seconds on a microcomputer hard disk.

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. On each plot target positions were plotted using identifying numbers and the SRU track was plotted as a series of plusses. Plotting the SRU position symbols created a trackline history for each search craft. Each position symbol was associated with a known time on a hard copy printout that accompanied each plot. Figure 1-9 is a tracking system-generated reconstruction plot of an actual search conducted by the USCGC VIGOROUS.

Analysts used the tracking system plots and NVG Detection Logs to determine which targets were detected and which were missed on 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 (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 reported detection in the NVG Detection Log to locate the search craft on the hard copy tracking system plot. The range and bearing information for that reported detection was then compared to target positions on the tracking system plot. Then a detection/non-detection validity 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 a computer generated list of 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.

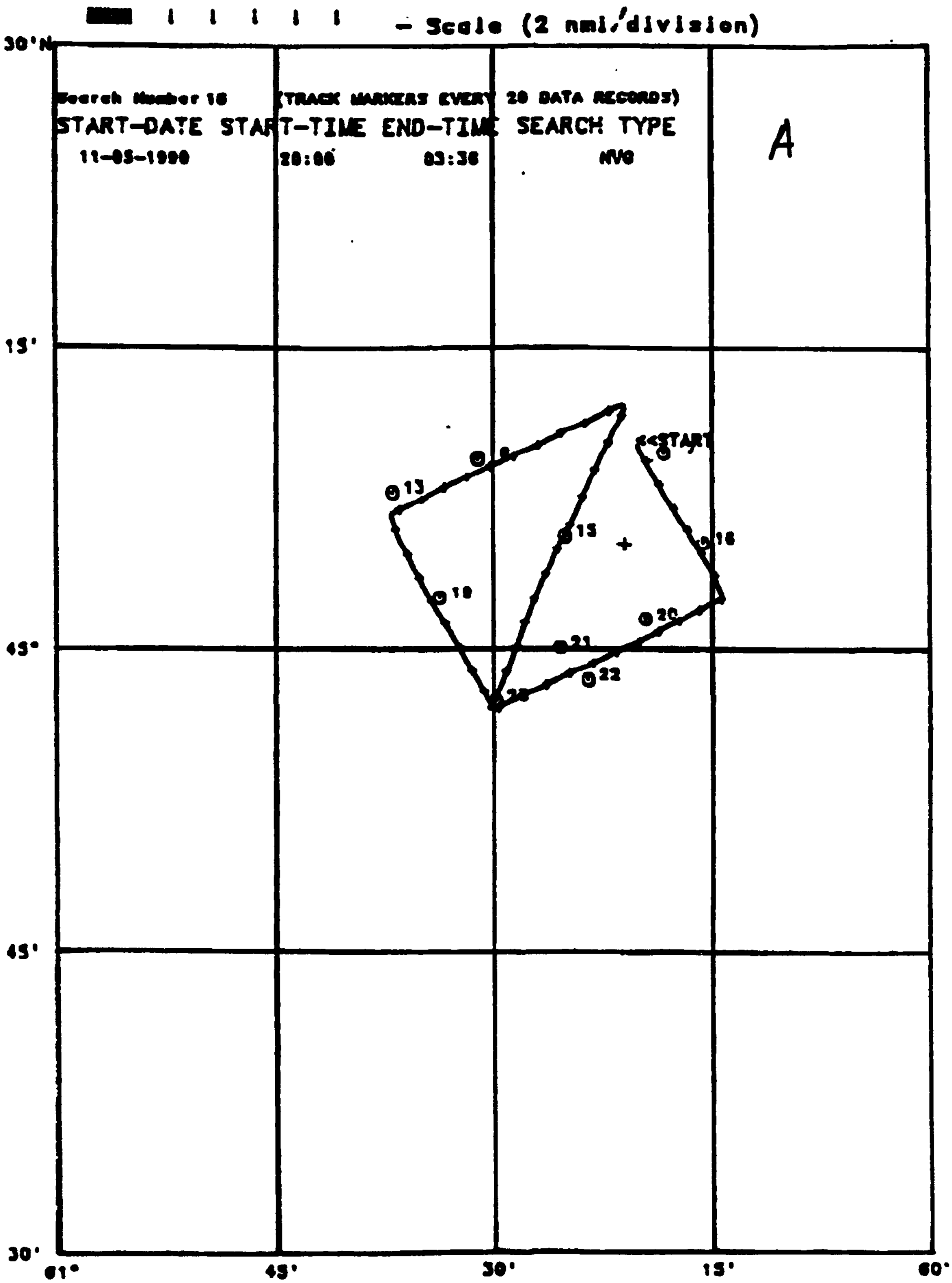

Figure 1-9. Example of a Search Pattern Performed by the USCGC VIGOROUS (Unlighted Life Raft Targets)

1.3.6 Range of Parameters Tested

A total of 22 potentially significant search parameters were recorded for each valid target detection opportunity. These parameters can be broadly classified as relating to the target, the SRU, the environment, ambient light, and human factors. These search parameters and their units of measure are as follows.

PARAMETER	UNIT OF MEASURE
Target-Related	
1. Target Type	Rafts: (4 or 6) 4- or 6-person orange raft (7 or 8) 4- or 6-person yellow raft
2. Target Subtype	lighted (1) or unlighted (0)
3. Lateral Range*	nautical miles
SRU-Related	
4. NVG Type	AN/PVS-5 (1) or AN/PVS-7 (0)
5. Search Speed	knots
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
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 closest point of approach (if target missed) or at time of detection
13. Relative Humidity	percent
14. Air Temperature	degrees Celsius

*See section 1.4.1 for definition.

PARAMETER (Cont'd)	UNIT OF MEASURE (Cont'd)
Ambient Light - Related	
15. Moon Elevation	degrees above or below the horizon
16. Moon Visible (from SRU)	yes (1)/no (0)
17. Relative Azimuth of the Moon	moon (visible or not) located along (-1)/away from (1)/across (0) line-of-sight to target at SRU closest point of approach (if target missed) or at time of detection
18. Moon Phase	new (0), 1/4 (.2), 1/2 (.5), 3/4 (.7), full (1.0)
Human Factors - Related	
19. Lookout Position†	location onboard SRU
20. Lookout ID†	individual identifier
21. Lookout NVG Experience†	hours
22. Time on Task	hours (actually searching)

The range of target types evaluated was discussed in section 1.3.3. Lateral range for target opportunities varied from 0 to 11.3 nmi for lighted life raft targets and 0 to 3.5 nmi for unlighted life raft targets.

The types of NVGs used on each SRU were discussed in section 1.2. Searches were typically conducted at 10 knots unless rough seas and weather made it impossible to search effectively and a speed reduction was made. The range of environmental parameters encountered over the three experiments is summarized in table 1-2.

A total of 17 individual lookouts are present in the VIGOROUS data set and 21 are present in the ALERT data set. NVG experience ranged from 0 to 19 hours onboard the VIGOROUS and 0 to 9 hours onboard the ALERT.

All remaining parameters were well-represented over their range of possible values.

† Items 19 through 21 were recorded for detections only.

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

SRU/ TARGET	ENVIRONMENTAL PARAMETERS								MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover (tenths)	Significant Wave Height (ft)	Whitecap Coverage	Relative Humidity (percent)	Air Temperature (deg. C)	Elevation (degrees)	Phase
Vigorous bridge/unlit targets	0	4 to 12	4 to 28	0 to 1.0	3 to 7	0 to 2	56 to 93	3.9 to 12.8	11 to 71	Full moon
Vigorous bridge/lit targets	0 to 3	0 to 10	5 to 32	.2 to 1.0	3 to 9	0 to 2	58 to 100	7.2 to 15	-61 to 35	Quarter to three quarter moon
Vigorous flying bridge/unlit targets	0	4 to 12	4 to 28	0 to 1.0	3 to 7	0 to 1	56 to 93	4.4 to 10.6	11 to 67	Full moon
Vigorous flying bridge/lit targets	0 to 1	4 to 10	5 to 26	.2 to 1.0	3 to 8	0 to 1	58 to 100	7.2 to 15	-64 to 35	Quarter to three quarter moon
Alert/unlit targets	0	2.5 to 15	3 to 34	.1 to 1.0	3 to 7.2	0 to 2	48 to 94	3 to 12	7 to 70	Full moon
Alert/lit targets	0 to 1	1.5 to 15	2 to 35	0 to 1.0	3.1 to 9.8	0 to 2	59 to 100	3 to 15.5	-66 to 35	None to three quarter moon

1.4 ANALYSIS APPROACH

1.4.1 Measure of Search Performance

The primary performance measure used by SAR mission coordinators to plan searches is sweep width (W). 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

x = Lateral range (i.e., closest point of approach) to targets of opportunity (see figure 1-10), and

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

Figure 1-11 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 less than the maximum detection distance for any given sweep so that scattered targets that may be detected beyond the limits of sweep width are equal in number to those that may be missed within those limits. Figure 1-12 (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 the distance W out to maximum detection range (MAX R_D) is indicated by the shaded portion at each end of the rectangle (areas B). Referring only to the shaded areas, when the number of targets missed equals the number of targets sighted (area A = sum of areas B), sweep width is defined. A detailed mathematical development and explanation of sweep width can be found in reference 6.

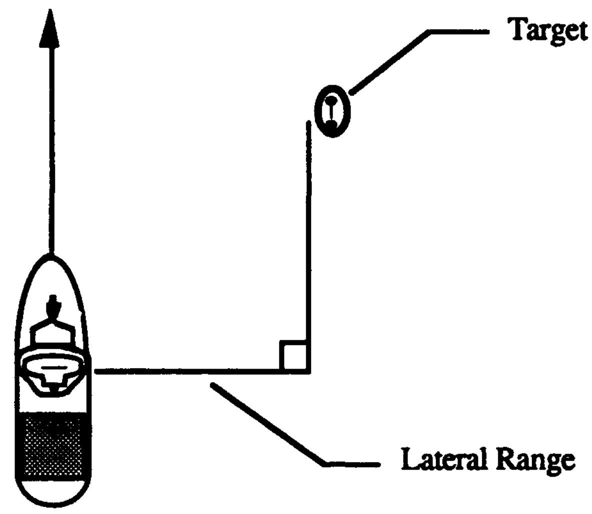

Figure 1-10. Definition of Lateral Range

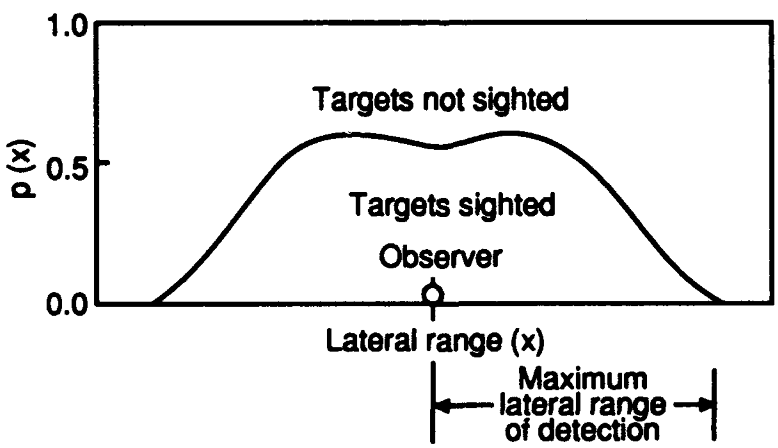

Figure 1-11. Relationship of Targets Detected to Targets Not Detected

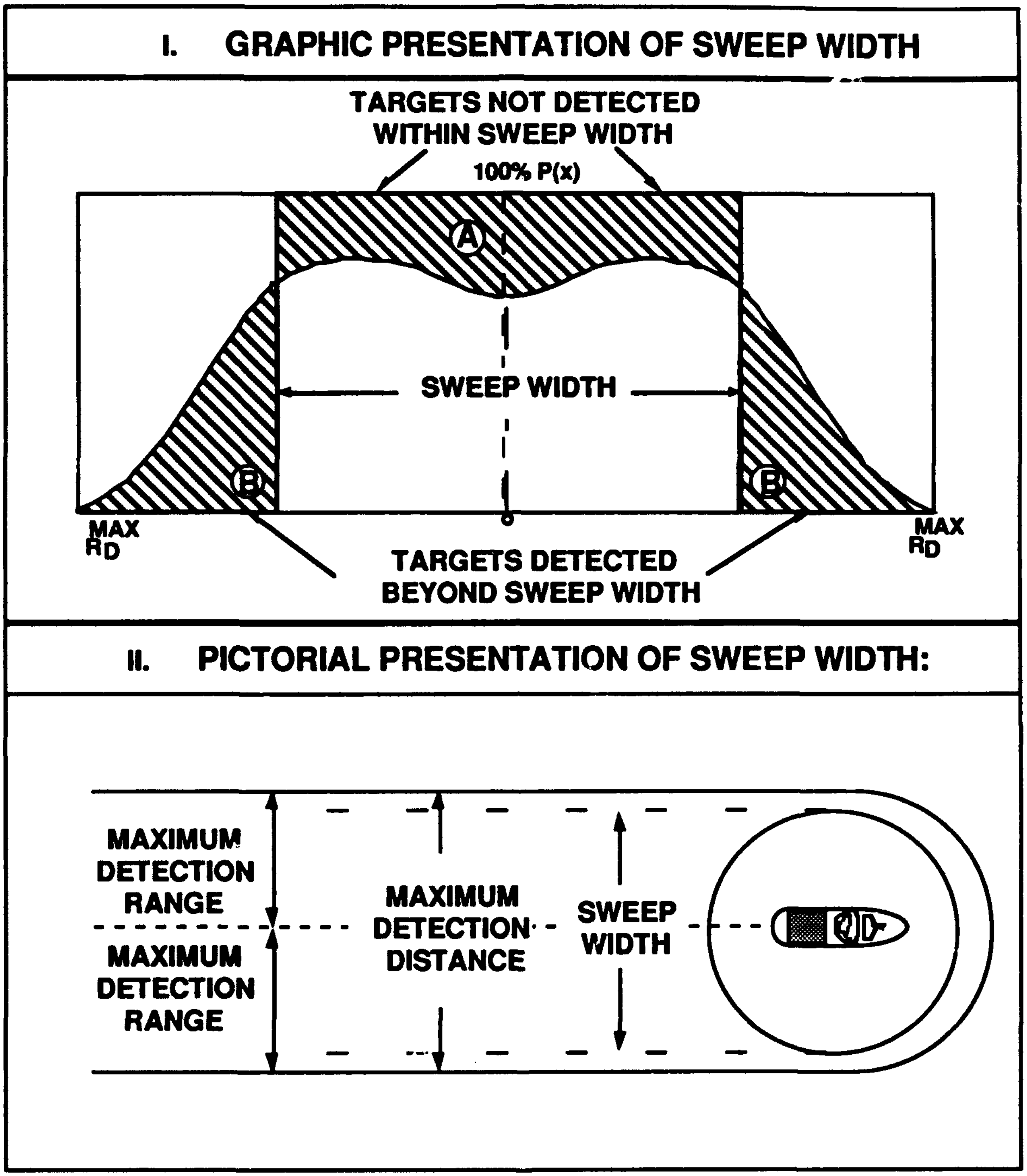

Figure 1-12. Graphic and Pictorial Presentation of Sweep Width

1.4.2 Analysis of Search Data

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

1. Which of the 22 search parameters identified in section 1.3.6 exerted significant influence on the detection performance of the SRUs against the target types tested?

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 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 1.3.5) to determine which SRU-target encounters were valid detection opportunities, and which of those opportunities resulted in successful target detections by the SRUs. The analyst listed each target detection opportunity on a raw data sheet along with a detection/miss indicator. Values for the 22 search parameters listed in section 1.3.6 were then obtained for each listed detection opportunity by consulting appropriate logs and environmental data buoy messages. A separate raw data sheet was completed for each search that was 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 stored on magnetic disk. A distinct data file was constructed for each SRU for each night it participated in data collection. Hard copies of these data files are provided in the appendix of this report.

From these single-SRU data files, six aggregate raw data files were built; one file for each SRU/target type combination evaluated (ALERT, VIGOROUS bridge, or VIGOROUS flying bridge versus lighted or unlighted targets). These six raw data files were merged into one Canso Bank data file. This raw data file 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 were entered and verified to be correct on the computer, basic statistics were obtained to characterize the data set. 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 their combinations present in the data set. The minimum, maximum, mean, and standard deviation values for each search parameter in the data set were obtained to determine the range of search conditions represented in the data set. Histograms showing the distribution of values for various parameters of interest were obtained to determine which search conditions were well-represented within the data set and which were not. Scatter plots depicting which combinations of search parameters were represented in the data set were also produced.

Once the raw data set was characterized in this manner, logistic multivariate regression analysis was used to determine which search parameters exerted significant influence on NVG detection performance and to develop lateral range curves from which NVG sweep widths could be computed. Analysis performed during this phase indicated there was a significant difference in data representing SRUs searching for lighted targets and that for SRUs searching for unlighted targets. The raw data file was separated into a lighted target file and an unlighted target file. For the unlighted data file, no difference in detection performance was found between the VIGOROUS bridge, the VIGOROUS flying bridge, and the ALERT data subsets and these were treated as a single SRU subset. For the lighted data file, no significant difference was found in the detection performance from the VIGOROUS bridge and VIGOROUS flying bridge and these were treated as a single SRU subset. For this lighted data file, a difference was found between the ALERT and VIGOROUS data subsets, and these two SRU subsets are treated separately. Analysis results are presented in chapter two for these data subsets.

1.4.2.3 LOGIT Multivariate Regression Model

Multivariate logistic regression models have proven to be appropriate analysis tools for fitting Coast Guard visual search data where the dependent variable is a discrete response (i.e., detection/no detection). The detection data from this NVG evaluation have been 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.

This type of 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 LOGIT module gives results equivalent to those given by the LOGODDS model, which was used with great success during earlier visual search performance analyses (reference 7). The logistic regression model was shown 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 = $a_0 + a_1x_1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n$,
a_i = Fitting coefficients (determined by computer regression), and
x_i = Independent variable values.

The method of maximum log-likelihood is employed in the model to optimize values of the coefficients a_i. A detailed theoretical development of the logistic regression analysis methodology is given in reference 8.

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 to the model (in which case computation can become very difficult).

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 use of relatively powerful computer resources.

With the advent of more powerful desktop computers has come the capability 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 9) uses the maximum log-likelihood method to fit a logistic curve to response data that can be broken down into discrete categories. As with LOGODDS, 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. This process is equivalent to A&T LOGODDS software, but allows for more than a binary (2-choice) response variable. When used to analyze a binary response data set, the LOGIT regression equation reduces to the same form as that given above for the LOGODDS model. Reference 10 documents a verification study performed by A&T that confirms the equivalence of the LOGODDS and LOGIT models for analysis of binary response data from Coast Guard detection performance evaluations.

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 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. From these lateral range curves, NVG sweep widths were computed.

1.4.2.4 Sweep Width Calculations

Sweep width, the measure of search performance used by Coast Guard search planners, was defined conceptually in section 1.4.1. 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 analysis procedure described in section 1.4.2.3 was used with the data set for each

SRU/target type combination. This procedure identified search parameters that exerted statistically significant influence on target detection probability. Histograms and scatter plots depicting the distribution of the significant parameters identified within each data set were then prepared. 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 would reflect 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 best illustrated by the following example.

STEP 1: Identification of Data Subsets. LOGIT analysis of the data set representing SRUs searching for lighted raft targets indicated that, in addition to lateral range, the SRU and wind speed exerted statistically significant influence on target detection probability. The distribution of the data for each SRU and wind speed was examined by generating histograms depicting values of these variables versus frequency of occurrence. These histograms were then compared with a scatter plot of the distribution of wind speed relative to the lateral range of each target detection opportunity for each SRU subset. The evaluation of these plots identified four subsets of data that were well represented in the data set. The first set of search conditions was represented by the ALERT searching in wind speeds of less than 20 knots. The second set of search conditions was represented by the ALERT searching in wind speeds of greater than or equal to 20 knots. The third set of search conditions was represented by the VIGOROUS searching in wind speeds of less than 20 knots. The final set of search conditions was represented by the VIGOROUS searching in wind speeds of greater than or equal to 20 knots.

STEP 2: Generation of Lateral Range Curves. Lateral range curve equations were generated by inputting the mean values of wind speed and the binary value for SRU type for each of the SRU data subsets to the LOGIT-generated expression for target detection probability. The equations that resulted were then plotted for lateral range values between 0 and 12 nmi. This process yielded distinct plots of lateral range versus target detection probability; one for each combination of search parameters identified in step 1 above.

STEP 3: Calculation of Sweep Widths. Sweep width values were calculated for each set of search conditions by integrating the applicable LOGIT expressions for target detection probability over the limits 0 to 12 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,

= 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 = 4 with x_2, x_3, and x_4 representing the specified values of visibility (in nmi), H_S (in feet), and moon visibility (0 or 1). The values of a_0, through a_4 would be determined by the LOGIT regression analysis.

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

W = 2A.

The methods illustrated in the example above 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 SRU/target type combination.

CHAPTER 2
TEST RESULTS

2.1 INTRODUCTION

This chapter summarizes the results of the NVG data analyses described in chapter 1. Two major discussions of results are presented in this chapter. Section 2.2 provides a quantitative analysis of NVG detection performance against each of the target types tested and section 2.3 provides an evaluation of human factors studied during the NVG experiments.

During the Canso Bank NVG experiment a total of 467 target detection opportunities were generated. Table 2-1 summarizes the distribution of these detection opportunities by SRU type and target type. Completed analyses indicate there is a significant difference in data representing SRUs searching for lighted targets and data representing SRUs searching for unlighted targets. Data have been separated into lighted target and unlighted target data sets.

Table 2-1. Numbers of Target Detection Opportunities by SRU Type and Target Type

TARGET TYPE	SRU TYPE		
	USCGC VIGOROUS		CCGS ALERT
	BRIDGE	FLYING BRIDGE	
Unlighted 4- and 6-person Life Rafts with Retroreflective Tape	55	38	36
Lighted 4- and 6-person Life Rafts with Retroreflective Tape	113	100	125

2.2 DETECTION PERFORMANCE

Sections 2.2.1 and 2.2.2 present discussions and detailed analyses of lighted and unlighted target data subsets. Lateral range curve fits and sweep width estimates are provided for statistically significant search parameter combinations that are well represented in the raw data. Data have been collected over a fairly limited range of environmental conditions and many instances exist where environmental parameters display relationships with each other (i.e., higher wind speed with higher H_s and more white caps). Lateral range was a significant variable for both lighted and unlighted raft targets. Wind speed was the significant parameter that best represented the effects of the environmental parameters for the lighted targets data set. Significant wave height was the significant parameter that best represented the effects of the related environmental parameters for the unlighted targets data set.

The lateral range plots depicted in this chapter show lateral range from the SRU trackline along the horizontal axis, and target detection probability along the vertical axis. The figures expressed as ratios on the plots represent the number of 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 for each 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 input into the LOGIT equation. Each data subset plotted represents a unique combination of significant search variable values.

2.2.1 <u>SRU Performance Against Lighted Raft Targets</u>

Three hundred and thirty-eight target detection opportunities were generated for this target type data set. LOGIT regression analysis at the 90-percent confidence level indicated that variation in target detection probability within this data set could best be explained by a combination of the lateral range, vessel, and wind speed parameters. In the Canso Bank area high winds, low visibility, and many whitecaps existed predominantly together. The identification of wind speed as a significant parameter is due in part to the correlation of wind speed, visibility and the existence/nonexistence of whitecaps Onboard the ALERT, only in less severe weather (lower wind speeds) were searches conducted through the opened bridge windows (no reflections from inside lighting).

After LOGIT analysis, the 338 detection opportunities in this data set were first sorted into 2 levels of vessel type (ALERT or VIGOROUS) and 2 levels of wind speed (less than 20 knots or greater than or equal to 20 knots). The data sets representing the VIGOROUS bridge and VIGOROUS flying bridge were found to be not significantly different as a result of the LOGIT analysis and are treated as one SRU data subset. Table 2-2 provides a breakdown of the number of detection opportunities in each data subset. These subsets were then sorted into 1-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 2-1, 2-2, 2-3, and 2-4.

The LOGIT-fitted lateral range curves shown in figures 2-1 through 2-4 were produced by solving the LOGIT regression model equation for the mean value of wind speed and the binary SRU type value (ALERT or the VIGOROUS) in each data subset. Lateral range curves were generated over a 0 to 12-nmi lateral range interval. For the ALERT, sweep width estimates of 6.7 nmi for the lower wind speed data subset and 5.2 nmi for the higher wind speed data subset were obtained by integrating the fitted LOGIT probability equations over the limits of 0 to 12 nmi. For the VIGOROUS, sweep width estimates of 11.1 nmi for the lower wind speed data subset and 9.6 nmi for the higher wind speed data subset were obtained by integrating the fitted LOGIT probability equations over the limits of 0 to 12 nmi.

Table 2-2. Lighted Target Data Subset Detection Opportunities by Vessel and WDSP

	SRU	
	CCGS ALERT	USCGC VIGOROUS
Wind Speed less than 20 knots	72	158
Wind speed greater than or Equal to 20 knots	53	55

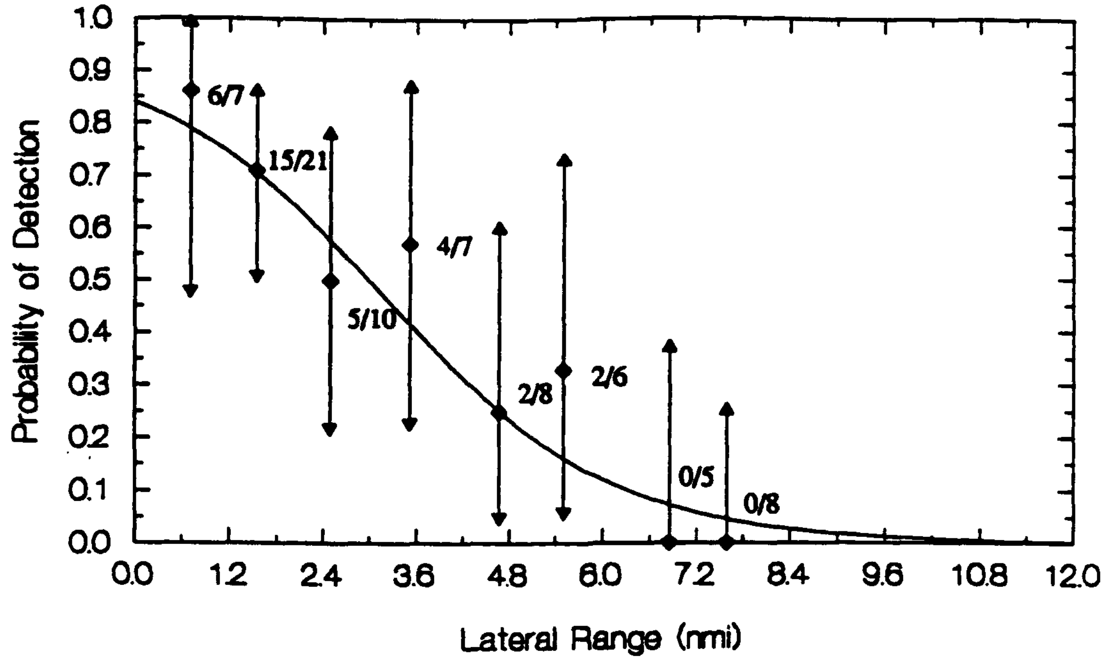

Figure 2-1. CCGS ALERT Detection of Lighted Life Rafts
(wind speed between 2 and 18 knots)

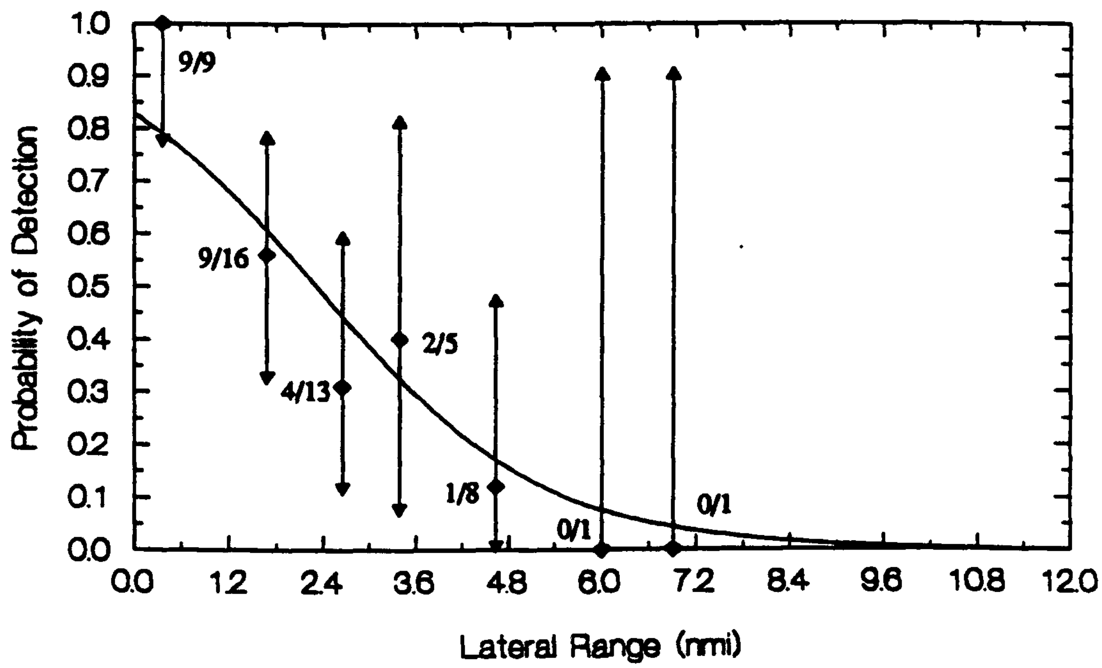

Figure 2-2. CCGS ALERT Detection of Lighted Life Rafts
(wind speed between 20 and 35 knots)

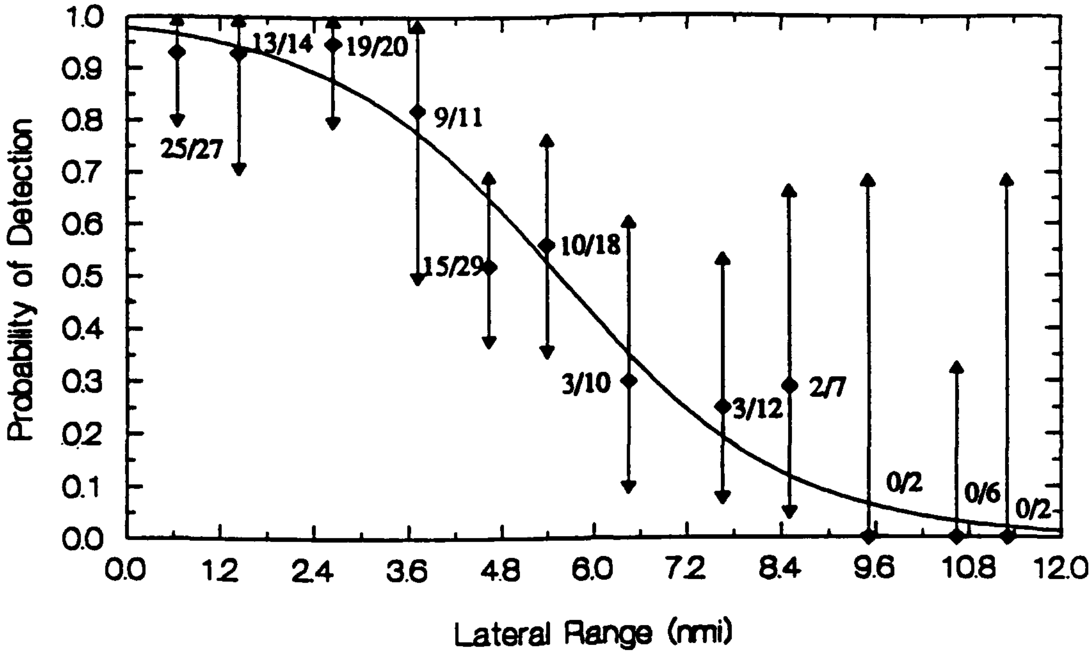

Figure 2-3. USCGC VIGOROUS Detection of Lighted Life Rafts
(wind speed between 5 and 19 knots)

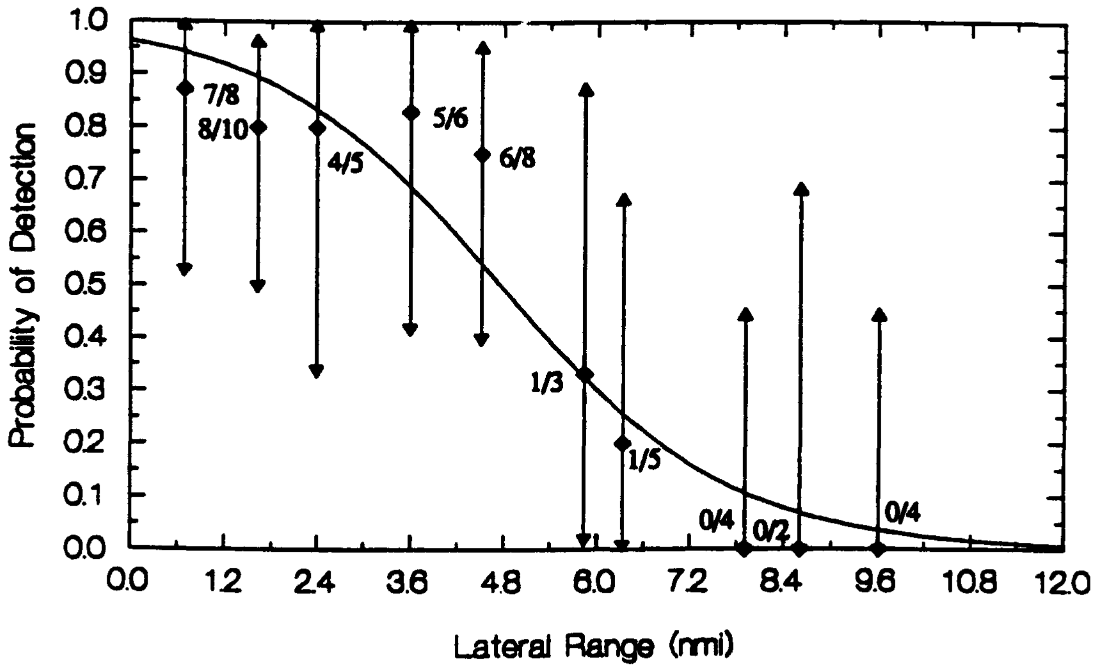

Figure 2-4. USCGC VIGOROUS Detection of Lighted Life Rafts
(wind speed between 20 and 32 knots)

2.2.2 Unlighted Life Raft Targets

One hundred and twenty-nine 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 could best be explained by a combination of the lateral range and significant wave height (H_S) parameters. For the unlighted life raft targets, SRU type was not a significant parameter. As with the lighted target data set, a correlation exists between several environmental parameters, however, for this data set H_S was found to be the most statistically significant parameter which could best describe actual search conditions.

After LOGIT analysis, the data were first sorted into two subsets representing either lower H_S (89 detection opportunities) of less than or equal to 5 feet or higher H_S (40 detection opportunities) of greater than 5 feet. These data subsets were each sorted into 0.5-nmi lateral range bins from 0 to the greatest lateral range in each data subset. The data subset of lower H_S displayed an unusually high detection probability (two detections in three opportunities) at 2.4 nmi. While these detections appear valid, they are not consistent with the rest of the data and were excluded from the calculation of the LOGIT-fitted lateral range curve and sweep width estimate for this data subset.

Figures 2-5 and 2-6 provide raw data plots and LOGIT-fitted lateral range curves for the two data subsets. The fitted lateral range curve was produced by solving the LOGIT regression model equation for the mean value of H_S over lateral ranges from 0 to 4 nmi. Sweep width estimates of 0.6-nmi and 1.3-nmi were obtained by integrating the fitted LOGIT probability equation for each data subset over the limits of 0 to 4 nmi.

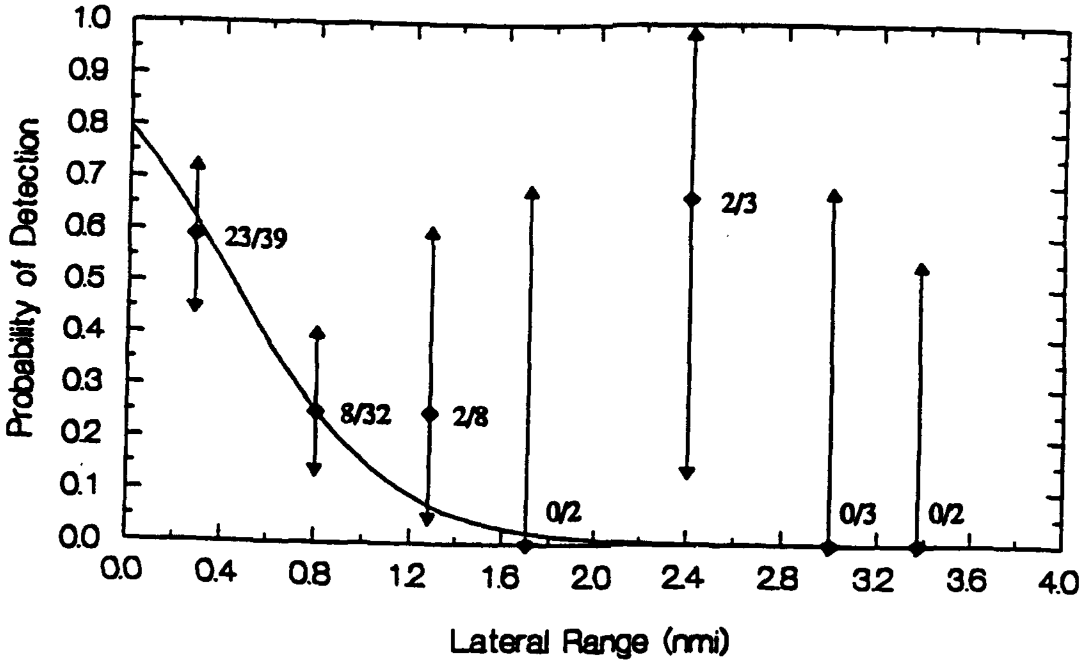

Figure 2-5. SRU Detection of Unlighted Life Rafts
(H_S between 3 and 5 feet)

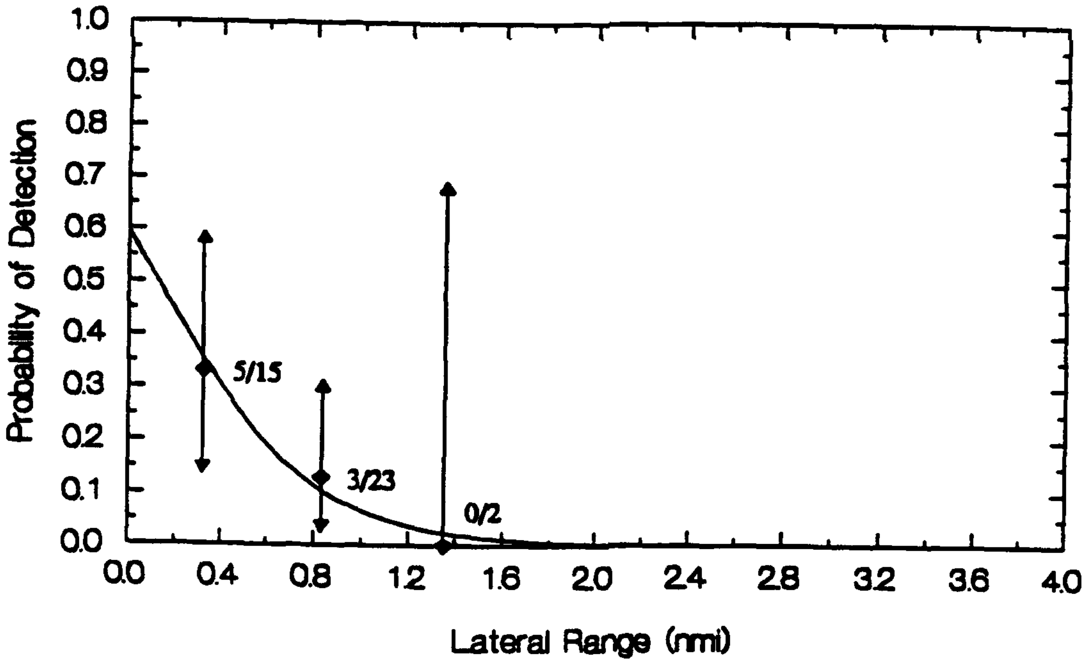

Figure 2-6. SRU Detection of Unlighted Life Rafts
(H_S between 5.6 and 7.2 feet)

2.3 HUMAN FACTORS

The next three sections provide information that relates to the human factors aspects of conducting NVG-assisted searches in the marine environment. Section 2.3.1 provides quantitative data on where and from what crew positions NVG detections were made. Sections 2.3.2 and 2.3.3 summarize subjective comments and observations made by the SRU crews and members of the R&D Center test team.

2.3.1 Analysis of Detection by Position

Figure 2-7 depicts the distribution of initial target detections made while searching for lighted targets. Figure 2-8 depicts the distribution of initial target detections made while searching for unlighted targets. Distribution of target detections is presented on the top half of each figure for the VIGOROUS and on the bottom half of each figure for the ALERT. The circular diagrams on the left side of figures 2-7 and 2-8 show the distribution of initial target detections as a function of relative bearing (expressed in "clock" format). This information is independent of which crew position made the detection. The silhouette diagrams on the right side of figures 2-7 and 2-8 show the distribution of initial target detections as a function of the four crew positions onboard the vessels. The information in the silhouette diagrams is independent of the clock bearings at which the targets were initially sighted.

The clock-bearing data in figure 2-7 and 2-8 indicate that almost all detections were made on or forward of the beam. In figure 2-7 an area of concentrated detections exists between the 11 and 1 o'clock position from both vessels. This was primarily due to the fact that the crews were instructed to search in this area. Targets ahead of the vessel remain inside the visual horizon longer than targets on the beam.

In both figures 2-7 and 2-8, there appears to be a higher number of detections made from the bridge wings than from the flying bridge. This difference exists because during searches in very severe weather flying bridge lookouts were not used, and more frequent reliefs of bridge wing lookouts were made.

On several occasions, the lookouts were relocated to the bridge wings on the VIGOROUS because of high winds. This explains the small discrepancies in the number of detections of the bridge wing and flying bridge.

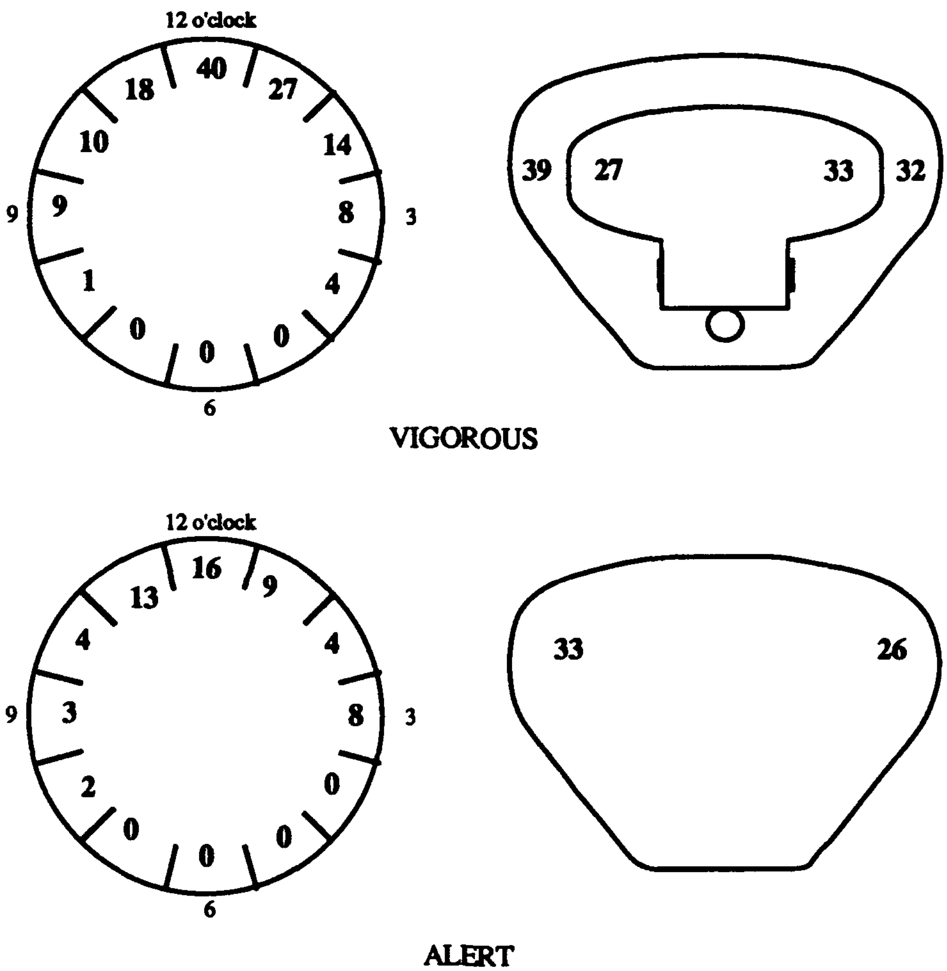

Figure 2-7. Distribution of VIGOROUS and ALERT Detections of Lighted Rafts by Clock Bearing and Crew Position

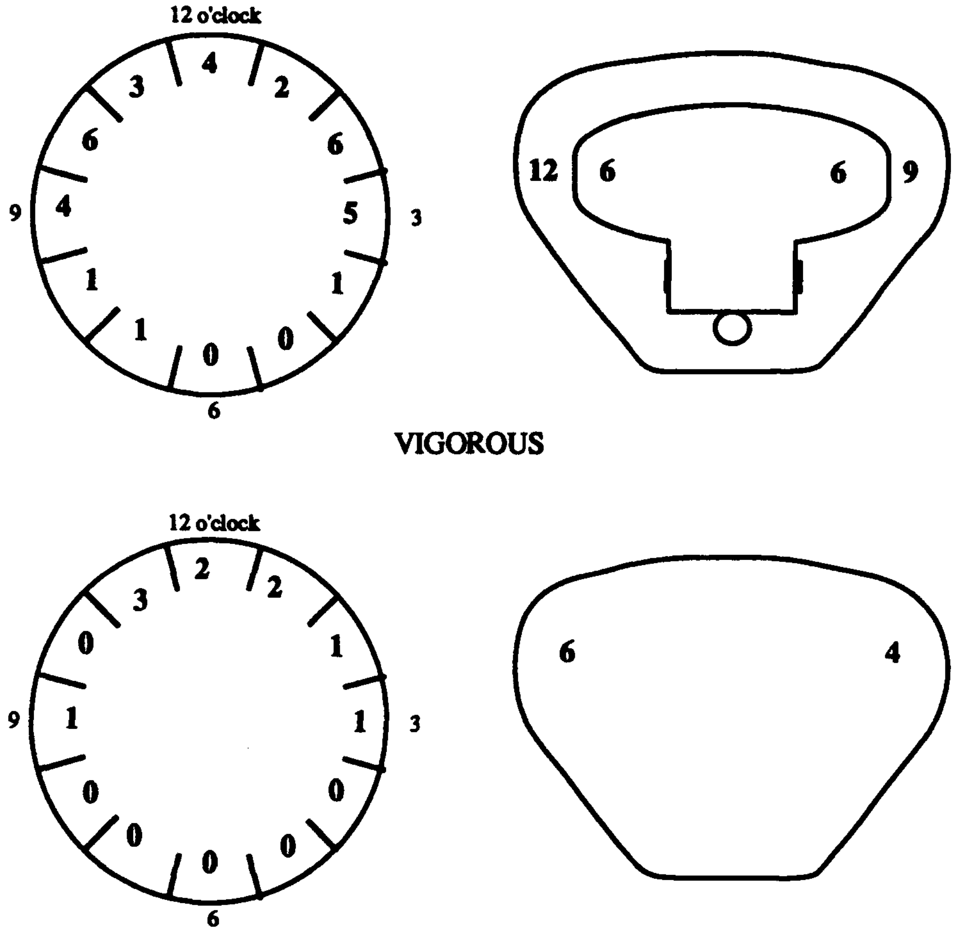

Figure 2-8. Distribution of VIGOROUS and ALERT Detection
of Unlighted Rafts by Clock Bearing and Crew Position

2.3.2 SRU Crew Comments Concerning NVG Use and Target Appearance

Subjective comments from the SRU crews concerning the comfort, ease-of-use, 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.

2.3.2.1 Crew Comments Concerning NVG Use

ALERT crew

1. Glare enters through the open sides of the PVS-7 goggles and distracts the lookouts.

2. Pilot house lighting creates glare on the inside of window surfaces.

VIGOROUS crew

1. On a dark night, the view through the NVG was "pretty grainy."

2. The engine exhaust obscured the view from the flying bridge when the relative wind was blowing from the stern toward the bow of the ship.

3. When lookouts searched while standing against the rail just aft of the bridge wing alidade, the ships running lights created glare which obscured part of the horizon. The part of the horizon obscured spanned from approximately 20 degrees off the bow to abeam on either side of the vessel. If the lookout stood back from the rail, or searched from in front of the pilot house this glare problem did not seem to exist.

4. As the visibility dropped, the flying bridge lookouts indicated that it was hard to distinguish the difference between the horizon and the water.

5. The flying bridge lookouts reported that sea spray greatly reduced visibility.

2.3.2.2 Crew Comments Concerning Target Appearance

SRU crew members were encouraged to provide a description of target appearance when detections were made. These target descriptions are listed in table 2-3 by SRU and target type. The descriptions appear in the table in descending order of frequency for each SRU/target type combination.

Table 2-3. Summary of Target Appearance Descriptions

TARGET TYPE	SEARCH UNIT TYPE	
	USCGC VIGOROUS	CCGC ALERT
Rafts With Lights	Light Raft White light Steady light Very dim Bobbing light Flashing on and off Bright Lighted raft Glow White light flashing White light behind ALERT Steady white light Light on and off 2 white lights Small light White light up and down Rotating white light Light (bird) Single white light Lighted raft Light blinking Dim light	Steady light Weak steady light Flashing Flash Weak sighting Light lapping
Rafts Without Lights	Raft Something white Like a whitecap that stays Speck in water Unlighted raft looked like a twinkie	Starboard side no light Intermittent light

2.3.3 Test Team Observations Concerning NVG Use

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

ALERT Observations

1. Performance drops off after approximately the first 30 minutes on NVGs (reference 11).

2. The starboard lookout experienced more reflections on the windows than the port lookout because the lighting for the navigation table was immediately aft of his position.

VIGOROUS Observations

1. The lookouts where instructed to scan the entire search area, but at times it appeared that they concentrated on the horizon, and possibly missed close-in targets.

2. Crew attitude toward searching was very upbeat, almost competitive. This may result in an abnormally high detection rate.

3. Lookouts were rotated every 30 minutes; this gives each watchstander a chance to man the helm and stay warm. This appeared to help keep the morale high.

4. The mast head light created a glare problem and was turned off during the search. The running lights were a problem only when the lookout was standing next to the rail just aft of the ship alidades.

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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. Additional conclusions based on earlier NVG experiments can be found in chapter 3 of references 1, 2, and 3.

3.1.1 Search Performance of SRUs with NVG for Lighted Targets

1. Results achieved during this experiment indicate that lighted targets are capable of being detected out to the limits of the visibility or the visual horizon which ever is less.

2. Environmental factors which effected SRU search performance while searching for these targets were best described by the wind speed parameter.

3.1.2 Search Performance of SRUs with NVG for Unlighted Targets

1. Environmental factors which effected SRU search performance while searching for these targets were best described by the significant wave height parameter.

3.1.3 General Conclusions

1. Detection performance of NVGs was significantly increased when the target (4- to 6-person life raft) was equipped with a light.

2. NVG detection performance (as measured by sweep width) was significantly greater when lookouts had a view unobstructed by glass (either through open bridge windows or by being stationed outside the pilot house). Glare and reflections of bridge lights are believed to be a very significant source of distraction and fatigue while searching through the glass of closed bridge windows.

3. No statistically significant difference was found for NVG-equipped lookouts searching from the VIGOROUS bridge or VIGOROUS flying bridge during the Canso Bank experiment.

4. For the environmental conditions encountered on Canso Bank, worsening conditions nearly halve NVG detection performance (as measured by sweep width).

3.2 RECOMMENDATIONS

The following interim recommendations are added to those already provided in references 1, 2, and 3. These recommendations are based on information obtained during the Canso Bank NVG experiment.

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

Daylight visual sweep widths are currently unavailable for SRUs in the 200-foot size range. The Canadian Coast Guard is evaluating data collected in the daylight portion of the fall 1990 Canso Bank experiment and comparison of daylight visual and NVG detection capabilities (as measured by sweep width) will be possible upon completion of that analysis. NVG sweep widths presented in chapter 2 are summarized here.

3.2.1 NVG Searches for Lighted Life Raft Targets.

CCGS ALERT, wind speeds 2 to 19 knots - use 6.7 nmi.
CCGS ALERT, wind speeds 20 to 35 knots - use 5.2 nmi.
USCGC VIGOROUS, wind speeds 5 to 19 knots - use 11.1 nmi.
USCGC VIGOROUS, wind speeds 20 to 32 knots - use 9.6 nmi.

3.2.2 NVG Searches for Unlighted Life Raft Targets

H_s **3 to 5 feet** - use 1.3 nmi.
H_s **5.6 to 7.2 feet** - use 0.6 nmi.

3.2.3 Recommendations For Future Research

1. More NVG search performance data should be collected in moonlit conditions. References 1, 2, and 3 indicate that moonlight significantly affects detection capability and very limited quantities of data exist for SRUs in the 200-foot size data set.

2. NVG search performance data should be collected when weather conditions other than those experienced during this experiment could be expected. Specifically, warm nights with good visibility and no cloud cover were not experienced during this experiment. Low visibility conditions are also very limited in this NVG data set.

3. Additional large surface SRUs (such as WPBs and other WMECs) should be evaluated for their NVG search performance.

4. 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 both retroreflective and non-retroreflective materials.

5. NVG detection performance for SRUs in the 200 foot size range should be evaluated against additional target types (i.e. small craft).

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REFERENCES

1. Reynolds, W.H.E., Robe, R.Q., Hover, G.L., and Plourde, J.V., Evaluation of Night Vision Goggles for Maritime Search and Rescue, Interim Report, Coast Guard R&D Center and A&T, Inc., April 1990.

2. Reynolds, W.H.E., Robe, R.Q., Hover, G.L., and Plourde, J.V., Evaluation of Night Vision Goggles for Maritime Search and Rescue, Interim Report, Coast Guard R&D Center and A&T, Inc., August 1990.

3. Robe, R.Q., Plourde, J.V., and Hover, G.L., Evaluation of Night Vision Goggles (NVG) for Maritime Search and Rescue (Third Interim Report), Interim Report, Coast Guard R&D Center and A&T, Inc., June 1991.

4. Litton Model M-912A/M-915A High Performance Night Vision Goggle, Litton Electron Devices data sheet, (date unknown).

5. Litton Model M-972 High Performance Night Vision Goggle, Litton Electron Devices data sheet, (date unknown).

6. Koopman, B. O., Search and Screening General Principles with Historical Applications, Pergamon Press, 1980.

7. 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.

8. Cox, D. R., The Analysis of Binary Data, Chapman and Hall, 1977.

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

REFERENCES (Cont'd)

10. Hover, G. L. and Exley, S. A. Evaluation of SYSTAT Software for Application to POD/SAR Project. A&T Memorandum to LT William Reynolds, 31 October 1989.

11. Donderi, D.C., Individual Differences in Visual Search Performance During the October 1990 Canso Bank Search and Rescue Exercise, Draft report to NORDCO, Ltd., July 1991.

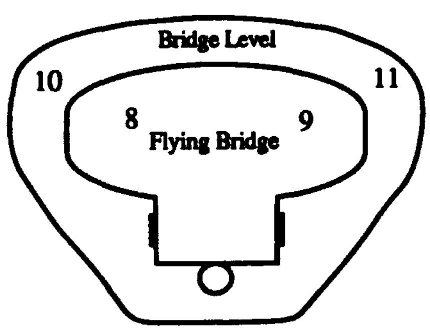
DATA APPENDIX

KEY TO DATA APPENDIX

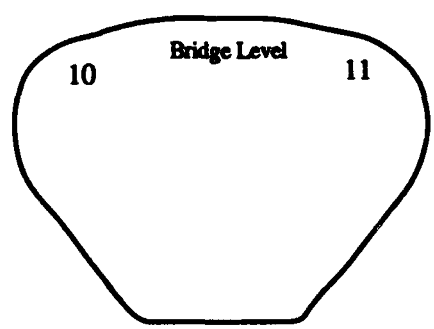
This appendix contains the raw data files for the joint Canadian Coast Guard/U.S. Coast Guard Night Vision Goggle experiment conducted on Canso Bank, Nova Scotia, Canada in the fall of 1990. Each data file is labeled with the search unit name and the date on which the data were collected.

The data files are listed in chronological order by search unit. Each file record represents one search unit/target interaction and describes the target detection opportunity using 22 parameters of interest. The following is a key to the format of each record.

Item 1:	DET	Detection? (1 = yes, 0 = 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:	ELEV	Moon elevation (degrees above(+) or below(-) the horizon)
Item 14:	MOONVIS	Moon visible from search unit (1 = yes, 0 = no)
Item 15:	MOONRA	Moon relative azimuth: (1 = looking into, 0 = looking across, -1 = looking away from)
Item 16:	PHS	Moon phase (0 = none, .2, .5, .7, 1 = full)
Item 17:	SPD	Search speed (knots)
Item 18:	ALTTYPE	NVG type as listed below:(1 = AN/PVS-5, 0 = AN/PVS-7)
Item 19:	POS	Position on search unit for detections or -9 for all missed targets. Position codes are shown below.



USCGC VIGOROUS



CCGS ALERT

Item 20:	LO	Lookout identification number for detections or -9 for all missed targets.
Item 21:	EXP	Lookout experience with NVGs (hours) for detections or -9 for all missed targets.
Item 22:	TYNO	Target type • Orange 4-person (4) • Orange 6-person (6) • Yellow 4-person (7) • Yellow 6-person (8)
Item 23:	SUBTY	Target subtype as listed below: • Lit (1) • Unlit (0)

ALERT OCTOBER 23 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0	0.3	0	10	20	1	3.1	1	-1	82	10.8	5	0	1	0.2	10	0	12	1	0	4	1
1	3.1	0.8	0	10	20	1	3.1	1	0	82	10.8	2	0	0	0.2	10	0	12	1	0	4	1
1	1.4	0.6	0	10	20	1	3.1	1	0	82	10.8	-6	0	0	0.2	10	0	12	9	0	4	1
1	1.3	0.8	0	10	20	1	3.1	1	-1	82	10.8	-5	0	1	0.2	10	0	12	9	0	4	1
1	2.6	0.2	0	8	24	1	3.6	1	1	81	11	-21	0	-1	0.2	10	0	12	11	0	4	1
1	2.8	0.7	0	8	24	1	3.6	1	0	81	11	-25	0	0	0.2	10	0	12	11	0	4	1
1	0	0.3	1	7	20	1	3.6	1	1	84	10.5	-32	0	-1	0.2	10	0	12	12	0	4	1
1	1.4	0.6	1	7	20	1	3.6	1	1	84	10.5	-34	0	0	0.2	10	0	12	12	0	4	1
1	3.8	0.6	1	6	20	1	3.3	1	-1	82	10	-45	0	0	0.2	10	0	13	5	0	4	1
1	1	0.9	1	7	17	1	3.6	1	-1	86	9.5	-57	0	0	0.2	10	0	12	14	0	4	1
1	1.7	0.7	1	7	21	1	3.6	1	0	84	10	-64	0	0	0.2	10	0	12	1	1	4	1
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1	2.5	0.3	1	7	17	1	3.6	1	0	86	9.5	-52	0	0	0.2	10	0	13	7	0	4	1
2	3.5	0.4	0	10	20	1	3.1	1	0	82	10.8	4	0	0	0.2	10	0	-9	-9	-9	7	1
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2	4.5	0.5	0	10	20	1	3.3	1	0	83	11	-14	0	0	0.2	10	0	-9	-9	-9	4	1
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2	4.1	0.2	1	8	24	1	3.6	1	-1	81	11	-21	0	1	0.2	10	0	-9	-9	-9	4	1

BOF

ALERT OCTOBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTYPE
1	0.1	0.1	1	3	27	1	6.6	2	-1	96	13.7	15	0	0	0.5	10	0	12	1	2	4	1
1	1	0.5	0	1.5	31	1	7.5	2	0	98	14.4	3	0	1	0.5	10	0	13	6	1	4	1
1	1.5	0.3	1	5	28	1	7.5	2	0	92	15.5	-4	0	0	0.5	10	0	12	15	0	4	1
1	0.6	0.7	1	6	30	1	9.8	2	0	97	15.3	-37	0	0	0.5	10	0	12	14	1	4	1
1	0.5	0.3	0	6	35	1	9.8	2	0	100	16	-43	0	1	0.5	10	0	12	18	0	4	1
2	2.5	1	0	5	29	1	9.8	2	0	97	14.8	-50	0	0	0.5	10	0	-9	-9	-9	4	1
2	3.3	1	1	3	32	1	7.9	2	-1	97	15.2	-19	0	0	0.5	10	0	-9	-9	-9	4	1
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2	2.7	0.9	0	3	31	1	7.5	2	-1	98	13.9	7	0	0	0.5	10	0	-9	-9	-9	4	1
1	0.5	0.4	1	3	32	1	7.9	2	1	97	15.2	-13	0	0	0.5	10	0	13	17	1	4	1
2	1.9	1	1	3	32	1	7.9	2	1	97	15.3	-19	0	0	0.5	10	0	-9	-9	-9	4	1
2	1.5	0.3	0	3	31	1	6.6	2	0	98	13.9	11	0	-1	0.5	10	0	-9	-9	-9	4	1
2	2.8	1	1	6	30	1	8.5	2	1	97	15.3	-30	0	0	0.5	10	0	-9	-9	-9	4	1
2	1.9	0.6	0	3	31	1	7.5	2	0	98	13.9	9	0	1	0.5	10	0	-9	-9	-9	4	1

EOF

ALERT OCTOBER 25 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.7	0.1	0	15	7	1	7.5	1	0	81	8.8	18	0	0	0.5	6	0	12	1	3	4	1
1	5.3	0.2	0	15	7	1	7.5	1	-1	81	8.8	18	0	0	0.5	6	0	12	1	3	4	1
1	3.7	0.6	0	15	7	1	7.5	1	0	81	8.8	16	0	0	0.5	6	0	13	16	1	4	1
1	1.1	0.6	0	15	7	1	7.5	1	0	81	8.8	17	0	1	0.5	6	0	12	1	3	4	1
1	3.5	1	0	15	7	1	7.5	1	0	81	8.8	14	0	1	0.5	6	0	12	1	3	4	1
1	1.8	0.7	0	15	7	1	7.5	1	0	85	8.5	10	0	0	0.5	10	0	13	3	2	4	1
1	1.3	0.1	0	15	9	1	7.2	0	1	84	8.3	8	0	0	0.5	10	0	13	6	2	4	1
1	1.7	0.9	0	15	9	1	7.2	0	0	84	8.3	1	0	0	0.5	10	0	13	6	2	4	1
1	0.8	0.4	0	15	10	1	6.9	0	0	81	8.5	-4	0	-1	0.5	10	0	13	11	2	4	1
1	1.4	0	0	15	7	1	6.9	0	0	82	9	-10	0	-1	0.5	10	0	12	12	2	4	1
1	3.4	0.4	0	15	7	1	6.9	0	-1	82	9	-23	0	0	0.5	10	0	13	2	0	4	1
1	1.7	0.5	0	15	7	1	6.9	0	0	82	9	-25	0	-1	0.5	10	0	13	2	0	4	1
1	1.6	0.3	0	15	14	1	6.2	1	0	85	9.1	-40	0	0	0.5	10	0	13	5	2	7	1
1	2	0.4	0	15	3	1	6.2	0	-1	84	9.5	-44	0	0	0.5	8	0	12	14	2	4	1
1	2.7	0.8	0	15	3	1	6.2	0	1	84	9.5	-48	0	0	0.5	8	0	13	7	1	4	1
2	4.8	1.1	0	15	14	1	6.2	1	1	85	9.1	-31	0	0	0.5	10	0	-9	-9	-9	7	1
2	7.2	0.2	0	15	7	1	7.5	0	1	81	8.8	18	0	0	0.5	6	0	-9	-9	-9	7	1
2	5.9	0	0	15	7	1	6.9	0	1	82	9	-10	0	0	0.5	10	0	-9	-9	-9	4	1
2	5.2	0.7	0	15	14	1	6.2	0	-1	85	9.1	-40	0	0	0.5	10	0	-9	-9	-9	4	1
2	7.1	0.3	0	15	9	1	7.2	0	1	84	8.3	6	0	0	0.5	10	0	-9	-9	-9	4	1
2	4.1	0.1	0	15	10	1	6.9	0	0	81	8.5	-1	0	0	0.5	10	0	-9	-9	-9	4	1
2	3.8	1	0	15	8	1	5.9	0	-1	92	9	-49	0	0	0.5	10	0	-9	-9	-9	4	1
2	6.9	0.6	0	15	3	1	6.2	0	0	84	9.5	-45	0	0	0.5	8	0	-9	-9	-9	4	1
2	7.7	0.9	0	15	7	1	6.9	0	-1	82	9	-29	0	0	0.5	10	0	-9	-9	-9	4	1
2	6	0	0	15	7	1	6.9	0	-1	82	9	-10	0	0	0.5	10	0	-9	-9	-9	4	1
2	4.7	0.2	0	15	9	1	7.2	0	-1	84	8.3	7	0	0	0.5	10	0	-9	-9	-9	4	1
2	7.7	0.2	0	15	10	1	6.9	0	-1	81	8.5	-2	0	0	0.5	10	0	-9	-9	-9	4	1
2	7.9	1	0	15	8	1	5.9	0	0	92	9	-49	0	0	0.5	10	0	-9	-9	-9	4	1

EOF

ALERT — OCTOBER 28 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	1.3	0.1	0	15	2	9	7.5	0	0	80	6.3	35	1	0	0.7	10	0	12	9	3	4	1
1	4.7	0.8	0	15	2	9	7.5	0	-1	80	6.3	35	1	0	0.7	10	0	12	9	3	4	1
1	0.9	0.8	0	15	2	9	7.5	0	1	80	6.3	35	1	0	0.7	10	0	13	3	3	4	1
1	2.5	0.5	0	15	14	9	7.2	0	0	64	7.1	31	0	1	0.7	10	0	13	11	3	4	1
1	1.1	0.9	0	15	14	9	7.2	0	0	64	7.1	29	0	0	0.7	10	0	12	15	2	4	1
1	3.4	0.3	0	15	12	9	6.7	0	0	62	7.1	26	0	1	0.7	10	0	13	2	1	4	1
1	4.5	0.1	0	15	16	9	7.2	1	0	69	7.2	19	0	0	0.7	10	0	13	5	3	4	1
1	0.7	1	0	15	16	9	7.2	1	0	69	7.2	14	0	0	0.7	10	0	13	5	3	4	1
1	1.6	0.5	0	15	14	10	6.9	1	0	70	8.5	8	0	0	0.7	10	0	13	1	4	4	1
1	5.3	0.7	0	15	14	10	6.9	1	1	70	8.5	7	0	-1	0.7	10	0	13	1	4	4	1
2	6.8	0.8	0	15	12	9	6.7	0	1	62	7.1	23	0	-1	0.7	10	0	-9	-9	-9	4	1
2	6.7	0.3	0	15	12	9	6.7	0	1	62	7.1	26	0	-1	0.7	10	0	-9	-9	-9	4	1
2	7	0.2	0	15	14	9	7.2	0	0	62	7.1	32	0	0	0.7	10	0	-9	-9	-9	4	1
2	5	0.6	0	15	2	9	7.5	0	-1	80	6.3	35	0	0	0.7	10	0	-9	-9	-9	4	1
2	0.7	0.4	0	15	12	9	6.7	0	1	62	7.1	27	0	-1	0.7	10	0	-9	-9	-9	4	1
2	5.3	0.2	0	15	14	10	6.9	0	1	70	8.5	11	0	-1	0.7	10	0	-9	-9	-9	4	1
2	1.5	0	0	15	16	9	7.2	1	1	69	7.2	13	0	-1	0.7	10	0	-9	-9	-9	4	1
2	6.9	1.1	0	15	24	2	6.6	1	1	69	8.6	-17	0	-1	0.7	10	0	-9	-9	-9	4	1
2	5	0.1	0	15	12	9	6.7	0	-1	62	7.1	27	0	1	0.7	10	0	-9	-9	-9	4	1
2	4.8	0.6	0	15	20	10	6.2	2	1	59	8.8	-8	0	-1	0.7	10	0	-9	-9	-9	4	1
2	8	0.6	0	15	7	9	7.9	0	-1	64	7	34	0	0	0.7	10	0	-9	-9	-9	4	1
2	7.3	0.8	0	15	18	10	6.6	1	1	68	8	-4	0	-1	0.7	10	0	-9	-9	-9	4	1
2	7.7	0	0	15	14	10	6.9	1	-1	69	8.5	3	0	1	0.7	10	0	-9	-9	-9	4	1
2	3.3	0.8	0	15	18	10	6.6	1	0	68	8	-4	0	0	0.7	10	0	-9	-9	-9	4	1
2	2	0.1	0	15	20	10	6.2	2	-1	59	8.8	-7	0	1	0.7	10	0	-9	-9	-9	4	1
2	6.8	0.1	0	15	14	10	6.9	1	-1	69	8.5	13	0	1	0.7	10	0	-9	-9	-9	4	1
2	2.6	1.1	0	15	24	10	6.6	2	0	69	8.6	-17	0	0	0.7	10	0	-9	-9	-9	4	1
EOF																						

ALERT — NOVEMBER 2 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0	0.4	0	15	22	1	4.6	1	-1	50	6	29	0	1	1	10	0	13	11	4	4	0
1	0.1	0.8	0	15	22	1	4.6	1	-1	50	6	33	0	1	1	10	0	13	11	4	6	0
1	0.1	0.2	0	15	20	1	4.3	1	0	48	6.4	50	0	1	1	10	0	12	1	5	4	0
1	0.2	0.8	0	15	20	1	3.9	1	0	54	7.7	62	0	0	1	10	0	13	3	5	4	0
1	0	0.5	0	15	11	1	3.9	1	0	57	8	65	0	-1	1	10	0	12	6	4	8	0
2	0.4	0.9	0	15	18	1	4.6	1	-1	57	5.9	45	0	0	1	10	0	-9	-9	-9	4	0
2	0.6	0.5	0	15	3	1	3.6	0	-1	50	7.3	60	0	0	1	10	0	-9	-9	-9	4	0
2	0.5	0.4	0	15	6	1	3.6	0	0	53	7.4	65	0	-1	1	10	0	-9	-9	-9	6	0
2	0.9	1	0	15	11	1	3.9	1	0	57	8	66	0	-1	1	10	0	-9	-9	-9	4	0
2	0.5	1	0	15	4	1	3.6	0	-1	58	7.9	56	0	-1	1	10	0	-9	-9	-9	4	0
2	0.4	0.6	0	15	19	1	5.6	1	0	69	6.2	23	0	0	1	10	0	-9	-9	-9	8	0
2	0.2	0.3	0	15	20	1	3.9	1	0	54	7.7	59	0	0	1	10	0	-9	-9	-9	4	0
EOF																						

ALERT NOVEMBER 3 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.3	0	12	19	9	3	1	0	81	5.8	10	1	0	1	10	0	12	1	5	4	0
1	0.3	0.8	0	12	19	9	3	1	0	81	5.8	16	0	0	1	10	0	12	1	5	6	0
1	0.3	0.8	0	15	18	1	3.3	1	0	75	5	38	1	-1	1	10	0	12	6	6	4	0
2	1	0.2	0	15	17	7	3.6	1	-1	71	4.5	51	1	0	1	10	0	-9	-9	-9	8	0
2	0.9	0.3	0	15	19	1	3.9	1	-1	73	4.8	67	1	0	1	10	0	-9	-9	-9	4	0
BOF																						

ALERT NOVEMBER 4 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.8	0	0	2.5	34	3	7.2	2	-1	93	10.7	50	1	0	1	10	0	-9	-9	-9	6	0
2	1	0.8	0	3	31	3	6.2	2	-1	93	11.3	38	1	0	1	10	0	-9	-9	-9	6	0
2	1	0.6	0	3	26	3	7.2	2	-1	93	10.7	56	1	0	1	10	0	-9	-9	-9	4	0
2	0.3	0.8	0	2.5	27	2	7.2	2	0	92	11.2	65	1	0	1	10	0	-9	-9	-9	4	0
2	0.6	0	0	4	22	9	5.9	1	0	94	11	11	0	1	1	10	0	-9	-9	-9	8	0
2	0.6	0.3	0	3	27	9	5.6	1	0	89	12	22	0	0	1	10	0	-9	-9	-9	4	0
2	0.6	0.7	0	4	22	9	5.9	1	0	94	11	17	0	0	1	10	0	-9	-9	-9	4	0
BOF																						

ALERT NOVEMBER 5 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	REHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.9	0.7	0	15	27	8	5.9	2	0	60	5.1	7	0	1	1	10	0	12	1	9	4	0
1	0	0.7	0	15	15	9	3.9	1	0	65	4	57	0	0	1	10	0	13	8	8	6	0
2	1	0.1	0	15	26	7	5.6	2	0	66	5	11	0	1	1	10	0	-9	-9	-9	4	0
2	1	0.7	0	15	26	7	5.6	2	1	66	5	16	0	0	1	10	0	-9	-9	-9	7	0
2	1	0.2	0	15	18	10	5.6	1	0	64	4.8	31	0	1	1	10	0	-9	-9	-9	8	0
2	0.6	0.1	0	15	22	9	5.6	2	-1	61	4.8	20	0	0	1	10	0	-9	-9	-9	4	0
2	0.4	0.5	0	15	22	9	5.6	2	1	61	4.8	24	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	0.2	0	15	20	9	4.6	1	1	61	4.5	41	0	0	1	10	0	-9	-9	-9	6	0
2	1.3	0.7	0	15	18	10	5.6	1	1	64	4.8	37	0	0	1	10	0	-9	-9	-9	4	0
2	0.7	0.5	0	15	12	9	3.6	0	0	62	3.8	64	0	1	1	10	0	-9	-9	-9	4	0
2	0.6	0.8	0	15	12	10	3.6	0	0	61	4	70	0	0	1	10	0	-9	-9	-9	4	0
2	1	0.2	0	15	8	9	3.6	0	0	62	3.9	68	0	0	1	10	0	-9	-9	-9	8	0
BOF																						

USCGC VIGOROUS FLYING BRIDGE OCTOBER 23 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	2.6	0.1	0	8	14	10	3	0	0	87	11.7	8	0	0	0.2	10	0	8	32	0	4	1
1	0.4	0.2	0	8	14	10	3	0	-1	87	11.7	8	0	0	0.2	10	0	9	28	0	4	1
1	1.2	0.9	0	8	14	10	3	0	-1	87	11.7	3	0	1	0.2	10	0	8	32	0	4	1
1	4.3	1.4	0	8	15	10	3	1	0	81	11.7	-1	0	0	0.2	10	0	9	29	0	4	1
1	1.6	1.4	0	8	15	10	3	1	-1	81	11.7	-1	0	1	0.2	10	0	9	29	0	4	1
1	2.1	2.4	0	8	20	9	3	1	0	82	12.8	-9	0	-1	0.2	10	0	8	29	0	4	1
1	2.2	2.8	0	8	20	9	4	1	1	82	12.8	-14	0	-1	0.2	10	0	9	31	0	4	1
1	3.2	3.3	0	8	20	9	4	1	0	82	12.8	-18	0	0	0.2	10	0	9	30	0	4	1
1	0.8	3.4	0	8	20	9	4	1	1	75	11.7	-19	0	-1	0.2	10	0	8	28	0	4	1
1	1.2	0.1	0	8	20	9	4	1	1	75	11.7	-25	0	-1	0.2	10	0	8	28	0	4	1
1	4.7	0.6	1	8	20	9	4	1	0	74	10.6	-29	0	0	0.2	10	0	8	37	0	4	1
1	3.9	1.2	1	8	20	9	3	1	0	74	10.6	-35	0	0	0.2	10	0	8	37	0	4	1
1	2.8	1.7	1	8	12	9	3	1	0	74	10.6	-40	0	1	0.2	10	0	9	37	0	4	1
1	0.5	1.8	1	8	12	9	3	1	-1	74	10.6	-42	0	1	0.2	10	0	8	34	0	4	1
1	5.9	2.8	1	8	16	9	4	1	0	87	10	-51	0	0	0.2	10	0	9	33	0	4	1
1	5.7	3.2	1	8	16	9	4	1	0	87	10	-55	0	1	0.2	10	0	9	33	0	4	1
1	2.3	3.8	1	8	17	9	4	1	0	93	10	-61	0	-1	0.2	10	0	9	33	0	4	1
2	7.8	0.9	1	8	20	9	4	1	0	74	10.6	-32	0	0	0.2	10	0	-9	-9	-9	7	1
2	5.1	0.9	0	8	14	10	4	0	0	87	11.7	3	0	0	0.2	10	0	-9	-9	-9	4	1
2	8.6	3.6	0	8	20	9	4	1	0	75	11.7	-22	0	0	0.2	10	0	-9	-9	-9	4	1
2	4.1	0.1	0	8	20	9	4	1	0	75	11.7	-25	0	0	0.2	10	0	-9	-9	-9	4	1
2	7.6	2.1	1	8	12	9	4	1	0	74	10.6	-45	0	0	0.2	10	0	-9	-9	-9	4	1
2	8	2.7	0	8	20	9	3	1	0	82	12.8	-22	0	0	0.2	10	0	-9	-9	-9	4	1
2	3.2	2.1	0	8	15	10	3	1	0	81	11.7	-16	0	0	0.2	10	0	-9	-9	-9	4	1
1	2.9	4.2	1	8	17	9	4	1	1	93	10	-64	0	1	0.2	10	0	9	33	0	4	1
2	7.5	1.7	0	8	15	10	3	1	0	81	11.7	-3	0	0	0.2	10	0	-9	-9	-9	4	1
2	3.9	2.7	0	8	20	9	3	1	0	82	12.8	-12	0	0	0.2	10	0	-9	-9	-9	4	1
1	0.3	3.3	1	8	20	9	4	1	0	74	10.6	-56	0	0	0.2	10	0	8	34	0	4	1
2	6.6	0.9	0	8	14	10	3	0	0	87	11.7	-5	0	0	0.2	10	0	-9	-9	-9	4	1
2	4.4	0.6	0	8	14	10	3	0	0	87	11.7	5	0	0	0.2	10	0	-9	-9	-9	4	1
2	8.5	0.1	0	8	14	10	3	0	0	87	11.7	8	0	0	0.2	10	0	-9	-9	-9	4	1
2	1.3	1.4	1	8	12	9	4	1	0	74	10.6	-39	0	0	0.2	10	0	-9	-9	-9	4	1
1	5.2	3	1	8	17	9	4	1	1	93	10	-64	0	0	0.2	10	0	9	33	0	4	1
2	4.8	1.8	1	8	12	9	3	1	0	74	10.6	-40	0	0	0.2	10	0	-9	-9	-9	4	1

EOF

USCGC VIGOROUS FLYING BRIDGE OCTOBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.8	0	1	6	26	10	7	1	-1	100	13.8	13	0	0	0.5	10	1	9	35	4	4	1
1	1.6	1.2	1	6	26	10	8	1	0	100	13.8	6	0	1	0.5	10	1	8	35	4	4	1
1	0.5	2.1	1	4	22	10	8	1	0	100	14.4	1	0	0	0.5	10	1	8	35	4	4	1
2	2.5	1.6	1	4	22	10	8	1	0	100	14.4	3	0	0	0.5	10	1	-9	-9	-9	4	1
1	4.8	2.4	1	4	17	10	8	1	0	100	15	-3	0	0	0.5	10	1	9	34	4	4	1
2	6.1	0.5	1	6	26	10	7	1	0	100	13.8	10	0	0	0.5	10	1	-9	-9	-9	4	1
2	2	2	1	6	26	10	8	1	0	100	13.8	8	0	0	0.5	10	1	-9	-9	-9	4	1
2	6.6	2.1	1	6	26	10	8	1	0	100	13.8	7	0	0	0.5	10	1	-9	-9	-9	4	1
1	5.8	1.9	1	4	22	10	8	1	0	100	14.4	2	0	0	0.5	10	1	10	33	4	4	1

BOF

USCGC VIGOROUS FLYING BRIDGE OCTOBER 25 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	1	0.1	0	10	19	10	7.5	1	1	80	10.6	20	0	1	0.5	10	1	8	43	4	4	1
1	5	0.1	0	10	19	10	7.5	1	0	80	10.6	20	0	0	0.5	10	1	8	43	4	4	1
1	4	0.2	0	10	19	10	7.5	1	1	80	10.6	19	0	0	0.5	10	1	9	42	4	4	1
1	0.8	0.3	0	10	19	10	7.5	1	0	80	10.6	19	0	0	0.5	10	1	8	43	4	4	1
1	2.4	1.1	0	10	19	10	7.5	1	1	80	10.6	14	0	0	0.5	10	1	9	42	4	4	1
1	3.9	1.2	0	10	19	10	7.5	1	0	80	10.6	11	0	0	0.5	10	1	8	43	4	4	1
1	1.5	1.5	0	10	15	10	7.5	1	1	75	11.1	11	0	0	0.5	10	1	9	43	4	4	1
1	4.3	2.7	0	10	9	10	7.2	1	0	80	10.6	5	0	-1	0.5	10	1	9	41	4	4	1
1	0.7	3.3	0	10	9	10	7.2	1	-1	80	10.6	1	0	-1	0.5	10	1	9	40	4	4	1
1	0.7	3.9	0	10	9	10	6.9	1	0	74	10.6	-5	0	-1	0.5	10	1	9	40	4	4	1
1	2.4	0.2	0	10	9	10	6.9	1	-1	74	10.6	-14	0	0	0.5	10	1	8	31	4	4	1
1	0.3	1.1	0	10	6	10	6.9	1	0	68	10.6	-17	0	0	0.5	10	1	8	31	4	7	1
1	2.9	2.4	0	10	7	10	6.2	0	0	80	10	-29	0	1	0.5	10	1	8	32	4	4	1
1	1.7	2.2	0	10	7	10	6.2	0	0	80	10	-28	0	1	0.5	10	1	9	29	4	4	1
1	4.6	3.2	0	10	5	10	6.2	0	0	87	10	-37	0	0	0.5	10	1	8	32	4	4	1
1	1	3.2	0	10	5	10	6.2	0	0	87	10	-37	0	1	0.5	10	1	9	29	4	4	1
2	5	0.2	0	10	19	10	7.5	1	0	80	10.6	19	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.8	3.9	0	10	9	10	6.9	1	1	74	10.6	-5	0	0	0.5	10	1	-9	-9	-9	4	1
2	6.3	3.9	0	10	9	10	6.9	1	-1	74	10.6	-4	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.1	0.5	0	10	9	10	6.9	1	-1	74	10.6	-10	0	0	0.5	10	1	-9	-9	-9	4	1
2	6.3	2.2	0	10	7	10	6.2	0	-1	80	10	-27	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.8	3.7	0	10	11	10	5.9	0	-1	86	9.4	-42	0	0	0.5	10	1	-9	-9	-9	4	1

BOF

USCGC VIGOROUS FLYING BRIDGE OCTOBER 28 1990

DET	LATRNG	TOT	PRECIP	VIS	VDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.8	0	0	10	6	9	8	0	1	65	8.3	35	0	-1	0.7	10	0	8	32	8	4	1
1	0.5	0.1	0	10	6	9	8	0	0	65	8.3	35	0	0	0.7	10	0	9	28	8	4	1
1	0.4	2.2	0	10	10	9	7	0	0	65	8.3	26	0	0	0.7	10	0	9	30	8	4	1
1	4.7	3	0	10	10	9	7	0	0	65	8.3	24	0	0	0.7	10	0	9	29	8	4	1
1	0.7	3.4	0	10	11	8	7	0	0	65	7.8	21	0	1	0.7	10	0	8	31	8	4	1
1	4.7	0.5	0	10	12	7	7	0	1	58	8.3	13	0	0	0.7	10	0	9	33	8	4	1
1	7.5	0.7	0	10	12	7	7	0	0	58	8.3	12	0	1	0.7	10	0	8	34	8	4	1
1	1.4	0.9	0	10	12	7	7	0	0	58	8.3	10	0	0	0.7	10	0	9	33	8	4	1
1	4.8	0.9	0	10	12	7	7	0	1	58	8.3	9	0	0	0.7	10	0	9	33	8	4	1
1	1.3	1.4	0	10	12	7	7	0	0	58	8.3	5	0	0	0.7	10	0	9	33	8	4	1
1	7.9	1.6	0	10	14	9	7	0	0	79	7.8	3	0	1	0.7	10	0	8	33	8	4	1
1	6.5	3.1	0	10	11	10	7	0	0	72	7.8	-13	0	-1	0.7	10	0	8	36	8	4	1
1	3.6	3.4	0	10	11	10	7	0	1	72	7.8	-16	0	-1	0.7	10	0	8	37	8	4	1
1	4.8	3.8	0	10	20	2	7	0	0	72	8.3	-19	0	0	0.7	10	0	9	34	8	4	1
2	5.5	0	0	10	11	8	7	0	1	65	7.8	17	0	-1	0.7	10	0	-9	-9	-9	4	1
2	11	0.8	0	10	12	7	7	0	1	58	8.3	12	0	-1	0.7	10	0	-9	-9	-9	4	1
2	5.2	3.2	0	10	10	9	7	0	1	65	8.3	22	0	-1	0.7	10	0	-9	-9	-9	4	1
2	10.5	1.2	0	10	12	7	7	0	1	58	8.3	7	0	-1	0.7	10	0	-9	-9	-9	4	1
1	8.6	1	0	10	8	9	7	0	-1	70	7.2	32	0	0	0.7	10	0	8	32	8	4	1
1	5.2	0.6	0	10	6	9	8	0	-1	65	8.3	34	0	0	0.7	10	0	8	5	8	4	1
2	9.8	3.8	0	10	20	2	7	0	1	72	8.3	-19	0	0	0.7	10	0	-9	-9	-9	4	1
2	5.5	0.4	0	10	6	9	8	0	-1	65	8.3	34	0	0	0.7	10	0	-9	-9	-9	4	1
2	4.6	1	0	10	12	7	7	0	1	58	8.3	8	0	-1	0.7	10	0	-9	-9	-9	4	1
2	9.4	4.2	0	10	20	2	7	0	1	72	8.3	-24	0	0	0.7	10	0	-9	-9	-9	4	1
2	9.5	0.1	0	10	6	9	8	0	-1	65	8.3	35	0	0	0.7	10	0	-9	-9	-9	4	1
1	2.5	0.3	0	10	12	7	7	0	0	58	8.3	12	0	0	0.7	10	0	9	33	8	4	1
2	0.7	0.8	0	10	12	7	7	0	1	58	8.3	10	0	-1	0.7	10	0	-9	-9	-9	4	1
2	6.5	3.1	0	10	10	9	7	0	-1	65	8.3	23	0	1	0.7	10	0	-9	-9	-9	4	1
2	2.8	3.3	0	10	11	10	7	0	-1	72	7.8	14	0	1	0.7	10	0	-9	-9	-9	4	1
2	11.3	0.7	0	10	6	9	8	0	-1	65	8.3	34	0	0	0.7	10	0	-9	-9	-9	4	1
2	10.4	2.5	0	10	14	9	6	0	0	79	7.8	-6	0	0	0.7	10	0	-9	-9	-9	4	1
1	3.7	2	0	10	8	9	7	0	-1	70	7.2	29	0	1	0.7	10	0	8	28	8	4	1
1	5.1	2.8	0	10	11	10	6	0	-1	72	7.8	-10	0	0	0.7	10	0	8	36	8	4	1
1	2.8	2.8	0	10	11	10	6	0	-1	72	7.8	-10	0	0	0.7	10	0	9	37	8	4	1
1	6.2	3.8	0	10	20	2	7	0	0	72	8.3	-20	0	0	0.7	10	0	8	38	8	4	1

EOP

USCGC VIGOROUS — FLYING BRIDGE — NOVEMBER 02 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	1	0	10	10	10	4	0	0	56	6.7	43	0	0	1	10	0	9	39	8	8	0
1	0.2	3.5	0	10	10	10	4	0	-1	70	6.7	63	0	1	1	10	0	8	43	8	4	0
1	0.2	1.4	0	10	4	10	4	0	0	58	7.8	62	0	0	1	10	0	9	30	12	8	0
1	0.4	2.4	0	8	8	10	4	0	0	65	7.8	55	0	-1	1	10	0	8	30	12	6	0
2	0.4	0.4	0	10	10	10	5	0	0	56	6.7	37	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	1.5	0	10	13	10	4	0	1	58	7.8	48	0	0	1	10	0	-9	-9	-9	4	0
2	0.5	2	0	10	13	10	4	0	1	58	7.8	53	0	0	1	10	0	-9	-9	-9	6	0
2	0.5	3.1	0	10	12	10	4	0	0	56	6.7	61	0	0	1	10	0	-9	-9	-9	4	0
2	0.9	4.2	0	10	10	10	4	0	0	70	6.7	65	0	1	1	10	0	-9	-9	-9	7	0
2	0.7	0.3	0	10	7	10	4	0	0	58	7.8	65	0	1	1	10	0	-9	-9	-9	4	0
2	0.3	0.7	0	10	7	10	4	0	0	58	7.8	65	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	1.9	0	10	4	10	4	0	0	58	7.8	59	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	3.6	0	8	9	10	4	0	0	57	7.2	43	0	-1	1	10	0	-9	-9	-9	4	0
2	0.8	0.9	0	10	7	10	4	0	0	58	7.8	64	0	0	1	10	0	-9	-9	-9	4	0

EOF

USCGC VIGOROUS — FLYING BRIDGE — NOVEMBER 03 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.9	0	12	24	3	3	1	0	84	4.4	39	1	1	1	10	0	8	32	15	6	0
1	1.4	0.1	0	10	15	0	4	0	-1	76	4.4	67	1	-1	1	10	0	8	34	12	8	0
1	0.8	3	0	10	8	1	4	1	1	76	4.4	58	1	0	1	10	0	9	34	12	7	0
1	0.8	3.5	0	10	8	1	4	1	-1	76	4.4	54	1	0	1	10	0	8	35	12	4	0
1	0.2	3.8	0	10	8	1	4	1	0	76	4.4	50	1	0	1	10	0	9	34	12	4	0
2	1	0.4	0	12	24	3	3	1	1	84	4.4	35	1	0	1	10	0	-9	-9	-9	4	0
2	1.2	1.4	0	10	17	1	4	0	1	62	6.1	46	1	0	1	10	0	-9	-9	-9	6	0
2	0.7	3	0	10	19	2	3	0	1	62	6.1	58	1	0	1	10	0	-9	-9	-9	4	0
2	1.2	3.5	0	10	10	0	4	0	-1	84	4.4	63	1	0	1	10	0	-9	-9	-9	6	0
2	0.7	2.1	0	10	12	0	4	1	-1	68	4.4	65	1	1	1	10	0	-9	-9	-9	4	0
2	1.7	2.4	0	10	12	0	4	1	0	68	4.4	63	1	-1	1	10	0	-9	-9	-9	4	0
2	1.3	3.5	0	10	8	1	4	1	1	76	4.4	54	1	0	1	10	0	-9	-9	-9	6	0

EOF

USCGC VIGOROUS — FLYING BRIDGE — NOVEMBER 04 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.4	0.1	0	6	24	4	6	0	0	93	10.6	21	1	1	1	10	0	-9	-9	-9	4	0
2	0.2	0.6	0	6	24	4	6	0	0	93	10.6	25	1	1	1	10	0	-9	-9	-9	8	0
2	0.4	1.2	0	6	28	4	6	1	0	93	10.6	31	1	1	1	10	0	-9	-9	-9	4	0
2	0.8	1.6	0	6	28	4	7	1	1	93	10.6	37	1	0	1	10	0	-9	-9	-9	4	0
2	0.8	0.5	0	4	25	5	7	1	0	93	10.6	61	1	0	1	10	0	-9	-9	-9	6	0
2	1	1	0	4	25	5	7	1	0	93	10.6	65	1	0	1	10	0	-9	-9	-9	4	0

EOF

USCGC VIGOROUS — FLYING BRIDGE — NOVEMBER 05 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	0.6	0	10	25	8	6	1	-1	68	5	16	0	1	1	10	0	8	39	16	4	0
1	0.8	1.1	0	10	19	8	6	1	1	68	5	20	0	0	1	10	0	9	43	12	7	0
1	0.3	2.3	0	10	14	7	6	0	0	68	5	32	1	0	1	10	0	9	41	16	4	0
2	0.9	0.1	0	10	25	8	6	1	0	68	5	11	0	1	1	10	0	-9	-9	-9	4	0
2	0.7	1.8	0	10	19	8	6	1	0	68	5	25	0	0	1	10	0	-9	-9	-9	4	0
2	0.4	2.9	0	10	14	7	5	0	0	68	5	38	1	1	1	10	0	-9	-9	-9	8	0

EOF

USCGC VIGOROUS BRIDGE OCTOBER 23 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	SS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	2.6	0.2	0	8	14	10	3	0	0	87	11.7	7	0	0	0.2	10	0	10	30	0	4	1
1	0.4	0.3	0	8	14	10	3	0	-1	87	11.7	7	0	1	0.2	10	0	10	30	0	4	1
1	5.1	0.4	0	8	14	10	3	0	0	87	11.7	6	0	0	0.2	10	0	11	29	0	4	1
1	1.2	0.9	0	8	14	10	3	0	-1	87	11.7	3	0	1	0.2	10	0	10	30	0	4	1
1	4.3	1.3	0	8	14	10	3	0	0	87	11.7	0	0	0	0.2	10	0	11	31	0	4	1
1	1.6	1.4	0	8	15	10	3	1	-1	81	11.7	-1	0	1	0.2	10	0	10	28	0	4	1
1	3.9	2.7	0	8	20	9	3	1	0	82	12.8	-11	0	0	0.2	10	0	11	32	0	4	1
1	3.2	3.2	0	8	20	9	4	1	0	82	12.8	-17	0	0	0.2	10	0	11	32	0	4	1
1	0.8	3.4	0	8	20	9	4	1	1	75	11.7	-19	0	-1	0.2	10	0	11	32	0	4	1
1	4.7	0.5	0	8	20	9	4	1	0	75	11.7	-28	0	0	0.2	10	0	11	35	0	4	1
1	2.2	4	0	8	20	9	4	1	0	82	12.8	-16	0	-1	0.2	10	0	10	28	0	4	1
1	4.1	4.5	0	8	20	9	4	1	0	75	11.7	-20	0	-1	0.2	10	0	10	31	0	4	1
1	2.1	2.4	0	8	20	9	4	1	0	82	12.8	-10	0	0	0.2	10	0	11	28	0	4	1
1	3.9	1.1	1	8	12	9	3	1	0	74	10.6	-37	0	0	0.2	10	0	11	35	0	4	1
1	4.6	1.7	1	8	12	9	3	1	0	74	10.6	-41	0	0	0.2	10	0	11	33	0	4	1
1	2.8	1.8	1	8	12	9	3	1	0	74	10.6	-42	0	1	0.2	10	0	10	36	0	4	1
1	0.5	1.9	1	8	12	9	3	1	-1	74	10.6	-41	0	1	0.2	10	0	10	36	0	4	1
1	0.3	2.9	1	8	16	9	4	1	-1	87	10	-52	0	0	0.2	10	0	10	37	0	4	1
1	5.7	3.2	1	8	16	9	4	1	0	87	10	-55	0	1	0.2	10	0	10	37	0	4	1
1	2.3	3.7	1	8	17	9	4	1	1	93	10	-59	0	0	0.2	10	0	11	34	0	4	1
1	3	3.7	1	8	17	9	4	1	0	93	10	-60	0	-1	0.2	10	0	10	36	0	4	1
1	5.2	3.9	1	8	17	9	4	1	1	93	10	-61	0	0	0.2	10	0	10	36	0	4	1
2	7.8	4.9	1	8	20	9	4	1	0	74	10.6	-42	0	0	0.2	10	0	-9	-9	-9	4	1
2	3.2	2.1	0	8	15	10	3	1	1	81	11.7	-7	0	-1	0.2	10	0	-9	-9	-9	4	1
2	7.6	2.1	1	8	12	9	3	1	0	74	10.6	-35	0	0	0.2	10	0	-9	-9	-9	4	1
2	8.6	0.6	0	8	20	9	4	1	0	75	11.7	-22	0	0	0.2	10	0	-9	-9	-9	4	1
2	8	2.7	0	8	20	9	3	1	0	82	12.8	-12	0	0	0.2	10	0	-9	-9	-9	4	1
2	7.5	1.7	0	8	15	10	3	1	0	81	11.7	-3	0	0	0.2	10	0	-9	-9	-9	4	1
2	6.6	0.9	0	8	14	10	3	0	0	87	11.7	2	0	0	0.2	10	0	-9	-9	-9	4	1
2	4.4	0.6	0	8	14	10	3	0	0	87	11.7	5	0	0	0.2	10	0	-9	-9	-9	4	1
2	8.5	0.1	0	8	14	10	3	0	0	87	11.7	8	0	0	0.2	10	0	-9	-9	-9	4	1
1	1.3	1.6	1	8	12	9	3	1	0	74	10.6	-39	0	0	0.2	10	0	10	34	0	4	1
1	1.2	0.5	0	8	20	9	3	1	0	75	11.7	-29	0	0	0.2	10	0	10	34	0	4	1
2	5.9	2.7	1	8	16	9	4	1	0	87	10	-51	0	0	0.2	10	0	-9	-9	-9	4	1

BOF

USCGC VIGOROUS — BRIDGE — OCTOBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	2	0.9	1	6	26	10	8	1	-1	100	13.8	8	0	0	0.5	10	1	11	37	4	4	1
1	1.6	1.3	1	4	22	10	8	1	0	100	14.4	6	0	1	0.5	10	1	10	33	4	4	1
1	2.5	1.5	1	4	22	10	8	1	0	100	14.4	4	0	0	0.5	10	1	11	34	4	4	1
1	0.5	2.1	1	4	22	10	8	1	0	100	14.4	0	0	1	0.5	10	1	10	33	4	4	1
1	0.9	4.1	3	0.5	26	10	8	2	1	100	15	-18	0	0	0.5	7	1	10	43	0	4	1
1	4.7	4.8	1	3	32	10	9	2	1	100	15	-25	0	0	0.5	7	1	11	42	0	4	1
1	3.4	5.1	1	3	32	10	9	2	0	100	15	-28	0	0	0.5	7	1	10	43	0	4	1
1	1.1	4.8	1	3	32	10	9	2	1	100	15	-25	0	0	0.5	7	1	11	43	0	4	1
2	0.8	0.2	1	6	26	10	7	1	0	100	13.8	12	0	0	0.5	10	1	-9	-9	-9	4	1
2	1.4	3.2	3	0.5	26	10	8	2	0	100	15	-10	0	0	0.5	7	1	-9	-9	-9	4	1
1	2.5	0.8	1	6	26	10	8	1	-1	100	13.8	9	0	0	0.5	10	1	11	37	4	4	1
2	6.1	0.5	1	6	26	10	7	1	0	100	13.8	10	0	0	0.5	10	1	-9	-9	-9	4	1
2	6.6	1.1	1	6	26	10	8	1	0	100	13.8	7	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.8	2.5	1	4	17	10	8	1	0	100	15	-3	0	0	0.5	10	1	-9	-9	-9	4	1
2	5.8	1.9	1	4	22	10	8	1	0	100	14.4	3	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.1	3.5	3	0.5	26	10	8	2	0	100	15	-13	0	0	0.5	7	1	-9	-9	-9	4	1
2	5.9	4.3	1	3	32	10	8	2	0	100	15	-21	0	0	0.5	7	1	-9	-9	-9	4	1

EOF

USCGC VIGOROUS — BRIDGE — OCTOBER 25 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	1	0.1	0	10	19	10	7.5	1	1	80	10.6	20	0	1	0.5	10	1	11	39	4	4	1
1	4	0.1	0	10	19	10	7.5	1	1	80	10.6	20	0	0	0.5	10	1	10	41	4	4	1
1	5	0.1	0	10	19	10	7.5	1	0	80	10.6	20	0	0	0.5	10	1	10	41	4	4	1
1	0.8	0.4	0	10	19	10	7.5	1	0	80	10.6	19	0	0	0.5	10	1	10	41	4	4	1
1	3	1.4	0	10	15	10	7.5	1	0	80	10.6	14	0	0	0.5	10	1	10	41	4	4	1
1	2.4	1.5	0	10	15	10	7.5	1	1	80	10.6	14	0	0	0.5	10	1	10	41	4	4	1
1	1.5	1.5	0	10	15	10	7.5	1	1	75	11.1	13	0	0	0.5	10	1	11	42	4	4	1
1	3.9	1.6	0	10	15	10	7.5	1	1	75	11.1	13	0	0	0.5	10	1	10	40	4	4	1
1	0.7	3.2	0	10	9	10	7.2	1	-1	80	10.6	1	0	-1	0.5	10	1	11	41	4	4	1
1	4.8	3.5	0	10	9	10	6.9	1	0	74	10.6	-2	0	0	0.5	10	1	10	42	4	4	1
1	6.3	3.8	0	10	9	10	6.9	1	-1	74	10.6	-4	0	0	0.5	10	1	11	41	4	4	1
1	0.7	3.9	0	10	9	10	6.9	1	0	74	10.6	-6	0	-1	0.5	10	1	11	32	4	4	1
1	2.4	0.1	0	10	9	10	6.9	1	-1	74	10.6	-6	0	-1	0.5	10	1	11	32	4	4	1
1	0.3	0.6	0	10	6	10	6.9	0	0	68	10.6	-11	0	0	0.5	10	1	10	29	4	7	1
1	1.7	2.5	0	10	7	10	6.2	0	0	80	10	-29	0	1	0.5	10	1	11	28	4	4	1
1	2.4	2.9	0	10	7	10	6.2	0	0	80	10	-26	0	0	0.5	10	1	10	31	4	4	1
1	1	3.3	0	10	5	10	6.2	0	0	87	10	-38	0	1	0.5	10	1	11	28	4	4	1
2	7.8	0.1	0	10	19	10	7.5	1	0	80	10.6	20	0	0	0.5	10	1	-9	-9	-9	7	1
2	8.7	1.2	0	10	19	10	7.5	1	0	80	10.6	15	0	0	0.5	10	1	-9	-9	-9	4	1
2	7.9	2.1	0	10	15	10	7.5	1	0	75	11.1	10	0	0	0.5	10	1	-9	-9	-9	4	1
2	7.4	2.5	0	10	9	10	7.2	1	0	80	10.6	7	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.1	0.5	0	10	9	10	6.9	1	-1	74	10.6	-10	0	0	0.5	10	1	-9	-9	-9	4	1
2	8.4	1.1	0	10	6	10	6.9	1	-1	68	10.6	-16	0	0	0.5	10	1	-9	-9	-9	4	1
2	6.3	2.2	0	10	7	10	6.2	0	-1	80	10	-27	0	0	0.5	10	1	-9	-9	-9	4	1
2	7.7	2.7	0	10	5	10	6.2	0	-1	87	10	-32	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.6	3.2	0	10	5	10	6.2	0	-1	87	10	-37	0	0	0.5	10	1	-9	-9	-9	4	1
2	4.8	3.8	0	10	11	10	5.9	0	-1	86	9.4	-42	0	0	0.5	10	1	-9	-9	-9	4	1

EOF

USCGC VIGOROUS | BRIDGE | OCTOBER 28 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.5	0.2	0	10	6	9	8	0	0	65	8.3	34	0	-1	0.7	10	0	11	30	8	4	1
1	0.4	2.4	0	10	10	9	8	0	0	65	8.3	27	0	0	0.7	10	0	10	28	8	4	1
1	6.5	3	0	10	10	9	7	0	-1	65	8.3	23	0	1	0.7	10	0	11	31	8	4	1
1	0.7	3.2	0	10	10	9	7	0	0	65	8.3	22	0	0	0.7	10	0	11	30	8	4	1
1	5.5	3.4	0	10	11	8	7	0	0	65	7.8	20	0	0	0.7	10	0	10	30	8	4	1
1	8.2	0.2	0	10	11	8	7	0	0	65	7.8	16	0	0	0.7	10	0	11	37	8	4	1
1	2.5	0.3	0	10	11	8	7	0	0	65	7.8	15	0	0	0.7	10	0	11	36	8	4	1
1	4.8	1.1	0	10	12	7	7	0	1	58	8.3	8	0	0	0.7	10	0	10	37	8	4	1
1	1.4	1.1	0	10	12	7	7	0	0	58	8.3	8	0	0	0.7	10	0	10	37	8	4	1
1	7.9	1.4	0	10	12	7	7	0	0	58	8.3	5	0	1	0.7	10	0	10	34	8	4	1
1	1.3	1.5	0	10	14	9	7	0	0	79	7.8	3	0	0	0.7	10	0	10	34	8	4	1
1	4.4	2.5	0	10	14	9	6	0	0	79	7.8	-5	0	0	0.7	10	0	10	34	8	4	1
1	5.1	2.7	0	10	11	10	6	0	-1	72	7.8	-9	0	0	0.7	10	0	10	35	8	4	1
1	2.8	2.9	0	10	11	10	6	0	-1	72	7.8	-10	0	0	0.7	10	0	11	34	8	4	1
1	3.6	3.4	0	10	11	10	7	0	0	72	7.8	-16	0	-1	0.7	10	0	10	35	8	4	1
1	4.8	3.8	0	10	20	2	7	0	0	72	8.3	-20	0	0	0.7	10	0	11	35	8	4	1
1	0.8	0	0	10	6	9	8	0	1	65	8.3	35	0	0	0.7	10	0	11	32	8	4	1
2	11	0.6	0	10	12	7	7	0	1	58	8.3	12	0	-1	0.7	10	0	-9	-9	-9	4	1
2	5.2	3	0	10	10	9	7	0	1	65	8.3	22	0	-1	0.7	10	0	-9	-9	-9	4	1
2	10.5	1.2	0	10	12	7	7	0	1	58	8.3	7	0	-1	0.7	10	0	-9	-9	-9	4	1
2	5.2	0.9	0	10	6	9	7	0	-1	65	8.3	34	0	0	0.7	10	0	-9	-9	-9	4	1
2	9.8	3.8	0	10	20	2	7	0	1	72	8.3	-19	0	0	0.7	10	0	-9	-9	-9	4	1
2	5.5	0.4	0	10	6	9	8	0	-1	65	8.3	34	0	0	0.7	10	0	-9	-9	-9	4	1
1	4.7	4.7	0	10	11	8	7	0	0	65	7.8	16	0	0	0.7	10	0	11	37	8	4	1
2	4.6	1	0	10	12	7	7	0	1	58	8.3	8	0	-1	0.7	10	0	-9	-9	-9	4	1
2	8.6	1.3	0	10	8	9	7	0	-1	70	7.2	32	0	0	0.7	10	0	-9	-9	-9	4	1
2	6.5	3.2	0	10	11	10	7	0	1	72	7.8	-14	0	-1	0.7	10	0	-9	-9	-9	4	1
2	9.5	0.2	0	10	6	9	8	0	-1	65	8.3	35	0	0	0.7	10	0	-9	-9	-9	4	1
2	4.7	5.6	0	10	11	8	7	0	-1	65	7.8	19	0	1	0.7	10	0	-9	-9	-9	4	1
2	0.7	0.8	0	10	12	7	7	0	1	58	8.3	10	0	-1	0.7	10	0	-9	-9	-9	4	1
2	11.3	0.7	0	10	6	9	8	0	-1	65	8.3	34	0	0	0.7	10	0	-9	-9	-9	4	1
2	10.4	2.5	0	10	14	9	6	0	0	79	7.8	-6	0	0	0.7	10	0	-9	-9	-9	4	1
2	7.5	0.7	0	10	12	7	7	0	-1	58	8.3	11	0	1	0.7	10	0	-9	-9	-9	4	1
2	9.4	4.2	0	10	20	2	7	0	1	72	8.3	-24	0	0	0.7	10	0	-9	-9	-9	4	1
1	3.7	2	0	10	8	9	7	0	-1	70	7.2	29	0	1	0.7	10	0	10	32	8	4	1

EOF

USCGC VIGOROUS — BRIDGE — NOVEMBER 02 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	0	0	10	10	10	4	0	0	56	6.7	43	0	0	1	10	0	11	43	8	8	0
1	0.2	3.3	0	10	10	10	4	0	-1	70	6.7	64	0	1	1	10	0	10	39	8	4	0
2	0.3	0.8	0	10	7	10	4	0	0	58	7.8	64	0	0	1	10	0	-9	-9	-9	4	0
1	0.2	1.4	0	10	4	10	4	0	0	58	7.8	62	0	0	1	10	0	11	32	12	8	0
1	0.4	2.4	0	8	8	10	4	0	0	65	7.8	55	0	-1	1	10	0	10	32	12	6	0
2	0.4	0.4	0	10	10	10	5	0	0	56	6.7	36	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	1.5	0	10	13	10	4	0	1	58	7.8	48	0	0	1	10	0	-9	-9	-9	4	0
2	0.5	2	0	10	13	10	4	0	1	58	7.8	53	0	0	1	10	0	-9	-9	-9	6	0
2	0.5	3.1	0	10	12	10	4	0	0	56	6.7	61	0	0	1	10	0	-9	-9	-9	4	0
2	0.9	4.2	0	10	10	10	4	0	0	70	6.7	65	0	1	1	10	0	-9	-9	-9	7	0
2	0.7	0.3	0	10	7	10	4	0	0	58	7.8	65	0	1	1	10	0	-9	-9	-9	4	0
2	0.8	1.9	0	10	4	10	4	0	0	58	7.8	59	0	0	1	10	0	-9	-9	-9	4	0
2	0.8	3.6	0	8	9	10	4	0	0	57	7.2	43	0	-1	1	10	0	-9	-9	-9	4	0
2	0.8	0.9	0	10	7	10	4	0	0	58	7.8	64	0	0	1	10	0	-9	-9	-9	4	0
EOF																						

USCGC VIGOROUS — BRIDGE — NOVEMBER 03 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	1.2	1.6	0	10	17	1	4	0	0	62	6.1	47	1	0	1	10	0	10	29	15	6	0
1	0.7	2.9	0	10	19	2	4	0	1	62	6.1	59	1	0	1	10	0	11	28	15	4	0
1	2.4	0.8	0	10	15	0	4	0	1	76	4.4	69	1	1	1	10	0	10	34	12	8	0
1	2.4	1.6	0	10	15	0	4	1	1	76	4.4	68	1	0	1	10	0	10	34	12	6	0
1	0.7	2.1	0	10	12	0	4	1	-1	68	4.4	65	1	0	1	10	0	11	34	12	4	0
1	0.8	3.1	0	10	8	1	4	1	1	76	4.4	57	1	0	1	10	0	11	36	12	7	0
1	0.8	3.5	0	10	8	1	4	1	-1	76	4.4	54	1	0	1	10	0	10	37	12	4	0
1	0.2	3.8	0	10	8	1	4	1	1	76	4.4	50	1	-1	1	10	0	11	36	12	4	0
2	1	0.4	0	12	24	3	3	1	1	84	4.4	35	1	1	1	10	0	-9	-9	-9	4	0
2	0.2	0.9	0	12	24	3	3	1	1	84	4.4	39	1	0	1	10	0	-9	-9	-9	6	0
2	1.2	3.5	0	10	10	0	4	0	-1	84	4.4	63	1	0	1	10	0	-9	-9	-9	6	0
2	1.4	0.1	0	10	15	0	4	0	-1	76	4.4	67	1	0	1	10	0	-9	-9	-9	8	0
2	3	0.5	0	10	15	0	4	0	0	76	4.4	68	1	-1	1	10	0	-9	-9	-9	8	0
2	3.5	1	0	10	15	0	4	1	-1	76	4.4	69	1	0	1	10	0	-9	-9	-9	4	0
2	2.4	1.4	0	10	15	0	4	1	-1	76	4.4	68	1	0	1	10	0	-9	-9	-9	6	0
2	3	1.8	0	10	15	0	4	1	-1	76	4.4	66	1	0	1	10	0	-9	-9	-9	7	0
2	1.7	2.4	0	10	12	0	4	1	0	68	4.4	63	1	0	1	10	0	-9	-9	-9	4	0
2	3.2	2.7	0	10	12	0	4	1	1	68	4.4	60		-1	1	10	0	-9	-9	-9	4	0
2	1.3	3.5	0	10	8	1	4	1	1	76	4.4	54	1	0	1	10	0	-9	-9	-9	6	0
2	3.4	1.8	0	10	17	3	4	0	-1	62	6.1	48	1	0	1	10	0	-9	-9	-9	4	0
EOF																						

USCGC VIGOROUS — BRIDGE — NOVEMBER 04 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.8	1.6	0	6	28	4	7	1	1	93	10.6	36	1	(	1	10	0	-9	-9	-9	4	0
1	0.1	3.1	0	5	27	6	7	2	0	82	12.8	69	0	-1	1	10	0	11	40	12	6	0
2	0.4	0.1	0	6	24	4	6	0	0	93	10.6	21	1	1	1	10	0	-9	-9	-9	4	0
2	0.2	0.6	0	6	24	4	6	0	0	93	10.6	25	1	1	1	10	0	-9	-9	-9	8	0
2	0.4	1.1	0	6	28	4	6	1	0	93	10.6	31	1	1	1	10	0	-9	-9	-9	4	0
2	0.8	0.5	0	4	25	5	7	1	0	93	10.6	61	1	0	1	10	0	-9	-9	-9	6	0
2	1	1	0	4	25	5	7	1	0	93	10.6	65	1	0	1	10	0	-9	-9	-9	4	0
2	0.4	2.5	0	5	27	6	7	2	1	82	12.8	71	0	0	1	10	0	-9	-9	-9	4	0

EOF

USCGC VIGOROUS — BRIDGE — NOVEMBER 05 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	0.6	0	10	25	8	6	1	-1	68	5	16	0	0	1	10	0	10	42	16	4	0
1	0.8	1.4	0	10	19	8	6	1	1	68	5	23	0	0	1	10	0	11	39	16	7	0
1	0.3	2.3	0	10	14	7	6	0	0	68	5	32	1	0	1	10	0	11	40	16	4	0
1	0.9	0.1	0	10	25	8	4	0	1	60	4.4	46	1	-1	1	10	0	10	30	19	4	0
1	0.6	0.3	0	10	25	8	4	0	0	60	4.4	48	1	0	1	10	0	10	30	19	6	0
1	0	0.7	0	10	15	9	4	0	0	75	3.9	63	0	0	1	10	0	10	30	19	6	0
1	0.1	1.6	0	10	10	9	4	0	0	68	4.4	68	1	0	1	10	0	10	30	19	4	0
2	0.3	2.3	0	10	10	9	4	0	0	68	4.4	69	0	0	1	10	0	-9	-9	-9	8	0
1	0.5	2.6	0	10	10	9	4	0	0	67	3.9	70	0	-1	1	10	0	10	31	19	4	0
2	0.9	0.1	0	10	25	8	6	1	0	68	5	11	0	1	1	10	0	-9	-9	-9	4	0
2	0.7	1.8	0	10	19	8	6	1	0	68	5	25	0	0	1	10	0	-9	-9	-9	4	0
2	1.4	1.9	0	10	19	8	6	1	0	68	5	28	0	0	1	10	0	-9	-9	-9	6	0
2	0.4	2.9	0	10	14	7	5	0	0	68	5	38	1	1	1	10	0	-9	-9	-9	8	0

EOF