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

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16. Abstract

Three experiments were conducted in 1989, three in 1990, and one experiment was conducted in 1991 by the U.S. Coast Guard Research and Development (R&D) Center to evaluate night vision goggles (NVGs) for their effectiveness in detecting small targets at night. Three types of NVGs have been evaluated: the AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) was evaluated onboard U.S. Coast Guard HH-3F, CH-3E, and HH-60J helicopters, and HU-25C and RG-8A fixed-wing aircraft. The AN/PVS-5C and AN/PVS-7A NVGs were evaluated onboard U.S. and Canadian Coast Guard Search and Rescue Units (SRUs) in the 200-foot size range and onboard U.S. Coast Guard 41-foot utility boats (UTBs). During the Spring 1991 experiment, 4- and 6-person unlighted life rafts with retroreflective tape and 18- and 21-foot white boats were employed as targets during realistically-simulated search missions. Three new SRUs were evaluated and new information obtained are discussed.

A total of 4098 target detection opportunities were generated for all the target types employed during the six experiments. These data were analyzed to determine which of 25 search parameters of interest exerted a statistically-significant influence on target detection probability. Lateral range curves and sweep width estimates are presented for SRU/target type combinations that contained sufficient data to support this detailed analysis. Human factors data are presented and discussed.

NVGs proved to be an effective nighttime search aid for helicopter searches for small SAR targets. The results for NVG use for SAR on CG Utility Boats indicated that NVGs did not significantly enhance search performance, and their routine use is not recommended. NVG enhanced the nighttime search performance of cutters and ships in the 200-foot size range.

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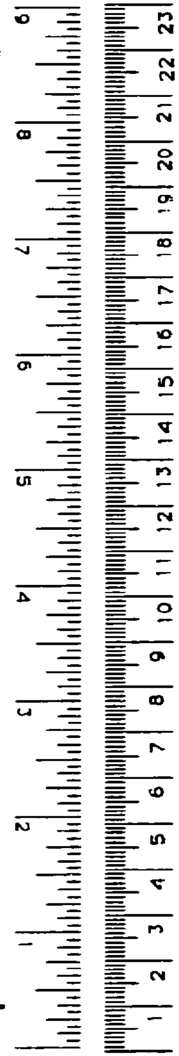
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

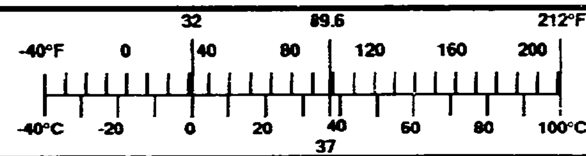
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	* 2.5	centimeters	cm
ft	feet	30.0	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
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	4.2	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 combined evaluation of seven experiments evaluating three types of night vision goggles (NVGs) for their effectiveness in the U.S. Coast Guard's maritime search and rescue (SAR) mission. The NVGs were evaluated onboard HH-3/CH-3 and HH-60J helicopters from U.S. Coast Guard Air Stations Traverse City, Michigan; Cape Cod, Massachusetts; Clearwater, Florida; and Air Training Center (ATC) Mobile, Alabama; on HU-25C and RG-8A fixed-wing aircraft from Air Station Miami, Florida: on 41-foot utility boats (UTBs) from U.S. Coast Guard Stations Fort Pierce, Florida; New London, Connecticut; Point Judith, Rhode Island; and Montauk, New York: and onboard a 210-foot U.S. Coast Guard Cutter (USCGC) and a 235-foot Canadian Coast Guard Ship (CCGS). Data were collected during six 3-week experiments conducted in Fort Pierce, FL; Block Island Sound (off the Connecticut/Rhode Island/New York coasts); and one in the North Atlantic Ocean on Canso Bank, Nova Scotia.

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

2. NVG Descriptions

Three NVG models were evaluated during the experiments onboard four types of search and rescue units (SRUs). The AN/AVS-6 Aviators Night Vision Imaging System (ANVIS) NVGs, equipped with Generation III photodetectors, were evaluated onboard the helicopters and fixed-wing aircraft. All helicopter and aircraft crew positions were provided with ANVIS NVGs on hinged helmet mounts. The UTB and 210-foot/235-foot vessel crews were provided with either AN/PVS-5C or AN/PVS-7A NVGs for use by lookouts only. The AN/PVS-5C and AN/PVS-7A were both equipped with Generation II-plus photodetectors and fixed headstrap mounts. Helmsmen and coxswains positioned inside the UTB wheelhouse were unable to operate with these NVGs due to the lack of NVG-compatible instruments and radar displays. Four lookout positions from the USCGC VIGOROUS (two bridge wings and two flying bridge) were used during the NVG searches. Two lookout positions inside the pilot house of the CCGS ALERT were used during the NVG searches. Data were collected for the USCGC VIGOROUS in such a manner that bridge and flying bridge detection opportunities could represent distinct data sets.

All three NVG models restricted visual perception in several ways. All of the models restricted the users to a 40-degree field of view (FOV), severely inhibited depth perception, reduced visual acuity to 20/40 at best, and provided a monochromatic (green) display. The ANVIS and the AN/PVS-7A designs allow 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 that had received basic instruction in NVG use. Standard search patterns were used to search for randomly placed targets within assigned search areas. For the Canso Bank experiment, search patterns were generated to provide a variety of lateral ranges to targets within the search area. The search crews were not alerted to target locations in advance.

A precision microwave tracking system (MTS) was used to monitor and record target and search craft positions. For the Canso Bank experiment, Global Positioning System (GPS) fixes were used to monitor and record target and search craft positions. Target detections and human-factors data (as well as environmental data for the Canso Bank experiment) were logged by data recorders onboard each search unit. Environmental data were logged onboard a chartered workboat for the Fort Pierce, FL, and Block Island Sound experiments. An environmental data buoy was deployed within each exercise area to record winds, sea conditions, and air/water temperatures. A wave rider data buoy was deployed on Canso Bank within the exercise area to record significant wave height, wave period, and wave front direction.

Data reconstruction was performed to determine which target opportunities resulted in detection and at what lateral range each opportunity occurred. Raw data files were developed that included each target detection or missed opportunity along with the values of 25 search variables of interest (22 for the Canso Bank experiment) for each target opportunity. These data were analyzed on a desktop computer using a variety of statistical techniques including binary, multivariate regression analysis. Lateral range versus target detection probability plots and sweep width estimates were developed for search conditions that were well represented in the data. The search variables were analyzed for their significance at the 90-percent confidence level.

Human factors data were compiled and analyzed quantitatively where possible. Subjective comments by search unit crews and data recorders were synopsized and incorporated into chapter 3, Conclusions and Recommendations, of this report.

RESULTS AND CONCLUSIONS

1. Results

A combined total of 4098 target detection opportunities were reconstructed from the seven NVG experiments for the target types discussed in this report. Six SRU types and nine target types were evaluated during all seven experiments. Table 1 provides a summary of environmental and moon parameters for each SRU/target type combination. For the VIGOROUS data set, no statistical difference was found to exist between the detection capabilities of the VIGOROUS bridge and the flying bridge. The bridge and flying bridge data sets were combined for the purpose of this analysis.

The data were separated into four data sets to evaluate the NVG performance for different SRUs. These data sets are described as follows:

1. Spring 1991 data were used to compare the performance of each RG-8A, HU-25C, and HH-60J SRU type to the performance of the HH-3/CH-3. Target types consisted of life rafts with retroreflective tape and small boats.

2. The data for all HH-3/CH-3 experiments were combined to form one data set. Target types consisted of life rafts (with and without retroreflective tape), small boats, PIW, and PIW equipped with PML, red safety lights, or "Firefly" strobes.

3. UTB data were analyzed as a single data set. The target types included life rafts (with and without retroreflective tape), small boats, and unlighted PIW.

4. The Canso Bank data involved the VIGOROUS and the ALERT and were analyzed as a single data set. Target types included lighted and unlighted life rafts with retroreflective tape.

The Spring 1991 data were used only for a comparative analysis of the SRU types against the HH-3/CH-3 under similar environmental conditions. The RG-8A and HU-25C performed significantly worse than the HH-3/CH-3 for all target types. The HH-60J performed statistically the same as the HH-3/CH-3 for all target types. Sweep widths were not generated for this data set.

Table 1. Range of Environmental and Moon Parameters Encountered (page 1 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
HH-3/CH-3 Boats	0 to 1	1.5 to 15	1 to 20	0 to 1.0	1.3 to 6.2	0 to 2	51 to 96	10.4 to 27	13.4 to 27.2	-68 to 65	none to full
HH-3/CH-3 PIWs	0	4 to15	5 to 22	0	1.3 to 3.6	0 to 2	74 to 86	11.6 to 24	13.3 to 23.9	-63 to 34	quarter to full
HH-3/CH-3 PIWs Strobe	0	3	15 to 17	1.0	2.3 to 2.6	1	82	11.5	13.6	30 to 46	half
HH-3/CH-3 PIW w/Red Safety Lights	0 to 3	15	5 to 15	.1 to .9	2 to 4.3	0 to 1	61 to 86	22.2 to 26	22 to24	-67 to 19	quarter to 3/4
HH-3/CH-3 PIW w/Personnel Marker Light	0	15	5 to 10	.2 to .4	5.2 to 6.2	0	63 to 69	21.1 to 21.5	20.8 to 22.2	47 to 57	full
HH-3/CH-3 Rafts w/retro-tape	0 to 2	5 to 15	2 to 14	0 to 1.0	1.3 to 6.6	0 to 1	50 to 95	15.7 to 27.0	18.4 to 27.2	-66 to 53	quarter to full
HH-3/CH-3 Rafts w/out retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.2	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	-69 to 69	none to full

Table 1. Range of Environmental and Moon Parameters Encountered (page 2 of 4)

SPU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
HH-60J Boats	0	8 to 15	1 to 14	0 to .9	1.6 to 3	0 to 1	66 to 98	23.6 to 26.2	24.2 to 24.6	5 to 49	3 quarter to full
HH-60J Rafts w/retro-tape	0	8 to 15	1 to 14	0 to .9	1.6 to 3	0 to 1	66 to 98	23.6 to 26.2	24.2 to 24.6	5 to 49	3 quarter to full
HU-25C Boats	0	10 to 15	3 to 10	0 to .3	1.6 to 3.0	0	69 to 84	25.5 to 26	25.2 to 26.5	-36 to 39	3 quarter to full
HU-25C Rafts w/retro-tape	0	10 to 15	3 to 10	0 to .3	1.6 to 3.0	0	69 to 84	25.5 to 26	25.2 to 26.5	-36 to 39	3 quarter to full
RG-8A Boats	0	15	5 to13	0 to 0.1	1.3 to 3.6	0	74 to 84	26.2 to 27	26.3 to 27	1 to 38	full
RG-8A Rafts w/retro-tape	0	15	5 to14	0 to 0.7	1.3 to 4.9	0 to 1	74 to 87	25.1 to 27	25.4 to 27	1 to 48	full
UTB/ Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	5.5 to 24.3	13.4 to 24.2	-60 to 51	none to full

Table 1. Range of Environmental and Moon Parameters Encountered (page 3 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
UTB PIWs	0	4 to 15	5 to 22	0	1.3 to 3.6	0 to 2	74 to 86	11.6 to 24	13.3 to 23.9	-63 to 34	quarter to full
UTB PIWs Strobe	0	3	17	1.0	2.3 to 2.6	1	82	11.5	13.6	43 to 46	half
UTB PIW w/Red Safety Lights	0	15	5 to 15	0.3 to 0.9	2 to 3.6	0 to 1	74 to 78	23.3 to 26	23.5 to 24	-64 to 6	quarter to 3/4
UTB Rafts w/retro-tape	0	.5 to 15	5 to 17	0 to 0.4	1.6 to 4.3	0 to 2	50 to 95	15.2 to 23.9	17.5 to 22.1	-63 to 38	quarter to full
UTB Rafts w/out retro-tape	0 to 2	1.5 to 15	2 to 24	0 to 1.0	1.3 to 4.6	0 to 2	51 to 100	6.1 to 24	13.5 to 23.6	-62 to 52	none to full
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	N/A	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	N/A	-61 to 35	quarter to 3/4

Table 1. Range of Environmental and Moon Parameters Encountered (page 4 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
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	N/A	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	N/A	-64 to 35	quarter to 3/4
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	N/A	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	N/A	-66 to 35	none to 3/4

Lateral range plots and sweep width estimates were developed for each of the other data sets. Sweep widths and NVG correction factors were calculated for each significant environmental condition identified for the SRU/target type combinations and the calculations, are summarized in table 2.

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

a. For all target types, the copilot position (left seat) made more detections than the pilot position (right seat) for all of the data sets. This difference is consistent across all target types and suggests a degraded pilot search capability from constant scan-shifting between NVGs outside the cockpit and unaided vision inside the cockpit, even while not actually flying the aircraft.

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

c. UTB data indicate that the starboard aft lookouts made more detections than the port aft lookouts, possibly because the cabin door is directly adjacent to the port aft lookout position. The open door may have allowed more light to interfere with NVG operation.

d. For WMEC searches, almost all detections of lighted targets were made on or forward of the beam. Most detections were between the 11 and 1 o'clock position on both vessels. This was primarily due to the fact that the crews were instructed to search in this area.

e. 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.

Table 2. Sweep Width Correction Factors for NVG Nighttime Searches

SRU	TARGET TYPE	NIGHT CONDITIONS	DAYLIGHT CORRECTION CONDITIONS	CORRECTION FACTOR	SWEEP WIDTH (W) (nmi)
HH-3/ CH-3	Small Boats (18 to 21 feet)	visibility ≤ 8 nmi	Weather and Aircraft speed	0.4	0.8
		visibility > 8 nmi			
		no moon	Weather and Aircraft speed	0.2	0.7
		moon	Weather and Aircraft speed	0.4	1.3
	Life Rafts with Retroreflective Tape	no moon	Weather and Aircraft speed	0.5	0.7
		moon	Weather and Aircraft speed	0.5	0.9
	Life Rafts without Retroreflective Tape	no moon	Weather and Aircraft speed	0.3	0.36
		moon			
		$H_s \leq 2.5$ feet	Weather and Aircraft speed	0.4	1.0
		H_s 2.5 - 5.2 feet	Weather and Aircraft speed	0.5	0.6
	PIW	visibility ≥ 10 nmi	Weather and Aircraft speed	2.0	0.4
		visibility < 10 nmi	*	N/A	N/A
	PIW-Green PML	all conditions	**	N/A	N/A
	PIW-Red Safety Light	no moon	Aircraft speed	6.0	1.3
		moon	Aircraft speed	2.0	0.3
	PIW-"Firefly" Strobe	3 nmi visibility		N/A	3.5

* There were not enough data collected under these conditions to calculate a nighttime sweep width or nighttime sweep width correction factor. Due to short daytime ranges, there will likely be no difference at different visibilities for nighttime searches.

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

Table 2. Sweep Width Correction Factors for NVG Nighttime Searches (Cont'd)

SRU	TARGET TYPE	NIGHT CONDITIONS	DAYLIGHT CORRECTION CONDITIONS	CORRECTION FACTOR	SWEEP WIDTH (W) (nmi)
UTB	Small Boats	no moon	Weather and Aircraft speed	0.1	0.2
		moon	Weather and Aircraft speed	0.2	0.4
	Life Rafts with Retroreflective Tape	none	Weather and Aircraft speed	0.1	0.2
	Life Rafts without Retroreflective Tape	no moon	Weather and Aircraft speed	0.1	0.2
		moon	Weather and Aircraft speed	0.3	0.6
	PIW	all conditions	*	N/A	0.06
	PIW-Red Safety Light	all conditions	*	N/A	N/A
	PIW- "Firefly" Strobe	all conditions	*	N/A	N/A
WMEC (Canso Bank)	Lighted Life Rafts	ALERT **			
		wind < 20 knots	N/A	N/A	6.7
		wind 20 - 35 knots	N/A	N/A	5.2
		VIGOROUS			
		wind < 20 knots	N/A	N/A	11.1
		wind 20 - 32 knots	N/A	N/A	9.6
	Unlighted Life Rafts	ALERT and VIGOROUS			
		$H_s \leq 5$ feet	N/A	N/A	1.3
		H_s 5 - 7.2 feet	N/A	N/A	0.6

* UTBs should not be used for PIW searches due to the extremely small values for sweep width.

** There are no daylight sweep width estimates calculated for the 200-foot size range vessels.

2. Conclusions

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

2. No consistent relationship between time on task and target detection probability existed for any SRU tested.

3. The presence of moon or artificial light within the FOV generally degrades the NVG detection performance against a light-equipped target (i.e., PIW with red safety light or lighted life rafts).

4. The presence of a visible moon significantly enhanced the NVG detection performance against unlighted targets.

5. NVG detection performance decreased in bad weather. For the environmental conditions encountered, worsening conditions nearly halved NVG detection performance.

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

RECOMMENDATIONS

1. Sweep widths correction factor recommendations for nighttime searches with NVGs are given in table 2. Corrections to daylight sweep width in the National Search and Rescue Manual (Reference 14) for fatigue, SRU speed, and weather should be applied when indicated in the table.

2. Search patterns should be oriented to minimize the time spent searching toward bright light sources. The major axis of a parallel search and the minor axis of a creeping line search should be offset 30 degrees from any major light source.

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

4. Future research should be conducted to gather data to augment the sparse data sets gathered so far. Data collection priorities, in descending order of preference are listed as follows:

   - PIW targets without lights in moonlight conditions,
   - life raft targets with retroreflective tape in moonlight conditions, and
   - PIW targets with red safety lights in moonlight conditions (helicopter) or all conditions (UTB).

5. HH-65A and HH-60J Coast Guard helicopters should be further evaluated for their NVG search performance.

6. Further data collection is recommended for helicopter searches in the following environmental conditions.

   - All moonlight conditions, particularly clear and calm weather conditions,
   - Warm nights with good visibility, and
   - Low visibility.

7. Further data collection is recommended for SRUs in the 200-foot size to evaluate NVG search performance against all target types.

8. 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 nonretroreflective materials.

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The authors would like to thank the many individuals from the numerous Coast Guard units that participated in this research effort. During the seven field experiments nearly 300 people participated actively as lookouts, observers, and staff. Many more than that we indirectly involved as crew on the USCGC VIGOROUS and the CCGS ALERT and in many support functions. In particular we would like to acknowledge the personnel from the following units, without whom the operational field experiments would not have been possible; Air Station Traverse City, Air Station Cape Cod, Air Station Miami, Air Station Clearwater, ATC Mobile, Station Fort Pierce, FL, Station Montauk, NY, Station New London, CT, and Station Point Judith, RI. We extend our special thanks to the personnel from the Watch Hill Lighthouse Keepers Association, Station Fort Pierce, FL and Aids to Navigation Team New Haven, CT, for providing logistical support during the field experiments. The crews of the R/V Osprey, R/V Uconn, M/V Big "D", and F/V Quranbaug Queen deserve recognition for their assistance in target and environmental buoy deployments/recoveries during the experiments.

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Special thanks are extended to the officers and crew of the USCGC VIGOROUS and the CCGS ALERT for their participation in the joint US/Canadian experiment on Canso Bank, Nova Scotia.

We would like to acknowledge the cooperation of the Canadian Coast Guard, the Canadian Transportation Development Center, and the technical staff at NORDCO, Ltd.

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CHAPTER 1
INTRODUCTION

1.1 SCOPE AND OBJECTIVES

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

This report is the sixth in a series of reports that provided information to the U.S. Coast Guard on the effectiveness of NVGs during SAR missions. Data were collected from operational Coast Guard search and rescue units (SRUs) for target types that were expected to be search objects during actual SAR missions. Data involving several environmental factors were collected and examined for their effect on the NVG-equipped lookout detection performance. The environmental data that substantially affect the NVG-equipped lookout's detection performance are described in this report. Analyses were conducted on SRU/target data sets for which sufficient data were collected. The references listed in table 1-1 present the results of these analyses.

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

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

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

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

Table 1-1. NVG Experiments

EXPERIMENT	DATE	LOCATION	REFERENCE DOCUMENT
1	Spring, 1989	Fort Pierce	1
2 and 3	Fall, 1989	Block Island Sound	1
4	Spring, 1990	Fort Pierce	2
5	Fall, 1990	Block Island Sound	3
6	Fall, 1990	Canso Bank	4
7	Spring, 1991	Fort Pierce	5

1.2 NIGHT VISION GOGGLE SYSTEM DESCRIPTIONS

The AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) was evaluated onboard U.S. Coast Guard HH-3F, CH-3E, and HH-60J helicopters, and HU-25C and RG-8A fixed-wing aircraft. The AN/PVS-5C and AN/PVS-7A NVGs were evaluated onboard U.S. Coast Guard SRUs in the 210-foot size class and 41-foot utility boats (UTBs). The AN/PVS-7A NVG was used during one nighttime search by one lookout onboard the HU-25C aircraft. All three NVG models amplify available light to produce a green monochromatic image of the nighttime scene. Because ambient light level varies, the NVG image quality varies; too much or too little light can cause poor image quality. All of the NVG systems evaluated severely inhibit depth perception and reduce visual acuity to no better than 20/40. Sections 1.2.1 and 1.2.2 describe specific features of the three NVG systems.

1.2.1 AN/AVS-6 ANVIS

The ANVIS NVGs shown in figure 1-1 are helmet-mounted and are designed for use onboard helicopters. These NVGs were modified with a headstrap for use onboard the fixed-wing aircraft. The ANVIS NVGs are used for operating in a broad range of night illumination conditions including starlight and overcast. Two Generation III image intensifier tubes are incorporated into a hinged binocular assembly that can easily be flipped up or down by the aviator. Adjustments for diopter correction, range focus, interpupillary separation, vertical positioning, fore-aft positioning (eye relief), and tilt positioning are also incorporated into the ANVIS NVGs.

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

When in use (down position), the binocular assembly is offset from the eyes so that limited non-NVG peripheral vision is available. The eyes can also be focused beneath the goggles to view instruments and controls. The ANVIS NVGs are limited to a 40-degree field of view (FOV). Peak spectral response is achieved between wavelengths of 0.65 and 0.90 microns that include visible light from green through red and a portion of the near-infrared spectrum. Incorporated into the ANVIS is a "minus blue" instrument light filter that eliminates wavelengths smaller than 0.625 microns (yellow). An automatic brightness control adjusts rapidly to changing illumination conditions.

The ANVIS NVGs tested during the R&D Center experiments were manufactured by ITT Electro-Optics Division, Litton Electron Devices, and Varian Corporation. Detailed ANVIS specifications and the principles of operation can be found in references 6 and 7.

1.2.2 AN/PVS-5C and AN/PVS-7A NVGs

The AN/PVS-5C and AN/PVS-7A NVGs shown in figure 1-2 and figure 1-3, respectively, are infantry-type NVGs that were designed to be worn with fixed headstrap mounts. The AN/PVS-5C NVGs 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 NVGs 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.

Automatic brightness control is provided in both NVG models. Adjustments for diopter correction, range focus, interpupillary separation, tilt positioning, and fore-aft (eye relief) positioning are incorporated in both NVG models. The headstrap assemblies 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 are limited to a 40-degree 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 8 and 9.

Figure 1-2. AN/PVS-5C Night Vision Goggles

Figure 1-3. AN/PVS-7A Night Vision Goggles

1.3 EXPERIMENT DESCRIPTIONS

A total of seven experiments were conducted in support of the NVG evaluation effort. The experiments are detailed in sections 1.3.1 through 1.3.6. Table 1-2 gives details regarding the dates of the experiments and the form of documentation.

Table 1-2. NVG Experiment Descriptions

EXPERIMENT	DATE	LOCATION	REFERENCE DOCUMENT	DOCUMENT
1	17 Apr to 06 May 1989	Fort Pierce	10	Quick Look
2 and 3	18 Sep to 07 Oct / 23 Oct to 11 Nov 1989	Block Island Sound	11	Quick Look
4	05 Mar to 23 Mar 1990	Fort Pierce	12	Quick Look
5	24 Sep to 12 Oct 1990	Block Island Sound	13	Quick Look
6	23 Oct to 06 Nov 1990	Canso Bank	4	Interim Report
7	22 Apr to 30 May 1991	Fort Pierce	5	Quick Look

1.3.1 Participants

The Fort Pierce and Block Island Sound NVG experiments were controlled by the Surveillance Systems Branch of the U.S. Coast Guard R&D Center, 1082 Shennecossett Road, Groton, CT. The Canso Bank NVG experiment was coordinated by the Canadian Coast Guard SAR R&D Office, 344 Slater Street, Ottawa, Canada and the Surveillance Systems Branch. The R&D Center Project and Test Managers arranged for the primary logistics support needed during the Fort Pierce and Block Island tests. The Canadian SAR R&D office and U.S. R&D Center Project and Test Managers arranged for the primary logistics support needed during the Canso Bank test. These agencies were responsible for maintaining a liaison between all Coast Guard and contractor participants and for maintaining top-level control of all experiment communications and data collection activities.

The prime contractor for the 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 Microwave Tracking Systems (MTS) and Global Positioning System (GPS) equipment, and provided data recorders onboard participating SRUs.

1.3.1.1 Fort Pierce, Florida Experiment, April 1989

During the first Florida experiment, a Coast Guard HH-3F helicopter (CG 1469) from Air Station Traverse City, MI was provided onsite at St. Lucie County Airport with a 7-person crew. The pilots were rotated midway through the 3-week test period, while the remaining five crew members stayed for the entire period with three flying on any particular night. U.S. Coast Guard Air Station Clearwater, FL provided limited maintenance and logistics support to the Traverse City aircraft and crew during its deployment.

U.S. Coast Guard Station Fort Pierce scheduled a 41-foot UTB (CG 41461) and crew for each night using its normal complement of personnel. Station Fort Pierce also provided dockage for the chartered workboat, a staging area and dock space for target craft, and assisted A&T personnel with the handling of target craft. Experiment-related message traffic was passed to and from the R&D Center Test Manager through the Station Fort Pierce communications center.

A 95-foot workboat, the research vessel (R/V) OSPREY, was chartered by A&T from the Florida Institute of Technology (FIT) to provide on-scene support to the Florida experiment. The R/V OSPREY deployed and retrieved the instrumented environmental data buoy in the Fort Pierce exercise area. The R/V OSPREY also deployed and retrieved the targets used during data collection and provided backup weather observations each night.

1.3.1.2 Block Island Sound Experiments September-November 1989

During the Fall 1989 Block Island Sound experiments, Coast Guard Air Station Traverse City, MI provided a CH-3E helicopter onsite at the Groton-New London Airport and a 7-person crew to support data collection. Midway through the 3-week period of the first experiment, aircraft number CG 9691 was provided with a complete aircrew change. Midway through the second experiment, aircraft number CG 2793 was provided with a complete aircrew change. U.S. Coast Guard Air Station Cape Cod, MA provided limited logistics support to the Traverse City crews during these deployments.

To support Block Island Sound data collection, U.S. Coast Guard Stations Montauk, NY, New London, CT, and Point Judith, RI, were each scheduled to provide a 41-foot UTB nightly. Vessels that participated on one or more nights are identified as:

Unit	Vessel Number
CG Station Montauk, NY	CG-41342
CG Station New London, CT	CG-41337, CG-41350
CG Station Point Judith, RI	CG-41385

Experiment-related message traffic was handled directly through the R&D Center in Groton, CT and a tenant command, the International Ice Patrol.

A 65-foot workboat, the R/V UCONN, was chartered by A&T from the University of Connecticut Marine Sciences Institute to provide on-scene support for the two Block Island Sound experiments. The R/V UCONN deployed the environmental data buoy, handled all target deployments/retrievals, and obtained backup weather observations. The environmental data buoy was recovered by the F/V QUIANIBAUG QUEEN under a direct charter from the R&D Center.

1.3.1.3 Fort Pierce, Florida Experiment, March 1990

During this Florida experiment, a U.S. Coast Guard HH-3F helicopter (CG 1488) from U.S. Coast Guard Air Station Cape Cod, MA was provided onsite at St. Lucie County Airport with a 7-person crew. The aircrew were rotated midway through the 3-week test period. U.S. Coast Guard Air Station Clearwater, FL provided limited maintenance and logistics support to the Cape Cod aircraft and crew during its deployment.

U.S. Coast Guard Station Fort Pierce scheduled a 41-foot UTB (CG 41341) and crew for each night using its normal complement of personnel. Station Fort Pierce also provided dockage for the chartered workboat, a staging area and dock space for target craft, and assisted A&T personnel with the handling of target craft. Experiment-related message traffic was passed to and from the R&D Center Test Manager through the Station Fort Pierce communications center.

A 95-foot workboat, the R/V OSPREY, was chartered by A&T from FIT to provide on-scene support to the Florida experiment. The R/V OSPREY deployed and retrieved the instrumented environmental data buoy in the Fort Pierce exercise area. The R/V OSPREY also deployed and retrieved the targets used during data collection and provided backup weather observations.

1.3.1.4 Block Island Sound Experiment September-October 1990

During the Fall 1990 Block Island Sound experiment, U.S. Coast Guard Air Station Cape Cod, MA provided an HH-3F helicopter based at Air Station Cape Cod, Otis Air Force Base, MA. Two pilots, rotated weekly, and a 3-person crew were assigned to support data collection. Aircraft number CG 1471 was provided for the entire 3-week experiment.

To support Block Island Sound data collection, U.S. Coast Guard Stations Montauk, NY, New London, CT, and Point Judith, RI were each scheduled to provide a 41-foot UTB nightly. Vessels that participated on one or more nights are identified as.

Unit	Vessel Number
CG Station Montauk, NY	CG-41342
CG Station New London, CT	CG-41337, CG-41350
CG Station Point Judith, RI	CG-41441

Experiment-related message traffic was handled directly through the R&D Center in Groton, CT and the International Ice Patrol.

A 65-foot workboat, the R/V UCONN, was chartered by A&T from the University of Connecticut Marine Sciences Institute to provide on-scene support for the Block Island Sound experiment. The R/V UCONN deployed and retrieved the environmental data buoy, handled all target deployments/retrievals, and obtained backup weather observations.

1.3.1.5 Canso Bank, Nova Scotia Experiment, October-November 1990

The U.S. Coast Guard Cutter (USCGC) VIGOROUS and the 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 A&T, and the prime contractor for the Canadian Coast Guard was NORDCO LTD. A&T and NORDCO prepared test plans, installed GPS equipment, and provided data recorders onboard participating SRUs. The targets were procured by both the Canadian and U.S. Coast Guard.

1.3.1.6 Fort Pierce, Florida Experiment, April-May 1991

During this Florida experiment, U.S. Coast Guard helicopters and fixed-wing aircraft were provided to support data collection. Aircraft that participated on one or more nights are listed below.

Unit	Aircraft	Type	Tail Number
Air Station Clearwater, FL	HH-3F	Helicopter	CG-1480
Air Station Traverse City, MI	CH-3E	Helicopter	CG-2791
Air Training Center (ATC) Mobile, AL	HH-60J	Helicopter	CG-6006
Air Station Miami, FL	HU-25C	Fixed-wing	CG-2140
Air Station Miami, FL	RG-8A	Fixed-wing	CG-8101, CG-8102

The helicopters and the RG-8A were onsite at St. Lucie County Airport during their respective test periods. The HU-25C was based at Air Station Miami, FL and landed at Vero Beach Airport for each nighttime search and picked up and dropped off the data recorder.

Experiment-related message traffic was passed to and from the R&D Center Test Manager through the Station Fort Pierce communications center.

A 58-foot workboat, the Big D, was chartered by A&T from Summerlin's Seven Seas, Inc. to provide on-scene support to the Florida experiment. The Big D deployed and retrieved the instrumented environmental data buoy in the Fort Pierce exercise area, deployed and retrieved targets that were used during data collection, and provided backup weather observations.

1.3.2 Exercise Areas

The exercise area for the Fort Pierce experiments was a 10- by 20-nautical mile (nmi) area centered at 27°32.6'N, 80°09.0'W along a major axis of 160 degrees magnetic. Figure 1-4 depicts the Fort Pierce exercise area and indicates the locations of land-based MTS components. SRUs were assigned specific search patterns within this area, which varied in size from 4- by 8-nmi to 10- by 12-nmi, depending on the target and SRU type.

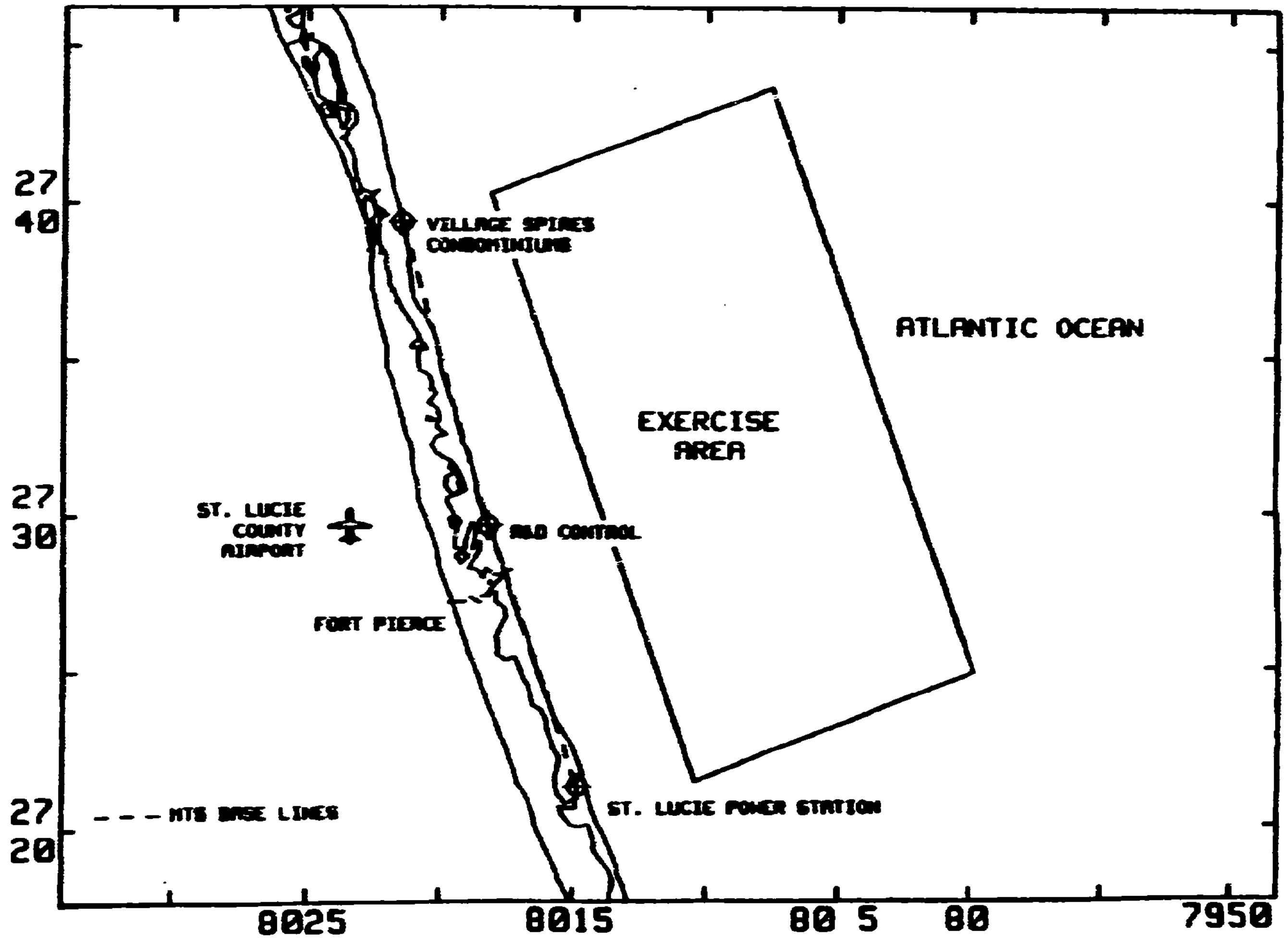


Figure 1-4. Fort Pierce Exercise Area

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

In both exercise areas, an operations center was established at the MTS master station location. The operations centers were equipped with all of the computer and communications equipment required to direct data collection activities and record target and SRU position information. These facilities, known as R&D Control, were located at the Sea Palms Condominiums in Fort Pierce during the Spring 1989 and 1991 experiments; at Watch Hill Light on Block Island Sound during the Fall 1989 and 1990 experiments; and at the Tiara North Condominiums in Fort Pierce during the Spring 1990 experiment. These locations are depicted in figures 1-4 and 1-5.

The exercise area for the Canso Bank experiment was an 18- by 25-nmi area centered at approximately 45°07.2'N, 60°23.7'W along a major axis of 65 degrees true. A variety of search patterns were generated while taking into account target types, SRU capabilities, and prevailing winds/seas. An array of 23 moorings were deployed within the 50-fathom contour on the Canso Bank with a wave rider buoy at the center. The mooring array was overlaid by the 18- by 25-nmi search grid that comprised 36 waypoints that were alphanumerically labeled. Figure 1-6 depicts the location of the exercise area, and figure 1-7 depicts an enlargement of the search area with target positions and grid array overlaid.

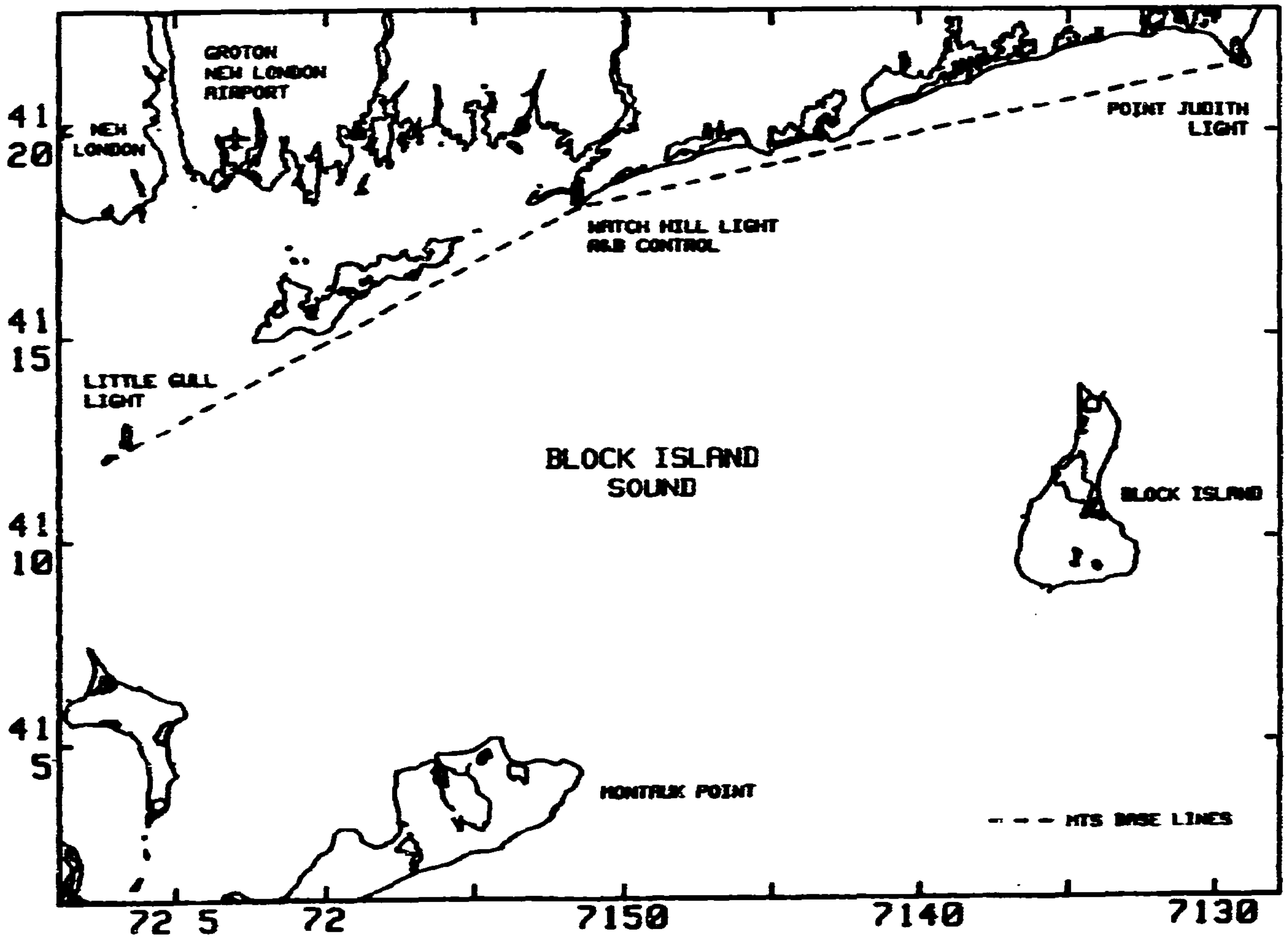


Figure 1-5. Block Island Sound Exercise Area

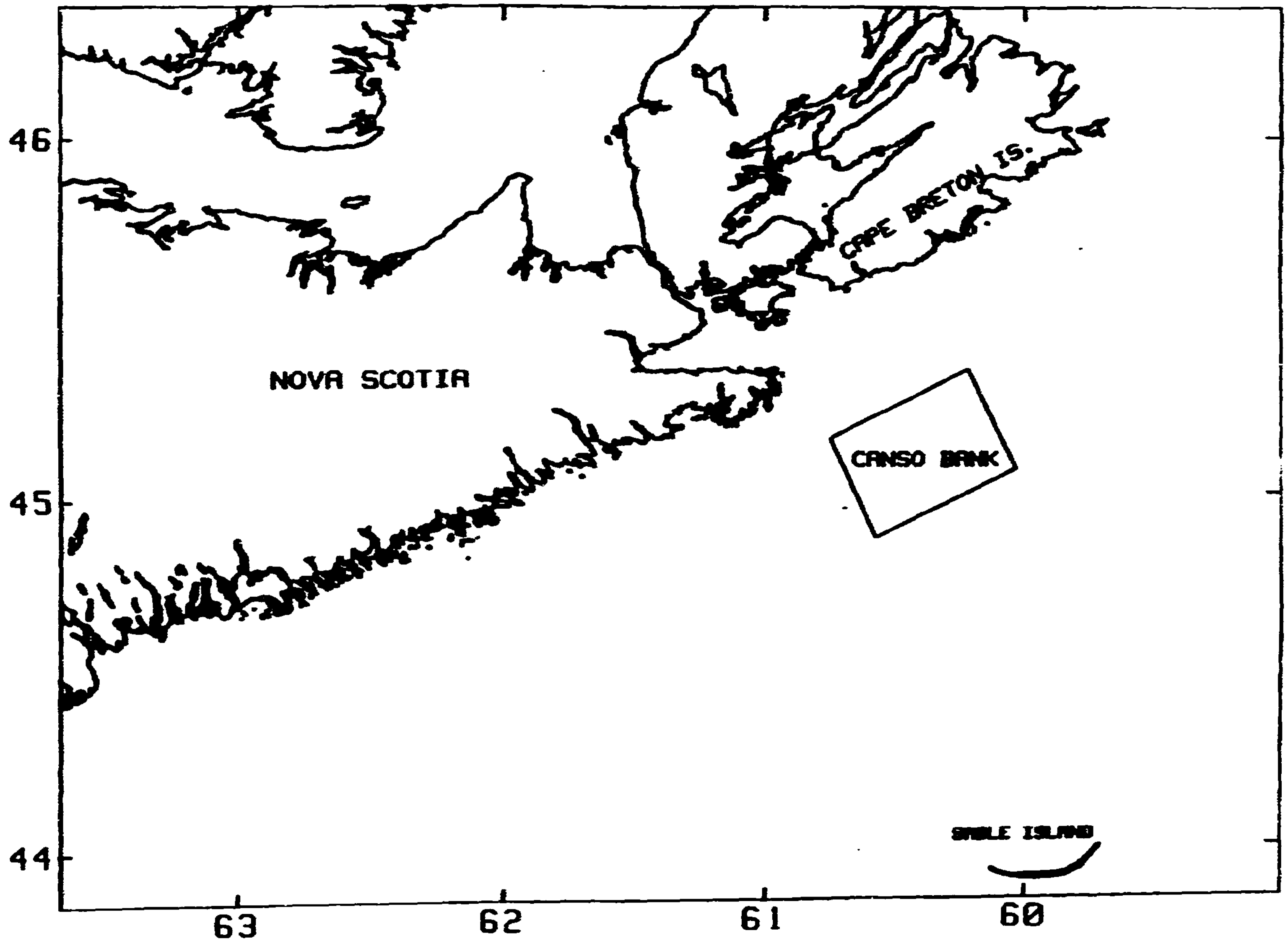


Figure 1-6. Canso Bank Exercise Area

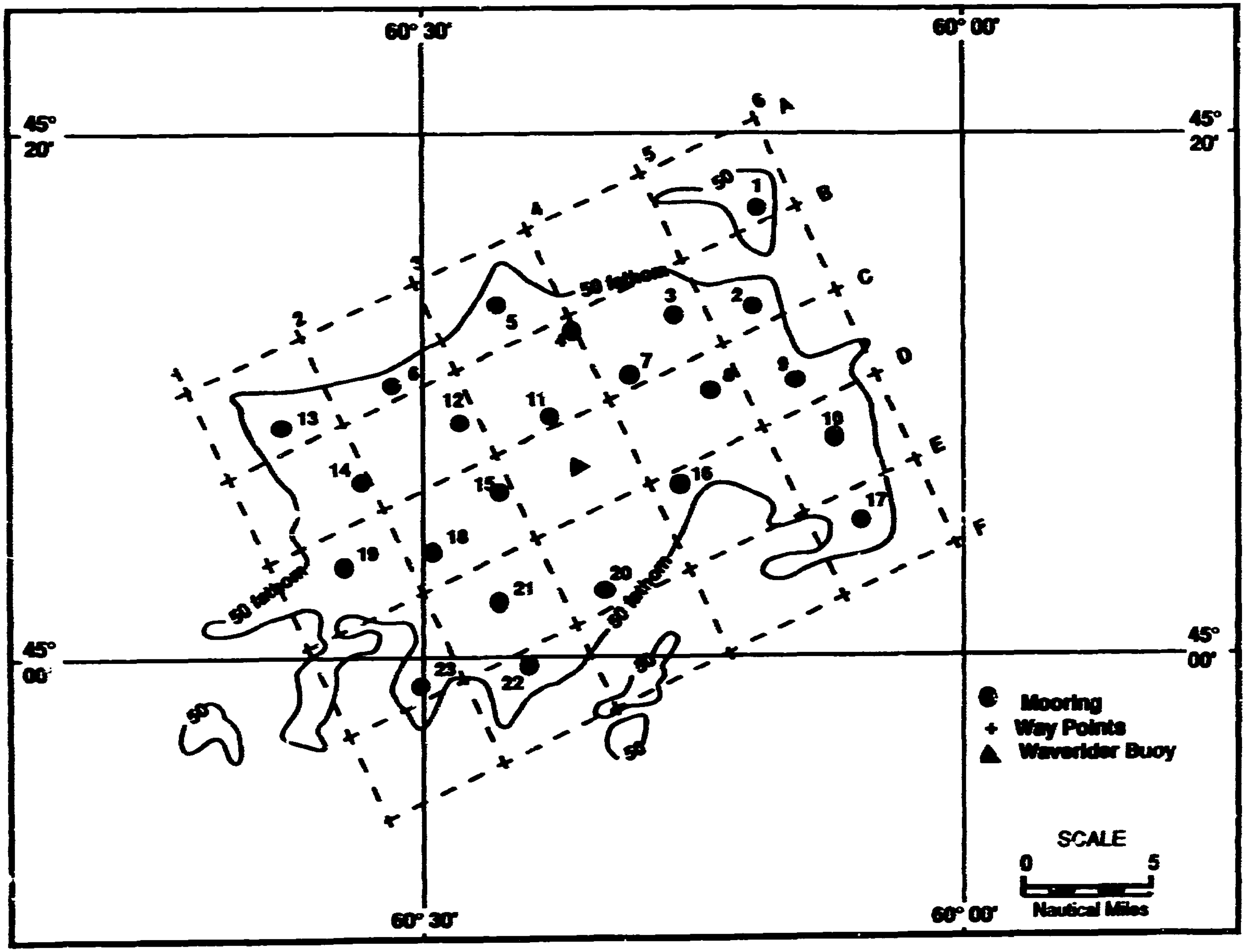


Figure 1-7. Canso Bank Exercise Area with Mooring Array and Search Grid

1.3.3 Targets

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

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

The targets that were deployed with lights include PIW targets and 4- and 6-person life rafts with retroreflective tape. The PIW targets were deployed with a military-issue, 1-second "firefly" strobe or green or red chemical lights. The chemical lights were Cyalume devices manufactured by the American Cyanamid Corporation. The green light was a U.S. Coast Guard-issue personnel marker light (PML) (shown in figure 1-8A). The red light was a red Safety Light stick (shown in figure 1-8B). The brightness of the two chemical lights was plotted in arbitrary units as a function of wavelength (see figure 1-9). Two aspects of figure 1-9 are worthy of note. First, most of the PML energy was eliminated by the minus-blue filter on the ANVIS NVGs. Only wavelengths longer than 625 nanometers were intensified by the ANVIS NVGs, making the PMLs nearly impossible to detect. Second, the brightness of both chemical lights diminished rapidly after activation. As a result, there was about a fivefold decrease in peak output after 1 hour. Brightness remained relatively stable for several hours after this time.

Four- and 6-person life rafts with retroreflective tape were equipped with a steady white light. Lighted life rafts were used only during the Canso Bank experiment. On some nights, the life raft lights were lighted and on others life raft lights were unlighted. Lighted and unlighted life rafts were not mixed together as search targets.

During most of the experiments target types were not mixed. However, during the Fort Pierce Spring 1991 experiment, a mix of life rafts and small boat targets were deployed together. On some nights, rough seas prevented the deployment of the small boat targets. All life raft targets were deployed with retroreflective tape applied using SOLAS specifications. Throughout the 3-week experiment, targets were attached to the moorings in randomly selected combinations based on data collection priorities. Table 1-3 provides the salient characteristics of targets deployed during these experiments. Figures 1-10 through 1-14 provide representative photographs of all targets.

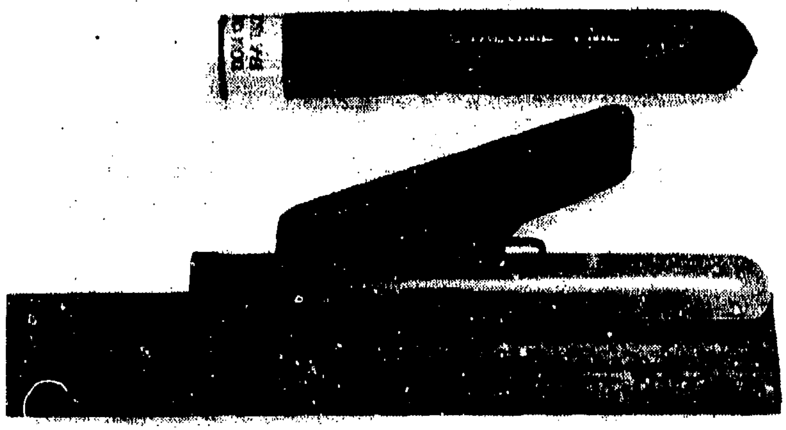


Figure 1-8A. Green Cyalume Personnel Marker Light

Figure 1-8B. Red Safety Light

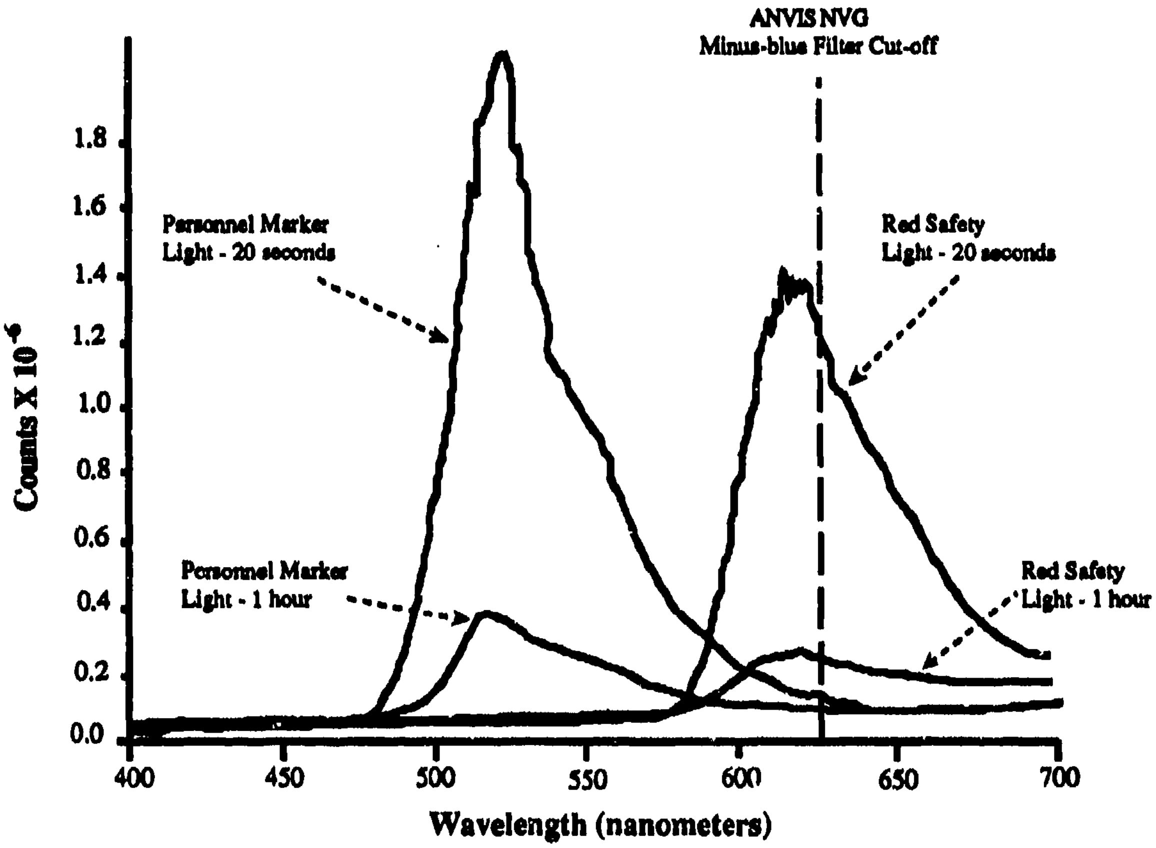


Figure 1-9. Brightness Versus Wavelength and Time for PML and Red Safety Light
(U.S. Coast Guard R&D Center Laboratory Measurements)

Table 1-3. NVG Target Descriptions

TARGET	TARGET DESCRIPTION	DIMENSIONS length x beam x freeboard (feet)	PRINCIPAL MATERIAL
PIW *	Department store style mannequin w/type I PFD and retroreflective tape	1.5 x 1 x 1	Plastic
PIW	PIW target w/ACR "Firefly" Rescue Light	Same as above equipment with a 1-second flash, 250,000 candle power strobe light	Plastic
Six-person life raft	B.F. Goodrich w/orange canopy and retroreflective tape**	8.1 x 5.9 rectangular x 4 ht.	Rubber/ fabric
	B.F. Goodrich w/orange canopy and retroreflective tape**	4.3 x 8.4 dia hexagon x 4.6 ht.	
	Dunlop/Beaufort w/orange canopy and retroreflective tape**	4 x 8.2 dia hexagon x 4.2 ht.	
	Dunlop/Beaufort w/yellow canopy and retroreflective tape**	7.5 x 5.5 rectangular x 3.7 ht.	
	Avon or Beaufort w/orange canopy†	7.2 dia. x 3.7 ht.	
	Dunlop w/orange canopy†	9 x 5.5 oval x 3.25 ht.	
Four-person life raft	Dunlop/Beaufort w/yellow canopy and retroreflective tape**	6.6 x 6.3 pentagon x 3.8 ht.	Rubber/ fabric
	Dunlop/Beaufort w/orange canopy and retroreflective tape**	6.6 x 6.3 pentagon x 3.8 ht.	
	Avon w/orange canopy†	6 dia. x 3.5 ht.	
	Viking w/orange canopy†	5.5 square x 3.5 ht.	
	Canadian Dunlop/Beaufort w/orange canopy and retroreflective tape**	4.9 x 4.9 square x 3.3 ht.	
Small boat	Rectangular white skiff w/console	18 x 7.5 x 1.6	Fiberglass
Small boat	Rectangular white skiff w/console, blue canvas bimini top, and blue bow shelter canvas	21 x 7.7 x 1.6	Fiberglass

* Equipped with either the PML or Red Safety Light attached to the PFD with plastic tie wrap.
** Targets were deployed for the Canso Bank experiment only.
† Rafts were deployed with or without retroreflective tape.

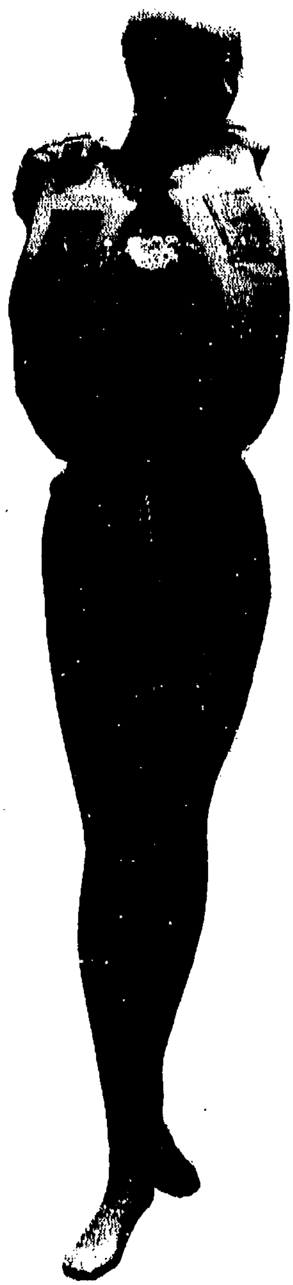


Figure 1-10. Persons-in-the-Water Target

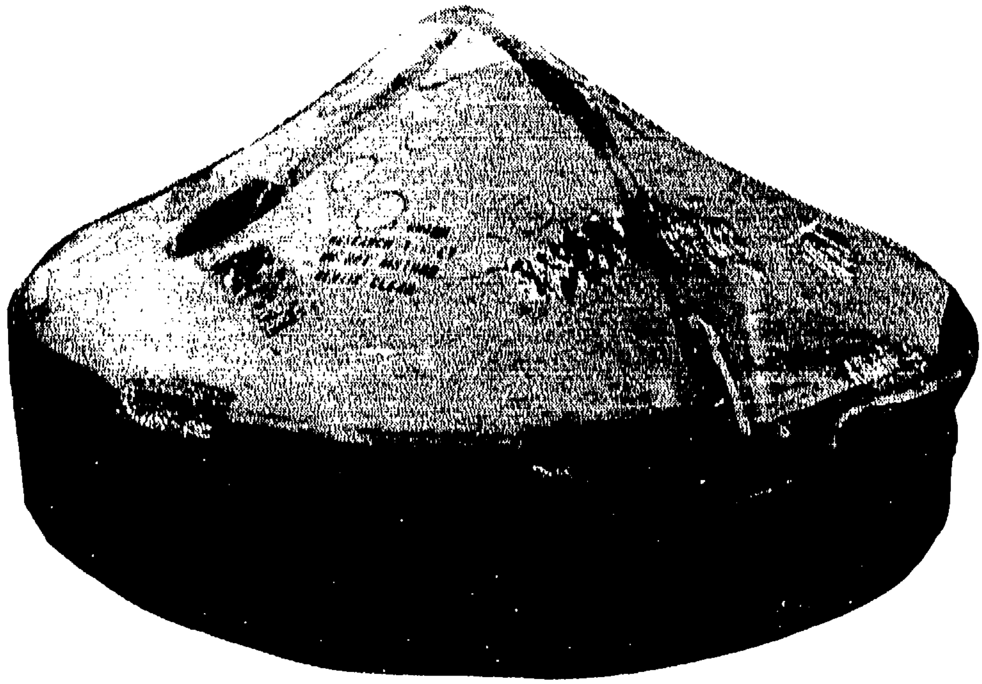


Figure 1-11. Four-Person Life Raft With Retroreflective Tape Applied in Accordance With SOLAS Specifications

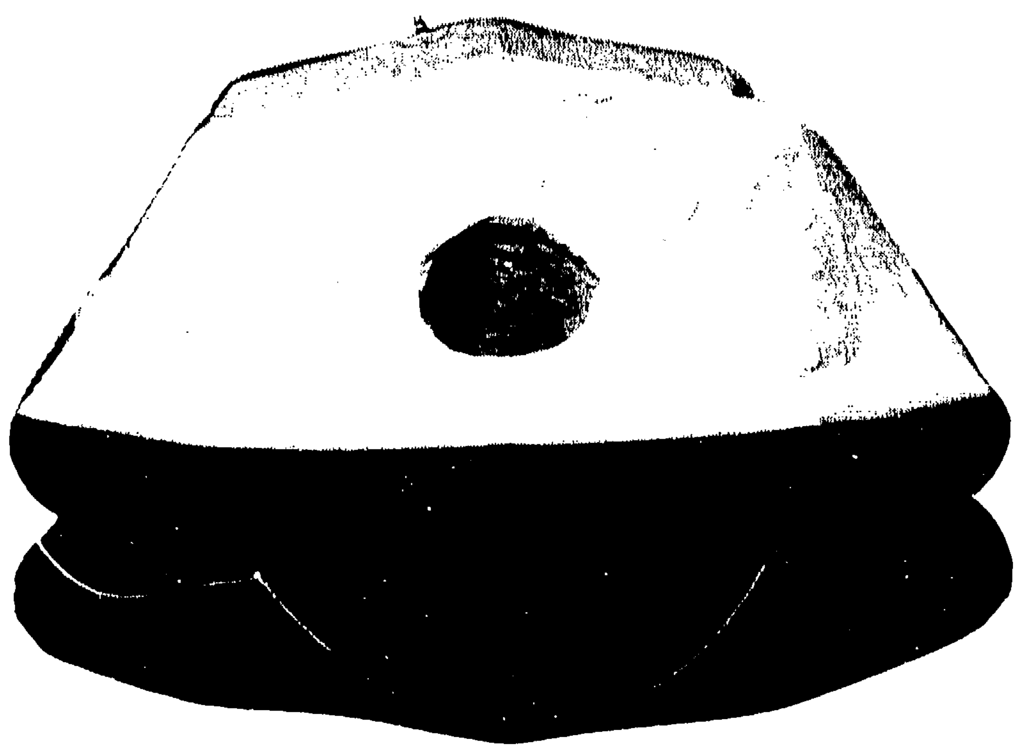


Figure 1-12. Six-Person Life Raft Target Without Retroreflective Tape

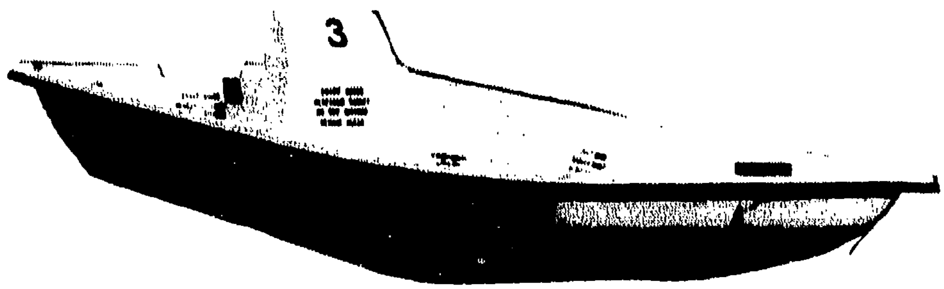


Figure 1-13. Eighteen-Foot Small Boat Target

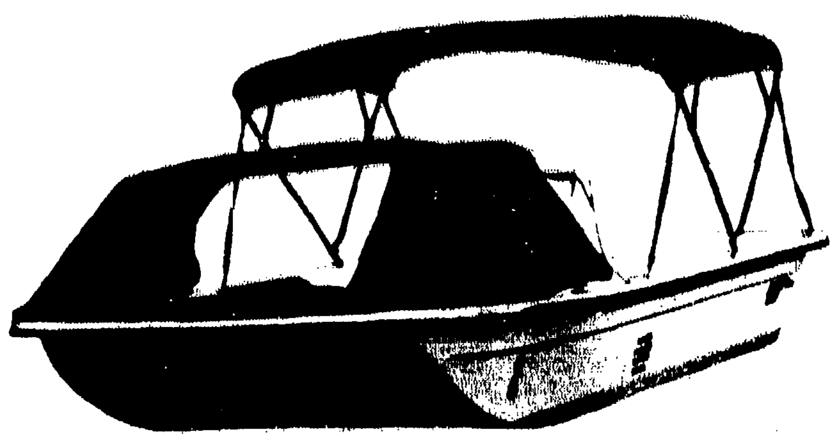


Figure 1-14. Twenty-One Foot Small Boat Target With Canvas

1.3.4 Lookout Positions

A variety of lookout position combinations were encountered on the different SRUs . The H-3 helicopters carried either four or five NVG-equipped lookouts. The lookouts included the pilot and copilot, an avionics operator searching through an enlarged window, a flight mechanic searching through the open door, and a rescue swimmer (when onboard) searching through a side window or out the open rear cargo door. The H60-J helicopter carried four NVG-equipped lookouts. The lookouts included the pilot and copilot, an avionics operator searching through an enlarged window, and a flight mechanic searching through the open door. The HU-25C aircraft carried two NVG-equipped lookouts; two crew members that searched through the enlarged aircraft window on either side of the aircraft. The HU-25C also searched with its Forward Looking Infrared system (FLIR). The RG-8 carried one NVG-equipped lookout who sat in the pilot seat of the aircraft looking straight ahead or to the right.

During the Canso Bank experiment, the lookouts onboard the ALERT typically searched through open windows within the enclosed bridge. During severe weather, the windows were closed, and searches were conducted through the window glass. 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 frequent reliefs of bridge wing lookouts were performed. VIGOROUS lookouts stood 4-hour watches and rotated among the four lookout and helm positions during the watch. ALERT lookouts stood 1-hour watches and were then relieved by a new lookout.

The UTBs typically searched with two lookouts that were rotated about every hour. These lookouts were stationed port and starboard forward of the pilot house. During high sea states, the sea spray would often drive the lookouts aft behind the pilot house.

1.3.5 Experiment Design and Conduct

During the experiments conducted in U.S. waters, detection data were obtained by conducting operationally realistic NVG searches using parallel search (PS) and creeping line search (CS) patterns, as defined in reference 14. Track spacing and search area dimensions were chosen to provide the maximum number of target detection opportunities at a variety of lateral ranges without producing multiple target distractions for the lookouts. The helicopters used a 1-nmi track spacing while searching for life rafts and small boats and a 0.5-nmi track spacing while searching for PIWs. The HU-25C and the RG-8A used a 2-nmi track spacing, and the UTBs used a 1-nmi track spacing for all target types. Figures 1-15 and 1-16 illustrate the type of search instructions that were provided to participating SRUs during the experiments. Helicopters typically searched at a 300-foot altitude and used a 90-knot ground speed for small boats and life rafts and a 60-knot ground speed for PIW. The HU-25C typically searched at a 500-foot altitude and used a 180-knot ground speed. The RG-8A typically searched at a 300- or 380-foot altitude and used a 90-knot ground speed. UTBs searched between 9 and 20 knots, depending on sea conditions. All of the search parameters were communicated to SRUs through a SAR Exercise (SAREX) message sent 12 to 24 hours before scheduled data collection.

During the experiment conducted in Canadian waters, search patterns were created by selecting a pattern of waypoints that resulted in a variety of target lateral ranges. Target density and weather factors had a significant influence on the type of search pattern used. Parallel searches were primarily used early in the experiment. Later in the experiment, a rough box was formed as a trackline for the search pattern. When the VIGOROUS and ALERT searched on the same night, each performed the same search with approximately a 1/2-hour separation at a search speed between 10 and 12 knots.

In the interest of realism, SRU crews were composed of personnel from the normal complement of the respective air stations or ships. With the exception of the helicopter pilots, special training in the adjustment, care, and use of NVGs was usually limited to briefings and demonstrations by the R&D Center Test Manager or an A&T representative. With the exception of some of the helicopter pilots who had prior NVG flight experience in the Army, most of the SRU crew members had little or no operational experience with NVGs. These experience and training levels are representative of what can currently be expected at many U.S. Coast Guard SAR facilities where NVGs are available. 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, the SRU did not divert from the assigned search pattern for the purpose of confirming target sightings. Target confirmation was made through postexperiment data analysis.

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

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

Search Plan No. Creeping Line Search

Center: 41° 12.5 N 71°48 W AXES: Major: 12Ø/3ØØ°T Minor: Ø3Ø/21Ø°T
START: 41° 11.22N 71°54.35W Right Length: 8.ØØ nm Track Spacing: 1.ØØ nm
Speed: 9Ø kts Time: ØØ:42 Width: 8.ØØ nm Track Miles: 63.ØØ nm
41°11.Ø4 71°55.26 41°17.96 71°49.94 41°13.96 71°4Ø.72 41°Ø7.Ø4 71°46.Ø4

Waypoint	Latitude	Longitude	Course	Range	Cumulative Distance
1	41°11.22N	71°54.35W			
2	41°17.28N	71°49.7ØW	Ø3Ø°T	7 nm	7 nm
3	41°16.78N	71°48.55W	12Ø°T	1 nm	8 nm
4	41°1Ø.72N	71°53.2ØW	21Ø°T	7 nm	15 nm
5	41°1Ø.22N	71°52.Ø5W	12Ø°T	1 nm	16 nm
6	41°16.28N	71°47.4ØW	Ø3Ø°T	7 nm	23 nm
7	41°15.78N	71°46.24W	12Ø°T	1 nm	24 nm
8	41°Ø9.72N	71°5Ø.9ØW	21Ø°T	7 nm	31 nm
9	41°Ø9.22N	71°49.75W	12Ø°T	1 nm	32 nm
10	41°15.28N	71°45.Ø9W	Ø3Ø°T	7 nm	39 nm
11	41°14.78N	71°43.94W	12Ø°T	1 nm	4Ø nm
12	41°Ø8.72N	71°4Ø.59W	21Ø°T	7 nm	47 nm
13	41°Ø8.22N	71°47.44W	12Ø°T	1 nm	48 nm
14	41°14.28N	71°42.75W	Ø3Ø°T	7 nm	55 nm
15	41°13.78N	71°41.64W	12Ø°T	1 nm	56 nm
16	41°Ø7.72N	71°46.29W	21Ø°T	7 nm	63 nm

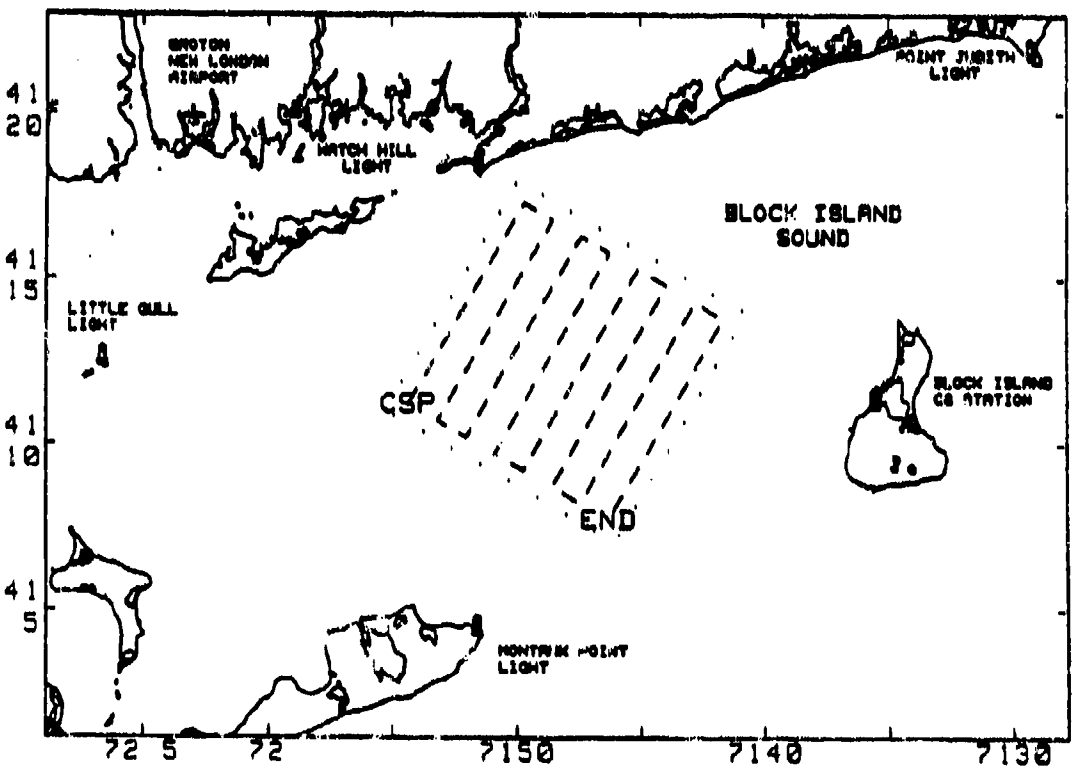


Figure 1-15. Example of Search Instructions Provided to Helicopter and Fixed-Wing Aircraft (Life Raft and Small Boat Targets)

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

Search Plan No. Parallel Search

Center: 41° 17.1 N 71°45.4 W AXES: Major: Ø75/255°T Minor: 165/345°T
START: 41° 17.34N 71°5Ø.65W Right Length: 8.ØØ nm Track Spacing: .5Ø nm
Speed: 15.Ø kts Time: Ø3:1Ø Width: 3.ØØ nm Track Miles: 47.5Ø nm
Corners of search area Area of this search: 24 sq nm
41°17.51 71°51.Ø6 41°19.58 71°4Ø.77 41°16.69 71°39.74 41°14.62 71°5Ø.Ø2

Waypoint	Latitude	Longitude	Course	Range	Cumulative Distance
1	41°17.34N	71°5Ø.65W			
2	41°19.28N	71°41.Ø1W	Ø75°T	7.5 nm	7.5 nm
3	41°18.8ØN	71°4Ø.84W	165°T	.5 nm	8 nm
4	41°16.85N	71°5Ø.48W	255°T	7.5 nm	15.5 nm
5	41°16.37N	71°5Ø.31W	165°T	.5 nm	16 nm
6	41°18.31N	71°4Ø.66W	Ø75°T	7.5 nm	23.5 nm
7	41°17.83N	71°4Ø.49W	165°T	.5 nm	24 nm
8	41°15.89N	71°5Ø.13W	255°T	7.5 nm	31.5 nm
9	41°15.4ØN	71°49.96W	165°T	.5 nm	32 nm
10	41°17.35N	71°4Ø.32W	Ø75°T	7.5 nm	39.5 nm
11	41°16.86N	71°4Ø.15W	165°T	.5 nm	4Ø nm
12	41°14.92N	71°49.79W	21Ø°T	7.5 nm	47.5 nm

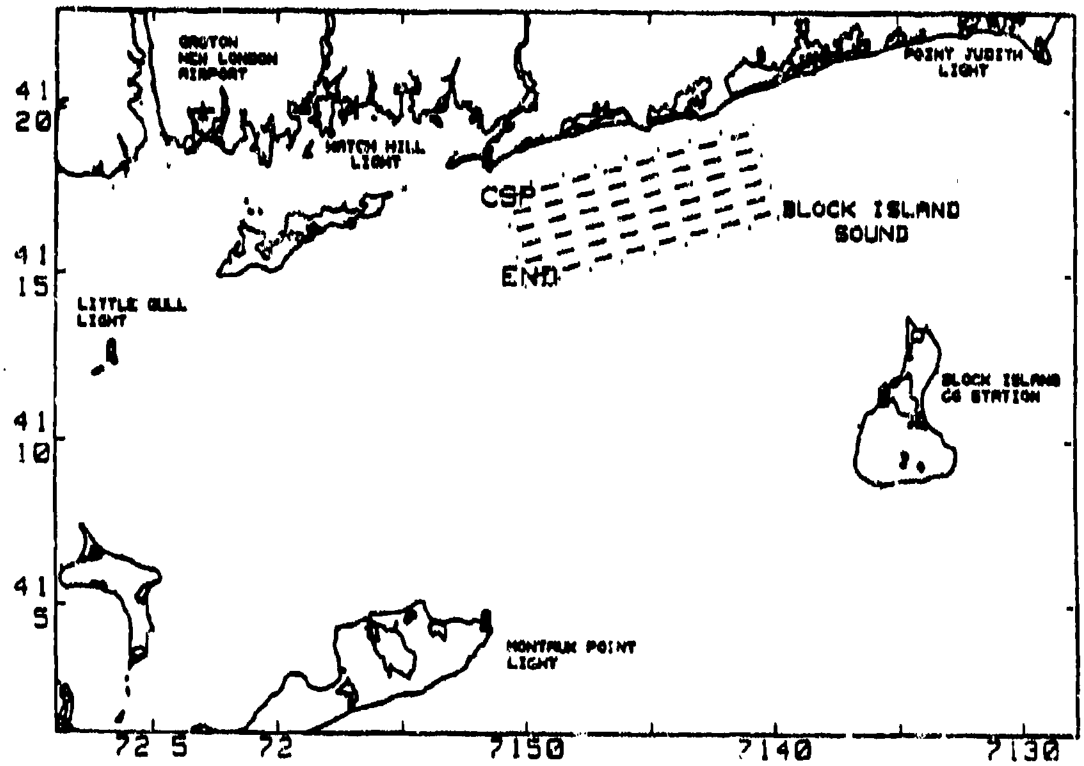


Figure 1-16. Example of Search Instructions Provided to Utility Boats (PIW Targets)

During the Canso Bank experiment, targets were attached to permanent moorings. The Canadian Test Manager determined when the targets would be repositioned or removed completely if severe weather conditions were forecasted. 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.

While NVGs were the primary sensor employed in the searches, a few incidental detections that were made with a radar assist are also included in the UTB data set. Helicopter crew members wore the ANVIS NVGs while searching and used radar to avoid severe weather. The HU-25C had a crewmember assigned to operate the FLIR as an independent sensor, and the FLIR was not used in assisting the NVG searchers for target detection.

Each night, a data recorder from the A&T field team accompanied each SRU to log human factors data, target detections, and crew comments. Crew information was recorded on the SRU Information Form (figure 1-17). Target detections, crew comments, and general observations were recorded on the NVG Detection Log (figure 1-18).

The Canso Bank data recorders from A&T and NORDCO used the Lookout Information Form (figure 1-19) to log human factors data. The Visual Sighting Report Form (figure 1-20) was used for target detections, crew comments, and general observations.

When a target was sighted, lookouts immediately relayed its relative bearing (the "clock" method was used for all experiments except the Canso Bank experiment), 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 MTS/GPS computer clock so that detections could be validated during postexperiment 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.

SRU INFORMATION FORM

DATE ______________________ MTS TRANSPONDER CODE ______________________

SRU TYPE ______________________ SERIAL NUMBER ______________________

COAST GUARD COMMAND ______________________________________

NAVIGATION INPUTS USED
(check all that apply)

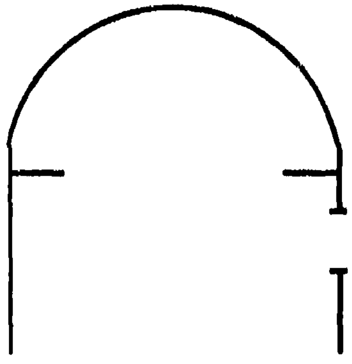
TACAN ___ VOR/DME ___ INS ___ LORAN-C ___ RDF ___ RADAR ___ DEAD REC. ___

CREW NAMES

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

SKETCH (show positions)

Aircraft



Vessel

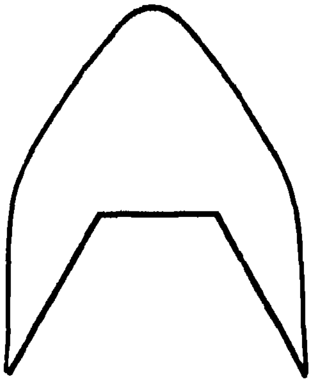


Figure 1-17. Search and Rescue Unit Information Form

NVG DETECTION LOG

AIRCRAFT/BOAT NO. ____________
TRANSPONDER CODE ____________

SEARCH START TIME ____________
SEARCH END TIME ____________
SEARCH DURATION ____________

DATE ____________
SEARCH ____________
SPEED ____________
ALTITUDE ____________

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

RECORDER: ____________________

Figure 1-18. NVG Detection Log

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

DATE________ SEARCH TYPE____________
SRU ________ SEARCH NO. ____________

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

Figure 1-19. 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 VISIBILITY (Yes/No)	HEADING (°T)	LOOKOUT LOCATION	LOOKOUT ID	CONFIRM MOORING NO.	REMARKS	OBS

Figure 1-20. Visual Sighting Report Form

On-scene environmental conditions were recorded on the Environmental Conditions Summary Form (figure 1-21) by an A&T technician onboard the chartered workboat. The Minimet environmental buoy provided additional environmental data. The buoy relayed information to the R&D Control facility over a UHF-FM data link three times per hour. This information was also stored as a backup in an internal memory onboard the buoy.

Figure 1-22 is an example of the data messages received from the Minimet buoy. Two of the three hourly messages relayed wind data, water temperature, and air temperature at 10 minutes and 40 minutes past the hour. At 30 minutes past the hour, wave spectrum data including significant wave height (H_S) were relayed. The buoy was the preferred environmental data source when duplicate sets of information (workboat and buoy) were available.

During the Canso Bank experiment, on-scene environmental conditions were recorded by contractor personnel onboard the U.S. and Canadian Coast Guard ships. A wave rider buoy also provided wave height, period, and direction information. Figure 1-23 depicts the Canso Bank Environmental Conditions Summary Form.

1.3.6 Tracking and Reconstruction

Target locations and SRU positions were monitored using an automated Microwave Tracking System (MTS) consisting of a Motorola Falcon 492 system controlled by a Hewlett-Packard desktop computer. The controlling software system was developed by the R&D Center to provide real-time positioning and tracking with search reconstruction accurate to better than 0.1 nmi. A mobile MTS transponder was installed on the workboat for use in target positioning and on each SRU so that a track history of each search pattern could be generated. SRU positions were recorded continuously by the MTS, displayed in real time on a computer screen at R&D Control, and recorded on a microcomputer hard disk every 10 to 30 seconds. Target positions were recorded by obtaining an MTS fix on the workboat when deploying and recovering each target, thus verifying that each target position was unchanged while deployed. A more detailed description of this system can be found in reference 15.

ENVIRONMENTAL CONDITIONS SUMMARY

REPORTING UNIT ________ DATE ________

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

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

OBSERVER: ________

Figure 1-21. Environmental Conditions Summary Form

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

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

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

Figure 1-22. Minimet Environmental Data Buoy Message Formats

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

DATE ____________
SEARCH ____________
SRU ____________

LOCAL TIME	VIS (nmi)	CLOUD COVER (tenths)	WX	TEMP (°C)		SHIP		APRNT WIND		TRUE WIND		COMB SEA		SWELL DIR (°T)	W.C. (N/S/M)	ROLL		PITCH		REMARKS	OBS
				DRY	WET	HDG (°T)	SP (kt)	DIR (° REL)	SP (kt)	DIR (°T)	SP (kt)	HT (ft)	PD (S)			AMP/2 (°)	PD (S)	AMP/2 (°)	PD (S)		

Figure 1-23. Canso Bank Environmental Conditions Summary Form

In the Fort Pierce exercise area, the tracking system recorded the range from a transponder to the MTS master unit located at the top of a high-rise condominium building in Fort Pierce. The tracking system also recorded the range from a transponder to the two relay stations (located on a meteorological tower at the Florida Power and Light Company, St. Lucie Plant, and at the Village Spires condominiums in Riomar). These locations are depicted in figure 1-4. In the Block Island Sound exercise area, the tracking system recorded the range from a transponder to the MTS master unit located at Watch Hill Light and from a transponder to the two primary relay stations (located at Little Gull Light and Point Judith Light). These locations are depicted in figure 1-5.

Search tracks and target locations were reconstructed by using the recorded target and SRU position data to generate an accurate geographic representation on hard-copy plots. Figures 1-24 and 1-25 are MTS-generated reconstruction plots of actual searches that were conducted during the second Block Island Sound experiment. On each plot, target positions were plotted using identifying letters, and the SRU track was identified by dots and plus signs. Plotting the SRU position marks created a trackline history for each search craft. Each position mark was associated with a known time on a hard-copy printout that accompanied each plot. Figure 1-24 depicts the CH-3E helicopter execution of the search instructions that were shown in figure 1-15. Figure 1-25 depicts the 41-foot UTB execution of the search instructions that were shown in figure 1-16.

During the Canso Bank experiment, target locations were monitored using GPS fixes (LORAN-C fixes were used as a back-up) that were correlated to identify differences in navigation units on each participating vessel. SRU positions were received continuously by the tracking system, displayed in real time on a computer screen, 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. Target positions were plotted on each plot 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 1-26 is a tracking system-generated reconstruction plot of an actual search.

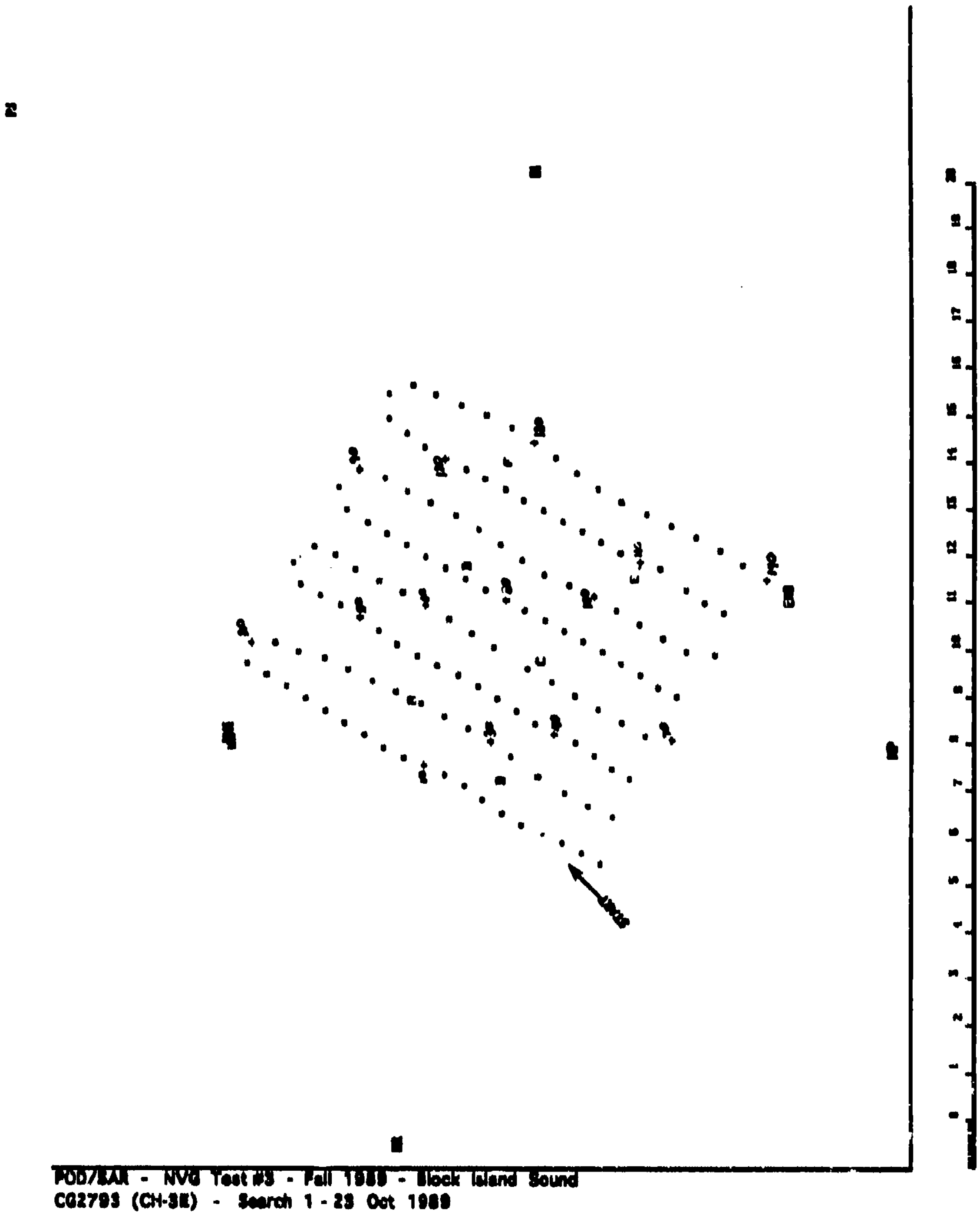


Figure 1-24. MTS Plot of a Typical Helicopter Search

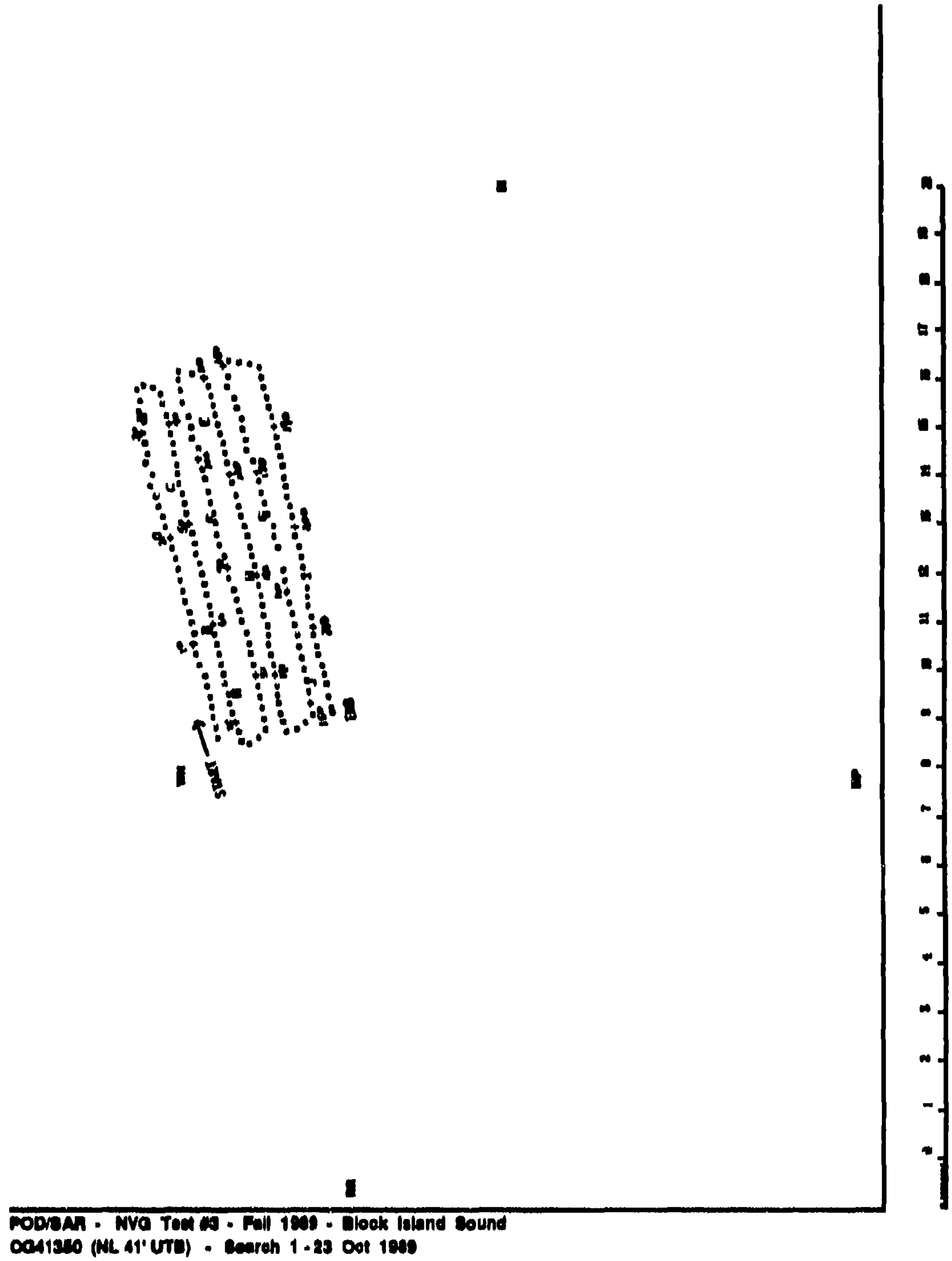


Figure 1-25. MTS Plot of a Typical UTB Search

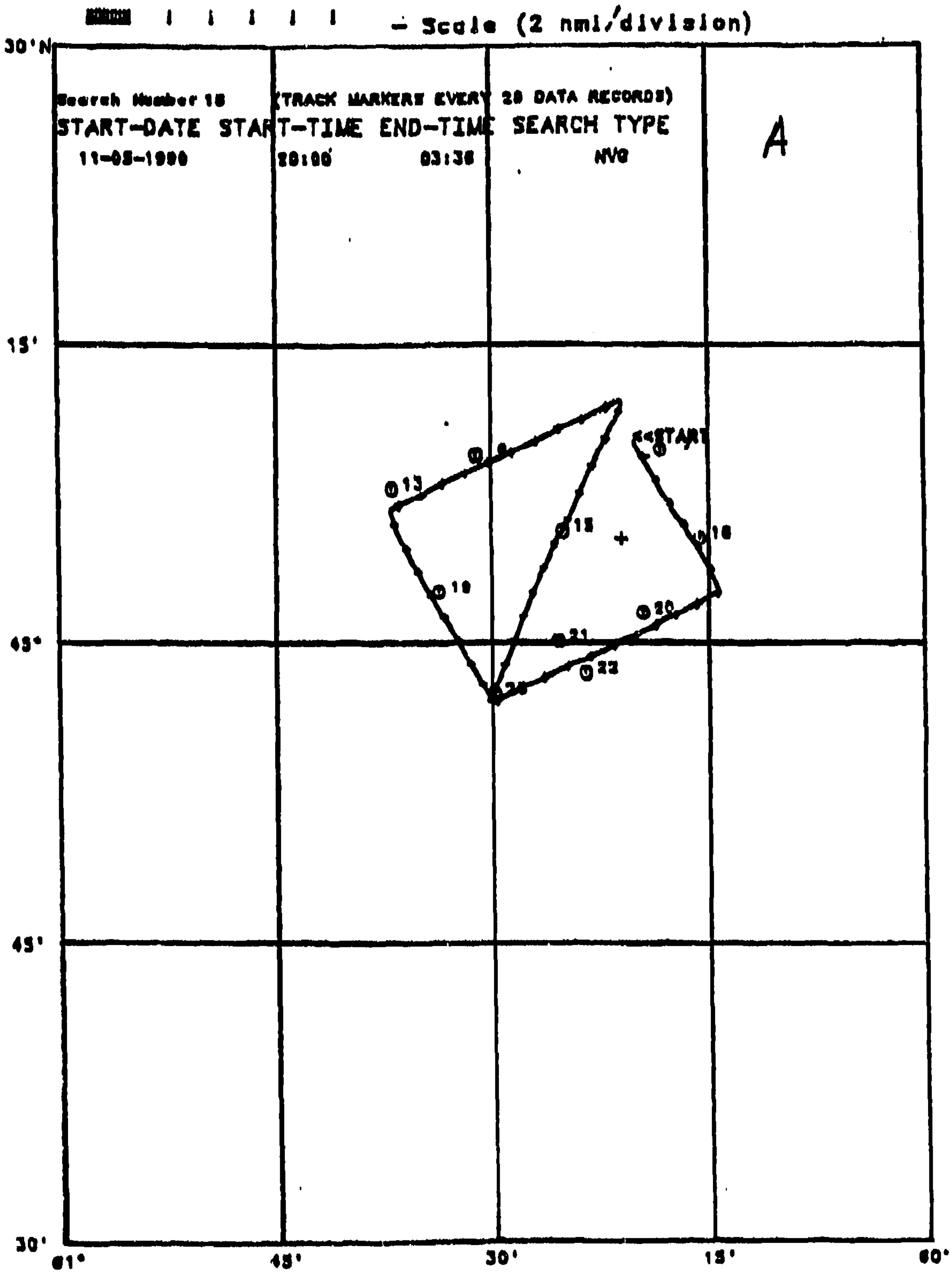


Figure 1-26. Example of a Search Pattern Performed by the USCGC VIGOROUS (Unlighted Life Raft Targets)

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

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

1.3.7 Range of Parameters Tested

A total of 25 potentially significant search parameters were recorded for each valid target detection opportunity. Only 22 search parameters were recorded for the Canso Bank experiment. The Canso Bank experiment did not include the water temperature and artificial light parameters. The parameters can be broadly classified as relating to the target, the SRU, the environment, ambient light, and human factors. The search parameters and their units of measure are as follows.

PARAMETER	UNIT OF MEASURE (See Appendix B for the description of the numbers in parentheses)	
Target-Related		
1. Target Type/Target Subtype	Life Rafts (2):	with retroreflective tape (-1) without retroreflective tape (0)
	Canso Bank	lighted (1) unlighted (0)
	Small Boats (1):	18-foot without canvas (0) 21-foot with canvas (1)
	PIW (3):	unlighted (0) strobe (9) red safety light (1) green PMLs (-1)
2. Lateral Range*	Nautical Miles	
SRU-Related		
3. NVG Type	41-foot UTB:	AN/PVS-5C (1) AN/PVS-7A (0)
	Helicopters and fixed-wing aircraft:	AN/AVS-6
4. Search Speed	Knots	
5. Search Altitude	Feet (aircraft only)	
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's CPA (if target missed) or at time of detection	
13. Relative Humidity	Percent	

*See section 1.4.1 for definition.

PARAMETER (Cont'd)	UNIT OF MEASURE (Cont'd)
14. Air Temperature	Degrees Celsius
15. Water Temperature**	Degrees Celsius
Ambient Light-Related	
16. Relative Azimuth of Artificial Light**	Light source located along (1)/away from (-1)/across (0)line-of-sight to target at SRU's CPA (if target missed) or at time of detection
17. Artificial Light Level**	rural (0)/suburban (1)/urban (2)
18. Moon Elevation	degrees above or below the horizon
19. Moon Visible (from SRU)	yes (1)/no (0)
20. Relative Azimuth of the Moon	moon (visible or not) located along (1)/away from (-1)/across (0) line-of-sight to target at SRU's CPA (if target missed) or at time of detection
21. Moon Phase	none, 1/4, 1/2, 3/4, full
Human Factors-Related	
22. Lookout Position†	location onboard SRU
23. Lookout ID†	individual identifier
24. Lookout NVG Experience†	hours
25. Time on Task	hours (actually searching)

**Items 15, 16 and 17 were not recorded as potentially-significant search parameters for the Canso Bank experiment.

†Items 22 through 24 were recorded for detections only.

A total of 95 individual aircraft lookouts, 132 UTB lookouts, and 43 VIGOROUS and ALERT lookouts are represented in the data set. NVG experience and time-on-task ranges are represented in table 1-4.

The range of environmental and moon parameters encountered over the seven experiments is summarized in table 1-5.

Table 1-4. Experience and Time-on-Task Ranges

SRU TYPE	EXPERIENCE RANGE (hours)	TIME-ON-TASK RANGE (hours)
HH-3/CH-3	0 to 106	0 to 5.6
HH-60J	0 to 758	0 to 3.9
HU-25C	0 to 80	0 to 4.0
RG-8A	0 to 105	0 to 4.3
UTBs	0 to 75	0 to 5.7
VIGOROUS	0 to 19	0 to 5.6
ALERT	0 to 9	0 to 1.1

Table 1-5. Range of Environmental and Moon Parameters Encountered (page 1 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
HH-3/CH-3 Boats	0 to 1	1.5 to 15	1 to 20	0 to 1.0	1.3 to 6.2	0 to 2	51 to 96	10.4 to 27	13.4 to 27.2	-68 to 63	none to full
HH-3/CH-3 PIWs	0	4 to15	5 to 22	0	1.3 to 3.6	0 to 2	74 to 86	11.6 to 24	13.3 to 23.9	-63 to 34	quarter to full
HH-3/CH-3 PIW's Strobe	0	3	15 to 17	1.0	2.3 to 2.6	1	82	11.5	13.6	30 to 46	half
HH-3/CH-3 PIW w/Red Safety Lights	0 to 3	15	5 to 15	.1 to .9	2 to 4.3	0 to 1	61 to 86	22.2 to 26	22 to24	-67 to 19	quarter to 3/4
HH-3/CH-3 PIW w/Personnel Marker Light	0	15	5 to 10	.2 to .4	5.2 to 6.2	0	63 to 69	21.1 to 21.5	20.8 to 22.2	47 to 57	full
HH-3/CH-3 Rafts w/retro-tape	0 to 2	5 to 15	2 to 14	0 to 1.0	1.3 to 6.6	0 to 1	50 to 95	15.7 to 27.0	18.4 to 27.2	-66 to 53	quarter to full
HH-3/CH-3 Rafts w/out retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.[illegible]	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	-69 to 69	none to full

Table 1-5. Range of Environmental and Moon Parameters Encountered (page 2 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
HH-60J Boats	0	8 to 15	1 to 14	0 to .9	1.6 to 3	0 to 1	66 to 98	23.6 to 26.2	24.2 to 24.6	5 to 49	3 quarter to full
HH-60J Rafts w/retro-tape	0	8 to 15	1 to 14	0 to .9	1.6 to 3	0 to 1	66 to 98	23.6 to 26.2	24.2 to 24.6	5 to 49	3 quarter to full
HU-25C Boats	0	10 to 15	3 to 10	0 to .3	1.6 to 3.0	0	69 to 84	25.5 to 26	25.2 to 26.5	-36 to 39	3 quarter to full
HU-25C Rafts w/retro-tape	0	10 to 15	3 to 10	0 to .3	1.6 to 3.0	0	69 to 84	25.5 to 26	25.2 to 26.5	-36 to 39	3 quarter to full
RG-8A Boats	0	15	5 to13	0 to 0.1	1.3 to 3.6	0	74 to 84	26.2 to 27	26.3 to 27	1 to 38	full
RG-8A Rafts w/retro-tape	0	15	5 to14	0 to 0.7	1.3 to 4.9	0 to 1	74 to 87	25.1 to 27	25.4 to 27	1 to 48	full
UTB/ Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	5.5 to 24.3	13.4 to 24.2	-60 to 51	none to full

Table 1-5. Range of Environmental and Moon Parameters Encountered (page 3 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
UTB PIWs	0	4 to 15	5 to 22	0	1.3 to 3.6	0 to 2	74 to 86	11.6 to 24	13.3 to 23.9	-63 to 34	quarter to full
UTB PIWs Strobe	0	3	17	1.0	2.3 to 2.6	1	82	11.5	13.6	43 to 46	half
UTB PIW w/Red Safety Lights	0	15	5 to 15	0.3 to 0.9	2 to 3.6	0 to 1	74 to 78	23.3 to 26	23.5 to 24	-64 to 6	quarter to 3/4
UTB Rafts w/retro-tape	0	.5 to 15	5 to 17	0 to 0.4	1.6 to 4.3	0 to 2	50 to 95	15.2 to 23.9	17.5 to 22.1	-63 to 38	quarter to full
UTB Rafts w/out retro-tape	0 to 2	1.5 to 15	2 to 24	0 to 1.0	1.3 to 4.6	0 to 2	51 to 100	6.1 to 24	13.5 to 23.6	-62 to 52	none to full
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	N/A	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	N/A	-61 to 35	quarter to 3/4

Table 1-5. Range of Environmental and Moon Parameters Encountered (page 4 of 4)

SRU/ TARGET	ENVIRONMENTAL PARAMETERS Cont'd									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover	Significant Wave Height (ft)	Whitecap Coverage (0,1,2)	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
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	N/A	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	N/A	-64 to 35	quarter to 3/4
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	N/A	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	N/A	-66 to 35	none to 3/4

1.4 ANALYSIS APPROACH

1.4.1 Measure of Search Performance

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

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

where

W = Sweep width

x = Lateral range (i.e., CPA) to targets of opportunity (see figure 1-27), and

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

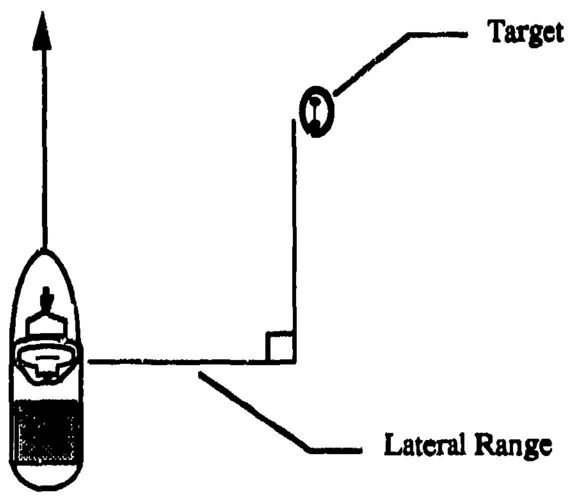


Figure 1-27. Definition of Lateral Range

Figure 1-28 shows a typical P(x) curve as a function of lateral range. In this figure, x is the lateral range of detection opportunities.

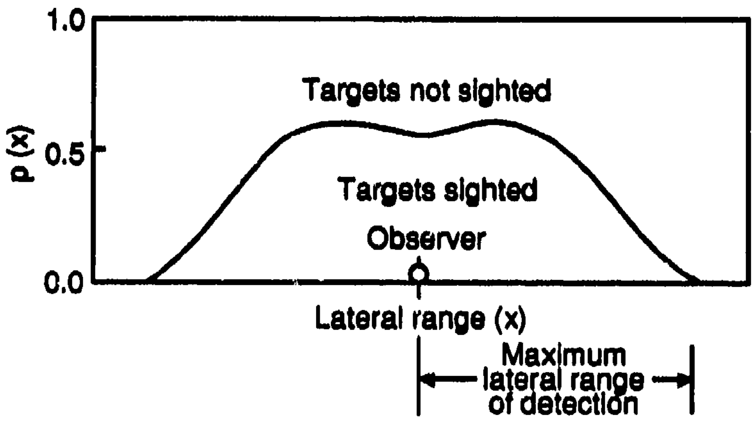


Figure 1-28. Relationship of Targets Detected to Targets Not Detected

Conceptually, sweep width is the numerical value obtained by choosing a value of lateral range that is less than the maximum detection distance such that scattered targets that might be detected beyond the chosen value of lateral range are equal in number to those that might be missed which are closer than the chosen value of lateral range. Figure 1-29 (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 16.

1.4.2 Analysis of Search Data

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

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

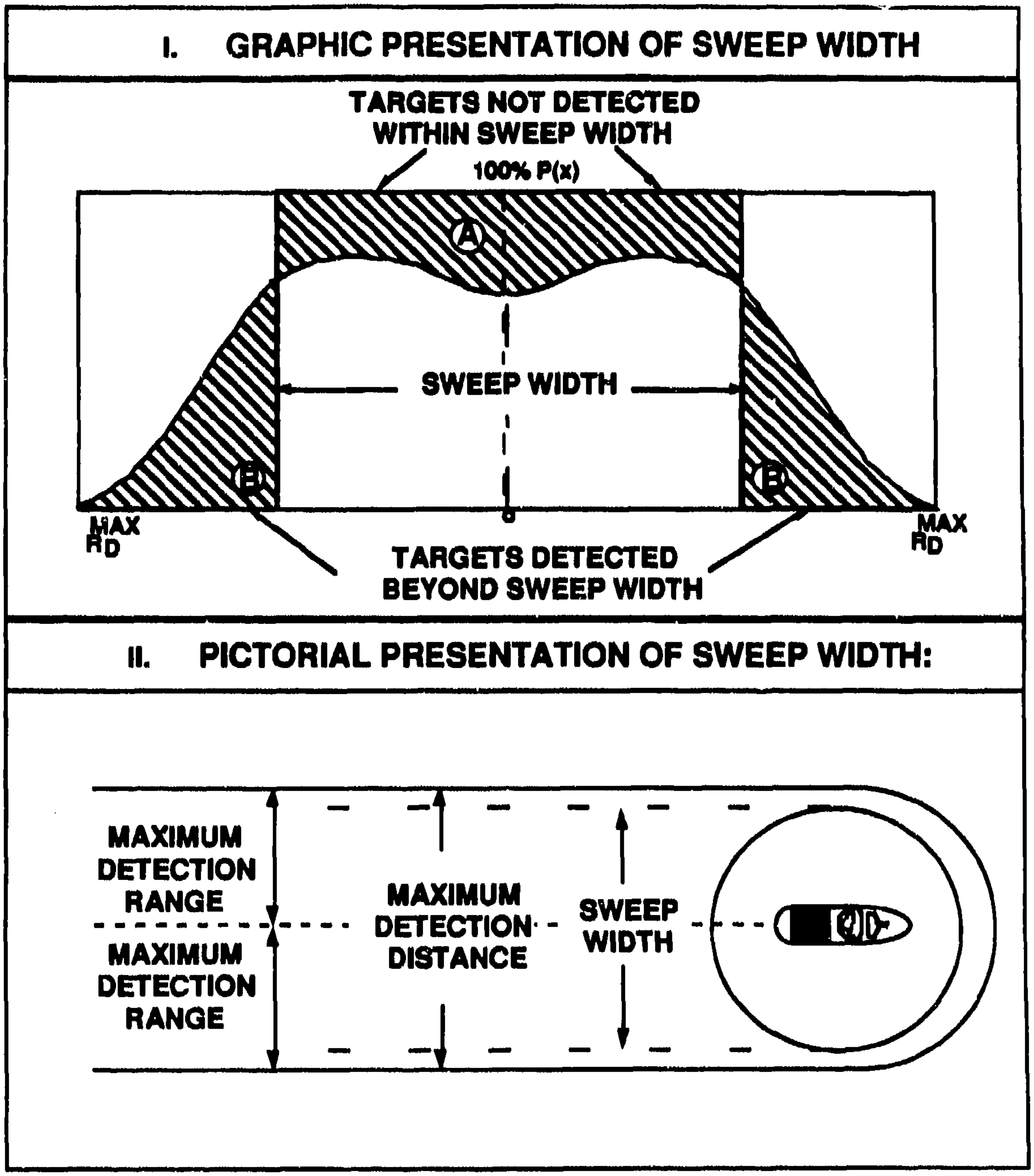


Figure 1-29. Graphic and Pictorial Presentation of Sweep Width

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

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

1.4.2.1 Development of Raw Data

After each experiment, the tracking system plots and NVG detection logs were used (as described in section 1.3.5) 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 25 search parameters listed in section 1.3.7 were obtained for each detection opportunity that was listed by consulting appropriate logs and environmental data buoy messages. A separate raw data sheet was completed for each search conducted by each SRU. The contents of these raw data sheets were entered into computer data files on an Apple Macintosh IIcx computer using spreadsheet software and then stored on magnetic disk. A separate data file was constructed for each SRU for each night it participated in data collection. Hard copies of the Spring 1991 data files are provided in appendix B of this report. Data from earlier experiments can be found in references 1, 2, 3 and 4. One data file for each SRU/target type combination to be evaluated was created. These raw data files served as input to all subsequent data sorting and statistical analysis routines used for this evaluation.

1.4.2.2 Data Sorting and Statistics

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

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

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

1.4.2.3 LOGIT Multivariate Regression Model

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

The LOGIT regression model is useful in quantifying the relationship between independent variables, x_i, and a probability of interest, R (in this case the probability of detecting a target). The independent variables can be continuous (e.g., range, wave height, wind speed) or discrete (e.g., moon visible or not (1 or 0)). The LOGIT module gives results that are equivalent to those given by the LOGODDS model that was used with great success during earlier visual search performance analyses (reference 15). The logistic regression model proved to be an effective means of identifying statistically significant search parameters and of quantifying their influence on the target detection probability versus lateral range relationship. This functional relationship, commonly referred to as the lateral range curve, provides a basis for computing sweep widths.

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

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

where

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

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

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

x_i = independent variable values.

The method of maximum log-likelihood is employed in the logistic regression model to optimize values of the coefficients a_i. A detailed theoretical development of the logistic regression analysis methodology is given in reference 17.

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 $0 \le R \le 1.0$; a linear model does not contain this assumption unless it is added, significantly increasing the computational load.

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

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

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

The primary disadvantages of a logistic regression model are:

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

2. The computational effort is substantial, requiring the use of relatively powerful computer resources. Until recently, a mini-mainframe computer (in the case of A&T LOGODDS, a VAX 11/780) was required to perform the necessary calculations efficiently.

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 18) 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 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 19 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 U.S. 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 a statistically significant influence on the target detection response. These fitting functions were then solved for representative sets of search conditions to generate lateral range curves. NVG sweep widths were computed from these lateral range curves.

1.4.2.4 Sweep Width Calculations

Sweep width, defined in section 1.4.1, is the measure of search performance used by U.S. Coast Guard search planners. Mathematically, the value of W is determined by computing the area under the lateral range curve. Before NVG sweep widths were computed for this report, the LOGIT analysis presented in section 1.4.2.3 was used with the data set for each SRU/target type combination. This analysis identified search parameters that exerted statistically significant influence on target detection probability. Histograms and scatter plots 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 reflected distinct sets of search conditions. Lateral range curves and sweep widths were then computed for each data subset.

The preceding analysis procedure, and the subsequent process of generating lateral range curves and computing sweep widths, is illustrated in the following example using the ALERT data set for lighted life raft searches.

STEP 1: Identification of Data Subsets. LOGIT analysis of this data set indicated that, in addition to lateral range, wind speed exerted statistically significant influence on target detection probability. The distribution data relative to wind speed were examined by generating a histogram depicting values of this variable versus frequency of occurrence. The histogram was then compared with a scatter plot of the distribution of wind speed relative to the lateral range of each target detection opportunity. The evaluation of these plots identified two subsets of data that were well represented in the data set. The first set of search conditions was represented by wind speeds of less than or equal to 20 knots, and the second set of search conditions was represented by wind speeds of greater than 20 knots.

STEP 2: Generation of Lateral Range Curves. Two lateral range curve equations were generated by inputting the mean values of wind speed for both data subsets to the LOGIT generated expression for target detection probability. The two distinct equations that resulted were then plotted for lateral range values between 0 and 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 both sets 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,
- x_1 = Lateral range, and

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

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

$$W = 2A.$$

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

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CHAPTER 2
TEST RESULTS

2.1 INTRODUCTION

A combined total of 4098 target detection opportunities were generated during the seven NVG experiments that were conducted for this evaluation. The data were separated into four data sets for analysis of NVG detection performance. The first data set consists of data that were collected during the Spring 1991 experiment and will be used to compare the performance of each RG-8A, HU-25C, and HH-60J type aircraft to the performance of the HH-3/CH-3 under similar environmental conditions. The target types for the first data set consist of life rafts with retroreflective tape and small boats.

The second data set consists of HH-3/CH-3 data. All of the HH-3/CH-3 data from experiments 1 through 7 were combined to create this data set. The target types consist of life rafts (with and without retroreflective tape), small boats, PIW, and PIW equipped with PML, red safety lights, or "Firefly" strobe lights.

The third data set consists of UTB data. The target types consist of life rafts (with and without retroreflective tape), small boats, and unlighted PIW.

The fourth data set consists of data that were collected during the Canso Bank experiment involving USCGC VIGOROUS and CCGS ALERT. The target types consist of lighted and unlighted life rafts.

Tables 2-1, 2-2, 2-3 and 2-4 summarize the distribution of the detection opportunities by SRU class and type and by target type.

The results of the analysis are presented in two sections. Section 2.2 provides a quantitative analysis of SRU detection performance against each target type. Section 2.3 provides an evaluation of the human factors that were studied during the NVG experiments.

2.2 DETECTION PERFORMANCE

Sections 2.2.1 through 2.2.4 present discussion and detailed analyses of the four data sets described in section 2.1. Lateral range curve plots and sweep width estimates are provided for statistically significant search parameter combinations that are well represented in the raw data. The search parameter combinations selected using LOGIT regression analysis are used to identify the variables that were significant at the 90 percent confidence level. Raw data plots are presented for data subsets that do not have sufficient data to support meaningful sweep width analysis. Appendix A contains all of the lateral range curve plots and the raw data plots.

The lateral range plots in the following sections show the target lateral range from the SRU trackline at CPA versus the probability of detection (P_{det}). Figure 2-1 is an example of a lateral range curve plot. When the data set was large enough to yield statistically significant variables, these variables (in addition to lateral range) were used to model the smoothed lateral range curve. The mean values of the variables (other than lateral range) were used as the x_i values in the LOGIT equation shown in section 1.4.2.3. Each data subset plotted represents a unique combination of significant search variable values.

Each data set showed lateral range as being the most significant variable affecting P_{det}. Lateral range values were binned to determine the probability of detection over a small lateral range window. The bin size depended on the maximum value of lateral range and the concentration of data, especially at the closer lateral range.

Each significant variable was evaluated to determine the separate effects on sweep width. Discrete variables (i.e., moonvis) were evaluated for each of their respective values. Continuous variables (i.e., visibility) were first binned into discrete subsets. For example:

bin 1 : $H_s \leq 2.3$ feet

bin 2 : $2.3 < H_s \leq 7.2$ feet

Each binned data set was then evaluated for the significant variables' effect on sweep width.

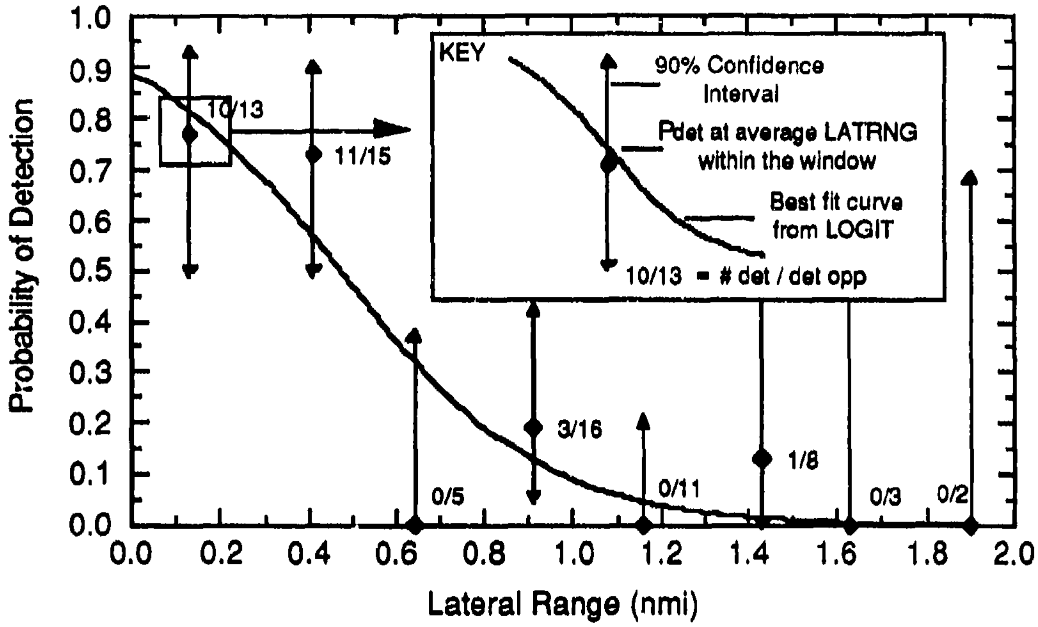


Figure 2-1. Example Lateral Range Curve/Plot, 0.25 LATRNG Window

2.2.1 Spring 1991 Detection Performance

This experiment provided a comparative study of the SRU detection performance of the HH-3/CH-3 to that of the RG-8A, the HU-25C, and the HH-60J for small boats and life rafts using retroreflective tape. Table 2-1 summarizes the target types and the number of detection opportunities for each SRU/target combination.

Table 2-1. Spring 1991 Detection Opportunity Summary

SRU	TARGET TYPE	NUMBER OF OPPORTUNITIES
RG-8A	Small Boats	40
	Life Rafts with Retroreflective Tape	87
HU-25C	Small Boats	116
	Life Rafts with Retroreflective Tape	166
HH-60J	Small Boats	73
	Life Rafts with Retroreflective Tape	90
HH-3/CH-3 SPRING 1991	Small Boats	186
	Life Rafts with Retroreflective Tape	282

To compare the detection performance of the HH-3/CH-3 to the detection performance of the other SRUs, six data sets were created. The HH-3/CH-3 life raft and small boat data were appended to the corresponding RG-8A, HU-25C, and HH-60J life raft and small boat data. Within the six data sets, the individual SRU data were identified by a variable (SRUTYPE) that had the following values:

$$\text{SRUTYPE} = \begin{cases} 0 \text{ if SRU} = \text{HH-3/CH-3} \\ 1 \text{ if SRU} = \text{RG-8A, HU-25C, or HH-60J} \end{cases}$$

The LOGIT regression analysis was then performed on each data set using SRUTYPE as the only variable in the model. The t-statistic from the LOGIT regression analysis (section 1.4.2) was used to determine, within a 90 percent confidence interval, whether the SRUTYPE was a significant parameter in the LOGIT regression model. From the sign (positive or negative) of the t-statistic and from a qualitative analysis of the data plots, it was determined whether the HH-3/CH-3 achieved higher, lower, or equivalent detection probabilities when compared to each of the other SRU types.

The raw data for each SRU-target combination are shown in figures A-1 through A-12. The data are presented for comparison purposes only, and neither LOGIT curves nor sweep widths were generated for this analysis.

The results of the LOGIT regression analysis show that the relative detection performances for each SRU type, when compared to the HH-3/CH-3, are as follows:

(1) RG-8A - Performed worse than HH-3 for both small boat and life raft targets.
(99+ percent confidence level)

(2) HU-25C- Performed worse than CH-3 for both small boat and life raft targets.
(99+ percent confidence level)

(3) HH-60J - Performed equivalently to the CH-3 for both small boat and life raft targets. (90 percent confidence level)

2.2.2 Data Set Two - HH-3/CH-3 Detection Performance

LOGIT regression analysis for the HH-3/CH-3 data set identified significant variables for each target type. Each significant variable was further evaluated to identify a threshold that allowed the data to be sorted into two discrete bins. In the case of two or more significant variables, in addition to lateral range, the data set was either broken into two subsets, corresponding to each variable, or the variables were combined to form one composite variable. For example, moon visibility and moon relative azimuth values were combined to form one moon bin with three discrete values.

For all HH-3/CH-3 searches, the presence of a natural or artificial light source within the FOV significantly degraded the detection capabilities of the NVGs. The probability of detection decreased for small boats, life rafts (with and without retroreflective tape), and PIWs (all) when the SRU was searching toward a visible moon or shore lights. In some cases, the relative azimuth of the moon or of the shore lights was identified as a significant variable in the LOGIT regression analysis; however, because search plans cannot always be based on searching away from a light source, moon and artificial light relative azimuth was not used as a variable in the model.

2.2.2.1 Small Boats

The LOGIT-generated best-fit P_{det} curves for HH-3/CH-3 searches for small boats are shown in figures A-13 through A-15, corresponding to the categories shown in table 2-2. LOGIT regression analysis identified lateral range, visibility, and moon visibility as the significant variables that best fit the data. Sweep widths for low visibility data (0.8 nmi) and the no moon data (0.7 nmi) are comparable, and both are nearly half the sweep width for moonlight searches (1.3 nmi). The low visibility data set was small; therefore, it could not be further sorted to analyze the effects of moon visibility on the probability of detection.

2.2.2.2 Life Rafts With Retroreflective Tape

The LOGIT-generated best-fit P_{det} curves for HH-3/CH-3 searches for life raft targets with retroreflective tape are shown in figures A-16 and A-17. Though visibility was identified by LOGIT as significant, the low visibility data were scarce, and the high visibility data had a very narrow range of values. For these reasons, visibility was not used to further sort this data set.

Table 2-2. HH-3/CH-3 Detection Opportunity Summary

SRU	TARGET TYPE	NIGHT CONDITIONS	SWEEP WIDTH (W) (nmi)	NUMBER OF OPPORTUNITIES
HH-3/ CH-3	Small Boats (18 to 21 feet)	visibility ≤ 8 nmi	0.8	49
		visibility > 8 nmi		
		no moon	0.7	257
		moon	1.3	452
	Life Rafts with Retroreflective Tape	no moon	0.7	165
		moon	0.9	215
	Life Rafts without Retroreflective Tape	no moon	0.36	225
		moon		
		$H_s \leq 2.5$ feet	1.0	73
		H_s 2.5 - 5.2 feet	0.6	96
	PIW	visibility ≥ 10 nmi	0.4	222
		visibility < 10 nmi	N/A	20
	PIW-Green PML	all conditions	N/A	90
	PIW-Red Safety Light	no moon	1.3	187
		moon	0.3	45
	PIW-"Firefly" Strobe	3 nmi visibility	3.5	152

The presence of moonlight increased the sweep width approximately 30 percent from 0.7 nmi during searches with no moon visible to 0.9 nmi during searches with the moon visible.

2.2.2.3 Life Rafts Without Retroreflective Tape

The LOGIT-generated best-fit P_{det} curves for HH-3/CH-3 searches for life rafts without retroreflective tape are shown in figures A-18 through A-20. The curves correspond to three categories identified in table 2-2. The original data set for this SRU/target combination identified moon visibility and wave height as the two significant variables that best fit the whole data set. The data set was separated into two separate data subsets· one for "moon visible" and one for "moon not visible." LOGIT regression analyses for the moon-not-visible data subset found lateral range to be the one significant variable, while lateral range and wave height remained significant for the moon-visible data subset. Sweep widths were lowest for no-moon data (0.36 nmi). For the moon-visible data, increasing wave height decreased the sweep width approximately 40 percent from 1.0 nmi for $H_s \leq 2.5$ to 0.6 nmi for $H_s > 2.5$. This is likely due to the light scattering effects of larger waves and their associated environmental conditions (whitecaps, rough surface) on the reflected moonlight. This assertion is supported by the low sweep width for the moon-not-visible data and the fact that wave height did not significantly affect the probability of detection.

2.2.2.4 Persons in the Water

The LOGIT-generated best-fit P_{det} curves for HH-3/CH-3 searches for PIW targets are shown in figure A-21. LOGIT regression analysis identified lateral range and visibility to be the significant variables that best fit the data. The data were sorted into the two visibility levels, less than 10 nmi and greater than or equal to 10 nmi.

The data sort resulted in a subset of 20 detection opportunities for the < 10 nmi visibility group and a second subset of 222 detection opportunities for the ≥ 10 nmi visibility group. The smaller of the two data subsets was not large enough to produce a credible sweep width estimate, and because only one detection exists, a raw data plot is not provided. The larger subset was sorted into seven, 0.1-nmi lateral range bins from 0.0 nmi through 0.6 nmi. A pronounced dip in target detection probability data at 0.0-nmi lateral range was likely due to these targets passing directly under the aircraft, out of the aft crew members' FOV, leaving only the pilots with a detection opportunity.

2.2.2.5 Persons in the Water With Red Safety Light

The LOGIT-generated best-fit P_{det} curves for HH-3/CH-3 searches for PIW targets with a red safety light are shown in figures A-22 and A-23. There were no tests run for these PIW targets using the HH-60J SRU.

LOGIT regression analysis indicated that lateral range, moon visibility, and the position of artificial light sources (shore lights) were the significant variables that best fit the data. The data were further sorted into the following subsets:

moonlight data	-	45 detection opportunities
no moonlight data	-	187 opportunities

The lateral range curves show a considerable decrease in overall probability of detection for moon-visible data compared to the no-moon visible probability of detection curves. Moon-visible sweep width (0.3 nmi), was also significantly less than no-moon sweep width (1.3 nmi). The actual effect of the moonlight on detection could be separated from sea surface conditions because of the small range of wave heights (H_s=3.6 to 4.3) in the moonlight data set. It is possible that with a wide range of values, H_s and whitecaps could be included as significant variables in moonlight data.

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

2.2.2.6 Persons in the Water With Green Personnel Marker Light

The raw data, sorted into 0.25 nmi lateral range bins, are plotted in figure A-24. A lateral range curve could not be accurately fit to the data.

Of the 90 detection opportunities generated during the HH-3/CH-3 searches, only four detections were made. The detections involving the sighting of the green PML were not made through the NVGs. One detection was made with the naked eye by the pilot. The remaining detections were made with the ANVIS NVGs by sighting the retroreflective tape or the PIW head. All four detections were made at a lateral range of less than 0.25 nmi.

2.2.2.7 Persons in the Water With "Firefly" Strobe Light

The LOGIT-generated best-fit P_{det} curve for HH-3/CH-3 searching for strobe light-equipped PIW targets is shown in figure A-25.

The LOGIT regression model was used to analyze the influence of lateral range and time on task parameters within the helicopter/strobe data set. The influence of other search variables could not be evaluated because all of the data were collected on a single night with a negligible variation in search conditions. The LOGIT regression analysis indicated that only lateral range was required to explain variations in target detection probability at the 90-percent confidence level. A sweep width of 3.5 nmi was obtained for this data set collected when the visibility was 3 nmi; however, given the relatively poor search conditions on that night, it is reasonable to expect much greater sweep widths for clear weather searches.

2.2.3 Utility Boat Detection Performance

Data for UTB detection capability searches were collected over the first five experiments. When applicable for the target type, the data were combined and analyzed for significant variables and the resulting sweep width. The analyses for each target type listed in table 2-3 are addressed in sections 2.2.3.1 through 2.2.3.6. Sweep width values determined for UTBs show many anomalous features and inconsistencies and should be applied with great care.

2.2.3.1 Small Boat

The LOGIT-generated best-fit curves for UTB searches for small boats are shown in figures A-26 and A-27. LOGIT regression analysis showed, at the 90-percent confidence level, that lateral range and moon visibility were the significant variables that best modelled the data. The sweep width increased from 0.20 nmi (with no moon visible) to 0.35 nmi (with the presence of moonlight), a 75-percent increase. Though moon visibility does increase the sweep width, lateral range was a much stronger variable in the probability of detection. Probability of detection very rapidly degraded with increasing lateral range.

Table 2-3. Utility Boat Detection Opportunity Summary

SRU	TARGET TYPE	NIGHT CONDITIONS	SWEEP * WIDTH (W) (nmi)	NUMBER OF OPPORTUNITIES
UTB	Small Boats	no moon	0.2	108
		moon	0.4	86
	Life Rafts with Retroreflective Tape	none	0.2	135
	Life Rafts without Retroreflective Tape	no moon	0.2	185
		moon	0.6	33
	PIW	all conditions	0.06	227
	PIW-Red Safety Light	all conditions	N/A	25
	PIW- "Firefly" Strobe	all conditions	N/A	12

* Routine searches by NVG equipped UTBs are not recommended.

2.2.3.2 Life Rafts With Retroreflective Tape

The LOGIT-generated best-fit P_{det} curve for UTB searches for life rafts with retroreflective tape is shown in figure A-28. LOGIT regression analysis identified lateral range as the only significant variable that best modelled the data. A sweep width estimate of 0.17 nmi was obtained. According to observations made during the experiments, the low sweep width for life rafts with retroreflective tape may be due to somewhat harsh environmental conditions that affected the crew's ability to concentrate on the search.

2.2.3.3 Life Rafts Without Retroreflective Tape

The LOGIT-generated best-fit P_{det} curves for UTB searches for life rafts without retroreflective tape are shown in figures A-29 and A-30. LOGIT regression analysis identified lateral range and moon visibility as the significant variables that best modelled the data. The no-moon sweep width, 0.17 nmi was the same for this target type as for life rafts with retroreflective tape under all moon conditions. As expected, sweep width increased, under moonlight conditions, to 0.55 nmi for UTB searches for life rafts without retroreflective tape.

However, the data set is small (33 different opportunities) with only 12 detections, and the sweep width may be biased high.

2.2.3.4 Persons in the Water

The LOGIT-generated best-fit P_{det} curve for UTB searches for PIW targets is shown in figure A-31. LOGIT regression analysis identified lateral range as the only significant variable that adequately describes the data. Although this data subset was large enough to calculate a sweep width, the exceptionally small sweep width (.06 nmi (120 yards)) and the small probability of detection at all lateral ranges of less than 0.35 make UTB searches for PIW not operationally practical.

2.2.3.5 Persons in the Water With Red Safety Light

The plot of raw data for PIW with red safety lights is shown in figure A-32. LOGIT regression analysis and a sweep width estimate were not computed on the data because of the small size of the data set. Based on observations of other UTB results and given the current data, it is likely that any sweep width calculation for this SRU/target type combination would be near that of unlighted PIW targets.

2.2.3.6 Persons in the Water With "Firefly" Strobe Light

The plot of raw data for PIW with strobe lights is shown in figure A-33. Poor visibility and moderate seas caused the UTB search to terminate early and, only 12 detection opportunities were generated. The 12 detection opportunities occurred at lateral ranges from 0.2 to 0.6 nmi and the two detections made were at 0.2 nmi.

2.2.4 Canso Bank

The Canso Bank experiment, conducted off the coast of Nova Scotia, used two SRUs, the USCGC VIGOROUS, and the CCGS ALERT. The target types tested were lighted and unlighted life rafts. The LOGIT regression analysis for the data collected from these SRUs is discussed in the following sections (see reference 4 for detailed discussions).

2.2.4.1 Lighted Life Rafts

The LOGIT-generated best-fit P_{det} curves for lighted life raft searches are shown in figures A-34 through A-37, which correspond to the categories listed in table 2-4. For this data subset, LOGIT regression analysis identified lateral range, SRU type, and wind speed to be the significant variables that best modelled the data. The identification of wind speed as a significant variable is due in part to the correlation in the data set of wind speed, visibility, and the existence/nonexistence of whitecaps (in the Canso Bank area high winds, low visibility, and many whitecaps exist predominantly together). Onboard the ALERT, all NVG searches were conducted from inside the pilot house, where window reflections decreased the sensitivity of the NVGs. In less severe weather, bridge wing windows were opened, decreasing the effect of interior reflections; however, some reflections were still present. Except in severe weather, the VIGOROUS lookouts were stationed on the exposed bridge wings.

For both ALERT and VIGOROUS, higher wind speeds resulted in a lower probability of detection for a given lateral range. Though this result was expected, it is not clear from the data whether the degradation in detection performance was due to the wind alone (possibly on personnel performance) or to the environmental factors that accompanied the higher winds. Sweep width estimates for the ALERT were 6.7 nmi for winds under 20 knots and 5.2 nmi for winds from 20-35 knots. The sweep width estimates for VIGOROUS under similar conditions were 11.1 nmi and 9.6 nmi respectively.

2.2.4.2 Unlighted Life Rafts

The LOGIT-generated best-fit P_{det} curves for unlighted life raft searches are shown in figures A-38 and A-39, which correspond to the two categories listed in table 2-4. For this data set, LOGIT regression analysis identified lateral range and significant wave height as the significant variables that best modelled the data. Unlike the lighted life raft results, this data subset shows no significant difference between the two SRU types.

The higher significant wave height data set displayed a 50-percent reduction in sweep width, from 1.3 nmi for wave heights $\leq$ 5 feet to 0.6 nmi for wave heights 5 to 7.2 feet. The sweep width values for the unlighted life raft results were significantly lower than the lighted life raft results.

Table 2-4. WMEC Detection Opportunity Summary

SRU	TARGET TYPE	NIGHT CONDITIONS	SWEEP WIDTH (W) (nmi)	NUMBER OF OPPORTUNITIES
WMEC (Canso Bank)	Lighted Life Rafts	ALERT		
		wind < 20 knots	6.7	72
		wind 20 - 35 knots	5.2	53
		VIGOROUS		
		wind < 20 knots	11.1	158
		wind 20 - 32 knots	9.6	55
	Unlighted Life Rafts	ALERT and VIGOROUS		
		$H_s \leq 5$ feet	1.3	89
		H_s 5 - 7.2 feet	0.6	40

2.3 HUMAN FACTORS

Sections 2.3.1 through 2.3.3 provide information that relates to the human factor aspects of conducting NVG-assisted searches in the marine environment. Section 2.3.1 provides quantitative data that detail 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 2-2 depicts a breakdown of target detections by crew position and reported clock bearing for each SRU/data group. The circular diagrams on the left side of figure 2-2 show the distribution of initial target detections as a function of relative bearing (expressed in "clock" format). The silhouette diagrams on the right side of figure 2-2 show the distribution of initial target detections as a function of the crew positions. The number and location of lookouts varied with each aircraft.

The HH-3/CH-3 helicopters operated with five crew positions during all of the experiments except the Spring 1991 experiment, which excluded the swimmer position. The HU-25C operated with two lookouts, one stationed on either side of the aircraft, and an operator using the FLIR in the aft section of the aircraft. The RG-8A operated with the pilot wearing NVG and the crewmember operating the FLIR. All participating aircraft displayed the same characteristic of detecting targets primarily on or forward of the beam. On the UTBs, unlike the helicopters, the crew positions depicted on the UTB silhouette diagrams were not always manned. The UTBs typically searched with two NVG-equipped lookouts who positioned themselves on the port and starboard bow when seas were calm and the weather was warm. When spray and/or cold wind was prevalent, the lookouts took shelter behind the wheelhouse at the port and starboard aft positions. The bow and aft center positions were seldom manned unless three or more NVG-equipped lookouts were available or when only a single lookout was searching with NVG. All helm detections were made with the naked eye. The 200-foot size range vessels operated with lookouts on either side of the vessel stationed on the bridge wing and, in the case of VIGOROUS, the flying bridge.

The information in figure 2-2 shows that the copilot position (left seat) made more detections than the pilot position (right seat) for all HH-3/CH-3 data sets. This occurred even when the two switched seats between sorties or on alternate nights. The difference in the number of detections made by the two positions is consistent across all target types. The difference also suggests a degradation in search capability that results from constant scan-shifting by the pilot between NVGs outside the cockpit and unaided vision inside the cockpit. This difference in detection performance might have been more pronounced except that during many searches, the aircraft was flown from the copilot seat for significant periods of time.

In the aft section of the helicopter, the flight mechanic usually searched through an open door with a wide FOV and no glass to reflect light and therefore made more detections overall than either the rescue swimmer position or the avionics position. The rescue swimmer position, which was not equipped with a seat on two of the four test helicopters, made substantially fewer initial detections than any other crew position. The swimmer confirmed many detections but was first to make a detection in only 68 cases (listed in figure 2-2).

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

Onboard the HH-60J, over twice as many detections were made from the pilot's position as were made from the co-pilot's position. This may be due to the co-pilot having spent more time operating the navigation computer than did the pilot. The HH-60J target detections occurred primarily on or forward of the beam.

Onboard the HU-25C, nearly all of the detections were made at the 3- and 9-o'clock bearings. This detection pattern occurred because both NVG observers were searching through the side-facing observer windows. The FLIR operator encountered equipment problems and was the first to see only a few targets as they passed beneath the aircraft.

The results of the RG-8A searches show the disadvantage of using only one searcher. There were no target detections on the left side of the aircraft, and the total number of detections for this SRU was approximately 1/5 the total achieved by the HH-3F during the same time period. The RG-8A FLIR was inoperative during this test.

The clock-bearing data in figure 2-2 indicate that most of the UTB detections were made between 9 and 10 o'clock on the port side and between 2 and 3 o'clock on the starboard side. A comparison of the composite clock bearing and silhouette data indicates that the starboard aft lookouts made more detections than the port aft lookouts. This may be because the cabin door is directly adjacent to the port aft lookout position. The open door may have allowed more light to interfere with NVG operation, and there were also distractions for the port aft lookout from inside the wheelhouse.

The clock-bearing data in figure 2-2 indicate that almost all of the detections onboard VIGOROUS and ALERT were made forward of the beam. Figure 2-2 shows that 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 also remained inside the visual horizon longer than targets on the beam.

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

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

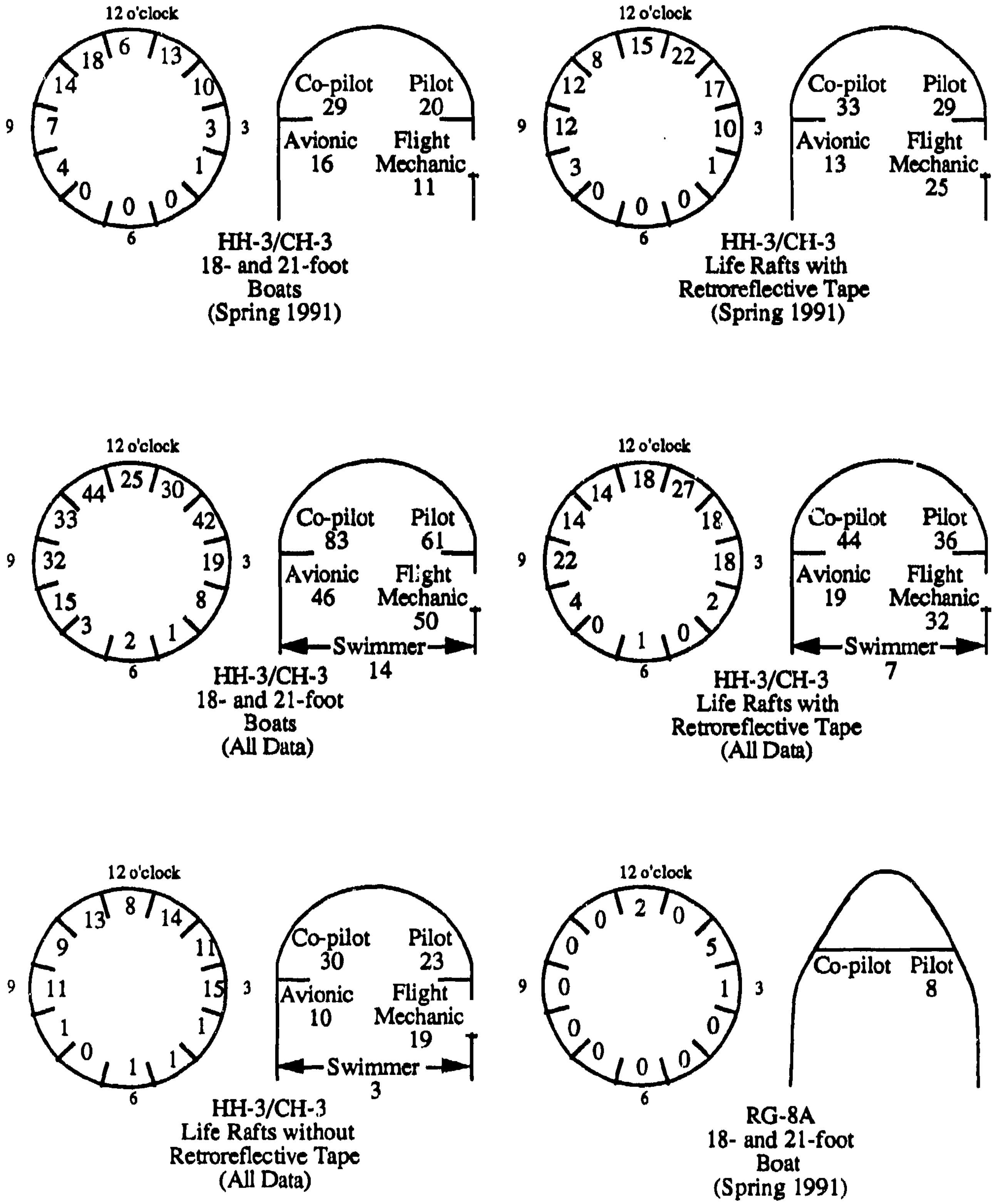
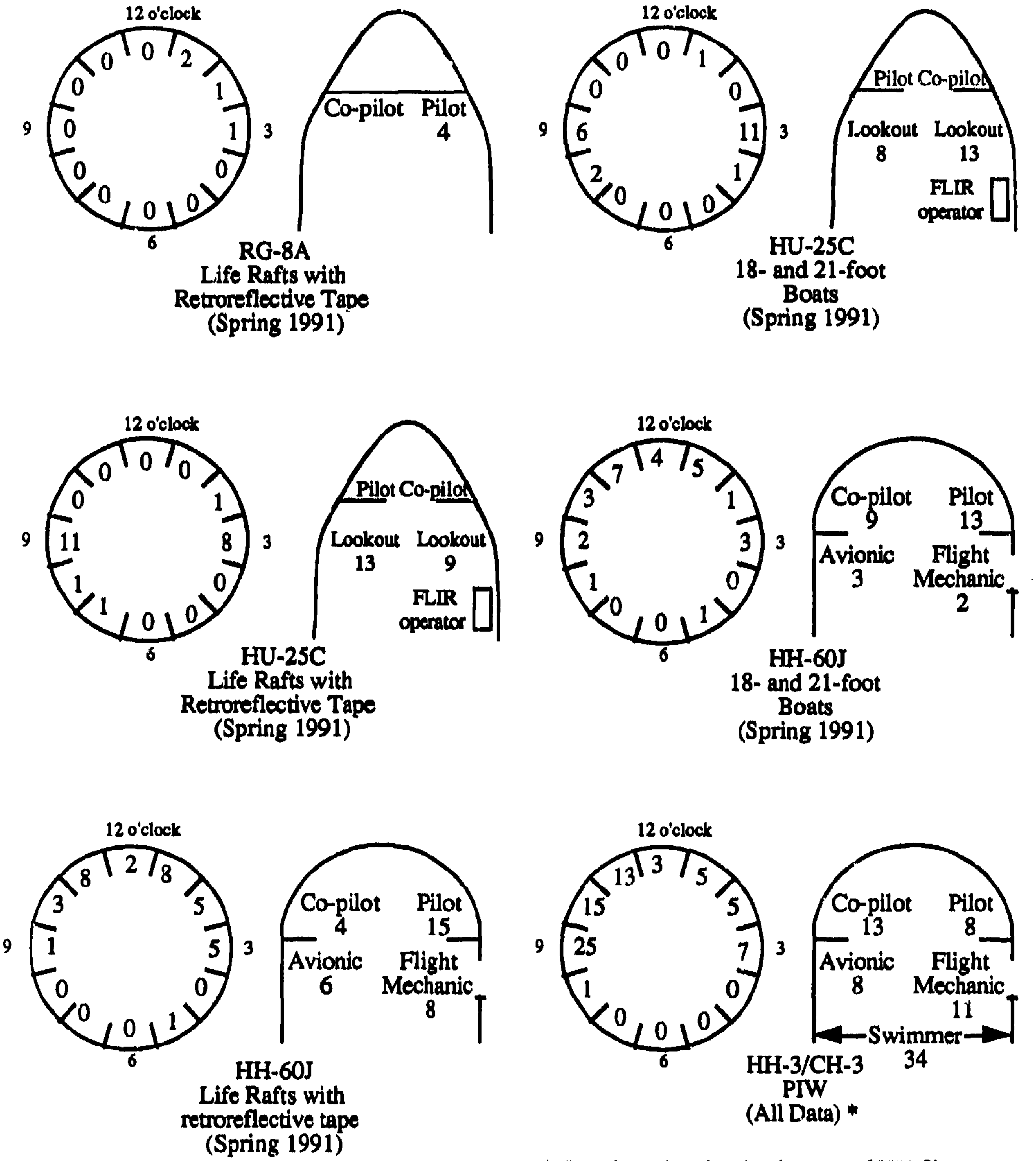


Figure 2-2. Total SRU Detections by Clock Bearing and Crew Position



* One detection for the data set of HH-3's searching for PIWs, in a second subgroup with low visibility, is not shown in appendix A

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

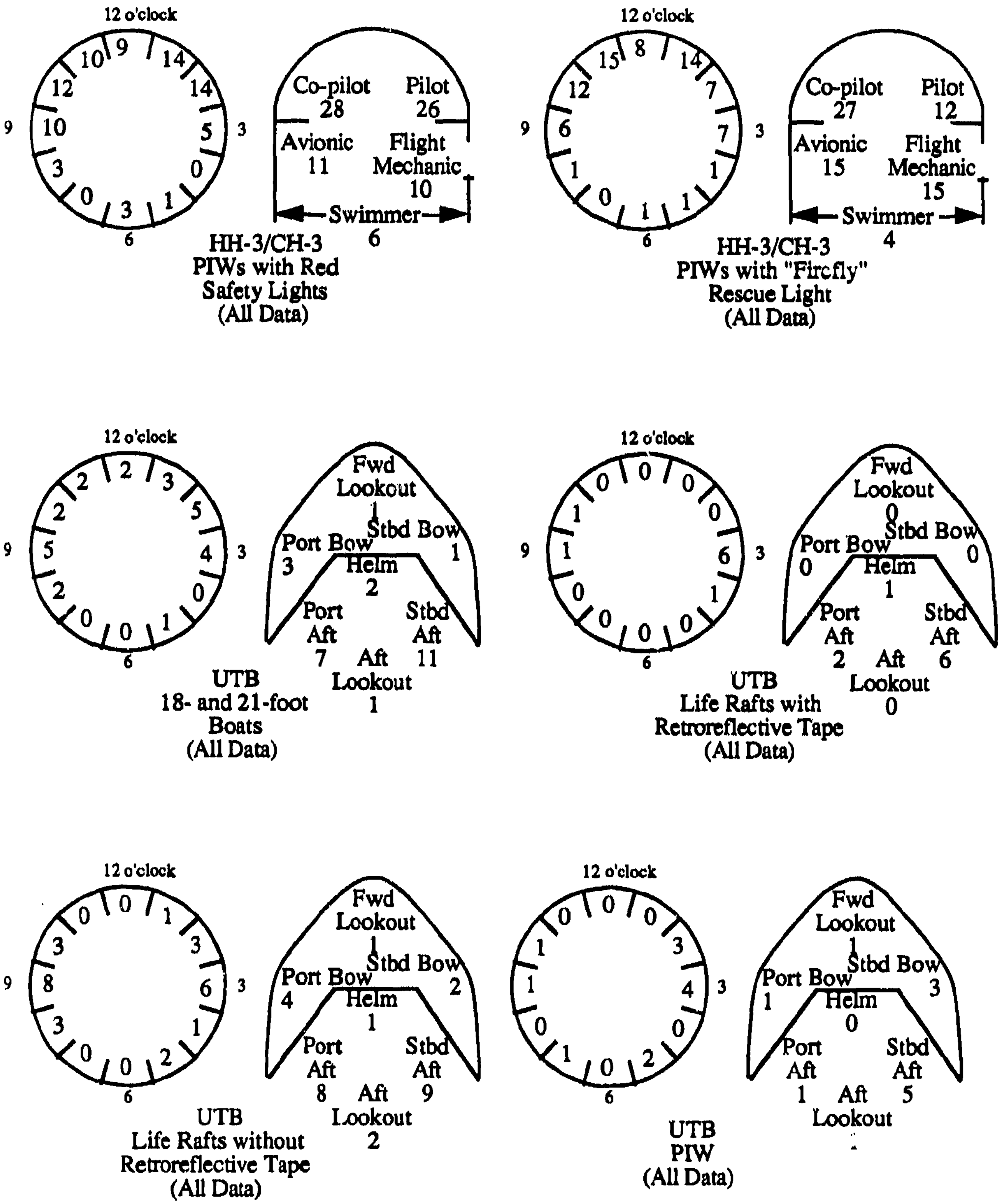


Figure 2-2. Total SRU Detections by Clock Bearing and Crew Position (Cont'd)

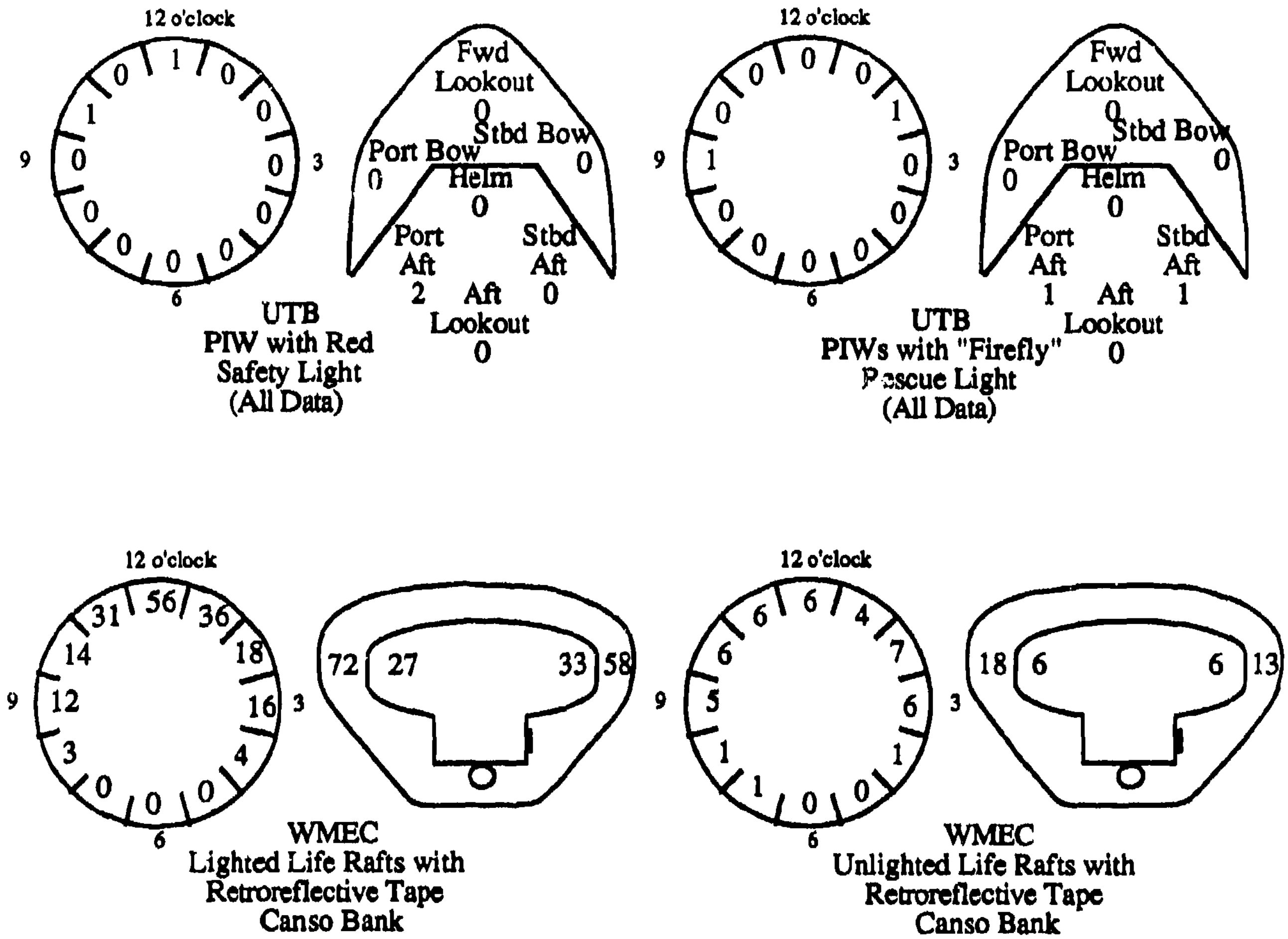


Figure 2-2. Total SRU Detections by Clock Bearing and Crew Position (Cont'd)

2.3.2 SRU Crew Comments Concerning NVG Use and Target Appearance

Subjective comments from the SRU crews concerning the comfort, ease-of-use, and effectiveness of the NVGs and their suitability for Coast Guard SAR operations were solicited each night by the data recorders. References 5, and 10 through 13 contain verbatim lists of the comments received during the seven NVG experiments. A summary of these comments is provided below.

2.3.2.1 Crew Comments Concerning NVG Use

Aircraft Crews

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

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

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

4. In periods of low ambient light, it was difficult to see outside the helicopter. The NVG display was black or grainy, and the instrument panel created too much glare on the windows. Also, outside the aircraft, the rotating beacon became more visible. This was more of a problem in fog or haze than on clear nights. On a clear night, the rotating beacon or search light can help illuminate targets.

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

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

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

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

9. Rough seas make it difficult to distinguish targets from waves/white caps.

UTB Crews

1. Goggles were easier to focus in good light conditions, the visual presentation was better, and it was easier to maintain concentration. In lower light levels, lookouts found that concentrating on whitecaps helped keep them from simply staring at the display lens.

2. On bright, moonlit nights it seemed that there was too much light for the NVGs.

3. Searching during a lightning storm is very difficult because the lightning blinds the NVG wearer more than a naked eye searcher.

4. Coxswains and helmsmen preferred not using NVGs because they felt it interfered with their job of navigating the boat. Some coxswains felt that keeping a pair of NVGs on hand to check lookout reports was a good idea, while others felt that the NVGs didn't provide any more information than rada .

5. There were many variations of "my eyes are tired." Typically, lookouts reported tired/sore/watery eyes after 1 hour, and after about 2 hours, they reported headaches and disorientation. Short breaks and lookout rotation appeared to help alleviate some of these problems.

6. Some lookouts, even those not normally prone to it, became seasick very easily while using NVGs. This occurred more often as seas became rougher, and UTBs occasionally returned to port because of crew seasickness.

7. There were many complaints that the AN/PVS-5C and AN/PVS-7A head gear was very uncomfortable and that the NVGs pressed on the face, but later in the searches there were fewer complaints of this nature. Some crews chose not to wear the headset and held the NVGs as they would binoculars. When the crews took their time and adjusted the headset straps to relieve some of the facial pressure, they grew tired more slowly and there were fewer complaints of headaches.

8. Looking at brighter shore lights reduced the effectiveness of the NVGs. Often, these lights would obscure up to half the distance from the horizon.

9. When sea conditions and sea spray forced lookouts behind the pilot house, the intensity of the running lights or stern light and their glare obscured, or partially obscured, the view through the NVGs. This left a fairly narrow sector abeam for effective searching. One crew secured the running lights and eliminated this problem.

10. Lighted objects could be easily seen on clear nights, even when not visible to the naked eye.

11. Crews that were given the opportunity to view a target with the NVG before commencing searches felt that it helped them by familiarizing them with the target appearance.

12. Plenty of lens cleaning paper was needed when spray or precipitation was present. Frequent breaks should be taken to rest eyes and clean lenses.

13. Some coxswains felt that what was really needed was a better radar.

ALERT crew

1. Glare enters through the open sides of the AN/PVS-7A NVGs 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. When the relative wind was blowing from the stern toward the bow of the ship, the engine exhaust obscured the view from the flying bridge.

3. When lookouts searched while standing against the rail just aft of the bridge wing alidade, the ship's running lights created a glare that 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. Table 2-5 lists these target descriptions by SRU and target type. The descriptions appear in the table in descending order of frequency for each SRU/target type combination.

Table 2-5. Summary of Target Appearance Descriptions

TARGET TYPE	SEARCH UNIT TYPE	
	AIRCRAFT	UTB
Small Boats	Bright/white/light Boat/Skiff Open white boat Black/dark/dark w/canvas Boat w/canvas White w/dark bottom Round/oblong/square	Boat/skiff Bright/white/light Boat w/console Boat w/canvas Black/dark Could not tell/something Greenish Flashing/blinking
Life Rafts without Retroreflective Tape	Raft Bright/white/light Light w/dark bottom Black/dark w/white top Black w/white reflection off anti-collision light	Raft Black Light w/dark bottom Bright/white/light blob Round-grey black
Life Rafts with Retroreflective Tape	White/light Raft with tape Flashing with aircraft beacon Flashing triangle Glowing object White/round donut	Raft with tape, bright top Ball of light/white Dark object Top of a raft
PIWs	Flash/glow Bright/white/light Reflective tape Bucket Person/head Not bright	Person/head Bucket
PIWs with Strobe	None Sometimes confused with flashing aids to navigation	Limited data
PIWs with Personnel Marker Light (green cyalume)	Retroreflective tape, no chem light Target, saw chem light under goggles first Two reflective balls	None
PIWs with Red Safety Light	Dim steady glowing light Light in the water Bobbing A little light A chem light Blinking light Very bright light	Dim light

Table 2-5. Summary of Target Appearance Descriptions (Cont'd)

TARGET TYPE	SEARCH UNIT TYPE	
	USCGC VIGOROUS	CCGC ALERT
Lighted Life Rafts with Retroreflective Tape	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
Unlighted Life Rafts with Retroreflective Tape	Raft Something white Like a whitecap that stays Speck in water Unlighted raft looked like a oblong object	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 the comments received from the SRU crews, but were made from a third-party viewpoint while not directly involved in the NVG search task. All of the data recorders were familiar with NVG characteristics and principles of operation. The data recorders also had at least 1 or 2 hours of experience using the NVGs while underway onboard an SRU or a workboat. Data recorder comments are summarized below.

Aircraft Observations

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

2. NVG training seems to vary between air stations. Some crews spent time adjusting and focusing the NVGs prior to take off, while others would focus after takeoff. Most of the crews maintained good scanning techniques until late in the sortie.

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

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

UTB Observations

1. Weather and sea conditions greatly affected searcher attitudes onboard the UTBs. Moderate sea swell or wind chop and/or poor ambient light frequently brought on seasickness and lack of enthusiasm for NVG use among the crews. Several crews

were very positive about NVG testing when calm seas and good ambient light prevailed.

2. UTB crews consistently complained about soreness in their eyes and headaches when using the NVGs, and some crews began experimenting with ways of relieving eye strain. These included using the NVGs in a hand-held mode and occasionally searching without the NVGs, sitting on the deck and supporting the NVGs with their hands, laying on the deck, and taking frequent short breaks. These methods appeared to somewhat ease crew discomfort.

3. On some nights, radar detected targets that could also be found by the unaided eye with a search light but not with NVGs. Even when NVG-equipped lookouts were notified that radar had a target in a certain area, they often were unable to locate it, whereas the coxswain using the search light could. (The majority of these types of incidents occurred on darker nights when NVG performance was marginal.)

4. Boat crews achieved consistently poorer detection results than did helicopter crews. This lack of success with the NVGs was reflected in crew attitudes and motivation during the later stages of the experiments.

5. The level of the UTB crews' knowledge and training, relative to the use and care of the NVG systems, was much more varied than that of the helicopter crews. Many crews had virtually no training at all prior to participating in the experiments.

6. UTB crews would likely benefit from a helmet-mounted NVG arrangement that allows non-NVG peripheral vision and that provides for flipping the goggles up and away from the face while still performing engineering checks, navigation chores, radar scans, and other non-search duties.

ALERT Observations

1. Performance drops off after approximately the first 30 minutes on NVGs (reference 20).

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 the starboard's position.

VIGOROUS Observations

1. The lookouts were 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. The crew's attitude toward searching was very upbeat, almost competitive. This may have resulted in a high detection rate.

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

4. The mast 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.

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. Table 3-1 summarizes the results of analyses presented in chapter 2. For all but the Spring 1991 data, detection performances for SRU/target combinations are measured by sweep width calculations. Using detection probabilities at varying lateral ranges, a qualitative evaluation was performed for the Spring 1991 data. HH-3/CH-3 data from the Spring 1991 experiment were combined with the data from the other experiments to create one HH-3/CH-3 data base.

Table 3-1. Sweep Width Analysis Results

SRU	TARGET TYPE	NIGHT CONDITIONS	SWEEP WIDTH (W) (nmi)	NUMBER OF OPPORTUNITIES
HH-3/ CH-3	Small Boats (18 to 21 feet)	visibility ≤ 8 nmi	0.8	49
		visibility > 8 nmi		
		no moon	0.7	257
		moon	1.3	452
	Life Rafts with Retroreflective Tape	no moon	0.7	165
		moon	0.9	215
	Life Rafts without Retroreflective Tape	no moon	0.36	225
		moon		
		$H_s \le 2.5$ feet	1.0	73
		H_s 2.5 - 5.2 feet	0.6	96
	PIW	visibility ≥ 10 nmi	0.4	222
		visibility < 10 nmi	N/A	20
	PIW-Green PML	all conditions	N/A	90
	PIW-Red Safety Light	no moon	1.3	187
		moon	0.3	45
	PIW-"Firefly" Strobe	3 nmi visibility	3.5	152

Table 3-1. Sweep Width Analysis Results (Cont'd)

SRU	TARGET TYPE	NIGHT CONDITIONS	SWEEP WIDTH (W) (nmi)	NUMBER OF OPPORTUNITIES
UTB	Small Boats	no moon	0.2*	108
		moon	0.4*	86
	Life Rafts with Retroreflective Tape	none	0.2*	135
	Life Rafts without Retroreflective Tape	no moon	0.2*	185
		moon	0.6*	33
	PIW	all conditions	0.06*	227
	PIW-Red Safety Light	all conditions	N/A	25
	PIW- "Firefly" Strobe	all conditions	N/A	12
WMEC (Canso Bank)	Lighted Life Rafts	ALERT		
		wind < 20 knots	6.7	72
		wind 20 - 35 knots	5.2	53
		VIGOROUS		
		wind < 20 knots	11.1	158
		wind 20 - 32 knots	9.6	55
	Unlighted Life Rafts	ALERT and VIGOROUS		
		$H_s \leq 5$ feet	1.3	89
		H_s 5 - 7.2 feet	0.6	40

* Routine searches by NVG equipped UTBs are not recommended.

3.1.1 Spring 1991 Comparative Evaluation

1. The HH-60J achieved detection probabilities that are not significantly different from those for the CH-3 during the same time period. The total number of samples for this data set was 73 when searching for small boats and 90 when searching for life rafts with retroreflective tape.

2. The RG-8A achieved detection probabilities that are substantially lower than those from the HH-3 during the same time period. The total number of samples for this data set was 39 when searching for small boats and 88 when searching for life rafts with retroreflective tape.

3. For targets beyond 0.25 nmi, the HU-25C achieved detection probabilities similar to the CH-3. However, the inability of NVG-equipped lookouts to search ahead of the aircraft resulted in a substantially lower detection probability inside 0.25 nmi. Searches conducted from an HU-25C, with a properly operating FLIR, are expected to achieve detection probabilities similar to the CH-3. The total number of samples for this data set was 116 when searching for small boats and 166 when searching for life rafts with retroreflective tape.

3.1.2 Search Performance of NVG-Equipped Helicopters

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

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

    - The sweep width for life raft targets without retroreflective tape, in no moonlight conditions, was half that in moonlight conditions with the higher observed H_s and nearly a third that in moonlight conditions with the lower observed H_s.

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

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

especially when viewed against a lighted background or in low ambient light conditions.

3. Green PMLs did not enhance the detectability of PIW targets when viewed through ANVIS NVGs. ANVIS NVG detections of PIW targets with PMLs were not achieved during a sortie that presented 90 opportunities for detecting these targets. The searches conducted through NVGs for these targets resulted in much lower detection probabilities than for the PIW targets without PML. This is likely due to lookouts searching for a bright light rather than for the shape of a mannequin with just the PFD. The green PMLs are invisible through NVGs.

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

5. The HH-3/CH-3 helicopter crews achieved detection probabilities against PIW targets that were comparable to the results for daylight visual search found in the National SAR Manual (see reference 14). The detectability of PIW targets was clearly enhanced by the retroreflective tape on the PFDs. The tape reflected shore lights and/or the helicopters' anticollision lights to produce flashes that were very distinct when viewed with the ANVIS NVGs.

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

7. One NVG-equipped helicopter crew achieved excellent search performance against "Firefly" strobe light targets under adverse search conditions. The NVG sweep width achieved in 3 nmi visibility was comparable to the National SAR Manual (reference 14) non-NVG searches for more powerful strobes in 5- to 20-nmi visibility.

3.1.3 Search Performance of NVG-Equipped Utility Boats

1. Based on a very limited data set, UTBs achieved only marginal detection performance against PIW targets with red safety lights at lateral ranges of less than 0.5 nmi. Detections were not achieved at lateral ranges greater than 0.5 nmi.

2. The presence of a visible moon appeared to significantly enhance UTB detection performance against small boat targets and life rafts without retroreflective tape.

3. NVG detection performance against life raft targets was no more than one-tenth of comparable daylight visual search levels. The addition of retroreflective tape to 4- and 6-person life rafts did not appear to improve their detectability by NVG-equipped UTBs.

4. The NVG-equipped UTBs achieved only marginal detection performance against the PIW targets. Even when the targets passed close-aboard (within 50 feet), only one-third (5 out of 15) were detected.

5. NVG-equipped UTBs were only marginally capable of mounting a successful NVG search effort against PIWs, life rafts, and open 18-foot boats. UTBs were fairly successful for 21-foot small boat targets with an erected canvas.

6. UTB crews were not capable of conducting effective NVG searches in seas greater than 2.5 to 3 feet. Platform motion, coupled with the narrow NVG FOV, consistently caused seasickness and disorientation. The effectiveness of the NVGs was also inhibited by the constant presence of sea spray, even when the lookouts sought shelter behind the wheelhouse.

7. Wheelhouse lights and running lights caused a great deal of interference with the NVGs. Lookouts were often forced to search in a narrow sector directly abeam.

3.1.4 Canso Bank Search and Rescue Unit Search Performance

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

indicate that lighted targets can be detected out to the limits of the visibility or to the visual horizon, whichever is less.

2. NVG detection performance was significantly greater when lookouts had a view unobstructed by glass (either through an open bridge window or by being stationed outside the pilot house). Glare and reflections of bridge lights are likely a significant source of distraction and fatigue while searching through the glass of closed bridge windows.

3. Statistically significant differences were not found for NVG-equipped lookouts searching from the VIGOROUS bridge or the VIGOROUS flying bridge during the Canso Bank experiment.

4. Environmental factors that affected SRU search performance while searching for lighted targets were best described as wind speed.

5. Environmental factors that affected SRU search performance while searching for unlighted targets were best described as significant wave height.

3.1.5 General Conclusions

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

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

3. The presence of moonlight or artificial light within the FOV generally degraded the NVG detection performance against a light-equipped target (i.e., PIW with red safety lights or lighted life rafts).

4. The presence of a visible moon significantly enhanced the NVG detection performance against unlighted targets.

5. NVG detection performance was decreased in bad weather. For the environmental conditions encountered, worsening conditions nearly halved NVG detection performance.

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

3.2 RECOMMENDATIONS

The following recommendations are offered concerning the employment, use, and further evaluation of NVGs in the Coast Guard SAR mission. These recommendations are based primarily on the quantitative data analyses and qualitative observations provided in this report and in reference 1 to 4. Consideration was also given to additional inputs provided by SRU crews, other Coast Guard sources, and Department of Defense (DoD) night-vision experts.

Daylight visual sweep widths, referenced in sections 3.2.1 and 3.2.2, are tabulated in reference 14 . Fatigue, weather, and speed corrections are not to be applied unless specified below. Daylight visual sweep widths are currently unavailable for the 200-foot size range vessels that searched during the Canso Bank experiment. NVG sweep widths for the Canso Bank data presented in chapter 2 are summarized in section 3.2.3.

Search patterns should be oriented to minimize the time needed to search toward a bright light source. To accomplish this:

- the major axis of a parallel search should be at least a 30-degree offset from any major light source;

- the minor axis of a creeping line search should be at least a 30-degree offset from any major light source.

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

3.2.1 NVG Searches With Helicopters

Sweep width estimates for nighttime NVG searches using helicopters were calculated based on daylight visual sweep estimates. The nighttime correction factors for the corrected daylight sweep width are listed in table 3-2.

Table 3-2. Sweep Width Correction Factors for NVG Nighttime Searches with Helicopters

TARGET TYPE	NIGHT CONDITIONS	DAYLIGHT CORRECTION CONDITIONS	CORRECTION FACTOR
Small Boats (18 to 21 feet)	visibility ≤ 8 nmi	Weather and Aircraft speed	0.4
	visibility > 8 nmi		
	no moon	Weather and Aircraft speed	0.2
	moon	Weather and Aircraft speed	0.4
Life Rafts with Retroreflective Tape	all moon conditions	Weather and Aircraft speed	0.5
Life Rafts without Retroreflective Tape	no moon	Weather and Aircraft speed	0.3
	moon		
	$H_s \leq 2.5$ feet	Weather and Aircraft speed	0.4
	H_s 2.5 - 5.2 feet	Weather and Aircraft speed	0.5
PIW	visibility ≥ 10 nmi	Weather and Aircraft speed	2.0
	visibility < 10 nmi	*	N/A
PIW with Green PML	all conditions	**	
PIW-Red Safety Light	no moon	Aircraft speed	6.0
	moon	Aircraft speed	2.0
PIW "Firefly" Strobe	all conditions	***	

*There were not enough data collected under these conditions to calculate a nighttime sweep width or nighttime sweep width correction factor. Due to short daytime ranges, there will likely be no difference at different visibilities for nighttime searches.

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

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

3.2.2 NVG Searches With Utility Boats

1. Routine searches by NVG equipped 41 foot UTBs should not be considered. NVGs when available, should be used as an identification aid on UTBs.

2. Due to the poor detection probability and low sweep widths for NVG searches using UTBs, UTBs should not be outfitted with NVGs solely for the purpose of conducting nighttime search missions.

3.2.3 NVG Searches With 200-foot Size Vessels

The sweep width estimates for 200-foot size vessels were calculated directly and are listed in table 3-3. CCGS ALERT conducted some of its lighted life raft searches inside the enclosed bridge area with closed bridge windows, and the glare from the windows biased low the corresponding average sweep width calculation for lighted life raft targets. No significant difference between SRUs was present for unlighted life rafts.

Table 3-3. Sweep Width Estimates for Canso Bank Data - 200-Foot Size Vessels

TARGET TYPE	SRU	ENVIRONMENTAL CONDITIONS *	SWEEP WIDTH(W) (NMI)
Lighted Life Rafts	CCGS ALERT	wind < 19 knots	6.7
		wind 20-35 knots	5.2
	USCGC VIGOROUS	wind < 19 knots	11.1
		wind 20-32 knots	9.6
Unlighted Life Rafts	Both	H_s < 5 feet	1.3
		H_s 5-7.2 feet	0.6

* Environmental conditions represented here are simplified for operational use and represent a conservative estimate of sweep width where interpolation/extrapolation was used. These numbers should not be used for any purpose other than search planning.

3.2.4 Recommendations For Future Research

1. The data collection priorities for future NVG experiments are listed below in descending order of preference:

   - PIW targets without lights in moonlit conditions,
   - raft targets with retroreflective tape in moonlit conditions, and
   - PIW targets with orange/red safety lights in moonlit conditions (helicopter) or all conditions (UTB).

2. The HH-65A and HH-60J Coast Guard helicopters should be evaluated for their NVG search performance. Onboard the HH-3/CH-3 helicopters evaluated in this study, the three crew positions aft of the cockpit made more than 43 percent of all initial target sightings. Since the HH-65A and HH-60J carry smaller crews, it is possible that their NVG detection performance will not be as good as that reported here. Any performance differences should be identified and quantified to ensure that accurate sweep widths are available for these newer aircraft.

3. Data should be collected for helicopter searches in the following environmental conditions:

   - All moonlight conditions, particularly clear and calm conditions;
   - Warm nights with good visibility; and
   - Low visibility.

4. Data should be collected in moonlight conditions using SRUs in the 200-foot size. Additional large surface SRUs (i.e., WPBs and other WMECs) should be evaluated for their NVG search performance against all target types, including small boats.

5. 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 nonretroreflective materials.

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APPENDICES

LATERAL RANGE PLOT/CURVE
APPENDIX A

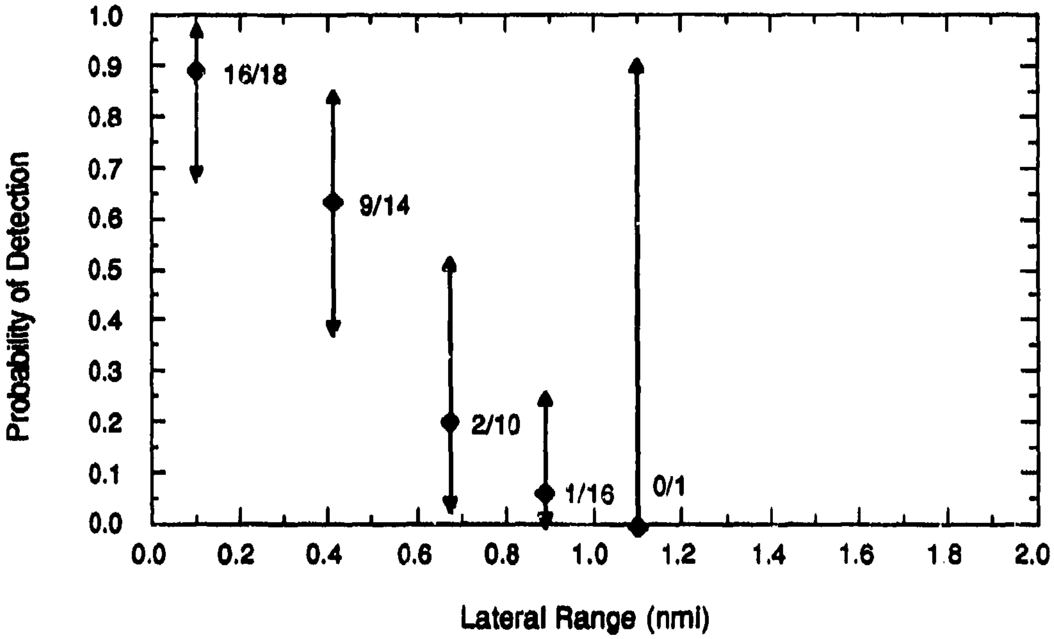


Figure A-1. HH-3 Searching for (18- to 21-foot) Small Boats

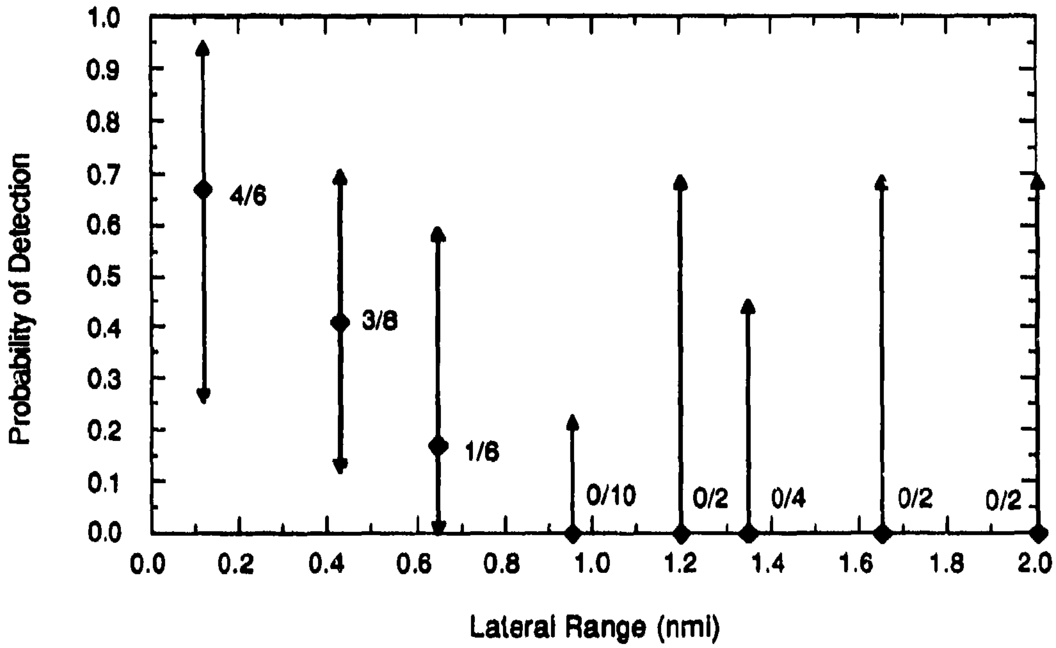


Figure A-2. RG-8A Searching for (18- to 21-foot) Small Boats

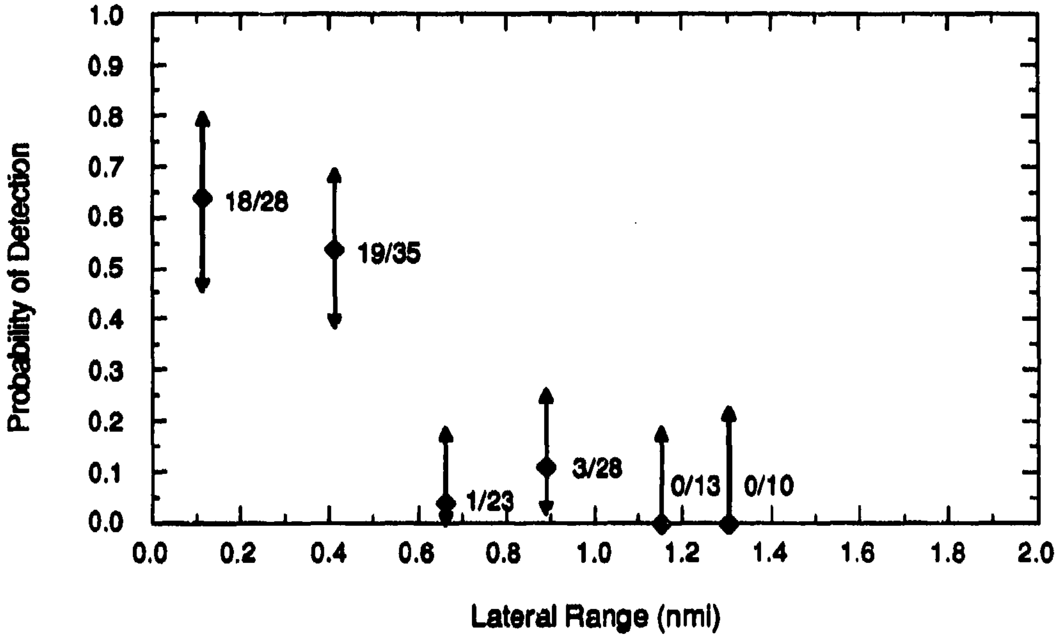


Figure A-3. HH-3 Searching for Life Rafts with Retroreflective Tape

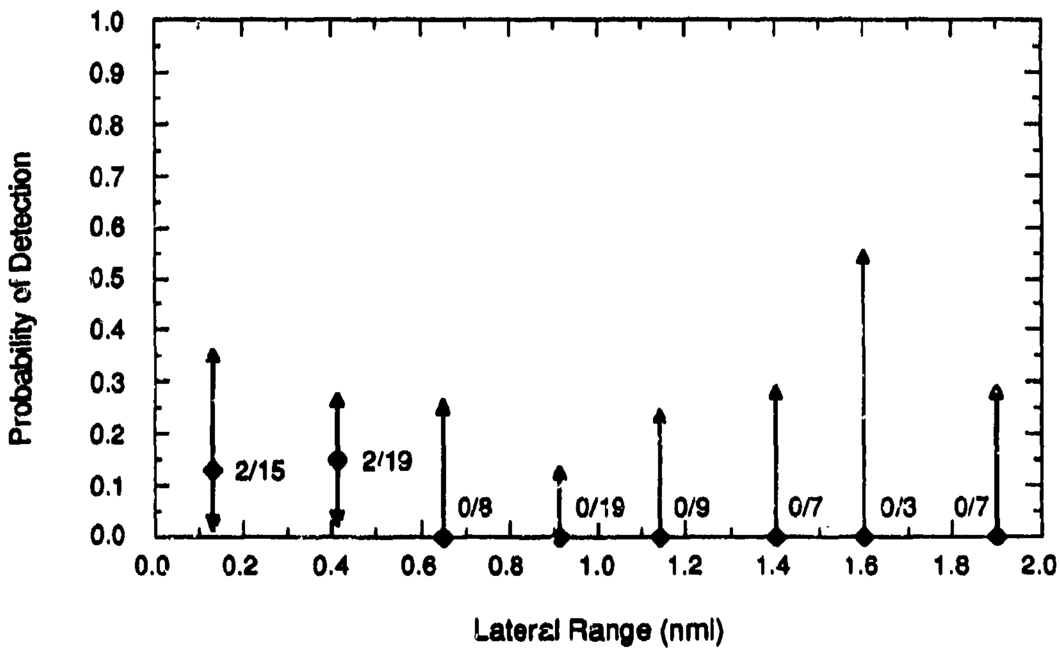


Figure A-4. RG-8A Searching for Life Rafts with Retroreflective Tape

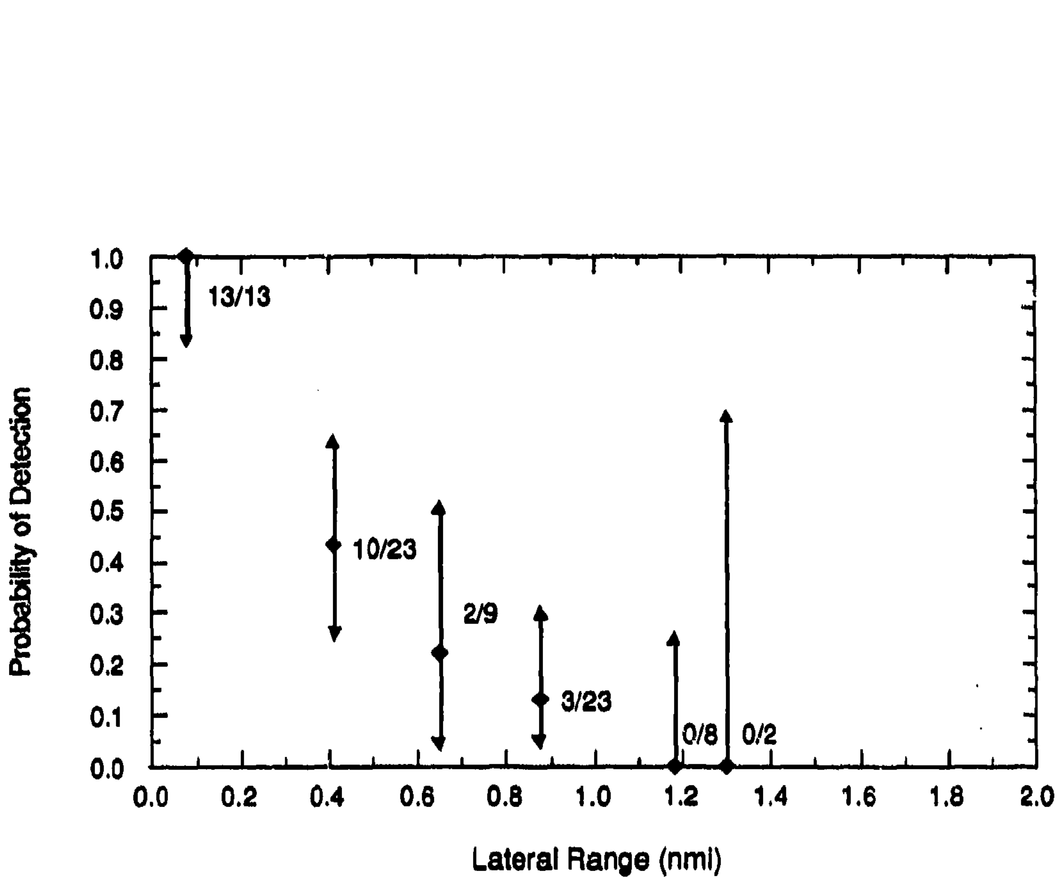


Figure A-5. CH-3 Searching for (18- to 21-foot) Small Boats

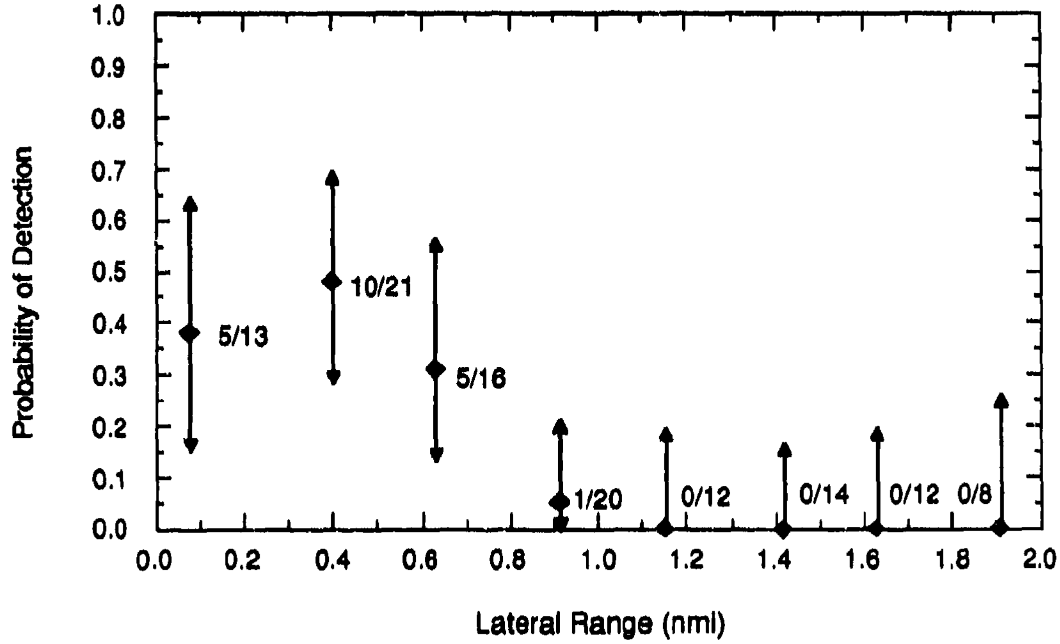


Figure A-6. HU-25C Searching for (18- to 21-foot) Small Boats

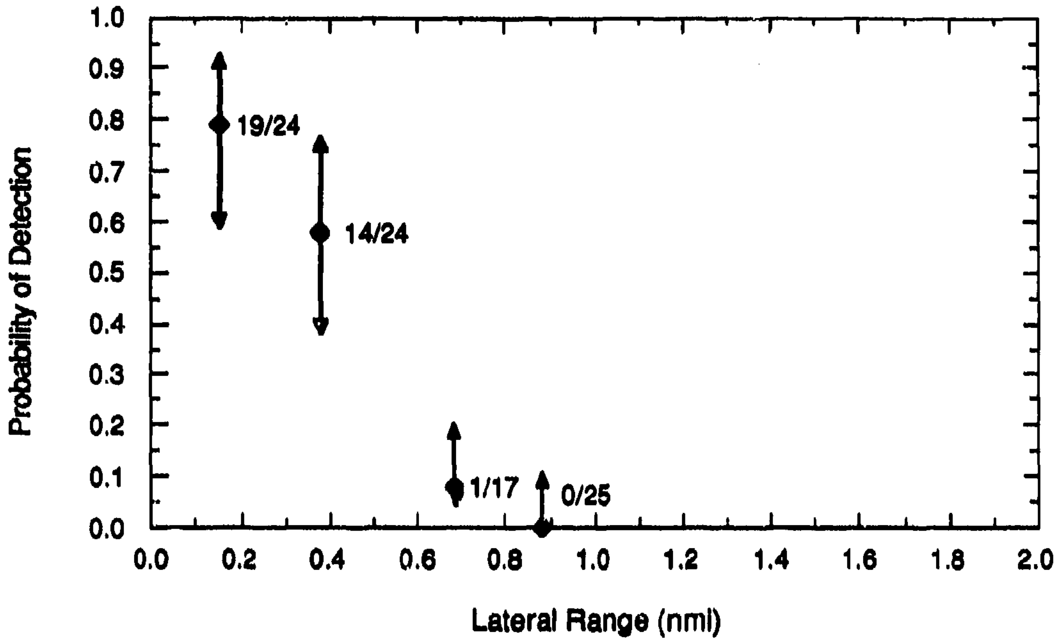


Figure A-7. CH-3 Searching for Life Rafts with Retroreflective Tape

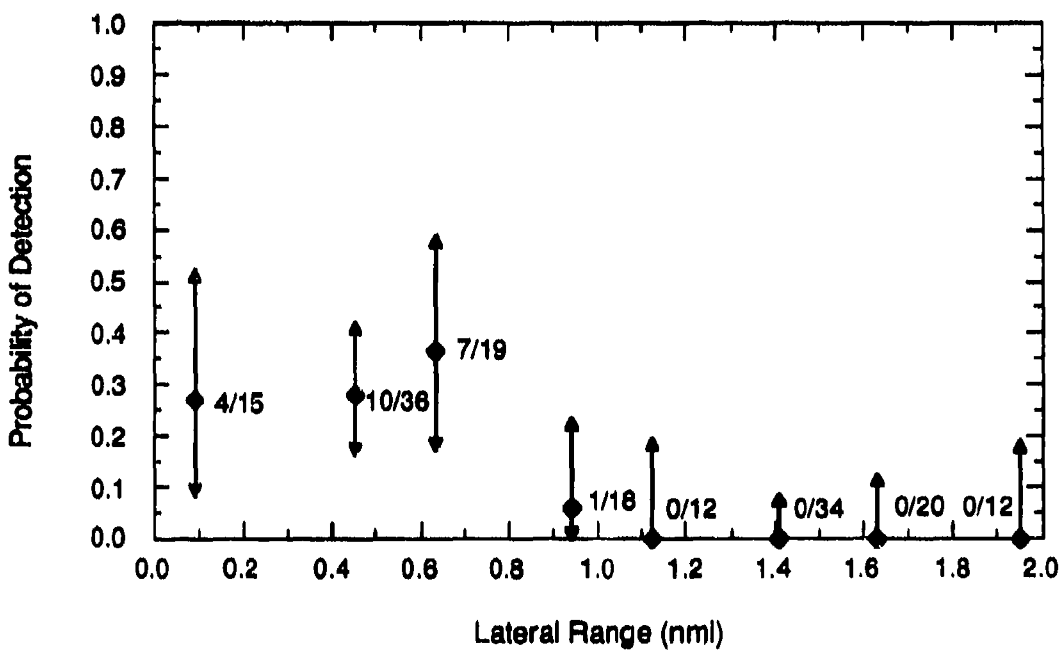


Figure A-8. HU-25C Searching for Life Rafts with Retroreflective Tape

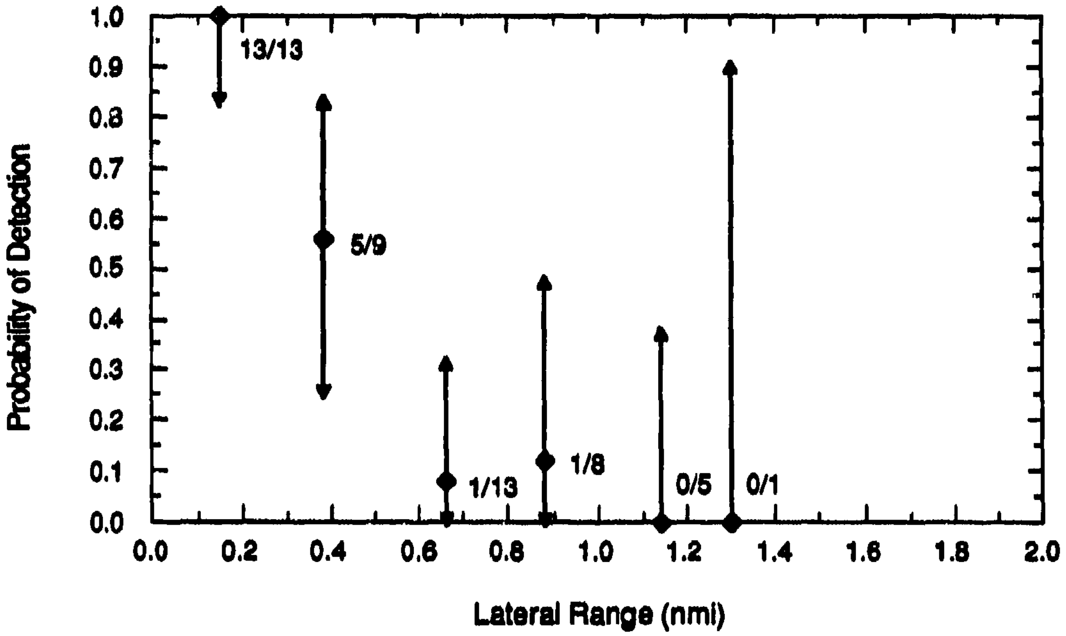


Figure A-9. CH-3 Searching for (18- to 21-foot) Small Boats

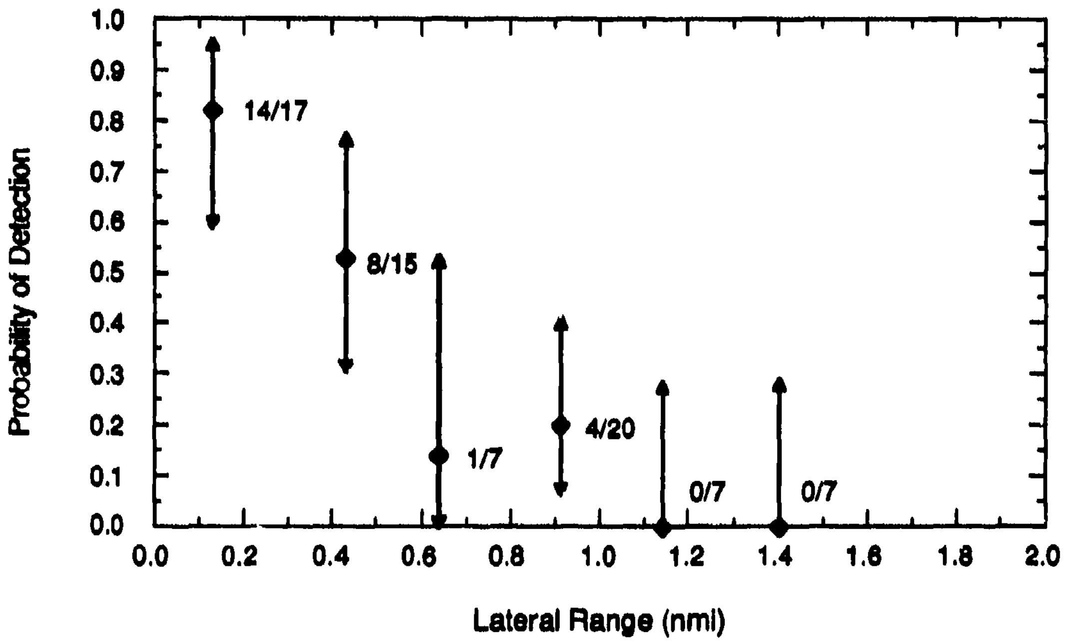


Figure A-10. HH-60J Searching for (18- to 21-foot) Small Boats

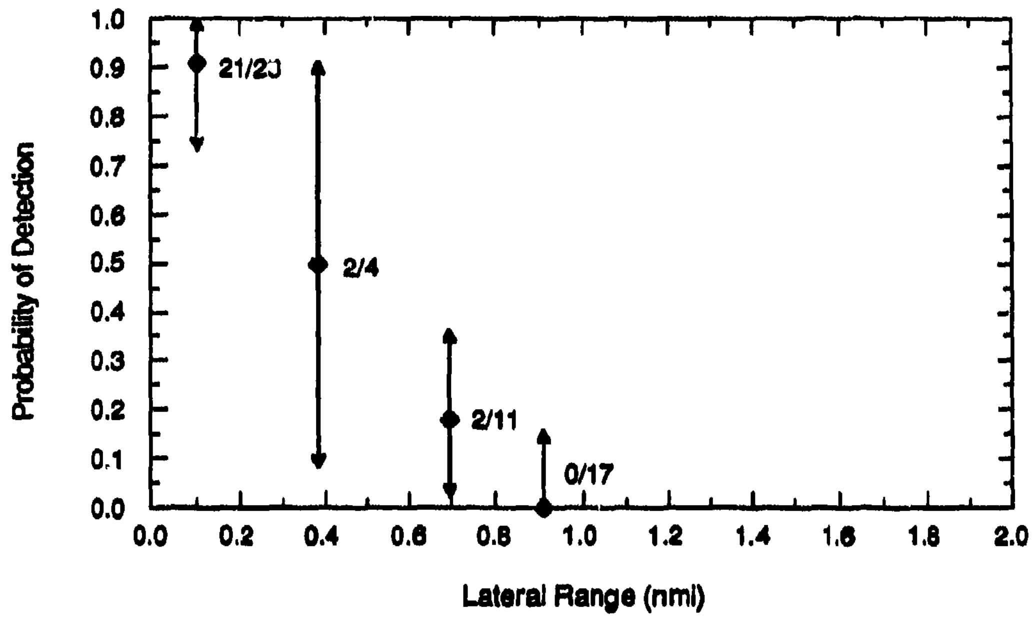


Figure A-11. CH-3 Searching for Life Rafts with Retroreflective Tape

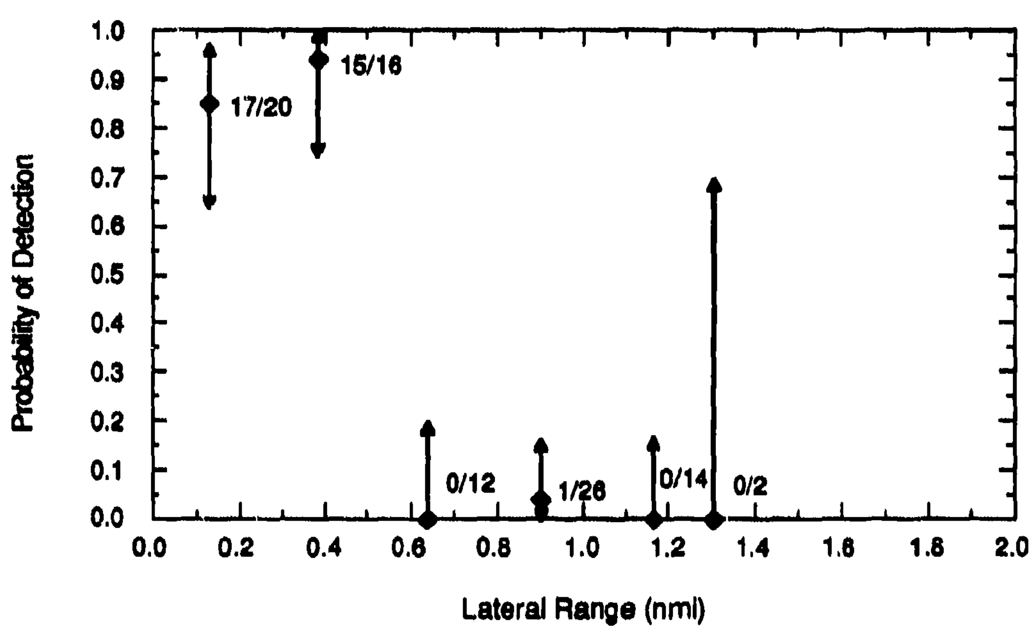


Figure A-12. HH-60J Searching for Life Rafts with Retroreflective Tape

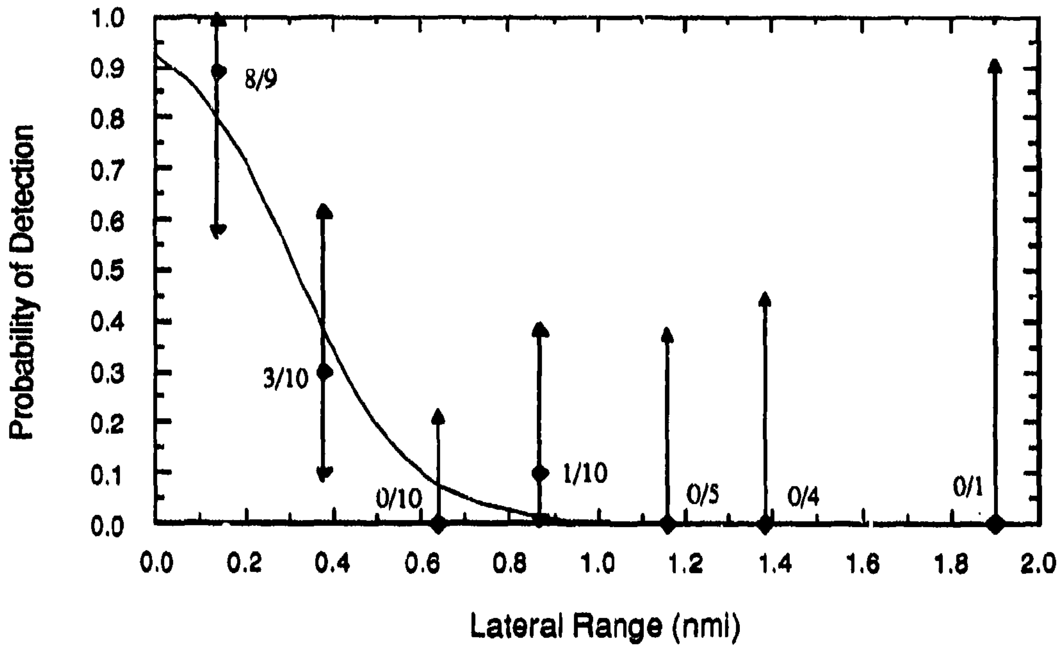


Figure A-13. HH-3/CH-3 Searching for (18- to 21-foot) Small Boats with Visibility ≤ 8 nmi

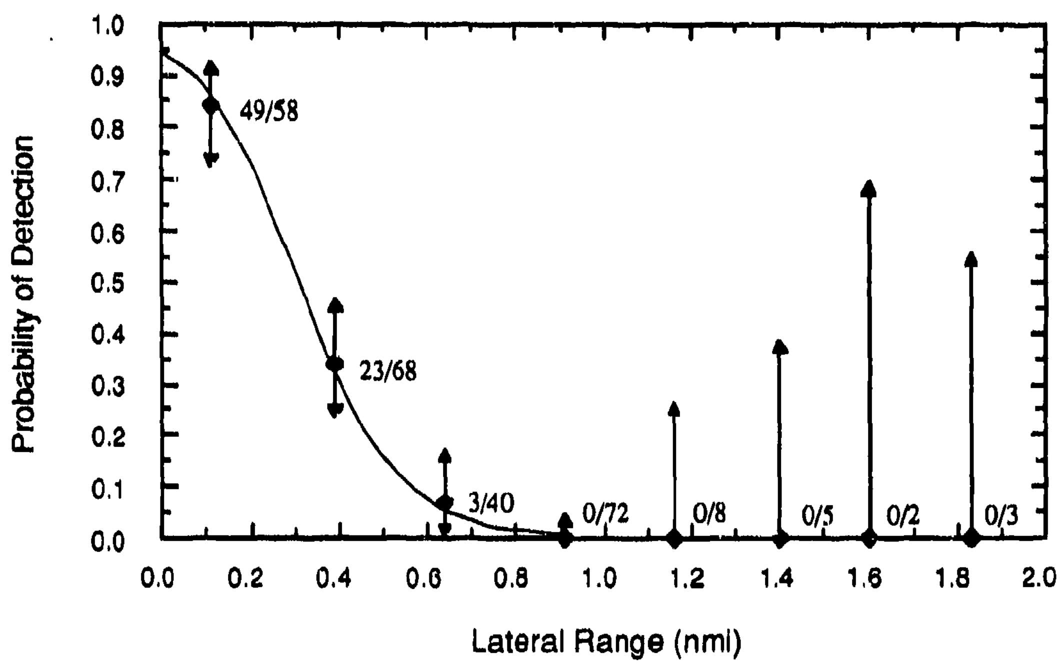


Figure A-14. HH-3/CH-3 Searching for (18- to 21-foot) Small Boats with Visibility > 8 nmi and in No Moon Light Conditions

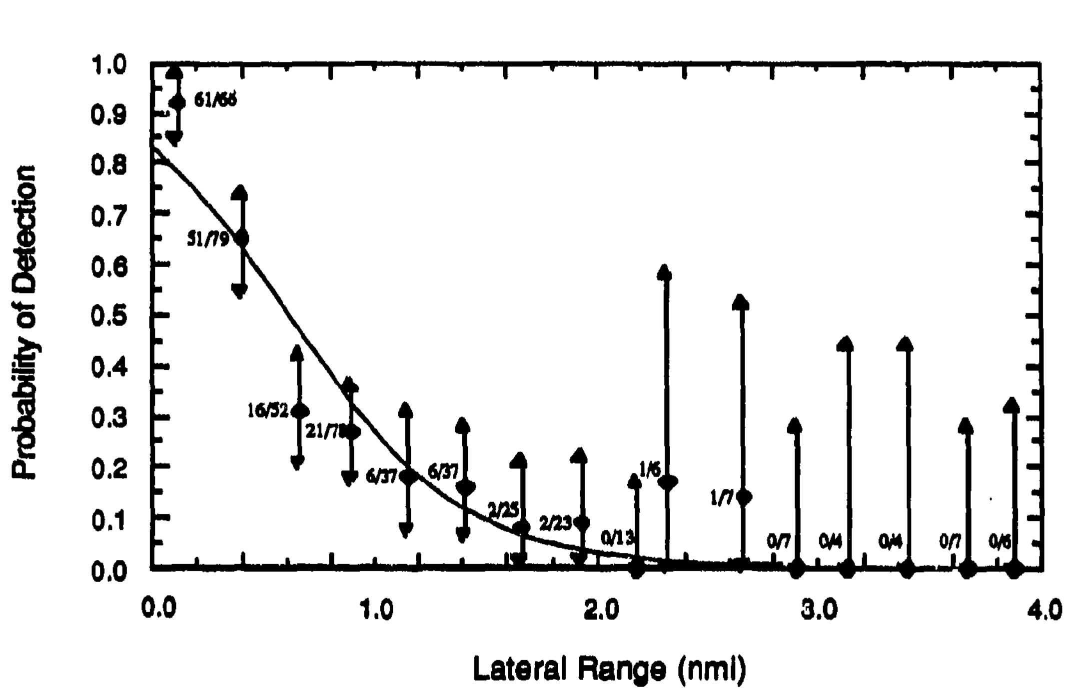


Figure A-15. HH-3/CH-3 Searching for (18- to 21-foot) Small Boats with Visibility > 8 nmi and in Moon Light Conditions

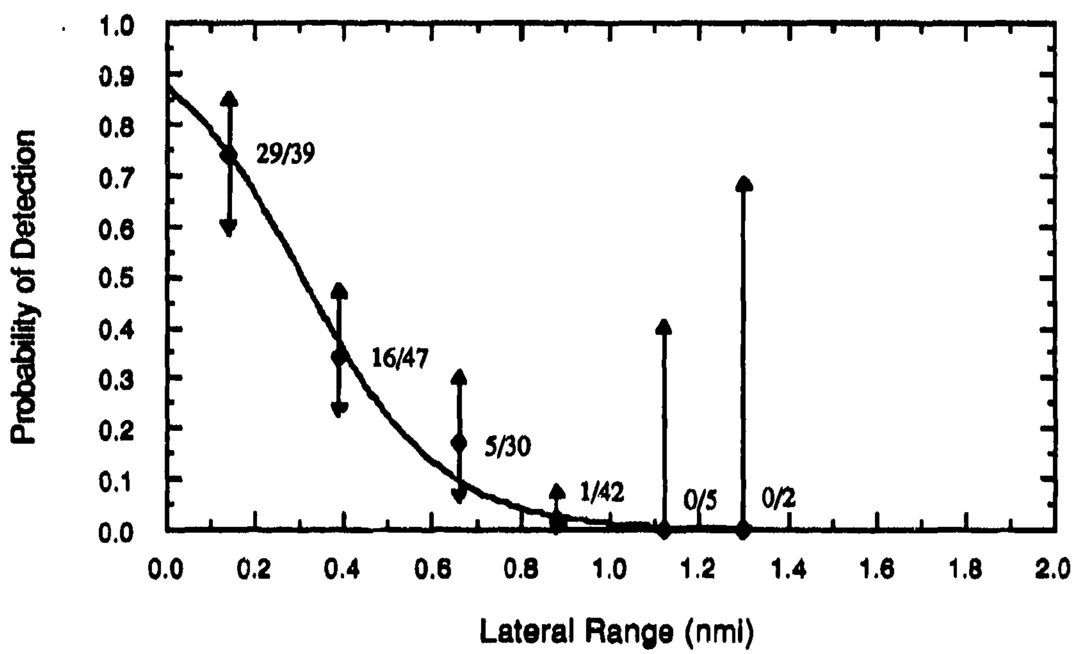


Figure A-16. HH-3/CH-3 Searching for Life Rafts with Retroflective Tape and in No Moon Light Conditions

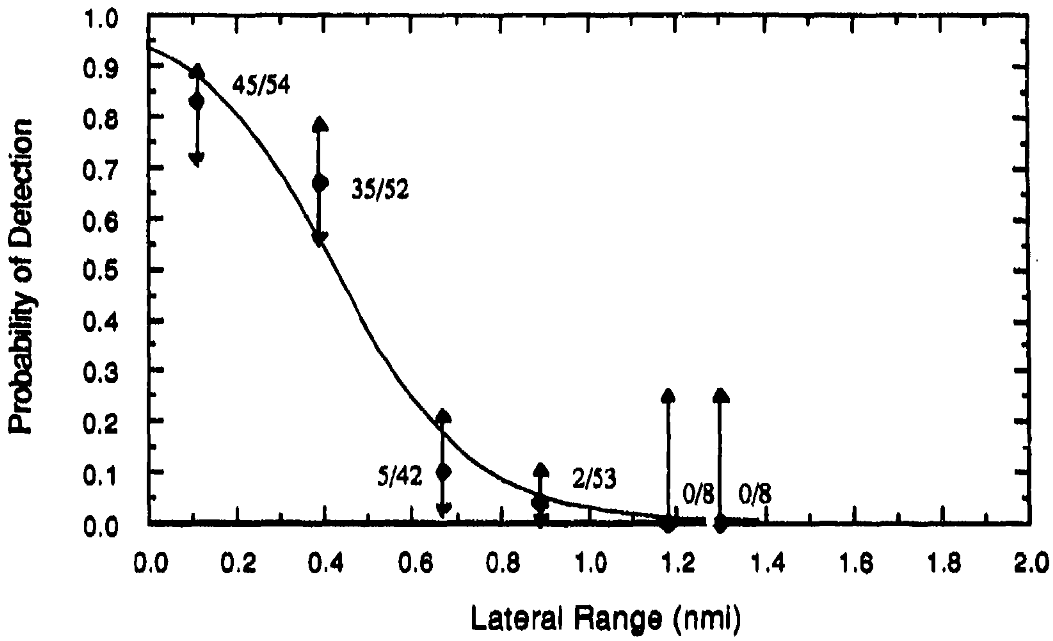


Figure A-17. HH-3/CH-3 Searching for Life Rafts with Retroflective Tape and in Moon Light Conditions

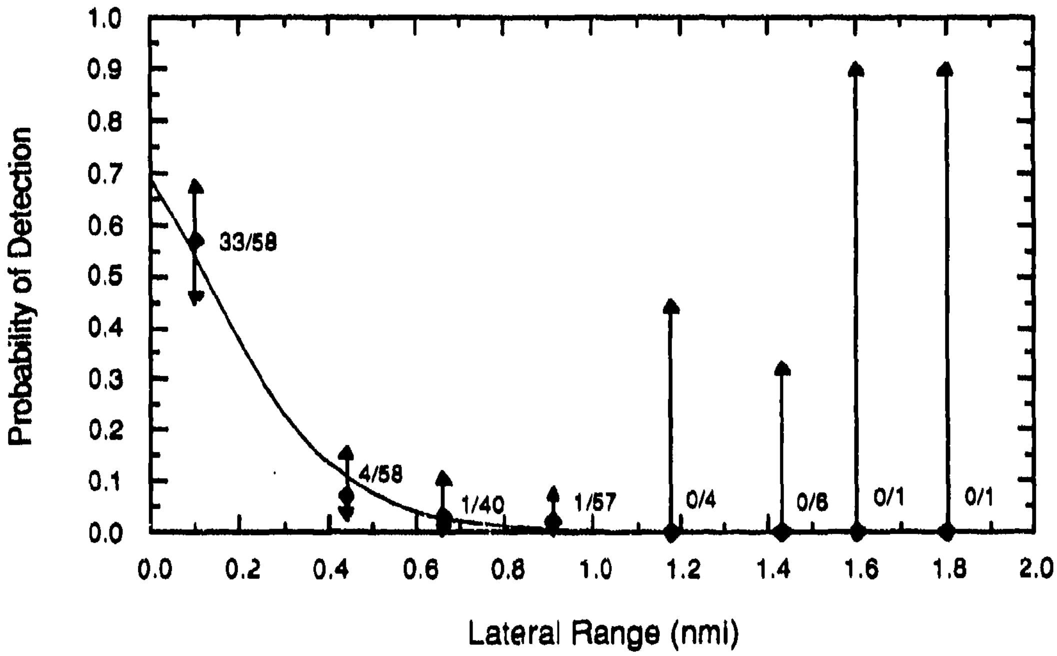


Figure A-18. HH-3/CH-3 Searching for Life Rafts without Retroflective Tape and in No Moon Light Conditions

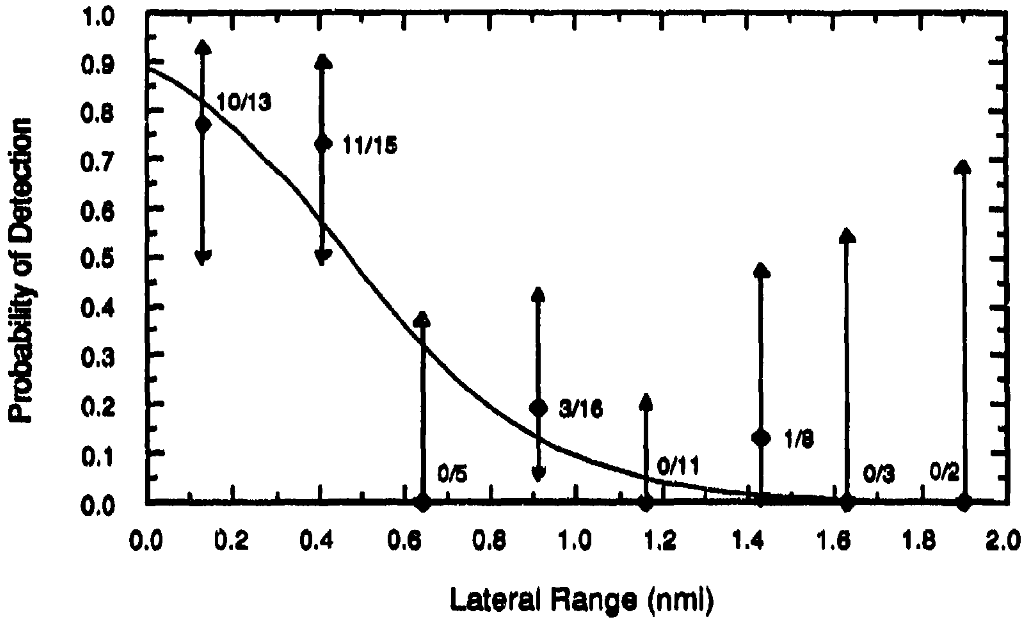


Figure A-19. HH-3/CH-3 Searching for Life Rafts without Retroflective Tape with $H_s \leq 2.5$ Feet and in Moon Light Conditions

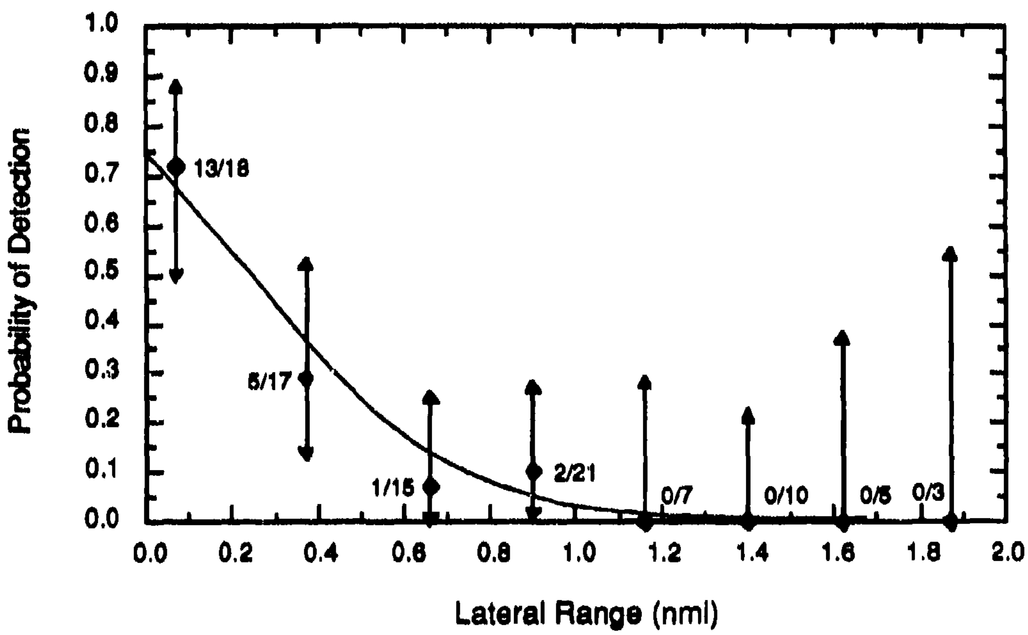


Figure A-20. HH-3/CH-3 Searching for Life Rafts without Retroflective Tape with $H_s > 2.5$ Feet and in Moon Light Conditions

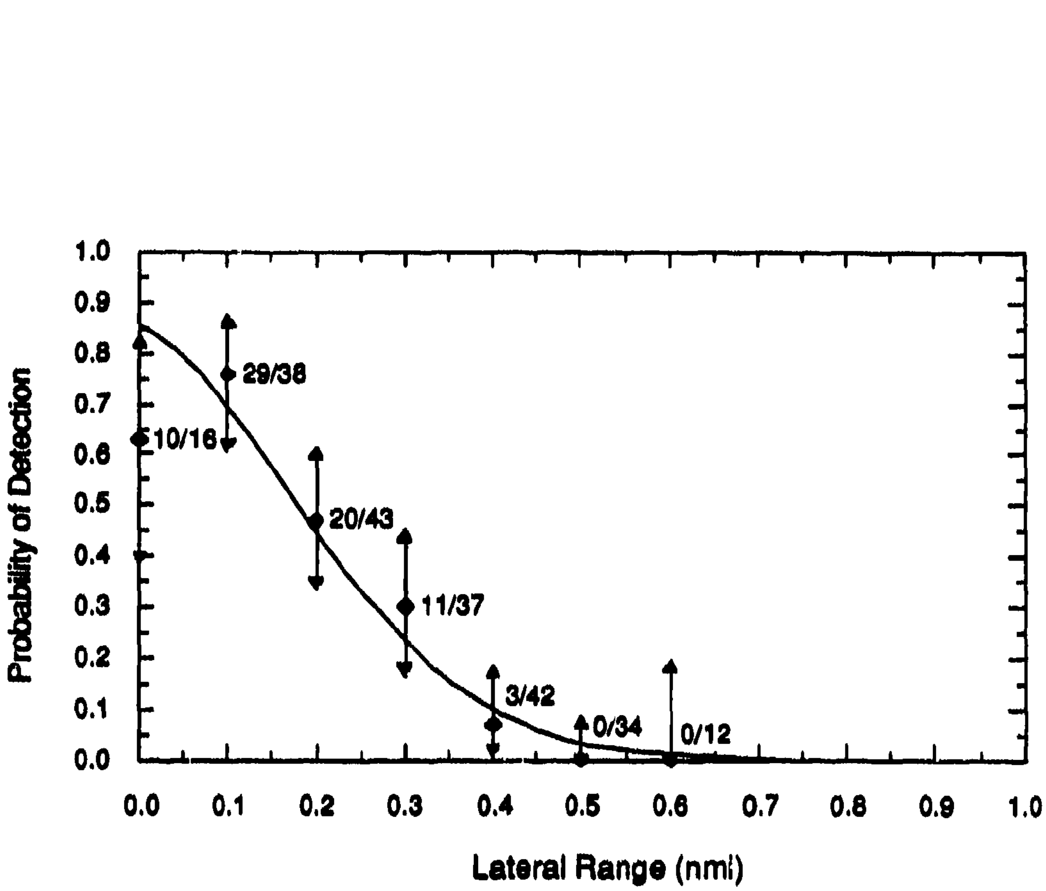


Figure A-21. HH-3/CH-3 Searching for PIWs with Visibility ≥ 10 nmi

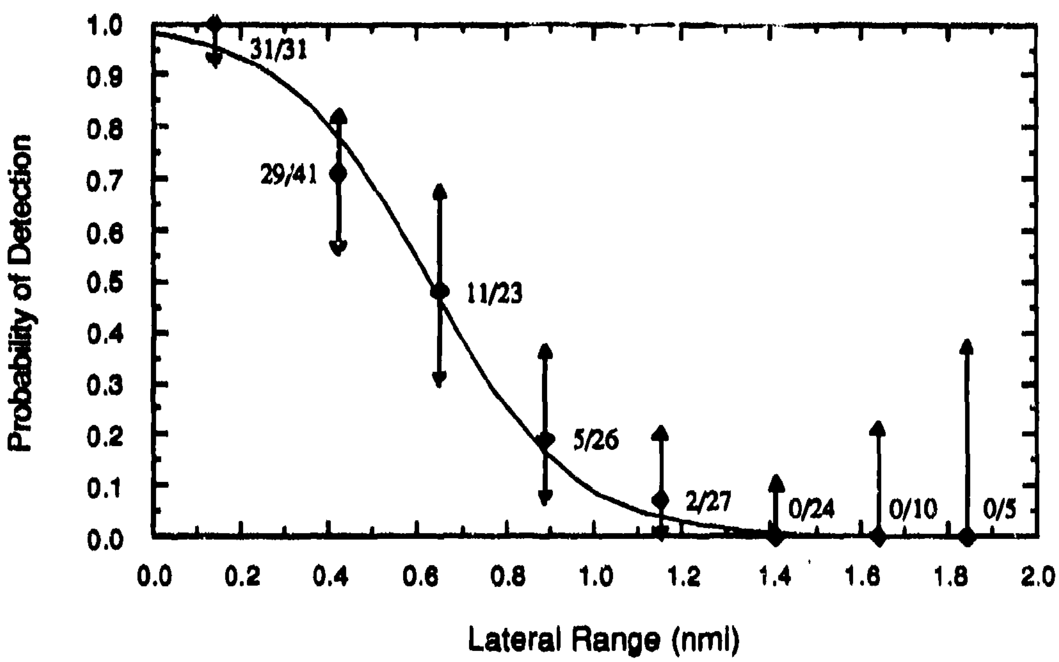


Figure A-22. HH-3/CH-3 Searching for PIWs with Red Saftey Lights in No Moon Light Conditions

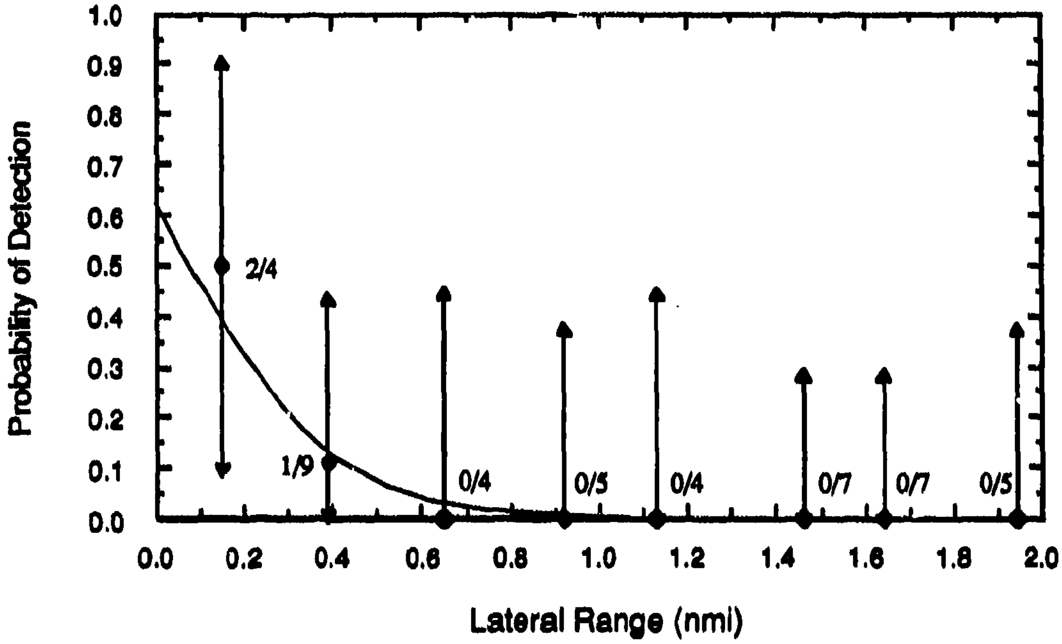


Figure A-23. HH-3/CH-3 Searching for PIWs with Red Saftey Lights in Moon Light Conditions

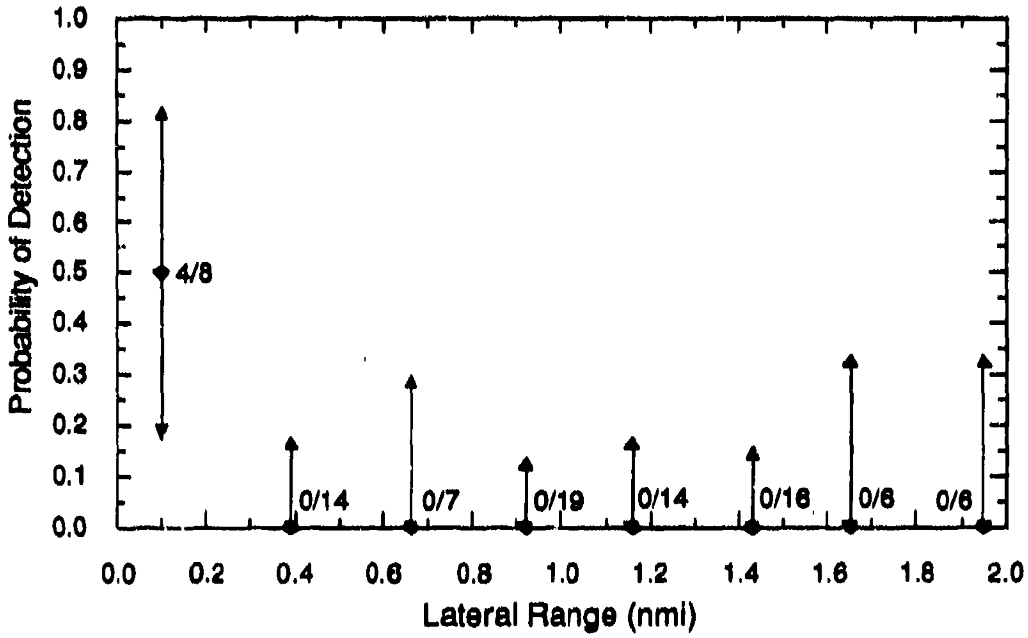


Figure A-24. HH-3/CH-3 Searching for PIWs with Green PML

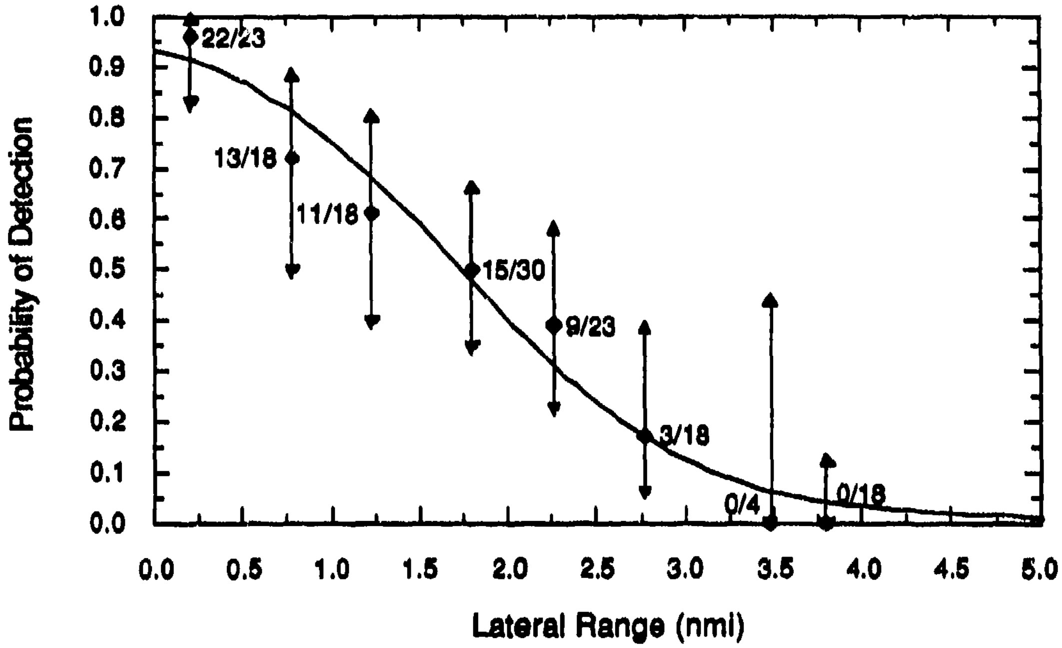


Figure A-25. HH-3/CH-3 Searching for PIWs with "Firefly" Strobe (visibility 3 nmi)

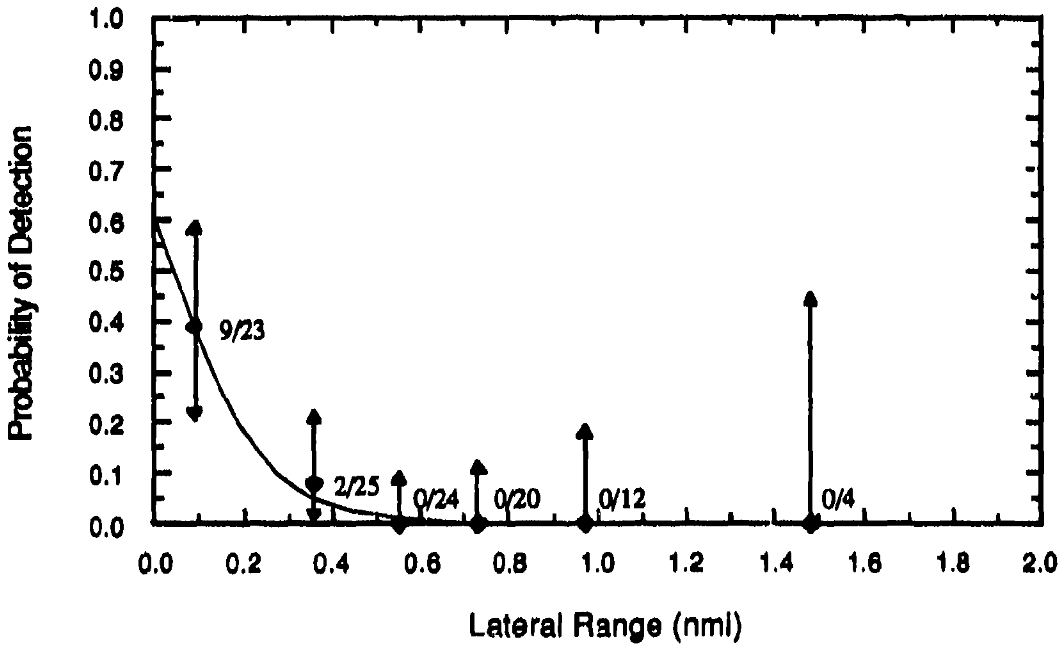


Figure A-26. UTB Searching for (18- to 21-foot) Small Boats in No Moon Light Conditions

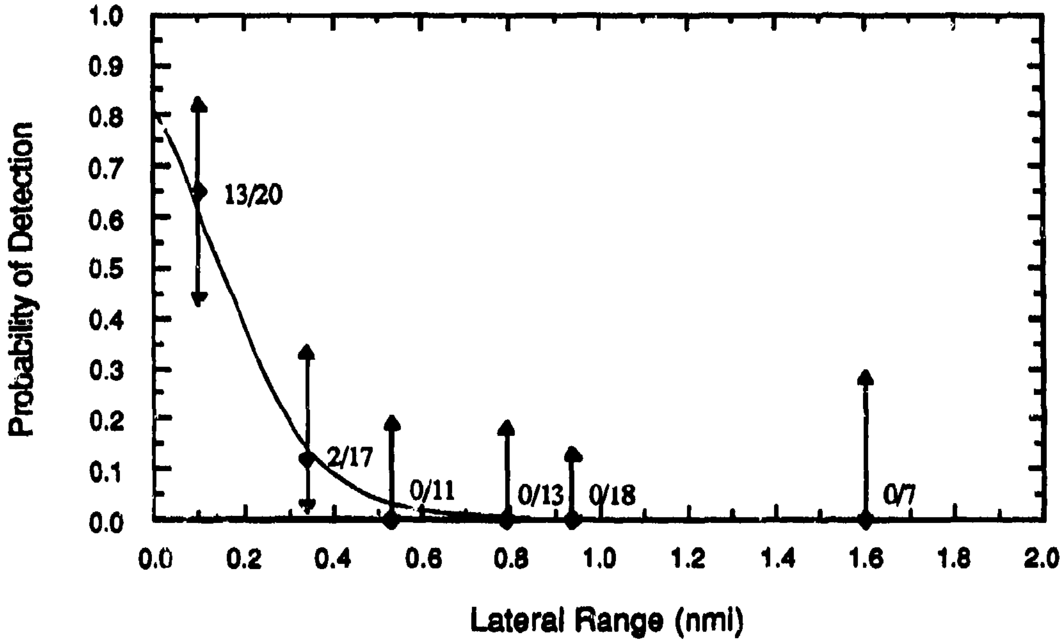


Figure A-27. UTB Searching for (18- to 21-foot) Small Boats in Moon Light Conditions

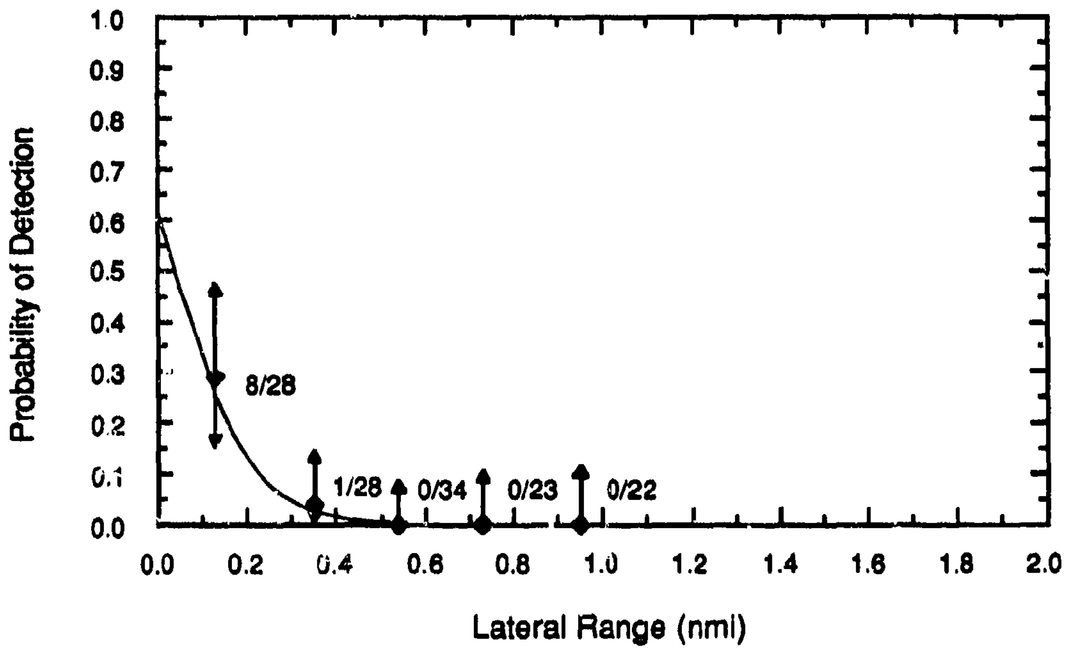


Figure A-28. UTB Searching for Life Rafts with Retroreflective Tape

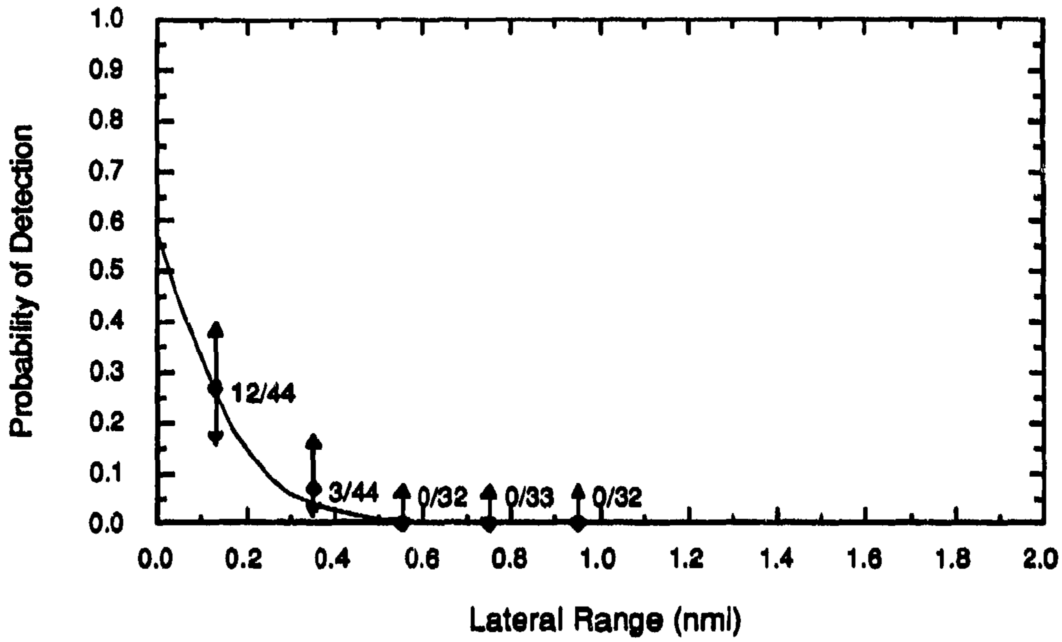


Figure A-29. UTB Searching for Life Rafts without Retroreflective Tape in No Moon Light Conditions

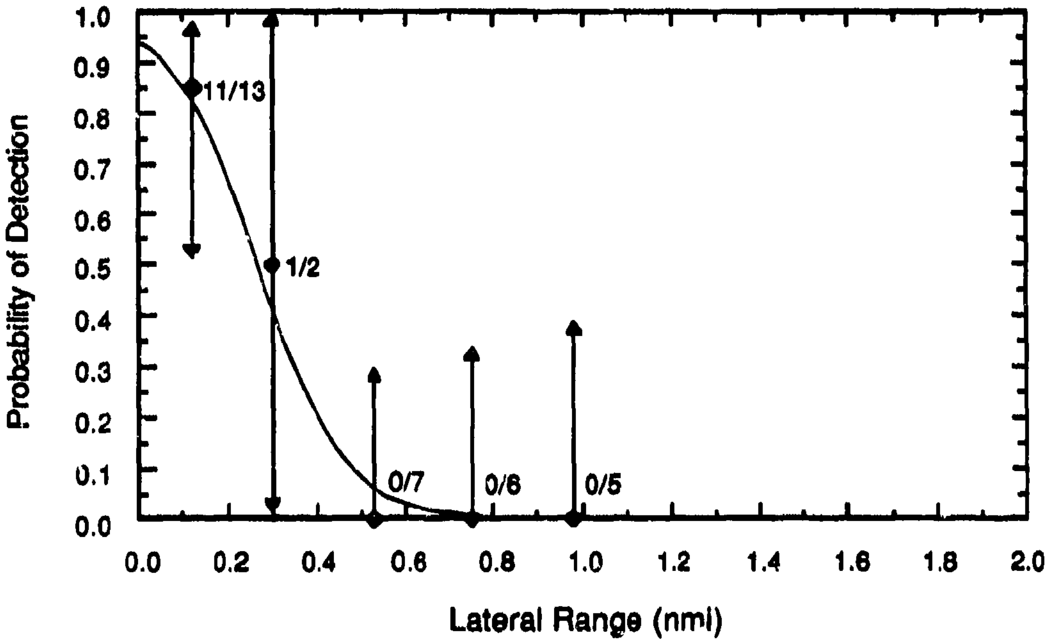


Figure A-30. UTB Searching for Life Rafts without Retroreflective Tape in Moon Light Conditions

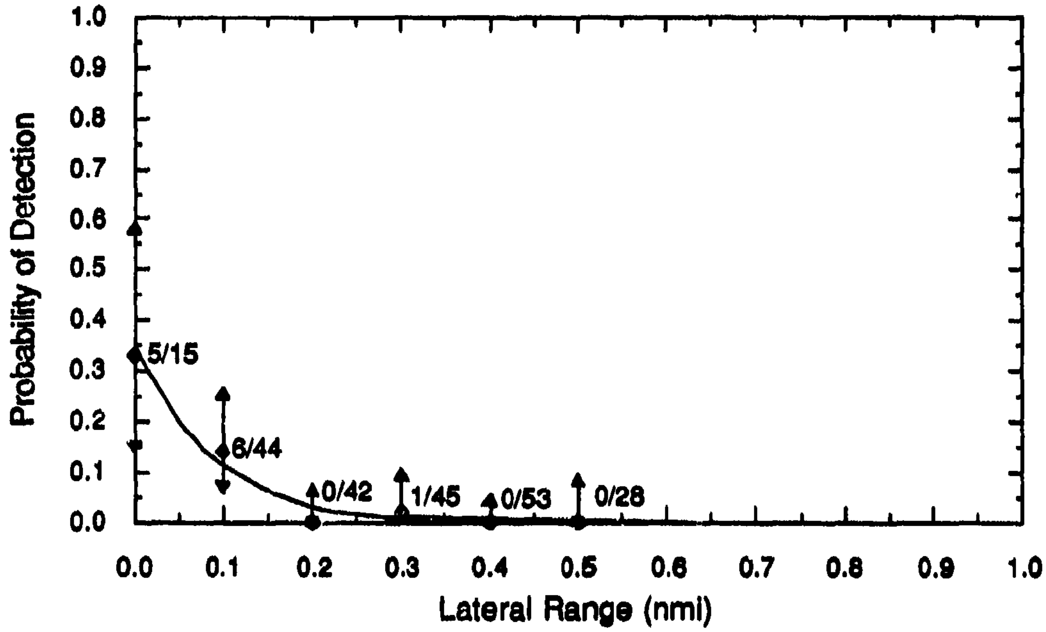


Figure A-31. UTB Searching for PIWs

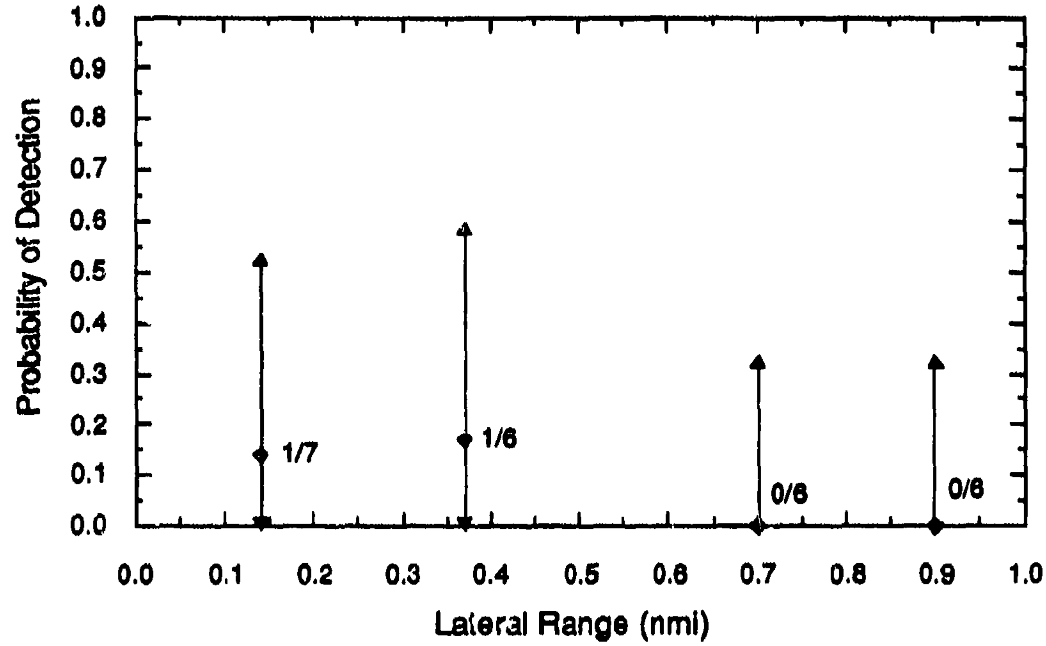


Figure A-32. UTB Searching for PIWs with Red Saftey Light

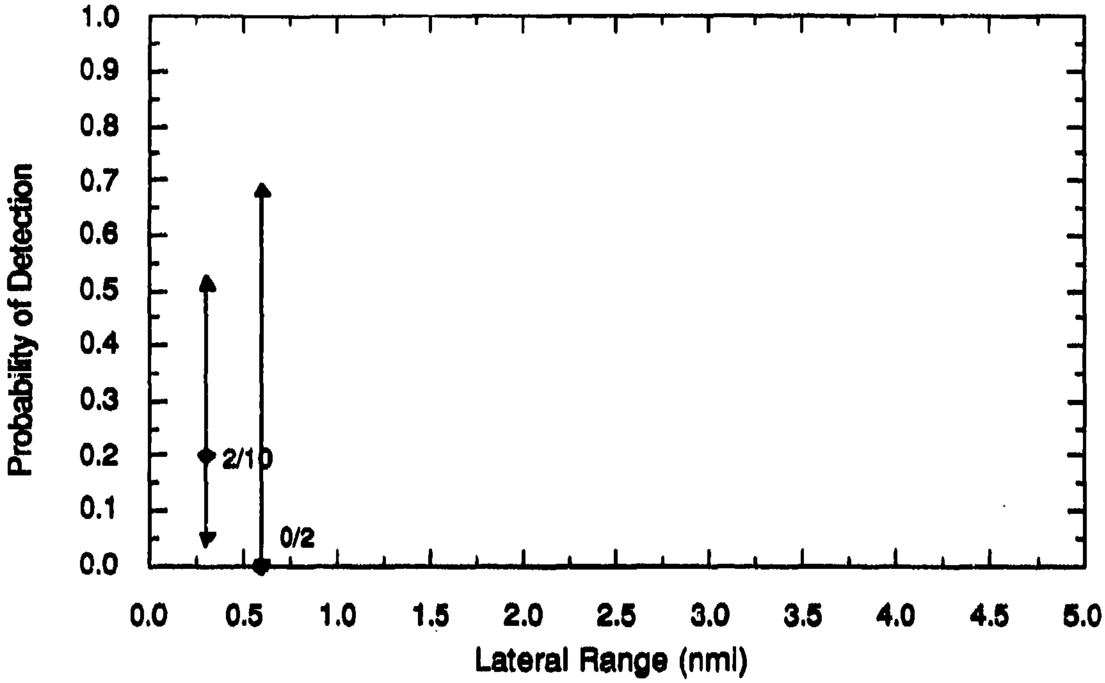


Figure A-33. UTB Searching for PIWs with "Firefly" Strobe

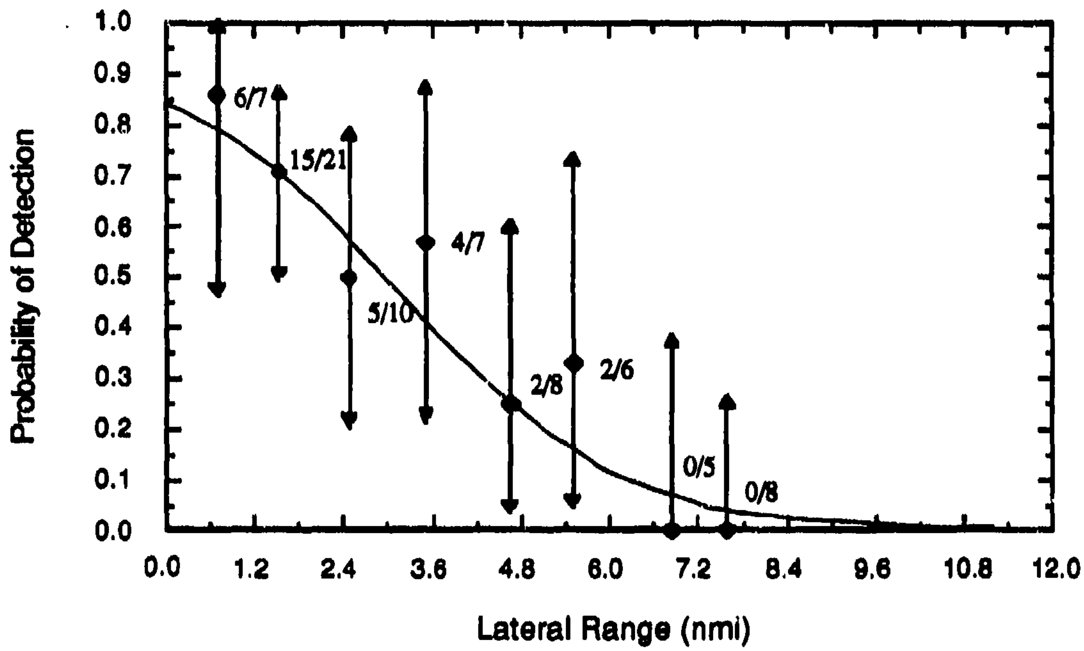


Figure A-34. ALERT Searching for Lighted Life Rafts with Wind Speed < 20 Knots

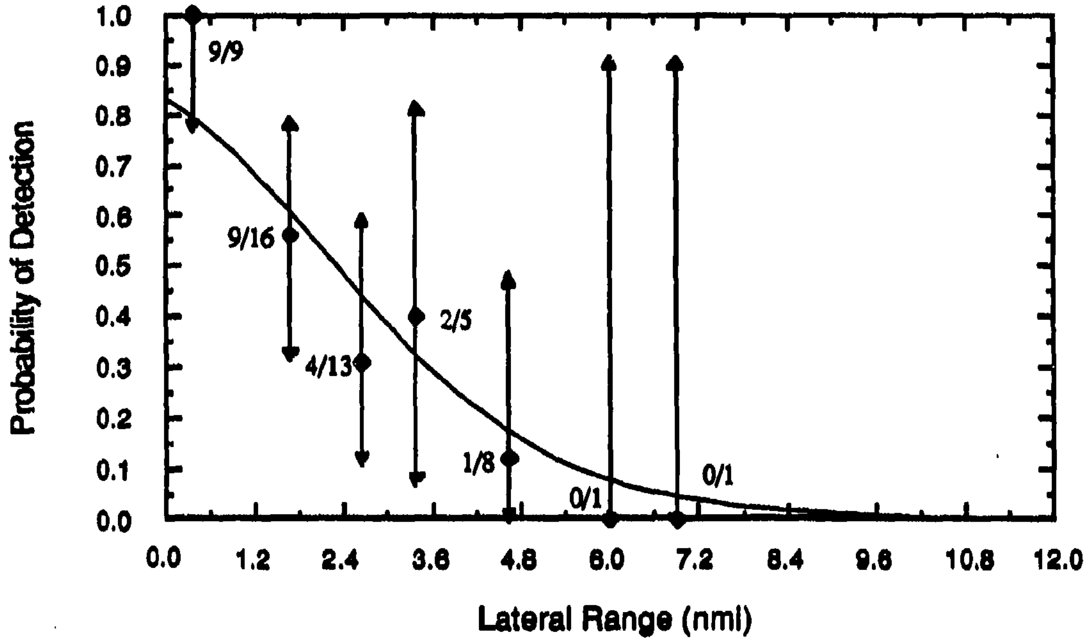


Figure A-35. ALERT Searching for Lighted Life Rafts with Wind Speed ≥ 20 Knots

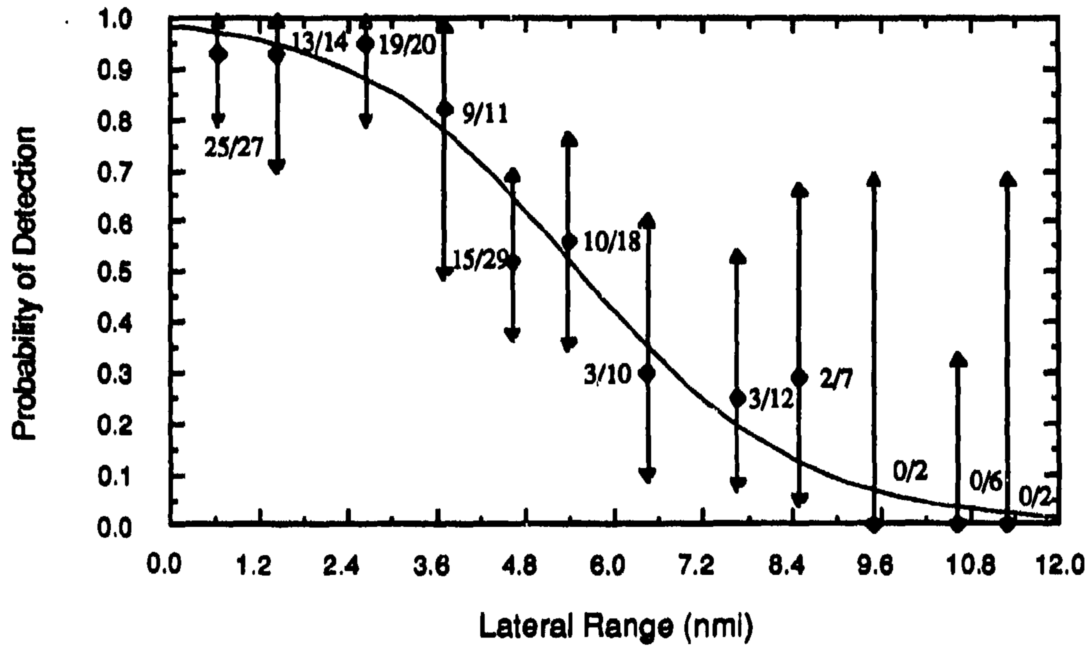


Figure A-36. VIGOROUS Searching for Lighted Life Rafts with Wind Speed < 20 Knots

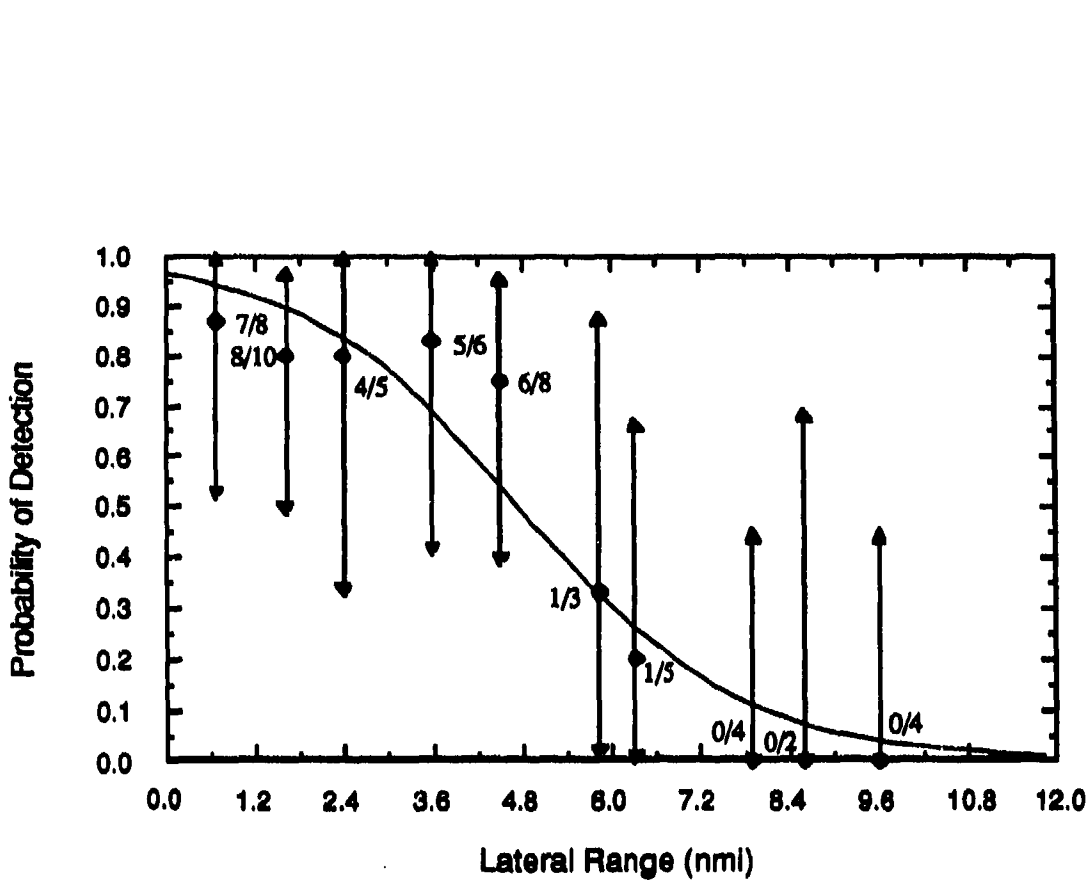


Figure A-37. VIGOROUS Searching for Lighted Life Rafts with Wind Speed ≥ 20 Knots

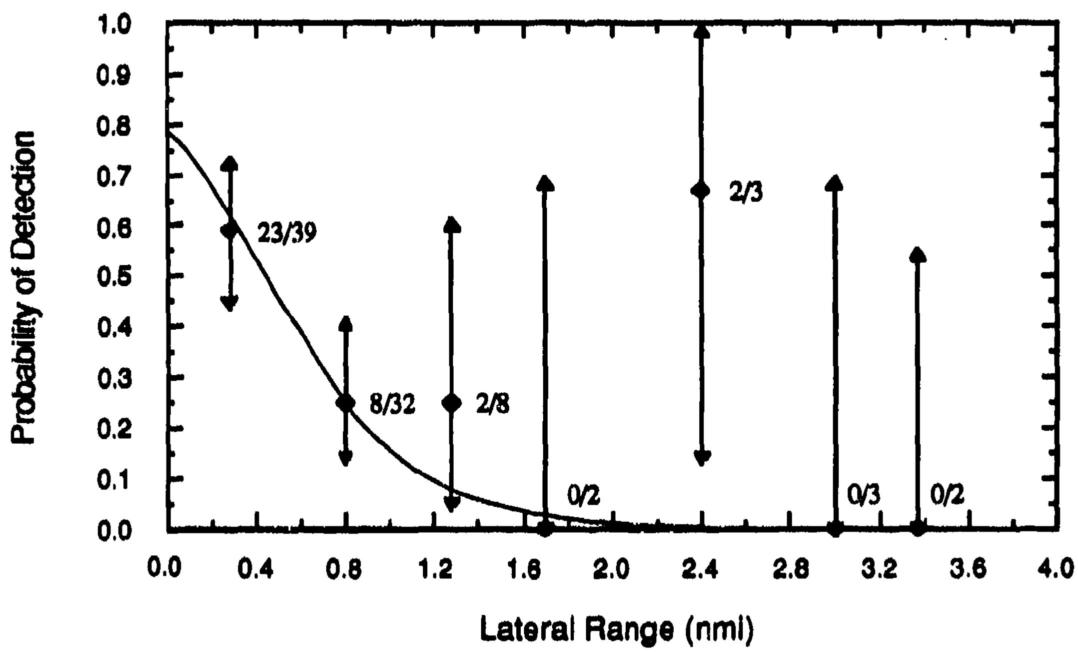


Figure A-38. VIGOROUS and ALERT Searching for Unlighted Life Rafts with $H_s \leq 5$ Feet

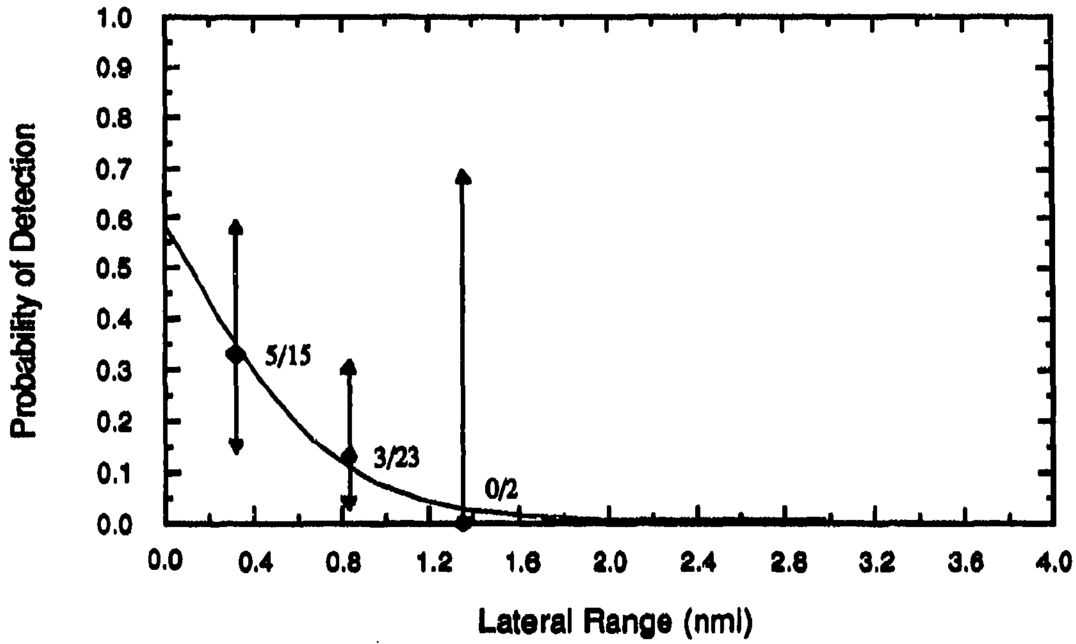


Figure A-39. VIGOROUS and ALERT Searching for Unlighted Life Rafts with H_s > 5 Feet

APPENDIX B

KEY TO DATA APPENDIX

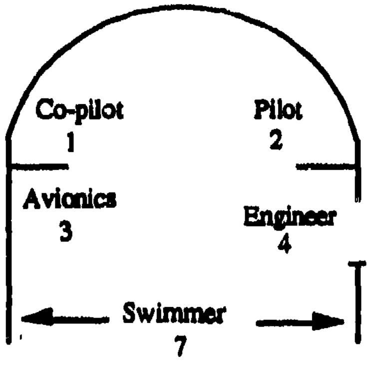
This appendix contains the raw data files for the U.S. Coast Guard NVG experiment conducted in the Spring of 1991. Each data file is labeled with the search unit hull number and the date on which the data were collected. The operational Coast Guard units corresponding to each hull number are listed below:

Hull No.	Unit Type	Operational Command
CG-1480	HH-3F	Coast Guard Air Station, Clearwater, FL
CG-2791	CH-3E	Coast Guard Air Station, Traverse City, MI
CG-6006	HH-60J	ATC, Mobile, AL
CG-8102/8101	RG-8A	Coast Guard Air Station, Miami, FL
CG-2140	HU-25C	Coast Guard Air Station, Miami, FL

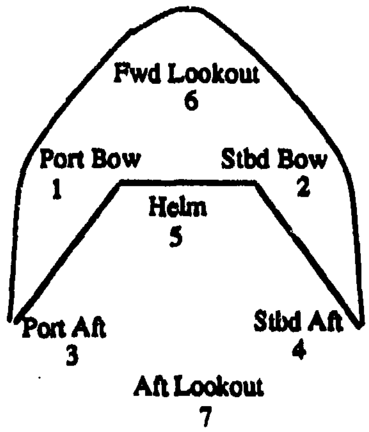
The data files are listed in chronological order by unit. Each file record represents one search unit/target interaction and describes the target detection opportunity using 25 parameters of interest. The following is a key to the format of each record.

Item 1:	DET	Detection? (1 = yes, 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:	WTTP	Water temperature (degrees Celsius)
Item 14:	RELAZ	Relative azimuth of artificial light (1 = looking into, 0 = looking across, -1 = looking away from)
Item 15:	LEV	Artificial light level (0 = rural, 1 = suburban, 2 = urban)
Item16:	ELEV	Moon elevation (degrees above (+) or below (-) the horizon)
Item 17:	MOONVIS	Moon visible from search unit (1 = yes, 0 = no)
Item 18:	MOONRA	Moon relative azimuth (1 = looking into, 0 = looking across, -1 = looking away from)
Item 19:	PHS	Moon phase (0 = none, .2, .5, .7, 1 = full)
Item 20:	SPD	Search speed (knots)
Item 21:	ALTTYPE	Search altitude or NVG type as listed below: • Helicopter data files - search altitude in feet; • Fixed winged aircraft data files - search altitude in feet;

Item 22:	POS	Position on search unit for detections or -9 for all missed targets. Position codes are shown below.



HELICOPTER



UTB

Item 23:	LO	Lookout identification number for detections or -9 for all missed targets.
Item 24:	EXP	Lookout experience with NVGs (hours) for detections or -9 for all missed targets.
Item 25:	TYNO	Target type (1 = skiff target or 2 = life raft target)
Item 26:	SUBTY	Target subtype as listed below: • Skiff (0 = 18-foot skiff, 1 = 21-foot skiff) • Life Raft (0 = life raft without retroreflective tape, -1 = life raft with retroreflective tape)

CG-6006 APRIL 22 1991

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.5	0.1	0	8	10	0	2.6	1	0	66	23.9	24.3	0	1	43	1	0	0.7	90	300	4	60	2	2	-1
1	0.5	0.4	0	8	10	0	2.6	1	0	66	23.9	24.3	-1	1	41	1	0	0.7	90	300	2	58	750	1	0
1	0.2	0.5	0	8	11	0	2.6	1	0	66	23.7	24.3	0	1	40	1	0	0.7	90	300	2	58	750	1	0
1	0.4	0.8	0	8	11	0	2.6	1	1	66	23.7	24.3	0	1	38	1	0	0.7	90	300	3	59	2	2	-1
1	0	0.8	0	8	11	0	2.6	1	0	66	23.9	24.3	0	1	38	1	0	0.7	90	300	2	58	750	1	0
1	0.3	1.1	0	8	12	0	2.6	1	-1	66	23.9	24.3	1	1	34	1	1	0.7	90	300	4	60	2	2	-1
2	1	0.1	0	8	10	0	2.6	1	0	66	23.9	24.3	-1	1	44	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.4	0.2	0	8	10	0	2.6	1	0	66	23.9	24.3	-1	1	43	1	-1	0.7	90	300	-9	-9	-9	1	0
2	1.5	0.3	0	8	10	0	2.6	1	0	66	23.9	24.3	1	1	42	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.6	0.3	0	8	1^	0	2.6	1	0	66	23.9	24.3	1	1	42	1	1	0.7	90	300	-9	-9	-9	2	-1
2	0.7	0.7	0	8	11	0	2.6	1	0	66	23.7	24.3	1	1	38	1	1	0.7	90	300	-9	-9	-9	1	0
2	1.4	0.7	0	8	11	0	2.6	1	0	66	23.7	24.3	-1	1	38	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.8	0.9	0	8	11	0	2.6	1	0	66	23.7	24.3	-1	1	36	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.2	0.9	0	8	11	0	2.6	1	0	66	23.7	24.3	1	1	36	1	1	0.7	90	300	-9	-9	-9	2	-1
2	0.9	1	0	8	12	0	2.6	1	0	66	23.9	24.3	-1	1	35	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.9	1	0	8	12	0	2.6	1	0	66	23.9	24.3	1	1	35	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.6	1	0	8	12	0	2.6	1	0	66	23.9	24.3	1	1	35	1	1	0.7	90	300	-9	-9	-9	2	-1
1	0.2	1.7	0	8	12	0	2.6	1	-1	66	24.1	24.2	1	1	26	1	0	0.7	90	300	2	58	750	2	-1
1	0.3	1.8	0	8	13	0	2.6	1	0	66	23.9	24.3	-1	1	25	1	-1	0.7	90	300	2	58	750	2	-1
1	0.8	2.1	0	8	13	0	2.6	1	1	66	23.9	24.3	-1	1	21	1	-1	0.7	90	300	3	59	3	1	0
1	0.3	2.4	0	8	13	0	2.6	1	1	66	23.9	24.3	0	1	18	1	0	0.7	90	300	3	59	3	2	-1
1	0.7	2.5	0	8	13	0	2.6	1	0	66	23.9	24.3	-1	1	16	1	0	0.7	90	300	2	58	750	1	0
2	0.2	1.5	0	8	12	0	2.6	1	0	66	23.7	24.3	-1	1	28	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.6	1.6	0	8	12	0	2.6	1	0	66	23.7	24.3	1	1	27	1	1	0.7	90	300	-9	-9	-9	2	-1
2	1.2	1.6	0	8	12	0	2.6	1	0	66	23.7	24.3	1	1	27	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.7	1.7	0	8	12	0	2.6	1	0	66	23.7	24.3	-1	1	26	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.2	1.8	0	8	12	0	2.6	1	0	66	23.7	24.3	-1	1	25	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.9	1.9	0	8	13	0	2.6	1	0	66	23.6	24.2	-1	1	24	1	-1	0.7	90	300	-9	-9	-9	1	0
2	1.1	1.9	0	8	13	0	2.6	1	0	66	23.6	24.2	1	1	23	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.2	2	0	8	13	0	2.6	1	0	66	23.6	24.2	1	1	22	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.6	2.2	0	8	13	0	2.6	1	0	66	23.6	24.2	1	1	19	1	1	0.7	90	300	-9	-9	-9	2	-1
2	1.5	2.3	0	8	13	0	2.6	1	0	66	23.6	24.2	1	1	19	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.6	2.3	0	8	13	0	2.6	1	0	66	23.6	24.2	1	1	18	1	1	0.7	90	300	-9	-9	-9	1	0
1	0.3	2.8	0	8	14	0	2.6	1	0	66	24.1	24.3	1	1	10	1	0	0.7	90	300	1	57	8	2	-1
1	0.1	2.9	0	8	14	0	2.6	1	0	66	24.1	24.3	-1	1	10	1	0	0.7	90	300	1	57	8	1	0
1	0.1	3.1	0	8	14	0	2.6	1	0	66	24.1	24.3	1	1	8	1	0	0.7	90	300	1	57	8	1	0
1	1	3.1	0	8	14	0	2.6	1	-1	66	24.1	24.3	0	1	8	1	0	0.7	90	300	3	59	2	1	0
1	0.5	3.2	0	8	14	0	2.6	1	1	66	24.1	24.3	0	1	7	1	1	0.7	90	300	2	58	750	2	-1
1	0.2	3.2	0	8	14	0	2.6	1	0	66	24.1	24.3	-1	1	7	1	1	0.7	90	300	3	59	2	1	0
1	0.1	3.3	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	5	1	0	0.7	90	300	3	59	2	2	-1
1	0.8	3	0	8	14	0	2.6	1	1	66	24.1	24.3	0	1	9	1	0	0.7	90	300	2	58	2	1	0
2	1	2.7	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	12	1	0	0.7	90	300	-9	-9	-9	2	-1
2	1.2	2.9	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	10	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.9	3.1	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	7	1	0	0.7	90	300	-9	-9	-9	1	0
2	1	3.2	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	6	1	0	0.7	90	300	-9	-9	-9	1	0
2	1	3.3	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	6	1	0	0.7	90	300	-9	-9	-9	2	-1
2	1.5	3.3	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	5	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.5	3.3	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	5	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.3	3.3	0	8	14	0	2.6	1	0	66	24.1	24.3	0	1	5	1	0	0.7	90	300	-9	-9	-9	2	-1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.7	0.1	0	15	7	5	2	0	0	83	26.2	24.5	-1	1	47	1	0	1	90	300	3	64	5	1	0
1	0	0.2	0	15	7	5	2	0	-1	83	26.2	24.5	0	1	48	1	-1	1	90	300	1	63	13	1	0
1	0	0.2	0	15	7	5	2	0	-1	83	26.2	24.5	0	1	48	1	-1	1	90	300	1	63	13	2	-1
1	0.7	0.3	0	15	7	5	2	0	0	83	26.2	24.5	1	1	48	1	0	1	90	300	1	63	13	2	-1
1	0	0.6	0	15	9	5	2	0	1	83	26	24.3	0	1	49	1	1	1	90	300	1	63	13	2	-1
1	0	0.7	0	15	9	5	2	0	1	83	26	24.3	0	1	49	1	1	1	90	300	1	63	13	2	-1
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1	0.3	1.1	0	15	8	2	2	0	0	87	26.2	24.3	1	1	49	1	0	1	90	300	4	65	0	2	-1
2	0.7	0.4	0	15	8	5	2	0	0	83	26	24.3	-1	1	48	1	0	1	90	300	-9	-9	-9	1	0
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2	1.3	0.8	0	15	9	2	2	0	0	87	26.2	24.3	-1	1	49	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	0.8	0	15	9	2	2	0	0	87	26.2	24.3	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.8	0	15	9	2	2	0	0	87	26.2	24.3	-1	1	49	1	0	1	90	300	-9	-9	-9	1	0
2	1	0.8	0	15	9	2	2	0	0	87	26.2	24.3	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	1	0	15	9	2	2	0	0	87	26.2	24.3	-1	1	49	1	0	1	90	300	-9	-9	-9	1	0
2	1.1	1.1	0	15	8	2	2	0	0	87	25.8	24.2	1	1	49	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	1.2	0	15	8	2	2	0	0	87	25.8	24.2	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
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1	0.4	1.9	0	15	5	0	2	0	0	91	25.3	24.5	0	1	47	1	0	1	90	300	4	65	0	2	-1
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1	0.4	2.3	0	15	5	0	2	0	0	91	25.3	24.5	1	1	45	1	1	1	90	300	2	24	80	1	0
1	0.2	2.4	0	15	4	0	2	0	0	91	25.2	24.5	0	1	44	1	0	1	90	300	4	65	0	2	-1
2	0.2	1.6	0	15	6	2	2	0	0	91	25.6	24.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	1.7	0	15	6	2	2	0	0	91	25.6	24.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	1.7	0	15	6	2	2	0	0	91	25.6	24.4	1	1	47	1	0	1	90	300	-9	-9	-9	1	0
2	0.2	1.9	0	15	5	2	2	0	0	91	25.2	24.4	1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	2.1	0	15	5	2	2	0	0	91	25.2	24.4	-1	1	46	1	0	1	90	300	-9	-9	-9	1	0
2	1	2.3	0	15	5	2	2	0	0	91	25.2	24.4	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	2.3	0	15	5	2	2	0	0	91	25.2	24.4	-1	1	44	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	2.4	0	15	5	2	2	0	0	91	25.2	24.4	1	1	44	1	0	1	90	300	-9	-9	-9	1	0
2	1	2.5	0	15	6	2	2	0	0	91	24.8	24.6	1	1	44	1	0	1	90	300	-9	-9	-9	1	0
2	0.5	2.6	0	15	6	4	2	0	0	95	24.8	24.6	1	1	43	1	1	1	90	300	-9	-9	-9	2	-1
2	1.2	2.6	0	15	6	4	2	0	0	95	24.8	24.6	1	1	43	1	1	1	90	300	-9	-9	-9	1	0
1	0.5	3	0	15	4	2	2	0	0	95	25.2	24.4	0	1	38	1	0	1	90	300	3	64	5	1	0
1	0.1	3.3	0	15	5	4	2	0	0	91	25.1	24.4	0	1	35	1	0	1	90	300	1	63	13	2	-1
1	0.1	3.3	0	15	5	4	2	0	-1	91	25.1	24.4	0	1	34	1	0	1	90	300	3	64	5	1	0
1	0.9	3.7	0	15	5	4	2	0	0	91	24.8	24.5	0	1	32	1	0	1	90	300	3	64	5	1	0
1	0.1	3.7	0	15	5	4	2	0	0	91	24.8	24.5	-1	1	32	1	-1	1	90	300	4	65	0	2	-1
1	0.2	4	0	15	5	4	1.6	0	0	91	24.8	24.5	1	1	29	1	0	1	90	300	4	65	0	2	-1
2	0.4	2.8	0	15	4	2	2	0	-1	91	25.2	24.4	0	1	39	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	3.1	0	15	4	2	2	0	1	91	25.2	24.4	0	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	1.1	3.2	0	15	5	2	2	0	-1	91	25.1	24.4	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	3.2	0	15	5	2	2	0	-1	91	25.1	24.4	0	1	36	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	3.4	0	15	5	4	2	0	1	91	25.1	24.4	0	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	3.4	0	15	5	4	2	0	1	91	25.1	24.4	0	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	3.7	0	15	5	4	1.6	0	-1	91	24.8	24.5	0	1	31	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	3.8	0	15	5	4	1.6	0	1	91	24.8	24.5	0	1	31	1	0	1	90	300	-9	-9	-9	1	0
2	1	3.9	0	15	5	4	1.6	0	-1	91	24.8	24.5	0	1	30	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	4	0	15	5	4	1.6	0	-1	91	24.8	24.5	0	1	28	1	0	1	90	300	-9	-9	-9	2	-1

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SKY	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
[illegible]	0.3	0.2	0	15	7	5	2	0	0	83	26	24.3	0	1	49	1	-1	1	90	300	4	62	5	1	0
[illegible]	0.4	0.2	0	15	9	5	2	0	0	83	26.2	24.3	-1	1	49	1	0	1	90	300	4	62	5	2	-1
[illegible]	0.5	0.3	0	15	9	5	2	0	0	83	26.2	24.3	1	1	49	1	0	1	90	300	4	62	5	2	-1
1	0.1	0.3	0	15	9	5	2	0	1	83	26.2	24.3	0	1	49	1	0	1	90	300	1	57	12	1	0
1	0.5	0.4	0	15	9	2	2	0	-1	87	26.2	24.3	1	1	49	1	0	1	90	300	1	57	12	1	0
1	0.1	0.5	0	15	9	2	2	0	-1	87	26.2	24.3	0	1	49	1	-1	1	90	300	2	58	754	2	-1
1	0.3	0.6	0	15	9	2	2	0	0	87	26.2	24.3	1	1	49	1	0	1	90	300	4	62	5	1	0
1	0.2	0.9	0	15	9	2	2	0	0	87	25.8	24.2	0	1	49	1	1	1	90	300	1	57	12	2	-1
1	0.2	1.1	0	15	9	2	2	0	1	87	25.8	24.2	0	1	48	1	1	1	90	300	1	57	12	1	0
1	0.1	1.2	0	15	6	2	2	0	-1	87	25.6	24.4	0	1	48	1	-1	1	90	300	2	58	754	2	-1
2	0.8	0.5	0	15	9	2	2	0	0	87	26.2	24.3	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	0.7	0	15	9	2	2	0	0	87	25.8	24.2	-1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	0.8	0	15	9	2	2	0	0	87	25.8	24.2	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	1	0.9	0	15	9	2	2	0	0	87	25.8	24.2	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	1	0	15	9	2	2	0	0	87	25.8	24.2	-1	1	49	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	1	0	15	9	2	2	0	0	87	25.8	24.2	-1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.1	0	15	9	2	2	0	0	87	25.8	24.2	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	1.2	0	15	9	2	2	0	0	87	25.8	24.2	-1	1	48	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	1.2	0	15	9	2	2	0	0	87	25.8	24.2	1	1	48	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	1.4	0	15	6	0	2	0	0	91	25.6	24.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	0.7	0	15	9	2	2	0	0	87	25.6	24.4	1	1	49	1	0	1	90	300	-9	-9	-9	2	-1
1	0.2	1.7	0	15	5	0	2	0	0	91	25.3	24.5	0	1	46	1	0	1	90	300	2	58	754	1	0
1	0.2	1.7	0	15	5	0	2	0	0	91	25.3	24.5	0	1	46	1	0	1	90	300	1	57	12	2	-1
1	0.1	2	0	15	5	0	2	0	1	91	25.3	24.5	0	1	44	1	0	1	90	300	2	58	754	2	-1
1	0	2.1	0	15	4	0	2	0	1	91	25.2	24.5	0	1	44	1	0	1	90	300	2	58	754	2	-1
1	0.2	2.3	0	15	4	2	2	0	0	98	25.2	24.5	0	1	42	1	0	1	90	300	2	58	754	1	0
1	0.5	2.4	0	15	4	2	2	0	0	98	25.2	24.5	-1	1	42	1	0	1	90	300	1	57	12	1	0
1	0.3	2.4	0	15	4	2	2	0	0	98	25.2	24.5	0	1	41	1	-1	1	90	300	1	57	12	2	-1
2	0.8	1.8	0	15	5	0	2	0	0	91	25.3	24.5	1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	1.8	0	15	5	0	2	0	0	91	25.3	24.5	1	1	45	1	0	1	90	300	-9	-9	-9	1	0
2	1.1	1.9	0	15	5	0	2	0	0	91	25.3	24.5	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	2	0	15	5	0	2	0	0	91	25.3	24.5	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2.2	0	15	5	2	2	0	0	98	25.2	24.5	1	1	43	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	2.2	0	15	4	2	2	0	0	98	25.2	24.5	-1	1	43	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	2.2	0	15	4	2	2	0	0	98	25.2	24.5	1	1	43	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	2.3	0	15	4	2	2	0	0	98	25.2	24.5	-1	1	42	1	-1	1	90	300	-9	-9	-9	2	-1
2	0.6	2.4	0	15	4	2	2	0	0	98	25.2	24.5	1	1	42	1	1	1	90	300	-9	-9	-9	1	0
2	1.1	2.5	0	15	4	2	2	0	0	98	25.2	24.5	1	1	41	1	1	1	90	300	-9	-9	-9	1	0
1	0.3	3.5	0	15	5	4	1.6	0	0	91	24.8	24.5	-1	1	28	1	-1	1	90	300	2	58	754	1	0
1	0.2	3.8	0	10	6	6	1.6	0	0	91	24.8	24.6	1	1	26	1	0	1	90	300	2	58	754	2	-1
1	0.4	3.8	0	10	6	6	1.6	0	0	91	24.8	24.6	0	1	25	1	0	1	90	300	4	62	5	2	-1
1	0.5	3.8	0	10	6	6	1.6	0	1	91	24.8	24.6	0	1	25	1	0	1	90	300	4	62	5	2	-1
2	0.5	2.8	0	15	6	4	2	0	1	91	24.8	24.6	0	1	35	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	3	0	15	6	4	2	0	-1	91	24.8	24.6	0	1	33	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	3.1	0	15	6	4	2	0	-1	91	24.8	24.6	0	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	3.1	0	15	6	4	2	0	-1	91	24.8	24.6	0	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	0.2	3.2	0	15	5	4	1.6	0	1	91	24.7	24.5	0	1	31	1	0	1	90	300	-9	-9	-9	2	-1
2	0.4	3.2	0	15	5	4	1.6	0	1	91	24.7	24.5	0	1	30	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	3.3	0	15	5	4	1.6	0	1	91	24.7	24.5	0	1	30	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	3.4	0	15	5	4	1.6	0	-1	91	24.7	24.5	0	1	29	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	3.5	0	15	5	4	1.6	0	1	91	24.7	24.5	0	1	28	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	3.6	0	15	5	4	1.6	0	1	91	24.7	24.5	0	1	27	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	3.7	0	15	6	4	1.6	0	-1	91	24.5	24.3	0	1	26	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	3.9	0	10	6	6	1.6	0	1	91	24.5	24.3	0	1	25	1	0	1	90	300	-9	-9	-9	2	-1

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DST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.3	0	12	2	9	2.6	0	0	87	25	24.4	-1	1	28	1	0	1	90	300	3	64	11	2	-1
1	0.1	0.3	0	12	2	9	2.6	0	0	87	25	24.4	-1	1	28	1	0	1	90	300	1	63	18	2	-1
1	0.2	0.4	0	12	2	9	2.6	0	0	87	25	24.4	0	1	28	1	0	1	90	300	2	24	85	1	0
1	0	0.8	0	12	2	9	2.6	0	-1	87	24.8	24.5	0	1	31	1	-1	1	90	300	2	24	85	2	-1
1	0.1	0.8	0	12	2	9	2.6	0	1	87	24.8	24.5	0	1	31	1	1	1	90	300	1	63	18	1	0
1	0.2	0.9	0	12	2	9	2.6	0	-1	87	24.8	24.5	0	1	32	1	-1	1	90	300	2	24	85	1	0
2	0.5	0.2	0	12	2	9	2.6	0	0	87	25	24.4	-1	1	27	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	0.5	0	12	2	9	2.6	0	0	87	25	24.4	1	1	29	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	0.5	0	12	2	9	2.6	0	0	87	24.8	24.5	1	1	29	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	0.6	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	30	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.8	0	12	2	9	2.6	0	0	87	24.8	24.5	1	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1	0	12	2	9	2.6	0	0	87	24.7	24.4	1	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	1.2	0	12	2	9	2.6	0	0	87	24.7	24.4	1	1	33	1	0	1	90	300	-9	-9	-9	1	0
1	0.1	1.6	0	12	4	9	3	0	0	91	24.9	24.3	-1	1	35	1	0	1	90	300	1	63	18	2	-1
1	0.1	1.6	0	12	4	9	3	0	0	91	24.9	24.5	0	1	36	1	0	1	90	300	4	66	4	1	0
1	0	1.8	0	12	4	9	3	0	1	91	24.9	24.3	0	1	36	1	1	1	90	300	2	24	85	2	-1
1	0	2.1	0	12	2	9	3	0	1	91	25	24.4	0	1	37	1	1	1	90	300	1	63	18	2	-1
1	0.2	2.3	0	12	2	9	3	0	-1	91	25	24.4	0	1	37	1	-1	1	90	300	2	24	85	1	0
1	0.2	2.4	0	12	1	9	3	0	0	91	24.8	24.5	-1	1	38	1	0	1	90	300	3	64	11	1	0
2	0.8	1.7	0	12	4	9	3	0	0	91	24.9	24.3	1	1	36	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	1.6	0	12	4	9	3	0	0	91	24.9	24.3	-1	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.8	0	12	4	9	3	0	0	91	24.9	24.3	1	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2	0	12	2	9	3	0	0	91	25	24.4	1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2.3	0	12	2	9	3	0	0	91	25	24.4	1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2.4	0	12	2	9	3	0	0	91	25	24.4	1	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	2.3	0	12	1	8	3	0	0	91	24.8	24.5	1	1	38	1	0	1	90	300	-9	-9	-9	1	0
1	0.2	2.7	0	12	3	8	2.6	0	0	91	25	24.5	0	1	38	1	-1	1	90	300	1	63	18	1	0
1	0.2	2.8	0	12	3	8	2.6	0	0	91	25	24.5	0	1	38	1	-1	1	90	300	3	64	11	1	0
1	0.2	2.9	0	12	3	8	2.6	0	0	91	25	24.5	0	1	38	1	1	1	90	300	1	63	18	1	0
1	0.1	3.1	0	12	5	8	2.6	0	-1	91	25.2	24.5	0	1	37	1	-1	1	90	300	4	66	4	2	-1
1	0.7	3.3	0	12	5	7	2.6	0	-1	91	25.2	24.5	0	1	36	1	-1	1	90	300	4	66	4	2	-1
1	0.2	3.4	0	12	5	7	2.6	0	0	91	25.2	24.5	-1	1	36	1	0	1	90	300	2	24	85	2	-1
1	0.1	3.6	0	12	7	7	2.6	0	0	91	25.2	24.5	-1	1	35	1	0	1	90	300	1	63	18	2	-1
1	0.2	3.7	0	12	7	7	2.6	0	0	91	25.2	24.5	1	1	35	1	0	1	90	300	2	24	85	2	-1
2	0.9	2.8	0	12	3	8	2.6	0	1	91	25	24.5	0	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	0.7	3.2	0	12	5	7	2.6	0	1	91	25.2	24.5	0	1	37	1	1	1	90	300	-9	-9	-9	2	-1
2	0.7	3.4	0	12	5	7	2.6	0	-1	91	25.2	24.5	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	0.4	3.5	0	12	5	7	2.6	0	1	91	25.2	24.5	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	3.8	0	12	7	7	2.6	0	1	91	25.2	24.5	0	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	3.9	0	12	7	7	2.6	0	1	91	25.2	24.5	0	1	34	1	0	1	90	300	-9	-9	-9	2	-1
1	0.3	4.1	0	12	6	10	3	0	0	91	24.8	24.5	0	1	26	0	-1	1	90	300	3	64	11	1	0
1	0.1	4.7	0	12	5	10	3	0	1	91	24.8	24.6	-1	1	21	0	0	1	90	300	2	24	85	2	-1
1	0	4.9	0	12	5	10	3	0	0	91	24.8	24.6	-1	1	19	0	-1	1	90	300	1	63	18	2	-1
1	0.1	5	0	12	6	10	3	0	0	91	24.8	24.5	1	1	18	0	1	1	90	300	2	24	83	2	-1
2	0.6	4.1	0	12	6	10	3	0	1	91	24.8	24.5	0	1	26	0	0	1	90	300	-9	-9	-9	1	0
2	0.6	4	0	12	6	10	3	0	-1	91	24.8	24.5	0	1	27	0	0	1	90	300	-9	-9	-9	1	0
2	0.3	4.2	0	12	6	10	3	0	1	91	24.8	24.5	0	1	25	0	0	1	90	300	-9	-9	-9	1	0
1	0.2	4.4	0	12	6	10	3	0	-1	91	24.8	24.5	1	1	24	0	0	1	90	300	4	66	4	2	-1
2	0.8	4.5	0	12	6	10	3	0	1	91	24.8	24.5	0	1	23	0	0	1	90	300	-9	-9	-9	2	-1
2	0.8	4.6	0	12	5	10	3	0	-1	91	24.8	24.6	0	1	22	0	0	1	90	300	-9	-9	-9	2	-1
2	0.7	4.7	0	12	5	10	3	0	-1	91	24.8	24.6	0	1	20	0	0	1	90	300	-9	-9	-9	1	0
2	0.3	4.8	0	12	5	10	3	0	1	91	24.8	24.6	0	1	20	0	0	1	90	300	-9	-9	-9	1	0
2	0.9	5.1	0	12	6	10	3	0	1	91	24.8	24.5	0	1	18	0	0	1	90	300	-9	-9	-9	2	-1
2	0.9	5.1	0	12	6	5	2.6	0	1	91	24.8	24.5	0	1	17	0	0	1	90	300	-9	-9	-9	2	-1

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DGT	LATRNG	TOT	PRSCIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0	0.3	0	12	2	9	2.6	0	1	87	24.8	24.5	0	1	31	1	1	1	90	300	2	58	758	2	-1
1	0.2	0.3	0	12	2	9	2.6	0	1	87	24.8	24.5	0	1	31	1	1	1	90	300	2	58	758	2	-1
1	0.2	0.6	0	12	2	9	2.6	0	0	87	24.7	24.4	1	1	33	1	0	1	90	300	4	60	7	2	-1
1	0	0.8	0	12	2	9	2.6	0	1	87	24.7	24.4	0	1	34	1	1	1	90	300	2	58	758	2	-1
1	0	1	0	12	2	9	2.6	0	-1	87	24.7	24.4	0	1	34	1	-1	1	90	300	2	58	758	1	0
1	0.3	1.1	0	12	4	9	2.6	0	0	91	24.9	24.3	0	1	35	1	0	1	90	300	2	58	758	1	0
2	1.3	0.1	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	30	1	0	1	90	300	-9	-9	-9	1	0
2	0.3	0.1	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	31	1	0	1	90	300	-9	-9	-9	1	0
2	0.6	0.3	0	12	2	9	2.6	0	0	87	24.8	24.5	1	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	0.2	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	31	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	0.4	0	12	2	9	2.6	0	0	87	24.8	24.5	1	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.2	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	31	1	0	1	90	300	-9	-9	-9	2	-1
2	1	0.5	0	12	2	9	2.6	0	0	87	24.7	24.4	1	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.5	0	12	2	9	2.6	0	0	87	24.8	24.5	-1	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	0.7	0	12	2	9	2.6	0	0	87	24.7	24.4	1	1	33	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.7	0	12	2	9	2.6	0	0	87	24.7	24.4	-1	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	1	0	12	4	9	2.6	0	0	87	24.9	24.3	1	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	0.8	0	12	2	9	2.6	0	0	87	24.7	24.4	-1	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	1	0	12	4	9	2.6	0	0	87	24.9	24.3	1	1	35	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	0.9	0	12	2	9	2.6	0	0	87	24.9	24.3	-1	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	1	1.2	0	12	4	9	3	0	0	91	24.9	24.3	1	1	35	1	0	1	90	300	-9	-9	-9	1	0
1	0.5	1.4	0	12	4	9	3	0	0	91	24.9	24.3	0	1	36	1	0	1	90	300	1	57	17	1	0
1	0.9	1.4	0	12	2	9	3	0	0	91	25	24.4	-1	1	36	1	0	1	90	300	2	58	758	2	-1
1	0	1.8	0	12	2	9	3	0	-1	91	25	24.4	0	1	37	1	1	1	90	300	2	58	758	2	-1
1	0.2	2	0	12	1	8	2.6	0	1	91	24.8	24.5	0	1	38	1	0	1	90	300	4	59	7	2	-1
1	0.1	2.1	0	12	1	8	2.6	0	-1	91	24.8	24.5	0	1	38	1	-1	1	90	300	2	58	758	1	0
1	0.1	2.3	0	12	1	8	2.6	0	1	91	24.8	24.5	0	1	38	1	1	1	90	300	2	58	758	1	0
2	0.4	1.6	0	12	2	9	3	0	0	91	25	24.4	-1	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	1	1.7	0	12	2	9	3	0	0	91	25	24.4	1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.3	0	12	4	9	3	0	0	91	24.9	24.3	-1	1	36	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	1.5	0	12	2	9	3	0	0	91	25	24.4	-1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	1.7	0	12	2	9	3	0	0	91	25	24.4	1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.7	0	12	2	9	3	0	0	91	25	24.4	-1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.9	0	12	1	9	3	0	0	91	24.8	24.5	1	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	1.9	0	12	1	9	3	0	0	91	24.8	24.5	-1	1	38	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2.2	0	12	1	8	2.6	0	0	91	24.8	24.5	1	1	38	1	1	1	90	300	-9	-9	-9	2	-1
2	1.3	2	0	12	1	8	2.6	0	0	91	24.8	24.5	-1	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	0.8	2.3	0	12	1	8	2.6	0	0	91	24.8	24.5	1	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	1	2.1	0	12	1	8	2.6	0	0	91	24.8	24.5	-1	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	1.3	2.4	0	12	1	8	2.6	0	0	91	24.8	24.5	1	1	38	1	1	1	90	300	-9	-9	-9	1	0
1	0.2	1.6	0	12	2	9	3	0	0	91	25	24.4	-1	1	37	1	1	1	90	300	3	59	7	2	-1
1	0.2	2.7	0	12	5	8	2.6	0	1	91	25.2	24.5	0	1	37	1	0	1	90	300	1	57	17	1	0
1	0	2.7	0	12	5	8	2.6	0	0	91	25.2	24.5	1	1	37	1	0	1	90	300	2	58	758	1	0
1	0.4	3	0	12	5	7	2.6	0	0	91	25.2	24.5	1	1	36	1	0	1	90	300	2	58	758	2	-1
1	0	3.3	0	12	7	7	2.6	0	0	91	25.2	24.5	-1	1	35	1	0	1	90	300	2	58	758	2	-1
1	0.9	3.3	0	12	7	7	2.6	0	-1	91	25.2	24.5	0	1	35	1	0	1	90	300	1	57	17	1	0
1	0.4	3.4	0	12	7	7	2.6	0	0	91	25.2	24.5	-1	1	34	1	-1	1	90	300	1	57	17	2	-1
1	0.3	3.5	0	12	7	7	2.6	0	-1	91	25.2	24.5	0	1	34	1	0	1	90	300	4	59	7	2	-1
2	0.9	2.6	0	12	3	8	2.6	0	-1	91	25.2	24.5	0	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	1	2.6	0	12	3	8	2.6	0	-1	91	25.2	24.5	0	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	2.8	0	12	5	7	2.6	0	1	91	25	24.5	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	2.8	0	12	5	7	2.6	0	-1	91	25	24.5	0	1	36	1	0	1	90	300	-9	-9	-9	2	-1
2	1	3	0	12	5	7	2.6	0	1	91	25	24.5	0	1	36	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	3.1	0	12	5	7	2.6	0	-1	91	25	24.5	0	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	1	3.4	0	12	7	7	2.6	0	1	91	24.9	24.5	0	1	35	1	0	1	90	300	-9	-9	-9	2	-1
2	0.1	3.3	0	12	7	7	2.6	0	1	91	24.9	24.5	0	1	35	1	0	1	90	300	-9	-9	-9	1	0
2	1.1	3.5	0	12	7	7	2.6	0	1	91	24.9	24.5	0	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	0.6	3.6	0	12	7	7	2.6	0	1	91	24.9	24.5	0	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	3.5	0	12	7	7	2.6	0	-1	91	24.9	24.5	0	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	3.7	0	12	6	7	2.6	0	1	91	24.8	24.5	0	1	33	1	0	1	90	300	-9	-9	-9	2	-1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.5	0.2	0	15	10	2	3.3	1	0	78	26	25.3	-1	1	-5	0	0	1	90	300	2	24	80	1	0
1	0.5	0.5	0	15	10	2	3.3	1	0	78	26	25.3	-1	1	0	0	0	1	90	300	4	65	6	2	-1
1	0.1	0.6	0	15	10	2	3.3	1	1	78	26	25.3	0	1	0	1	0	1	90	300	1	63	30	2	-1
1	0.2	0.6	0	15	10	2	3	0	0	78	26	25.3	0	1	2	1	0	1	90	300	4	65	6	2	-1
1	0.2	0.9	0	15	10	2	3	0	0	78	26	25.3	0	1	5	1	0	1	90	300	2	24	80	1	0
1	0.2	1.1	0	15	9	2	3	0	0	78	26	25.3	1	1	7	1	0	1	90	300	2	24	80	2	-1
1	0.4	1.2	0	15	9	2	3	0	0	78	26	25.3	-1	1	8	1	0	1	90	300	1	63	30	1	0
1	0.5	1.2	0	15	9	2	3	0	0	78	26	25.3	1	1	9	1	-1	1	90	300	1	63	30	1	0
2	0.3	0.3	0	15	10	2	3.3	1	0	78	26	25.3	1	1	-2	0	0	1	90	300	-9	-9	-9	1	0
2	0.8	0.4	0	15	10	2	3.3	1	0	78	26	25.3	-1	1	-1	0	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.7	0	15	10	2	3	0	0	78	26	25.3	-1	1	2	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	0.7	0	15	10	2	3	0	0	78	26	25.3	1	1	3	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.9	0	15	10	2	3	0	0	78	26	25.3	1	1	5	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	1	0	15	10	2	3	0	0	78	26	25.3	-1	1	6	1	0	1	90	300	-9	-9	-9	2	-1
1	0.7	1.5	0	15	10	2	3	0	0	78	25.9	25.3	-1	1	13	1	0	1	90	300	4	65	6	1	0
1	0.3	1.7	0	15	10	1	3	0	0	84	25.9	25.3	0	1	15	1	0	1	90	300	2	63	30	1	0
1	0.5	1.9	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	17	1	0	1	90	300	4	65	6	2	-1
1	0	1.9	0	15	9	1	3	0	0	84	25.9	25.3	-1	1	18	1	0	1	90	300	1	24	80	2	-1
1	0.3	2	0	15	9	1	3	0	0	84	25.9	25.3	1	1	18	1	0	1	90	300	2	63	30	2	-1
1	0.9	2	0	15	9	1	3	0	0	84	25.9	25.3	0	1	19	1	0	1	90	300	4	65	6	1	0
1	0.1	2.3	0	15	9	1	3	0	0	84	25.9	25.3	0	1	21	1	0	1	90	300	1	24	80	1	0
1	0.1	2.5	0	15	7	1	3	0	0	84	25.8	25.3	0	1	24	1	0	1	90	300	2	63	30	2	-1
1	0.5	2.7	0	15	7	1	3	0	0	84	25.8	25.3	1	1	25	1	0	1	90	300	1	24	80	1	0
2	0.9	1.8	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	16	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	1.8	0	15	10	1	3	0	0	84	25.9	25.3	1	1	16	1	0	1	90	300	-9	-9	-9	1	0
2	1	1.8	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	16	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	1.9	0	15	10	1	3	0	0	84	25.9	25.3	1	1	17	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	2.1	0	15	9	1	3	0	0	84	25.8	25.3	1	1	20	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	2.4	0	15	10	1	3	0	0	84	25.8	25.3	1	1	22	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	2.4	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	22	1	0	1	90	300	-9	-9	-9	2	-1
2	0.4	2.6	0	15	7	1	3	0	0	84	25.9	25.3	-1	1	24	1	0	1	90	300	-9	-9	-9	1	0
1	0.9	2.7	0	15	7	1	3	0	-1	84	25.8	25.3	0	1	27	1	-1	1	90	300	4	65	6	1	0
1	0.4	3	0	15	7	1	3	0	-1	84	25.7	25.2	1	1	29	1	-1	1	90	300	4	65	6	2	-1
1	0.1	3.1	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	30	1	0	1	90	300	1	63	30	1	0
1	0.4	3.2	0	15	7	1	3	0	0	84	25.7	25.2	0	1	30	1	0	1	90	300	1	63	30	1	0
1	0.2	3.4	0	15	6	1	3	0	0	84	25.7	25.2	1	1	32	1	0	1	90	300	2	24	80	2	-1
1	0.3	3.5	0	15	6	1	3	0	0	84	25.7	25.2	1	1	33	1	0	1	90	300	4	65	6	2	-1
1	0.1	3.9	0	15	7	1	3	0	0	84	25.6	25.2	1	1	35	1	0	1	90	300	2	24	80	2	-1
2	0.4	2.9	0	15	7	1	3	0	-1	84	25.7	25.2	0	1	29	1	-1	1	90	300	-9	-9	-9	1	0
2	1.3	3	0	15	7	1	3	0	-1	84	25.7	25.2	0	1	29	1	-1	1	90	300	-9	-9	-9	1	0
2	0.8	3	0	15	7	1	3	0	1	84	25.7	25.2	0	1	29	1	1	1	90	300	-9	-9	-9	1	0
2	1.2	3.1	0	15	7	1	3	0	-1	84	25.7	25.2	0	1	30	1	-1	1	90	300	-9	-9	-9	1	0
2	0.6	3.1	0	15	7	1	3	0	1	84	25.7	25.2	0	1	30	1	1	1	90	300	-9	-9	-9	2	-1
2	0.5	3.2	0	15	7	1	3	0	1	84	25.7	25.2	0	1	31	1	1	1	90	300	-9	-9	-9	1	0
2	0.8	3.3	0	15	7	1	3	0	1	84	25.7	25.2	0	1	31	1	1	1	90	300	-9	-9	-9	1	0
2	0.8	3.6	0	15	6	1	3	0	1	84	25.7	25.2	0	1	33	1	1	1	90	300	-9	-9	-9	2	-1
2	0.8	3.6	0	15	6	1	3	0	1	84	25.7	25.2	0	1	33	1	1	1	90	300	-9	-9	-9	2	-1
2	0.9	4	0	15	7	1	3	0	1	84	25.6	25.2	0	1	35	1	1	1	90	300	-9	-9	-9	2	-1
1	0.4	4.2	0	15	9	0	2.6	0	0	84	25.7	25.2	0	1	39	1	0	1	90	300	1	24	80	1	0
1	0.4	4.3	0	15	9	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	90	300	4	65	6	2	-1
1	0.4	4.4	0	15	9	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	90	300	1	24	80	1	0
1	0.6	4.5	0	15	9	0	2.6	0	-1	84	25.7	25.2	0	1	39	1	0	1	90	300	1	24	80	2	-1
1	0.2	4.7	0	15	9	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	90	300	1	24	80	2	-1
1	0.2	4.8	0	15	9	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	90	300	1	24	80	2	-1
1	0.1	5.2	0	15	9	1	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	90	300	2	63	30	2	-1
2	1.2	4.1	0	15	9	1	2.6	0	-1	84	25.7	25.2	0	1	39	1	-1	1	90	300	-9	-9	-9	1	0
2	0.6	4.3	0	15	9	0	2.6	0	1	84	25.7	25.2	0	1	39	1	1	1	90	300	-9	-9	-9	1	0
2	0.9	4.4	0	15	9	0	2.6	0	-1	84	25.7	25.2	0	1	39	1	-1	1	90	300	-9	-9	-9	1	0
2	0.7	4.4	0	15	9	0	2.6	0	1	84	25.7	25.2	0	1	39	1	1	1	90	300	-9	-9	-9	2	-1

CG-2791 APRIL 29 1991 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.8	4.6	0	15	9	0	2.6	0	1	84	25.7	25.2	0	1	39	1	1	1	90	300	-9	-9	-9	1	0
2	0.7	4.9	0	15	9	0	2.6	0	1	84	25.7	25.2	0	1	39	1	1	1	90	300	-9	-9	-9	2	-1
2	0.7	4.9	0	15	9	0	2.6	0	1	84	25.7	25.2	0	1	39	1	1	1	90	300	-9	-9	-9	2	-1
2	1	5.4	0	15	9	1	2.6	0	1	84	25.7	25.2	0	1	37	1	1	1	90	300	-9	-9	-9	2	-1

CG-2140 **APRIL 29 1991**

DET	LATRNC	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.6	0.3	0	15	10	2	3	0	0	78	26	25.3	1	1	11	1	0	1	180	500	3	69	0	2	-1
1	0.7	0.3	0	15	10	2	3	0	0	78	26	25.3	1	1	11	1	0	1	180	500	3	69	0	2	-1
1	0.5	0.4	0	15	10	1	3	0	0	84	25.9	25.3	1	1	14	1	0	1	180	500	3	69	0	2	-1
2	1.3	0	0	15	10	2	3	0	0	78	26	25.3	-1	1	8	1	0	1	180	500	-9	-9	-9	1	0
2	1.3	0.1	0	15	10	2	3	0	0	78	26	25.3	-1	1	9	1	0	1	180	500	-9	-9	-9	2	-1
2	0.7	0.2	0	15	10	2	3	0	0	78	26	25.3	1	1	10	1	0	1	180	500	-9	-9	-9	1	0
2	0.5	0.2	0	15	10	2	3	0	0	78	26	25.3	1	1	11	1	0	1	180	500	-9	-9	-9	2	-1
2	0.5	0.4	0	15	10	2	3	0	0	78	25.9	25.3	1	1	12	1	0	1	180	500	-9	-9	-9	1	0
2	0	0.4	0	15	10	1	3	0	-1	84	25.9	25.3	0	1	13	1	0	1	180	500	-9	-9	-9	1	0
2	1.9	0.1	0	15	10	2	3	0	0	78	26	25.3	-1	1	10	1	0	1	180	500	-9	-9	-9	2	-1
2	1.4	0.2	0	15	10	2	3	0	0	78	26	25.3	-1	1	10	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	0.2	0	15	10	2	3	0	0	78	26	25.3	-1	1	11	1	0	1	180	500	-9	-9	-9	1	0
2	1.6	0.3	0	15	10	2	3	0	0	78	26	25.3	-1	1	12	1	0	1	180	500	-9	-9	-9	2	-1
1	0.9	0.6	0	15	9	1	3	0	0	84	25.9	25.3	0	1	15	1	0	1	180	500	4	70	0	1	0
1	0.4	0.9	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	18	1	0	1	180	500	4	70	0	2	-1
1	0.4	0.9	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	18	1	0	1	180	500	4	70	0	2	-1
2	1	0.7	0	15	9	1	3	0	0	84	25.9	25.3	-1	1	16	1	0	1	180	500	-9	-9	-9	1	0
2	0.5	0.7	0	15	9	1	3	0	0	84	25.9	25.3	-1	1	16	1	0	1	180	500	-9	-9	-9	2	-1
2	1.1	0.8	0	15	9	1	3	0	0	84	25.9	25.3	1	1	17	1	0	1	180	500	-9	-9	-9	2	-1
2	0.5	0.8	0	15	9	1	3	0	0	84	25.9	25.3	-1	1	17	1	0	1	180	500	-9	-9	-9	1	0
2	0.8	0.9	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	18	1	0	1	180	500	-9	-9	-9	2	-1
2	0.3	0.9	0	15	10	1	3	0	0	84	25.9	25.3	-1	1	19	1	0	1	180	500	-9	-9	-9	1	0
2	1.4	0.6	0	15	9	1	3	0	0	84	25.9	25.3	1	1	15	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	0.6	0	15	9	1	3	0	0	84	25.9	25.3	1	1	16	1	0	1	180	500	-9	-9	-9	1	0
2	1.6	0.7	0	15	9	1	3	0	0	84	25.9	25.3	1	1	16	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	0.7	0	15	9	1	3	0	0	84	25.9	25.3	1	1	17	1	0	1	180	500	-9	-9	-9	2	-1
2	1.7	0.9	0	15	10	1	3	0	0	84	25.9	25.3	1	1	18	1	0	1	180	500	-9	-9	-9	1	0
1	0.6	1.2	0	15	7	1	3	0	0	84	25.9	25.3	1	1	22	1	0	1	180	500	4	70	0	1	0
1	0.6	1.3	0	15	7	1	3	0	0	84	25.8	25.3	1	1	23	1	0	1	180	500	3	69	0	2	-1
1	0.2	1.3	0	15	7	1	3	0	0	84	25.8	25.3	1	1	23	1	0	1	180	500	3	69	0	2	-1
1	0.7	1.3	0	15	7	1	3	0	0	84	25.8	25.3	1	1	23	1	0	1	180	500	3	69	0	2	-1
1	0.5	1.4	0	15	7	1	3	0	0	84	25.8	25.3	0	1	24	1	0	1	180	500	4	70	0	1	0
1	0.4	1.5	0	15	7	1	3	0	0	84	25.8	25.3	1	1	25	1	0	1	180	500	3	69	0	2	-1
2	1.2	1.1	0	15	7	1	3	0	0	84	25.9	25.3	-1	1	21	1	0	1	180	500	-9	-9	-9	1	0
2	1.4	1.1	0	15	7	1	3	0	0	84	25.9	25.3	-1	1	22	1	0	1	180	500	-9	-9	-9	2	-1
2	0	1.5	0	15	7	1	3	0	0	84	25.8	25.3	0	1	25	1	0	1	180	500	-9	-9	-9	1	0
2	1.7	1.1	0	15	7	1	3	0	0	84	25.9	25.3	-1	1	22	1	0	1	180	500	-9	-9	-9	2	-1
2	1.1	1.2	0	15	7	1	3	0	0	84	25.9	25.3	-1	1	22	1	0	1	180	500	-9	-9	-9	2	-1
2	1.1	1.3	0	15	7	1	3	0	0	84	25.8	25.3	-1	1	23	1	0	1	180	500	-9	-9	-9	1	0
2	1.2	1.4	0	15	7	1	3	0	0	84	25.8	25.3	-1	1	24	1	0	1	180	500	-9	-9	-9	2	-1
1	0.5	1.7	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	28	1	0	1	180	500	4	70	0	2	-1
1	0.6	1.8	0	15	7	1	3	0	0	84	25.7	25.2	0	1	29	1	0	1	180	500	3	69	0	1	0
1	0.4	1.8	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	29	1	0	1	180	500	4	70	0	2	-1
1	0.3	1.9	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	30	1	0	1	180	500	4	70	0	2	-1
1	0.4	2	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	31	1	0	1	180	500	3	69	0	1	0
2	1.3	1.6	0	15	7	1	3	0	0	84	25.8	25.3	1	1	27	1	0	1	180	500	-9	-9	-9	2	-1
2	0.9	1.6	0	15	7	1	3	0	0	84	25.8	25.3	1	1	27	1	0	1	180	500	-9	-9	-9	1	0
2	1	1.6	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	28	1	0	1	180	500	-9	-9	-9	1	0
2	1.1	1.8	0	15	7	1	3	0	0	84	25.7	25.2	1	1	28	1	0	1	180	500	-9	-9	-9	2	-1
2	0.8	1.9	0	15	7	1	3	0	0	84	25.7	25.2	-1	1	29	1	0	1	180	500	-9	-9	-9	2	-1
2	1.6	1.6	0	15	7	1	3	0	0	84	25.7	25.2	1	1	28	1	0	1	180	500	-9	-9	-9	1	0
2	1.7	1.8	0	15	7	1	3	0	0	84	25.7	25.2	1	1	28	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	1.3	0	15	7	1	3	0	0	84	25.7	25.2	1	1	29	1	0	1	180	500	-9	-9	-9	2	-1
2	1.7	1.8	0	15	7	1	3	0	0	84	25.7	25.2	1	1	29	1	0	1	180	500	-9	-9	-9	1	0
1	0.5	2.3	0	15	8	1	2.6	0	0	84	25.6	25.2	1	1	38	1	0	1	180	500	3	70	0	2	-1
1	0.6	2.3	0	15	8	1	2.6	0	0	84	25.6	25.2	1	1	38	1	0	1	180	500	3	70	0	2	-1
1	0.4	2.7	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	3	70	0	1	0
2	1.3	2.1	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	37	1	0	1	180	500	-9	-9	-9	1	0
2	1.3	2.1	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	0.7	2.2	0	15	8	1	2.6	0	0	84	25.6	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	0.1	2.3	0	15	8	1	2.6	0	0	84	25.6	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	0.5	2.4	0	15	8	1	2.6	0	0	84	25.6	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	0.1	2.5	0	15	8	1	2.6	0	0	84	25.5	25.2	0	1	38	1	0	1	180	500	-9	-9	-9	1	0

CG-2140 APRIL 29 1991 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1.9	2.2	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	2.2	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	2.3	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	1.6	2.7	0	15	8	1	2.6	0	0	84	25.6	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
1	0.6	2.8	0	15	8	1	2.6	0	0	84	25.5	25.2	-1	1	39	1	0	1	180	500	3	70	0	1	0
1	0.4	3	0	15	9	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	3	70	0	1	0
2	1.3	2.6	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.8	2.6	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	1.2	2.7	0	15	8	1	2.6	0	0	84	25.5	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	0.6	2.7	0	15	8	1	2.6	0	0	84	25.5	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1	2.8	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.5	2.9	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.9	2.9	0	15	9	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.5	2.9	0	15	9	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.4	2.7	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	1.5	2.8	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.4	2.8	0	15	8	1	2.6	0	0	84	25.5	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.7	2.9	0	15	9	1	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	1	0
1	0.2	3.3	0	15	8	0	2.6	0	0	84	25.7	25.2	0	1	39	1	0	1	180	500	4	70	0	2	-1
2	1.3	3.2	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.7	3.2	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	0.5	3.3	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.6	3.3	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	0.4	3.4	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	0.1	3.5	0	15	8	0	2.6	0	0	84	25.7	25.2	0	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	0.4	3.5	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.9	3.1	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	1.9	3.2	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	3.2	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
2	1.5	3.3	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	1	0
2	1.7	3.4	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	39	1	0	1	180	500	-9	-9	-9	2	-1
1	0.7	3.8	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	4	70	0	1	0
1	0.6	3.9	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	3	69	0	2	-1
1	0.9	3.9	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	3	69	0	2	-1
1	0.4	3.9	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	3	69	0	2	-1
1	0.5	4	0	15	9	1	2.6	0	0	84	25.7	25.2	-1	1	37	1	0	1	180	500	4	70	0	1	0
2	1.3	3.6	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	0.8	3.6	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	1.1	3.7	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	0.7	3.7	0	15	8	0	2.6	0	0	84	25.7	25.2	-1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1	3.8	0	15	9	0	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1.4	3.7	0	15	8	0	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	1	0
2	1.5	3.8	0	15	9	0	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1.4	3.8	0	15	9	1	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	2	-1
2	1.6	3.9	0	15	9	1	2.6	0	0	84	25.7	25.2	1	1	38	1	0	1	180	500	-9	-9	-9	1	0

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.4	0	15	8	1	2.3	0	0	79	25.8	25.8	-1	1	-22	0	1	0.7	90	300	1	24	100	1	0
1	0.1	0.6	0	15	9	1	2.3	0	1	77	25.7	25.7	0	1	-19	0	0	0.7	90	300	1	24	100	2	-1
1	0.2	1	0	15	8	1	2.3	0	0	77	25.8	25.7	1	1	-15	0	0	0.7	90	300	1	24	100	2	-1
1	0.3	1.1	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-14	0	0	0.7	90	300	4	66	10	2	-1
1	0	1.3	0	15	8	1	2	0	-1	77	25.8	25.7	0	1	-11	0	0	0.7	90	300	3	72	7	1	0
2	1.2	0.2	0	15	8	1	2.3	0	0	79	25.8	25.8	-1	1	-25	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.8	0.5	0	15	9	1	2.3	0	0	79	25.7	25.7	1	1	-22	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.9	0.5	0	15	9	1	2.3	0	0	79	25.7	25.7	-1	1	-21	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.4	0.6	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-20	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	0.8	0	15	9	1	2	0	0	77	25.7	25.7	1	1	-18	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.8	1	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-16	0	0	0.7	90	300	-9	-9	-9	2	-1
1	0.6	1.1	0	15	8	1	2	0	1	77	25.8	25.7	0	1	-14	0	0	0.7	90	300	1	24	100	1	0
2	0.8	1.2	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-13	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.9	1.2	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-13	0	0	0.7	90	300	-9	-9	-9	1	0
2	1	1.2	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-12	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.4	1.3	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-11	0	0	0.7	90	300	-9	-9	-9	1	0
1	0.3	1.7	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-5	0	1	0.7	90	300	1	24	100	1	0
1	0.3	1.9	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-3	0	0	0.7	90	300	3	72	7	2	-1
1	0.1	2	0	15	6	1	2	0	1	77	25.7	25.6	0	1	-2	0	0	0.7	90	300	1	24	100	2	-1
1	0	2.3	0	15	6	1	2	0	-1	77	25.7	25.6	0	1	2	1	0	0.7	90	300	2	63	40	2	-1
1	0.2	2.4	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	2	1	0	0.7	90	300	2	63	40	2	-1
1	0.1	2.8	0	15	6	1	2	0	0	79	25.7	25.6	0	1	5	1	-1	0.7	90	300	1	24	100	1	0
2	1.2	1.5	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	[illegible]	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	1.8	0	15	7	1	2	0	0	77	25.8	25.7	1	1	-4	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.9	1.8	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-4	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.6	2.1	0	15	6	1	2	0	0	77	25.7	25.6	1	1	0	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.9	2.3	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	1	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	2.4	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	3	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	2.5	0	15	6	1	2	0	0	79	25.7	25.6	1	1	3	1	0	0.7	90	300	-9	-9	-9	2	-1
2	1	2.5	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	4	1	0	0.7	90	300	-9	-9	-9	1	0
2	1	2.6	0	15	6	1	2	0	0	79	25.7	25.6	1	1	4	1	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	2.7	0	15	6	1	2	0	0	79	25.7	25.6	1	1	5	1	0	0.7	90	300	-9	-9	-9	1	0
1	0.2	2.7	0	15	6	1	2	0	-1	79	25.7	25.6	1	1	7	1	-1	0.7	90	300	2	63	40	2	-1
1	0.2	3	0	15	6	1	2	0	0	79	25.7	25.6	1	1	10	1	0	0.7	90	300	2	63	40	1	0
1	0	3.1	0	15	6	1	2	0	0	79	25.7	25.6	1	1	11	1	0	0.7	90	300	1	24	100	1	0
1	0.3	3.2	0	15	6	1	2	0	0	79	25.7	25.6	1	1	12	1	0	0.7	90	300	2	63	40	2	-1
1	0.4	3.5	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	15	1	1	0.7	90	300	2	63	40	2	-1
1	0.3	3.7	0	15	6	1	2	0	-1	79	25.6	25.5	0	1	17	1	0	0.7	90	300	3	72	7	2	-1
2	0.8	2.8	0	15	6	1	2	0	-1	79	25.7	25.5	0	1	8	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.9	2.9	0	15	6	1	2	0	1	79	25.7	25.5	0	1	9	1	1	0.7	90	300	-9	-9	-9	2	-1
2	1.2	3	0	15	6	1	2	0	1	79	25.7	25.5	0	1	10	1	1	0.7	90	300	-9	-9	-9	1	0
2	1	3.1	0	15	6	1	2	0	-1	79	25.7	25.5	0	1	11	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.7	3.3	0	15	6	1	2	0	1	79	25.7	25.5	0	1	13	1	1	0.7	90	300	-9	-9	-9	2	-1
2	0.9	3.3	0	15	6	1	2	0	1	79	25.7	25.5	0	1	14	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.7	3.4	0	15	6	1	2	0	-1	79	25.7	25.5	0	1	14	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	1.1	3.6	0	15	6	1	2	0	-1	79	25.7	25.5	0	1	16	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.8	3.8	0	15	6	1	2	0	1	79	25.7	25.5	0	1	17	1	1	0.7	90	300	-9	-9	-9	1	0
1	0.2	3.9	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	31	1	0	0.7	90	300	2	63	40	2	-1
1	0.3	4.2	0	15	5	3	1.6	0	1	83	25.5	25.5	0	1	32	1	0	0.7	90	300	2	63	40	1	0
1	0	4.3	0	15	3	3	1.6	0	0	83	25.5	25.5	1	1	33	1	0	0.7	90	300	1	24	100	1	0
1	0.3	4.4	0	15	3	3	1.6	0	-1	83	25.5	25.5	0	1	33	1	-1	0.7	90	300	4	66	10	2	-1
1	0.3	4.7	0	15	3	3	1.6	0	1	83	25.5	25.5	0	1	34	1	1	0.7	90	300	1	24	100	2	-1
1	0.9	4.8	0	15	3	3	1.6	0	0	83	25.5	25.5	0	1	35	1	0	0.7	90	300	2	63	40	1	0
1	0	5	0	15	2	1	1.6	0	0	83	25.3	25.5	-1	1	35	1	0	0.7	90	300	1	24	100	1	0
2	0.7	4	0	15	5	3	1.6	0	-1	83	25.5	25.5	0	1	31	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.9	4.1	0	15	5	3	1.6	0	1	83	25.5	25.5	0	1	32	1	1	0.7	90	300	-9	-9	-9	2	-1
2	1.2	4.2	0	15	5	3	1.6	0	1	83	25.5	25.5	0	1	32	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.9	4.3	0	15	[illegible]	3	1.6	0	-1	83	25.5	25.5	0	1	33	1	-1	0.7	90	300	-9	-9	-9	1	0
2	0.6	4.5	0	15	[illegible]	3	1.6	0	1	83	25.5	25.5	0	1	34	1	1	0.7	90	300	-9	-9	-9	2	-1

CG-2791 MAY 1 1991 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1	4.5	0	15	3	3	1.6	0	1	83	25.5	25.5	0	1	34	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.8	4.8	0	15	3	3	1.6	0	-1	83	25.5	25.5	0	1	34	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.4	4.9	0	15	2	1	1.6	0	-1	83	25.3	25.5	0	1	35	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	1	5	0	15	2	1	1.6	0	1	83	25.3	25.5	0	1	35	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.5	5	0	15	2	1	1.6	0	1	83	25.3	25.5	0	1	36	1	1	0.7	90	300	-9	-9	-9	2	-1

CG-2140 **MAY 1 1991**

DET	LATRNG		PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.2	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-18	0	-1	0.7	180	500	4	73	20	1	0
1	0.3	0.5	0	15	9	1	2	0	0	77	25.8	25.7	-1	1	-15	0	0	0.7	180	500	4	73	20	1	0
2	1.8	0	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-20	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.5	0.2	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-18	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	0.3	0	15	9	1	2	0	0	77	25.7	25.7	1	1	-18	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	0.3	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-17	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.7	0.3	0	15	9	1	2	0	0	77	25.7	25.7	1	1	-16	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	0.3	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-16	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	0.4	0	15	9	1	2	0	0	77	25.7	25.7	-1	1	-16	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	0.4	0	15	9	1	2	0	0	77	25.8	25.7	1	1	-15	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	0.5	0	15	9	1	2	0	0	77	25.8	25.7	-1	1	-15	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	0.5	0	15	9	1	2	0	0	77	25.8	25.7	1	1	-15	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	0.5	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-14	0	0	0.7	180	500	-9	-9	-9	1	0
2	2	0.5	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-13	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.4	0.6	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-13	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.5	0.6	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-12	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	0.6	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-12	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	0.7	0	15	8	1	2	0	0	77	25.8	25.7	0	1	-12	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	0.7	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-12	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.7	0.7	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	2	0.8	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	0.8	0	15	8	1	2	0	0	77	25.8	25.7	1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.5	0.8	0	15	8	1	2	0	0	77	25.8	25.7	-1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.2	0.8	0	15	7	1	2	0	0	77	25.8	25.7	1	1	-10	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.6	0.9	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-10	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.2	0.9	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-9	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.8	1	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-8	0	0	0.7	180	500	-9	-9	-9	1	0
1	0.2	1.2	0	15	7	1	2	0	0	77	25.8	25.7	1	1	-5	0	0	0.7	180	500	4	74	80	1	0
1	0.3	1.5	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-1	0	0	0.7	180	500	4	74	80	1	0
2	1.7	1	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-7	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.6	1.2	0	15	7	1	2	0	0	77	25.8	25.7	-1	1	-5	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	1.3	0	15	7	1	2	0	0	77	25.8	25.7	1	1	-4	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.2	1.3	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-4	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.7	1.3	0	15	6	1	2	0	0	77	25.7	25.6	1	1	-3	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.9	1.4	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-3	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	1.4	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-3	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	1.4	0	15	6	1	2	0	0	77	25.7	25.6	1	1	-2	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	1.5	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	-2	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	1.5	0	15	6	1	2	0	0	77	25.7	25.6	1	1	-2	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	1.5	0	15	6	1	2	0	0	77	25.7	25.6	1	1	0	0	0	0.7	180	500	-9	-9	-9	1	0
2	2	1.5	0	15	6	1	2	0	0	77	25.7	25.6	1	1	0	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	1.6	0	15	6	1	2	0	0	77	25.7	25.6	1	1	0	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.5	1.6	0	15	6	1	2	0	0	77	25.7	25.6	1	1	0	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	1.6	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	1	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	1.7	0	15	6	1	2	0	0	77	25.7	25.6	0	1	1	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	1.7	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	2	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.6	1.7	0	15	6	1	2	0	0	77	25.7	25.6	1	1	2	1	0	0.7	180	500	-9	-9	-9	2	-1
2	2	1.7	0	15	6	1	2	0	0	77	25.7	25.6	-1	1	2	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.3	1.8	0	15	6	1	2	0	0	77	25.7	25.6	1	1	3	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	1.8	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	3	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.1	1.8	0	15	6	1	2	0	0	79	25.7	25.6	1	1	3	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.5	1.8	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	4	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.3	1.9	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	4	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.9	2	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	4	1	0	0.7	180	500	-9	-9	-9	1	0
1	0.1	2.2	0	15	6	1	2	0	0	79	25.7	25.5	1	1	7	1	0	0.7	180	500	4	74	80	1	0
1	0.2	2.3	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	8	1	0	0.7	180	500	4	74	80	2	-1
2	1.9	2	0	15	6	1	2	0	0	79	25.7	25.6	-1	1	6	1	0	0.7	180	500	-9	-9	-9	1	0
2	1.6	2.2	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	7	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	2.3	0	15	6	1	2	0	0	79	25.7	25.5	1	1	8	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.7	2.3	0	15	6	1	2	0	0	79	25.7	25.5	1	1	9	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1	2.4	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	9	1	0	0.7	180	500	-9	-9	-9	2	-1

CG-2140 MAY 1 1991 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.5	2.4	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	10	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	2.4	0	15	6	1	2	0	0	79	25.7	25.5	1	1	10	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	2.5	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	10	1	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	2.5	0	15	6	1	2	0	0	79	25.7	25.5	1	1	10	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	2.5	0	15	6	1	2	0	0	79	25.7	25.5	-1	1	11	1	0	0.7	180	500	-9	-9	-9	1	0
1	0.6	2.6	0	15	5	0	2	0	0	83	25.5	25.5	1	1	22	1	0	0.7	180	500	4	74	80	1	0
1	0.5	2.6	0	15	5	0	2	0	0	83	25.5	25.5	1	1	22	1	0	0.7	180	500	4	74	80	1	0
2	0.7	2.6	0	15	5	0	2	0	0	83	25.5	25.5	1	1	23	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.5	2.7	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	23	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.2	2.7	0	15	5	0	2	0	0	83	25.5	25.5	1	1	23	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1	2.7	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	24	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.6	2.7	0	15	5	0	2	0	0	83	25.5	25.5	1	1	24	1	0	0.7	180	500	-9	-9	-9	2	-1
2	2	2.8	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	24	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	2.8	0	15	5	0	2	0	0	83	25.5	25.5	1	1	24	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.3	2.8	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	25	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.2	2.9	0	15	5	0	2	0	0	83	25.5	25.5	1	1	25	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.4	2.9	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	25	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1	2.9	0	15	5	0	2	0	0	83	25.5	25.5	-1	1	25	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.8	3	0	15	6	0	2	0	0	83	25.5	25.5	-1	1	26	1	0	0.7	180	500	-9	-9	-9	1	0
1	0.6	3.3	0	15	6	1	2	0	0	83	25.5	25.5	1	1	29	1	0	0.7	180	500	3	73	20	2	-1
1	0.4	3.4	0	15	5	1	2	0	0	83	25.5	25.5	-1	1	30	1	0	0.7	180	500	3	73	20	2	-1
1	0.4	3.5	0	15	5	3	1.6	0	0	83	25.5	25.5	-1	1	30	1	0	0.7	180	500	4	74	80	1	0
1	0.1	3.5	0	15	5	3	1.6	0	0	83	25.5	25.5	0	1	31	1	0	0.7	180	500	3	73	20	1	0
1	1.5	3.1	0	15	5	1	2	0	0	83	25.5	25.5	-1	1	27	1	0	0.7	180	500	-9	-9	-9	1	0
2	1.8	3.2	0	15	6	1	2	0	0	83	25.5	25.5	-1	1	28	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0	3.2	0	15	6	1	2	0	0	83	25.5	25.5	0	1	28	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.1	3.3	0	15	6	1	2	0	0	83	25.5	25.5	1	1	29	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	3.4	0	15	6	1	2	0	0	83	25.5	25.5	1	1	29	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.1	3.4	0	15	5	1	2	0	0	83	25.5	25.5	-1	1	30	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	3.5	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	30	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.3	3.5	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	31	1	0	0.7	180	500	-9	-9	-9	2	-1
1	0.4	3.6	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	31	1	0	0.7	180	500	4	74	80	1	0
1	0.2	3.7	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	32	1	0	0.7	180	500	3	73	20	2	-1
2	0.6	3.6	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	31	1	0	0.7	180	500	-9	-9	-9	1	0
2	2	3.6	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	31	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	3.7	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	32	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	3.7	0	15	5	3	1.6	0	0	83	25.5	25.5	-1	1	32	1	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	3.7	0	15	5	3	1.6	0	0	83	25.5	25.5	-1	1	32	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.6	3.8	0	15	5	3	1.6	0	0	83	25.5	25.5	1	1	32	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	3.8	0	15	3	3	1.6	0	0	83	25.5	25.5	1	1	32	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	3.8	0	15	3	3	1.6	0	0	83	25.5	25.5	-1	1	32	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1.2	3.9	0	15	3	3	1.6	0	0	83	25.5	25.5	1	1	33	1	0	0.7	180	500	-9	-9	-9	1	0
2	0.5	3.9	0	15	3	3	1.6	0	0	83	25.5	25.5	-1	1	33	1	0	0.7	180	500	-9	-9	-9	2	-1
2	1	3.9	0	15	3	3	1.6	0	0	83	25.5	25.5	-1	1	33	1	0	0.7	180	500	-9	-9	-9	2	-1
2	0.8	4	0	15	3	3	1.6	0	0	83	25.5	25.5	-1	1	33	1	0	0.7	180	500	-9	-9	-9	1	0

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.1	0.5	0	15	5	0	1.6	0	-1	75	26	26.2	0	1	-15	0	0	0.7	90	300	2	24	106	2	-1
2	0.8	0.2	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-19	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	0.2	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-19	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.2	0.3	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-18	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.2	0.3	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-17	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.9	0.6	0	15	5	0	1.6	0	0	74	26	26.2	1	1	-14	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.3	0.7	0	15	5	0	1.6	0	0	74	26	26.2	-1	1	-13	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	0.9	0	15	5	0	1.6	0	0	74	26	26.2	1	1	-10	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.4	0.9	0	15	5	0	1.6	0	0	74	26	26.1	-1	1	-10	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.8	1	0	15	5	0	1.6	0	0	74	26	26.1	-1	1	-9	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.3	1.1	0	15	5	0	1.6	0	0	74	26	26.1	-1	1	-8	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	1.2	0	15	5	0	1.6	0	0	74	26	26.1	1	1	-6	0	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	1.2	0	15	5	0	1.6	0	0	74	26	26.1	1	1	-6	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.7	1.5	0	15	6	1	1.6	0	0	74	26	26	-1	1	-2	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.7	1.6	0	15	6	1	1.6	0	0	74	26	26	-1	1	-2	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.3	1.7	0	15	6	1	1.6	0	0	74	26	26	1	1	-1	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.2	1.7	0	15	6	1	1.6	0	0	74	26	26	1	1	0	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.2	1.9	0	15	6	1	1.6	0	0	74	26	26	-1	1	0	0	0	0.7	90	300	-9	-9	-9	2	-1
2	0.8	1.9	0	15	5	1	1.6	0	0	74	26	25.9	1	1	2	1	0	0.7	90	300	-9	-9	-9	2	-1
2	0.3	2.1	0	15	5	1	1.6	0	0	74	26	25.9	-1	1	3	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	2.3	0	15	5	1	1.6	0	0	74	26	25.9	1	1	6	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.6	2.3	0	15	5	1	1.6	0	0	74	26	25.9	-1	1	6	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.6	2.4	0	15	5	1	1.6	0	0	74	25.8	25.8	-1	1	7	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.4	2.4	0	15	5	1	1.6	0	0	74	25.8	25.8	1	1	8	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.2	2.5	0	15	5	1	1.6	0	0	74	25.8	25.8	-1	1	8	1	0	0.7	90	300	-9	-9	-9	2	-1
2	0.5	2.6	0	15	5	1	1.6	0	0	74	25.8	25.8	1	1	9	1	0	0.7	90	300	-9	-9	-9	1	0
2	0.7	2.6	0	15	5	1	1.6	0	0	74	25.8	25.8	1	1	9	1	0	0.7	90	300	-9	-9	-9	2	-1
1	0.1	2.7	0	15	5	1	1.6	0	0	74	25.8	25.8	1	1	11	1	0	0.7	90	300	2	24	106	1	0
1	0	3.1	0	15	4	1	1.6	0	0	74	25.6	25.8	-1	1	15	1	0	0.7	90	300	1	63	45	1	0
1	0	3.3	0	15	3	1	1.6	0	0	74	25.7	25.8	-1	1	17	1	0	0.7	90	300	1	63	45	2	-1
1	0.1	3.8	0	15	4	1	1.6	0	0	74	25.8	25.8	1	1	22	1	0	0.7	90	300	2	24	106	1	0
1	0.3	3.9	0	15	4	1	1.6	0	1	74	25.8	25.8	0	1	22	1	1	0.7	90	300	1	63	45	2	-1
2	0.8	2.9	0	15	4	1	1.6	0	1	74	25.6	25.8	0	1	13	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.7	3	0	15	4	1	1.6	0	-1	74	25.6	25.8	0	1	14	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.4	3	0	15	4	1	1.6	0	1	74	25.6	25.8	0	1	14	1	1	0.7	90	300	-9	-9	-9	2	-1
2	1	3.1	0	15	4	1	1.6	0	-1	74	25.6	25.8	0	1	16	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.8	3.2	0	15	4	1	1.6	0	1	74	25.6	25.8	0	1	16	1	1	0.7	90	300	-9	-9	-9	1	0
2	0.4	3.5	0	15	3	1	1.6	0	-1	74	25.7	25.8	0	1	19	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	0.6	3.6	0	15	3	1	1.6	0	[illegible]	74	25.7	25.8	0	1	20	1	1	0.7	90	300	-9	-9	-9	2	-1
2	0.7	3.7	0	15	3	1	1.6	0	-1	74	25.7	25.8	0	1	20	1	-1	0.7	90	300	-9	-9	-9	2	-1
2	1	4	0	15	4	1	1.6	0	1	74	25.8	25.8	0	1	23	1	1	0.7	90	300	-9	-9	-9	1	0

CG-2140 MAY 3 1991

DST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1.5	0.1	0	15	7	0	1.6	0	0	69	25.9	26.5	-1	1	-39	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	0.1	0	15	7	0	1.6	0	0	69	25.9	26.5	-1	1	-37	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	0.1	0	15	7	0	1.6	0	0	69	25.9	26.5	1	1	-37	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	0.2	0	15	7	0	1.6	0	0	69	25.9	26.5	-1	1	-37	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.4	0.2	0	15	7	0	1.6	0	0	69	25.9	26.5	1	1	-37	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	0.3	0	15	7	0	1.6	0	0	69	25.9	26.5	-1	1	-36	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	0.3	0	15	7	0	1.6	0	0	69	25.9	26.5	1	1	-35	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	0.4	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-35	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	0.4	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-34	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	0.4	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-34	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	0.5	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-33	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	0.5	0	15	6	0	1.6	0	-1	69	25.9	26.5	0	1	-33	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.4	0.5	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-33	0	0	0.7	180	500	-9	-9	-9	1	0
1	0.1	0.7	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-31	0	0	0.7	180	500	4	81	4	1	0
2	1.4	0.5	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-32	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	0.6	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-32	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.9	0.6	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-31	0	0	0.7	180	500	-9	-9	-9	1	0
2	2	0.7	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-31	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	0.7	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-31	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	0.7	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-30	0	0	0.7	180	500	-9	-9	-9	1	0
2	2	0.8	0	15	6	0	1.6	0	0	69	25.9	26.5	1	1	-29	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.1	0.8	0	15	6	0	1.6	0	0	69	25.9	26.5	-1	1	-29	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.5	0.9	0	15	6	0	1.6	0	0	69	25.9	26.4	1	1	-29	0	0	0.7	180	500	-9	-9	-9	2	-1
2	2	0.9	0	15	6	0	1.6	0	0	69	25.9	26.4	-1	1	-28	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	0.9	0	15	6	0	1.6	0	-1	69	25.9	26.4	0	1	-28	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	0.9	0	15	6	0	1.6	0	0	69	25.9	26.4	1	1	-28	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	1	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-27	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	1	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-27	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.5	1.1	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-26	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	1.1	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-25	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	1.2	0	15	6	0	1.6	0	0	75	25.9	26.4	1	1	-24	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	1.2	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-24	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	1.2	0	15	6	0	1.6	0	0	75	25.9	26.4	1	1	-24	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	1.3	0	15	6	0	1.6	0	0	75	25.9	26.4	-1	1	-23	0	0	0.7	180	500	-9	-9	-9	1	0
2	1	1.3	0	15	6	0	1.6	0	0	75	25.9	26.4	1	1	-23	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	1.4	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-23	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	1.4	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-22	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.2	1.4	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-21	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	1.5	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-21	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	1.5	0	15	6	0	1.6	0	-1	75	26	26.3	0	1	-20	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.4	1.5	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-20	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.3	1.6	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-19	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.8	1.6	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-19	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.8	1.6	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-19	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	1.7	0	15	6	0	1.6	0	-1	75	26	26.3	0	1	-18	0	0	0.7	180	500	-9	-9	-9	1	0
2	2	1.7	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-18	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	1.7	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-18	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	1.7	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-17	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.9	1.8	0	15	6	0	1.6	0	0	75	26	26.3	1	1	-17	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.1	1.8	0	15	6	0	1.6	0	0	75	26	26.3	-1	1	-16	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.6	1.9	0	15	5	0	1.6	0	0	75	26	26.2	1	1	-16	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0	1.9	0	15	5	0	1.6	0	-1	74	26	26.2	0	1	-15	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.4	1.9	0	15	5	0	1.6	0	0	74	26	26.2	1	1	-15	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.7	2	0	15	5	0	1.6	0	0	74	26	26.2	-1	1	-15	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.6	2	0	15	5	0	1.6	0	0	74	26	26.2	-1	1	-14	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.5	2.1	0	10	5	0	1.6	0	0	74	26	26.2	-1	1	-13	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.5	2.1	0	10	5	0	1.6	0	0	74	26	26.2	-1	1	-12	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.3	2.2	0	10	5	0	1.6	0	0	74	26	26.2	1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	2.2	0	10	5	0	1.6	0	0	74	26	26.2	-1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.5	2.2	0	10	5	0	1.6	0	0	74	26	26.2	1	1	-11	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1	2.3	0	10	5	0	1.6	0	0	74	26	26.2	-1	1	-11	0	0	0.7	180	500	-9	-9	-9	1	0
2	1	2.3	0	10	5	0	1.6	0	0	74	26	26.1	1	1	-10	0	0	0.7	180	500	-9	-9	-9	2	-1
2	1.6	2.4	0	10	5	0	1.6	0	0	74	26	26.1	-1	1	-9	0	0	0.7	180	500	-9	-9	-9	1	0

CG-2140 MAY 3 1991 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.9	2.4	0	10	5	0	1.6	0	0	74	26	26.1	1	1	-9	0	0	0.7	180	500	-9	-9	-9	1	0
2	1.1	2.4	0	10	5	0	1.6	0	0	74	26	26.1	-1	1	-9	0	0	0.7	180	500	-9	-9	-9	1	0
2	0.9	2.4	0	10	5	0	1.6	0	0	74	26	26.1	1	1	-8	0	0	0.7	180	500	-9	-9	-9	1	0
2	0	2.5	0	10	5	0	1.6	0	-1	74	26	26.1	0	1	-7	0	0	0.7	180	500	-9	-9	-9	2	-1
2	0.4	2.5	0	10	5	0	1.6	0	0	74	26	26.1	1	1	-7	0	0	0.7	180	500	-9	-9	-9	1	0

CG-1480 MAY 20 1991

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	0.9	1	10	17	9	5.9	1	0	83	24.8	25.5	-1	1	47	1	-1	0.5	90	300	3	85	0	1	0
1	0.2	1	1	10	14	9	5.9	1	0	83	25	25.5	1	1	45	0	1	0.5	90	300	3	85	0	1	0
1	0.1	1.1	1	10	14	9	5.9	1	0	83	25	25.5	1	1	45	0	1	0.5	90	300	3	85	0	1	0
2	0.1	0.4	1	10	17	9	5.2	1	0	83	24.3	25.6	1	1	53	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.7	0.5	1	10	17	9	5.2	1	0	83	24.3	25.6	1	1	53	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.9	0.5	1	10	17	9	5.2	1	0	83	24.8	25.5	-1	1	52	0	-1	0.5	90	300	-9	-9	-9	2	-1
2	0	0.6	1	10	17	9	5.9	1	0	83	24.8	25.5	0	1	51	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	0.7	1	10	17	9	5.9	1	0	83	24.8	25.5	-1	1	50	0	-1	0.5	90	300	-9	-9	-9	2	-1
2	0.7	0.9	1	10	17	9	5.9	1	0	83	24.8	25.5	-1	1	48	1	-1	0.5	90	300	-9	-9	-9	1	0
2	0.7	1	1	10	17	9	5.9	1	0	83	24.8	25.5	-1	1	46	0	-1	0.5	90	300	-9	-9	-9	1	0
2	0.5	1	1	10	14	9	5.9	1	0	83	25	25.5	-1	1	46	0	-1	0.5	90	300	-9	-9	-9	1	0
2	1	1.4	1	10	14	9	5.9	1	0	83	25	25.5	1	1	43	1	1	0.5	90	300	-9	-9	-9	1	0
1	0	2.5	1	10	10	8	5.2	1	-1	87	24.3	25.3	0	1	21	1	0	0.5	90	300	2	84	72	1	0
1	0	2.5	1	10	10	8	5.2	1	-1	87	24.3	25.3	0	1	21	1	0	0.5	90	300	2	84	72	1	0
2	0.3	1.7	2	5	13	8	5.2	1	0	87	25.4	25.4	-1	1	32	0	-1	0.5	90	300	-9	-9	-9	2	-1
2	0.6	1.8	1	10	13	8	5.2	1	0	87	25.4	25.4	1	1	30	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.3	2	1	10	13	8	5.2	1	0	87	25.4	25.4	1	1	28	0	1	0.5	90	300	-9	-9	-9	2	-1
2	1	2	1	10	10	8	5.2	1	0	87	24.3	25.3	1	1	27	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.2	2.1	1	10	10	8	5.2	1	0	87	24.3	25.3	1	1	27	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.8	2.3	1	10	10	8	5.2	1	0	87	24.3	25.3	-1	1	24	0	-1	0.5	90	300	-9	-9	-9	1	0
2	0.1	2.3	1	10	10	8	5.2	1	0	87	24.3	25.3	1	1	23	0	1	0.5	90	300	-9	-9	-9	1	0
2	0.8	2.4	1	10	10	8	5.2	1	0	87	24.3	25.3	-1	1	22	0	-1	0.5	90	300	-9	-9	-9	1	0
2	0.6	2.4	1	10	10	8	5.2	1	0	87	24.3	25.3	-1	1	22	0	-1	0.5	90	300	-9	-9	-9	1	0
2	1	2.5	1	10	15	8	5.2	1	0	87	25.8	25.4	1	1	20	0	1	0.5	90	300	-9	-9	-9	1	0
2	0.9	2.9	0	15	16	6	5.2	1	-1	85	26.5	25.4	0	1	12	0	0	0.5	90	300	-9	-9	-9	1	0
2	0.4	3	0	15	16	6	5.9	1	-1	85	26.5	25.4	0	1	10	0	0	0.5	90	300	-9	-9	-9	1	0
2	0.6	3.1	0	15	16	6	5.9	1	1	85	26.5	25.4	0	1	10	0	0	0.5	90	300	-9	-9	-9	1	0
2	1	3.2	0	15	16	6	5.9	1	-1	85	26.5	25.4	0	1	9	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	3.4	0	15	16	4	5.9	1	-1	84	26.5	25.4	0	1	8	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.6	3.5	0	15	16	4	5.9	1	1	84	26.5	25.4	0	1	6	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	3.5	0	15	16	4	5.9	1	-1	84	26.4	25.4	0	1	5	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.2	3.6	0	15	17	4	6.6	1	1	78	26.4	25.4	0	1	-22	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0	3.8	0	15	18	4	6.2	1	0	78	26.4	25.4	0	1	-25	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.5	3.9	0	15	18	4	6.2	1	1	78	26.4	25.4	0	1	-24	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0	4.1	0	15	18	4	6.2	1	0	78	26.4	25.4	0	1	-23	0	0	0.5	90	300	-9	-9	-9	1	0
2	0.6	4.2	0	15	18	4	6.2	1	1	78	26.4	25.4	0	1	-22	0	0	0.5	90	300	-9	-9	-9	1	0

CG-1480 MAY 24 1991

DRT	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.4	0.3	0	15	9	6	4.9	1	-1	87	26	25.5	1	1	43	1	0	1	90	300	4	86	6	2	-1
1	0.2	0.3	0	15	9	6	4.9	1	1	87	26	25.5	-1	1	44	1	0	1	90	300	1	83	406	2	-1
1	0.5	0.4	0	15	9	6	4.9	1	1	87	26	25.5	-1	1	44	1	0	1	90	300	4	86	6	2	-1
1	0.4	0.7	0	15	9	6	4.9	1	-1	87	26	25.4	1	1	46	1	0	1	90	300	3	22	80	2	-1
1	0.3	1.1	0	15	9	6	4.9	1	-1	87	26.2	25.4	1	1	47	1	0	1	90	300	3	22	80	2	-1
1	0.3	1.3	0	15	9	6	4.9	1	0	87	26.2	25.4	0	1	47	1	0	1	90	300	1	83	406	2	-1
2	0.8	0.2	0	15	9	6	4.9	1	1	87	26	25.5	-1	1	43	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	0.4	0	15	9	6	4.9	1	1	87	26	25.5	-1	1	44	1	0	1	[illegible]	300	-9	-9	-9	2	-1
2	1.3	0.5	0	15	9	6	4.9	1	-1	87	26	25.5	1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.7	0	15	9	6	4.9	1	1	87	26	25.4	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	0.7	0	15	9	6	4.9	1	-1	87	26	25.4	1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	0.7	0	15	9	6	4.9	1	-1	87	26	25.4	-1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.9	0	15	9	6	4.9	1	1	87	26	25.4	-1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	0.9	0	15	9	6	4.9	1	-1	87	26	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	1.1	0	15	9	6	4.9	1	-1	87	26.2	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.2	0	15	9	6	4.9	1	1	87	26.2	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
1	0.5	1.6	0	15	14	6	4.6	1	0	87	25.8	25.4	-1	1	48	1	0	1	90	300	4	86	6	2	-1
1	0.4	1.6	0	15	14	6	4.6	1	0	87	25.8	25.4	-1	1	48	1	-1	1	90	300	2	84	78	2	-1
1	0.1	1.7	0	15	14	6	4.6	1	0	87	25.8	25.4	1	1	48	1	0	1	90	300	4	86	6	2	-1
1	0.2	1.8	0	15	14	6	4.6	1	0	87	25.8	25.4	0	1	48	1	-1	1	90	300	2	84	78	2	-1
1	0.3	2.5	0	15	14	6	4.6	1	-1	87	25.1	25.5	0	1	46	1	0	1	90	300	1	83	406	2	-1
2	1.3	1.4	0	15	9	6	4.6	1	1	87	26.2	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	1.8	0	15	14	6	4.6	1	1	87	25.8	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.9	0	15	14	6	4.6	1	-1	87	25.8	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2	0	15	8	6	4.6	1	1	87	25.1	25.5	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2.1	0	15	8	6	4.6	1	-1	87	25.1	25.5	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	2.1	0	15	8	6	4.6	1	-1	87	25.1	25.5	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2.3	0	15	8	6	4.6	1	1	87	25.1	25.5	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	2.3	0	15	8	6	4.6	1	-1	87	25.1	25.5	1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	2.5	0	15	11	6	4.6	1	-1	87	25.5	25.5	1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	2.6	0	15	11	6	4.6	1	1	87	25.5	25.5	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2.8	0	15	11	6	4.6	1	-1	87	25.5	25.5	1	1	44	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	1.7	0	15	14	6	4.6	1	-1	87	25.8	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
1	0.5	3.2	0	15	11	6	4.6	1	1	87	26	25.5	-1	1	23	1	0	1	90	300	3	22	80	2	-1
1	0.1	3.6	0	15	11	4	4.6	1	0	87	26.1	25.5	1	1	19	1	0	1	90	300	2	84	78	2	-1
1	0	3.7	0	15	11	4	4.6	1	0	87	26.1	25.5	1	1	17	1	0	1	90	300	3	22	80	2	-1
1	0.5	4	0	15	14	4	4.9	1	0	87	26.2	25.5	-1	1	15	1	0	1	90	300	1	83	406	2	-1
1	0.2	4.1	0	15	14	4	4.9	1	1	87	26.2	25.5	-1	1	13	1	-1	1	90	300	2	84	78	2	-1
2	0.7	2.8	0	15	12	6	4.9	1	0	87	26.1	25.5	0	1	26	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	3.1	0	15	11	6	4.6	1	0	87	26	25.5	0	1	24	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	3.1	0	15	11	6	4.6	1	0	87	26	25.5	0	1	24	1	0	1	90	300	-9	-9	-9	2	-1
2	1	3.4	0	15	11	4	4.6	1	0	87	26.1	25.5	0	1	21	1	0	1	90	300	-9	-9	-9	2	-1
1	0.8	3.6	0	15	11	4	4.6	1	0	87	26.1	25.5	-1	1	19	1	0	1	90	300	4	86	6	2	-1
2	1.1	3.7	0	15	11	4	4.6	1	0	87	26.1	25.5	0	1	17	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	3.8	0	15	11	4	4.6	1	0	87	26.1	25.5	0	1	17	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	4.1	0	15	14	4	4.9	1	0	87	26.2	25.5	0	1	14	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	4.1	0	15	14	4	4.9	1	0	87	26.2	25.5	0	1	13	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	3.5	0	15	11	4	4.6	1	0	87	26.1	25.5	0	1	20	1	0	1	90	300	-9	-9	-9	2	-1
1	0.2	4.4	0	15	13	4	4.9	1	1	87	26.3	25.5	-1	1	7	1	-1	1	90	300	4	86	6	2	-1
1	0.4	4.6	0	15	12	4	4.9	1	1	87	26.3	25.4	-1	1	4	1	0	1	90	300	2	84	78	2	-1
1	0.2	5	0	15	12	5	5.2	1	-1	87	26.3	25.4	1	1	0	0	1	1	90	300	2	84	78	2	-1
1	0.2	5.2	0	15	13	0	5.2	1	0	87	26	25.4	0	1	-2	0	0	1	90	300	1	83	406	2	-1
1	0	5.4	0	15	13	0	5.2	1	1	87	26	25.4	-1	1	-5	0	-1	1	90	300	2	84	78	2	-1
1	0.9	5.5	0	15	13	0	5.2	1	0	87	26	25.4	0	1	-5	0	0	1	90	300	2	84	78	2	-1
1	0.2	5.6	0	15	13	0	5.2	1	1	87	26	25.4	-1	1	-6	0	-1	1	90	300	2	84	78	2	-1
2	1.2	4.3	0	15	13	4	4.9	1	0	87	26.3	25.5	0	1	3	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	4.5	0	15	13	4	4.9	1	0	87	26.3	25.5	0	1	5	0	0	1	90	300	-9	-9	-9	2	-1
2	1	4.5	0	15	13	4	4.9	1	0	87	26.3	25.5	0	1	5	0	0	1	90	300	-9	-9	-9	2	-1
2	1.2	4.8	0	15	12	4	5.2	1	0	87	26.3	25.4	0	1	3	0	0	1	90	300	-9	-9	-9	2	-1
2	1	4.8	0	15	12	[illegible]	5.2	1	0	87	26.3	25.4	0	1	2	0	0	1	90	300	-9	-9	-9	2	-1
2	1.1	5.1	0	15	12	5	5.2	1	0	87	26.3	25.4	0	1	-1	0	0	1	90	300	-9	-9	-9	2	-1
2	1.1	5.2	0	15	13	5	5.2	1	0	87	26	25.4	0	1	-2	0	0	1	90	300	-9	-9	-9	2	-1
2	1.3	5.2	0	15	13	5	5.2	1	0	87	26	25.4	0	1	-3	0	0	1	90	300	-9	-9	-9	2	-1
2	1.3	5.3	0	15	13	5	5.2	1	0	87	26	25.4	0	1	-4	0	0	1	90	300	-9	-9	-9	2	-1
2	0.7	5.5	0	15	13	0	5.2	1	0	87	26	25.4	0	1	-5	0	0	1	90	300	-9	-9	-9	2	-1

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DET	LATRNG	TCT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RZLHM	AIRTP	WTTP	RELAZ	LEV	SLEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1.4	0	0	15	9	7	4.9	1	1	87	26	25.5	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	0.3	0	15	9	7	4.9	1	1	87	26	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.4	0	15	9	7	4.9	1	1	87	26	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1	0.4	0	15	9	7	4.9	1	1	87	26	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	0.5	0	15	9	7	4.9	1	0	87	26	25.4	0	1	47	1	1	1	90	300	-9	-9	-9	2	-1
2	0.2	0.5	0	15	9	7	4.9	1	-1	87	25	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	0.5	0	15	9	7	4.9	1	1	87	26	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	2	0.6	0	15	9	7	4.9	1	1	87	26.2	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.1	0.6	0	15	9	7	4.9	1	-1	87	26.2	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1.4	0.7	0	15	9	7	4.6	1	1	87	26.2	25.4	-1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1.3	0.7	0	15	9	7	4.6	1	-1	87	26.2	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	0.7	0	15	9	7	4.6	1	-1	87	26.2	25.4	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.4	0.9	0	15	9	7	4.6	1	1	87	26.2	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	0.9	0	15	9	7	4.6	1	-1	87	26.2	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.9	0	15	9	7	4.6	1	-1	87	26.2	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1	1	0	15	9	7	4.6	1	1	87	26.2	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.1	0	15	14	7	4.6	1	-1	87	25.8	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.6	1.3	0	15	14	7	4.6	1	1	87	25.8	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	0.2	1.3	0	15	14	7	4.6	1	-1	87	25.8	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.1	1.3	0	15	14	7	4.6	1	-1	87	25.8	25.4	1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.4	0	15	14	7	4.6	1	1	87	25.8	25.4	-1	1	48	1	0	1	90	300	-9	-9	-9	2	-1
2	1.4	1.6	0	15	8	7	4.6	1	-1	87	25.1	25.5	1	1	47	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	1.8	0	15	8	7	4.6	1	1	87	25.1	25.5	-1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	0.4	1.9	0	15	8	7	4.6	1	0	87	25.1	25.5	-1	1	46	1	-1	1	90	300	-9	-9	-9	2	-1
2	0.8	1.9	0	15	8	7	4.6	1	1	87	25.1	25.5	-1	1	46	1	0	1	90	300	-9	-9	-9	2	-1
2	1.5	2	0	15	8	7	4.6	1	0	87	25.1	25.5	1	1	46	1	1	1	90	300	-9	-9	-9	2	-1
2	0.2	2	0	15	11	7	4.6	1	0	87	25.5	25.5	0	1	45	1	1	1	90	300	-9	-9	-9	2	-1
2	0	2.2	0	15	11	7	4.6	1	0	87	25.5	25.5	0	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1.5	2.2	0	15	11	7	4.6	1	1	87	25.5	25.5	-1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2.2	0	15	11	7	4.6	1	-1	87	25.5	25.5	1	1	45	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	2.3	0	15	11	7	4.6	1	-1	87	25.5	25.5	1	1	44	1	0	1	90	300	-9	-9	-9	2	-1
2	2	2.4	0	15	11	7	4.6	1	-1	87	25.5	25.5	1	1	44	1	0	1	90	300	-9	-9	-9	2	-1
2	0.4	2.4	0	15	11	7	4.6	1	-1	87	25.5	25.5	1	1	44	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	2.5	0	15	11	7	4.6	1	0	87	25.6	25.6	-1	1	43	1	-1	1	90	300	-9	-9	-9	2	-1
2	1.1	2.6	0	15	11	7	4.6	1	0	87	25.6	25.6	1	1	42	1	1	1	90	300	-9	-9	-9	2	-1

CG-1480 MAY 27 1991

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.5	0.2	0	15	10	1	3.3	0	0	84	27	26.3	-1	1	18	1	0	1	90	300	2	89	250	1	0
1	0.2	0.9	0	15	7	1	3.3	0	1	83	26.8	26.3	0	1	24	1	0	1	90	300	2	89	250	1	0
1	0.1	1.1	0	15	7	1	3.3	0	0	83	26.8	26.3	-1	1	26	1	0	1	90	300	3	91	70	1	0
1	0.8	1.3	0	15	9	1	3.3	0	-1	83	26.8	26.3	1	1	27	1	0	1	90	300	3	91	70	1	0
1	0.7	0.4	0	15	10	1	3.3	0	0	84	26.9	26.3	1	1	19	1	0	1	90	300	4	92	5	1	0
2	0.5	0.3	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	19	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	0.5	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	20	1	0	1	90	300	-9	-9	-9	2	-1
2	0.1	0.7	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	22	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	0.7	0	15	10	1	3.3	0	0	84	26.9	26.3	1	1	22	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	0.7	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	22	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	0.8	0	15	7	1	3.3	0	0	84	26.8	26.2	-1	1	22	1	0	1	90	300	-9	-9	-9	2	-1
2	0	0.8	0	15	7	1	3.3	0	1	83	26.8	26.2	0	1	23	1	1	1	90	300	-9	-9	-9	2	-1
2	0.7	1	0	15	7	1	3.3	0	0	83	26.8	26.2	-1	1	24	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	1.2	0	15	7	1	3.3	0	0	83	26.8	26.2	1	1	26	1	0	1	90	300	-9	-9	-9	2	-1
1	0.1	1.5	0	15	9	1	3.3	0	-1	83	26.8	26.3	1	1	29	1	-1	1	90	300	1	90	100	1	0
1	0.6	1.7	0	15	10	1	3.3	0	0	83	27	26.5	1	1	30	1	0	1	90	300	4	92	5	1	0
1	0.5	2	0	15	10	0	3.3	0	0	83	27	26.5	1	1	33	1	0	1	90	300	3	91	70	2	-1
1	0.7	2.1	0	15	11	0	3.3	0	0	83	27	26.3	0	1	34	1	0	1	90	300	3	91	70	2	-1
1	0.2	2.4	0	15	11	0	3.3	0	0	83	27	26.3	0	1	35	1	0	1	90	300	3	91	70	1	0
1	0.5	2.5	0	15	11	0	3.3	0	0	83	27	26.3	1	1	35	1	0	1	90	300	4	92	5	2	-1
2	0.7	1.4	0	15	9	1	3.3	0	0	83	26.8	26.3	-1	1	28	1	0	1	90	300	-9	-9	-9	1	0
2	0	2	0	15	10	0	3.3	0	1	83	27	26.5	0	1	32	1	1	1	90	300	-9	-9	-9	2	-1
2	0.6	1.6	0	15	10	1	3.3	0	0	83	27	26.5	-1	1	30	1	0	1	90	300	-9	-9	-9	2	-1
2	0.2	1.8	0	15	10	0	3.3	0	0	83	27	26.5	1	1	31	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	2.2	0	15	11	0	3.3	0	0	83	27	26.3	1	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	0.6	2.3	0	15	11	0	3.3	0	0	83	27	26.3	-1	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	2.6	0	15	11	0	3.3	0	0	83	27	26.3	1	1	36	1	0	1	90	300	-9	-9	-9	1	0
1	0.4	2.7	0	15	13	1	3.3	0	1	83	27	26.4	0	1	36	1	0	1	90	300	4	92	5	2	-1
1	0.1	2.9	0	15	13	0	3.6	0	1	83	26.9	26.3	0	1	36	1	0	1	90	300	3	91	70	2	-1
1	0.4	3	0	15	13	0	3.6	0	-1	83	26.9	26.3	0	1	36	1	0	1	90	300	1	90	100	1	0
1	0.5	3.2	0	15	13	0	3.6	0	0	83	26.9	26.3	-1	1	35	1	0	1	90	300	3	91	70	1	0
1	0.3	3.3	0	15	13	0	3.6	0	-1	83	26.9	26.3	0	1	35	1	0	1	90	300	3	91	70	1	0
1	0	3.6	0	15	13	0	3.6	0	0	83	26.9	26.3	1	1	33	1	0	1	90	300	3	91	70	2	-1
2	1	2.9	0	15	13	1	3.3	0	-1	83	26.9	26.3	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	0.7	3	0	15	13	0	3.6	0	1	83	26.9	26.3	0	1	36	1	1	1	90	300	-9	-9	-9	1	0
2	1.1	3.1	0	15	13	0	3.6	0	-1	83	26.9	26.3	0	1	35	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	3.3	0	15	13	0	3.6	0	1	83	26.8	26.3	0	1	35	1	0	1	90	300	-9	-9	-9	1	0
2	0.3	3.4	0	15	13	0	3.6	0	1	83	26.8	26.3	0	1	34	1	0	1	90	300	-9	-9	-9	2	-1
2	0.3	3.6	0	15	13	0	3.6	0	0	83	26.8	26.3	0	1	33	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	3.7	0	15	13	0	3.6	0	1	83	26.8	26.3	0	1	32	1	0	1	90	300	-9	-9	-9	2	-1
2	0.7	2.6	0	15	13	1	3.3	0	1	83	27	26.4	0	1	37	1	0	1	90	300	-9	-9	-9	2	-1
2	0	2.6	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	37	1	0	1	90	300	-9	-9	-9	2	-1

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0	0.2	0	15	10	1	3.3	0	-1	84	26.9	26.3	0	1	20	1	-1	1	90	380	2	93	0	1	0
2	0.4	0.1	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	20	1	0	1	90	380	-9	-9	-9	1	0
2	0.1	0.3	0	15	10	1	3.3	0	0	84	26.9	26.3	-1	1	22	1	0	1	90	380	-9	-9	-9	2	-1
2	0.1	0.5	0	15	7	1	3.3	0	0	83	26.8	26.2	1	1	23	1	0	1	90	380	-9	-9	-9	2	-1
2	0.4	0.9	0	15	9	1	3.3	0	0	83	26.8	26.3	-1	1	26	1	0	1	90	380	-9	-9	-9	2	-1
2	0.6	1	0	15	9	1	3.3	0	0	83	26.8	26.3	1	1	27	1	0	1	90	380	-9	-9	-9	2	-1
2	1	1.1	0	15	9	1	3.3	0	0	83	26.8	26.3	1	1	28	1	0	1	90	380	-9	-9	-9	1	0
2	0.5	1.1	0	15	9	1	3.3	0	0	83	26.8	26.3	-1	1	28	1	0	1	90	380	-9	-9	-9	2	-1
2	0.8	1.2	0	15	9	1	3.3	0	0	83	26.8	26.3	-1	1	29	1	0	1	90	380	-9	-9	-9	1	0
2	0.5	1.4	0	15	10	1	3.3	0	0	83	27	26.5	1	1	30	1	0	1	90	380	-9	-9	-9	1	0
2	0.3	0.6	0	15	10	1	3.3	0	0	83	26.8	26.2	-1	1	25	1	0	1	90	380	-9	-9	-9	2	-1
2	0.5	0.8	0	15	10	1	3.3	0	0	83	26.8	26.2	1	1	26	1	0	1	90	380	-9	-9	-9	2	-1
2	0.2	0.9	0	15	11	1	3.3	0	0	83	26.8	26.3	1	1	26	1	0	1	90	380	-9	-9	-9	1	0
2	1	1.2	0	15	9	1	3.3	0	0	83	26.8	26.3	1	1	29	1	0	1	90	380	-9	-9	-9	2	-1
1	0.1	2.7	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	38	1	-1	1	90	380	2	93	100	1	0
2	0.1	1.6	0	15	10	0	3.3	0	0	83	27	26.5	-1	1	33	1	0	1	90	380	-9	-9	-9	1	0
2	0.6	1.7	0	15	11	0	3.3	0	0	83	27	26.3	1	1	34	1	0	1	90	380	-9	-9	-9	1	0
2	0.9	1.8	0	15	11	0	3.3	0	0	83	27	26.3	-1	1	34	1	0	1	90	380	-9	-9	-9	2	-1
2	0.4	1.4	0	15	11	0	3.3	0	0	83	27	26.3	1	1	35	1	0	1	90	380	-9	-9	-9	2	-1
2	0.8	2	0	15	11	0	3.3	0	0	83	27	26.3	-1	1	36	1	0	1	90	380	-9	-9	-9	2	-1
2	0.2	2.1	0	15	11	0	3.3	0	0	83	27	26.3	1	1	36	1	0	1	90	380	-9	-9	-9	2	-1
2	0.9	2.3	0	15	11	1	3.3	0	0	83	27	26.5	1	1	37	1	0	1	90	380	-9	-9	-9	2	-1
2	0.6	2.1	0	15	11	0	3.3	0	0	83	27	26.5	1	1	36	1	0	1	90	380	-9	-9	-9	2	-1
2	0.7	2.3	0	15	11	1	3.3	0	0	83	27	26.5	-1	1	36	1	0	1	90	380	-9	-9	-9	1	0
1	0.1	2.4	0	15	11	1	3.3	0	-1	83	27	26.5	0	1	37	1	-1	1	90	380	-9	-9	-9	1	0
2	0.7	2.4	0	15	11	1	3.3	0	0	83	27	26.5	-1	1	37	1	0	1	90	380	-9	-9	-9	2	-1
2	0.8	2.5	0	15	11	1	3.3	0	0	83	27	26.5	1	1	37	1	0	1	90	380	-9	-9	-9	2	-1
2	0.1	2.6	0	15	13	1	3.3	0	0	83	27	26.4	1	1	38	1	0	1	90	380	-9	-9	-9	2	-1
2	0.8	2.7	0	15	13	1	3.3	0	0	83	27	26.4	1	1	38	1	0	1	90	380	-9	-9	-9	2	-1
2	1	2.9	0	15	13	1	3.3	0	0	83	27	26.4	1	1	38	1	0	1	90	380	-9	-9	-9	1	0
1	0.2	3.3	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	37	1	-1	1	90	380	2	93	100	1	0
1	0.6	3.5	0	15	13	1	3.3	0	1	83	27	26.4	0	1	37	1	0	1	90	380	2	93	100	1	0
1	0.3	3.6	0	15	13	0	3.3	0	0	83	26.9	26.3	1	1	36	1	0	1	90	380	2	93	100	1	0
1	0.2	3.9	0	15	13	0	3.6	0	0	83	26.8	26.3	-1	1	35	1	0	1	90	380	2	93	100	2	-1
2	0.7	4.1	0	15	13	0	3.6	0	-1	83	26.8	26.3	0	1	35	1	0	1	90	380	-9	-9	-9	2	-1
2	0.4	4.2	0	15	13	0	3.6	0	-1	83	26.8	26.3	0	1	34	1	0	1	90	380	-9	-9	-9	2	-1
2	0.9	4.3	0	15	13	0	3.6	0	1	83	26.8	26.3	0	1	34	1	0	1	90	380	-9	-9	-9	2	-1
2	0.3	3.9	0	15	13	0	3.6	0	-1	83	26.9	26.3	0	1	35	1	0	1	90	380	-9	-9	-9	2	-1
2	0	4.1	0	15	13	0	3.6	0	0	83	26.9	26.3	0	1	34	1	0	1	90	380	-9	-9	-9	2	-1
2	1	4.2	0	15	13	0	3.6	0	1	83	26.8	26.3	0	1	34	1	0	1	90	380	-9	-9	-9	2	-1
2	0.6	3.7	0	15	13	1	3.3	0	1	83	26.9	26.3	0	1	36	1	1	1	90	380	-9	-9	-9	1	0
2	0.3	3.8	0	15	13	0	3.6	0	-1	83	26.9	26.3	0	1	36	1	0	1	90	380	-9	-9	-9	1	0
2	0.7	3.8	0	15	13	0	3.6	0	1	83	26.9	26.3	0	1	36	1	0	1	90	380	-9	-9	-9	1	0
2	0.9	3.4	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	37	1	0	1	90	380	-9	-9	-9	1	0
2	0.9	3.6	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	36	1	0	1	90	380	-9	-9	-9	1	0
2	0.6	3.1	0	15	13	1	3.3	0	1	83	27	26.4	0	1	38	1	0	1	90	380	-9	-9	-9	2	-1
2	0.5	3.1	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	38	1	1	1	90	380	-9	-9	-9	2	-1
2	0.4	3.3	0	15	13	1	3.3	0	1	83	27	26.4	0	1	37	1	0	1	90	380	-9	-9	-9	2	-1
2	1	3.3	0	15	13	1	3.3	0	-1	83	27	26.4	0	1	37	1	-1	1	90	380	-9	-9	-9	1	0

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.3	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	-4	0	0	1	90	300	3	85	8	2	-1
1	0.2	0.5	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	-3	0	0	1	90	300	4	86	16	1	0
1	0.1	0.7	0	15	5	0	1.3	0	0	75	26.5	27	1	1	0	1	0	1	90	300	4	86	16	1	0
1	0.3	0.7	0	15	5	0	1.3	0	0	75	26.5	27	1	1	0	1	0	1	90	300	3	85	8	2	-1
1	0.2	1.2	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	6	1	0	1	90	300	1	95	300	1	0
1	0	1.3	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	7	1	0	1	90	300	1	95	300	2	-1
1	0	1.3	0	15	5	0	1.6	0	-1	74	26.5	26.9	0	1	8	1	-1	1	90	300	2	90	100	1	0
2	0.6	0.5	0	15	5	0	1.3	0	0	75	26.5	27	1	1	-2	0	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.7	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	0	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	0.9	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	2	1	0	1	90	300	-9	-9	-9	2	-1
2	1	1	0	15	5	0	1.3	0	0	75	26.5	27	1	1	5	1	0	1	90	300	-9	-9	-9	2	-1
2	0.5	1	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	4	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	1.2	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	6	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.4	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	9	1	0	1	90	300	-9	-9	-9	2	-1
2	0.8	1.1	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	5	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	1.4	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	8	1	0	1	90	300	-9	-9	-9	1	0
2	1.1	0	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	-9	0	0	1	90	300	-9	-9	-9	2	-1
2	1.1	0.3	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	-5	0	0	1	90	300	-9	-9	-9	2	-1
1	0	1.8	0	15	7	0	1.6	0	-1	74	26.5	26.8	0	1	14	1	-1	1	90	300	1	95	300	1	0
1	0.5	2	0	15	7	0	1.6	0	0	79	26.5	26.8	1	1	16	1	0	1	90	300	4	86	16	1	0
1	0.4	2.1	0	15	7	0	1.6	0	-1	79	26.5	26.8	1	1	17	1	-1	1	90	300	1	95	300	2	-1
1	0.4	2.2	0	15	7	0	1.6	0	0	79	26.5	26.8	-1	1	18	1	0	1	90	300	1	95	300	2	-1
1	0.5	2.4	0	15	7	0	1.6	0	0	79	26.5	26.8	0	1	19	1	0	1	90	300	4	86	16	1	0
1	0.4	2.4	0	15	7	0	1.6	0	-1	79	26.4	26.8	1	1	[illegible]	1	-1	1	90	300	1	95	300	2	-1
1	0.1	2.6	0	15	7	0	1.6	0	0	79	26.4	26.8	0	1	[illegible]	1	0	1	90	300	2	90	100	1	0
1	0.2	2.7	0	15	7	0	1.6	0	-1	79	26.4	26.8	0	1	22	1	-1	1	90	300	1	95	300	2	-1
1	0.3	2.7	0	15	7	0	1.6	0	0	79	26.4	26.8	0	1	23	1	0	1	90	300	2	90	100	1	0
2	0.5	1.9	0	15	7	0	1.6	0	0	74	26.5	26.8	1	1	15	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	1.8	0	15	7	0	1.6	0	0	74	26.5	26.8	-1	1	14	1	0	1	90	300	-9	-9	-9	2	-1
2	0.6	2	0	15	7	0	1.6	0	0	79	26.5	26.8	-1	1	16	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	2.5	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	21	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	2.6	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	22	1	0	1	90	300	-9	-9	-9	2	-1
2	1.2	2.9	0	15	7	0	1.6	0	0	79	26.4	26.8	1	1	24	1	0	1	90	300	-9	-9	-9	2	-1
2	1	2.8	0	15	7	0	1.6	0	0	79	26.4	26.8	1	1	24	1	0	1	90	300	-9	-9	-9	1	0
1	0.1	3.2	0	15	9	0	1.6	0	0	79	26.3	26.8	-1	1	27	1	0	1	90	300	1	95	300	1	0
1	0.4	3.4	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	29	1	0	1	90	300	4	86	16	1	0
1	0.1	3.5	0	15	8	0	1.6	0	0	79	26.2	26.8	-1	1	30	1	0	1	90	300	1	95	300	1	0
1	0.4	3.6	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	30	1	0	1	90	300	4	86	16	2	-1
1	0.8	3.9	0	15	9	0	1.6	0	-1	79	26.2	27	0	1	32	1	-1	1	90	300	1	95	300	2	-1
1	0.2	4	0	15	9	0	1.6	0	0	79	26.2	27	1	1	33	1	0	1	90	300	1	95	300	2	-1
1	0	4.3	0	15	9	0	1.6	0	0	79	26.3	27.2	1	1	34	1	0	1	90	300	2	90	100	2	-1
2	0.9	3.4	0	15	9	0	1.6	0	1	79	26.2	26.8	0	1	29	1	1	1	90	300	-9	-9	-9	1	0
2	0.7	3.2	0	15	9	0	1.6	0	0	79	26.3	26.8	0	1	27	1	0	1	90	300	-9	-9	-9	2	-1
2	0.9	3.4	0	15	8	0	1.6	0	1	79	26.2	26.8	0	1	29	1	1	1	90	300	-9	-9	-9	2	-1
2	0.7	3.6	0	15	8	0	1.6	0	0	79	26.2	26.8	0	1	30	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	3.5	0	15	8	0	1.6	0	-1	79	26.2	26.8	0	1	30	1	-1	1	90	300	-9	-9	-9	2	-1
2	0.9	3.7	0	15	8	0	1.6	0	1	79	26.2	26.8	0	1	31	1	1	1	90	300	-9	-9	-9	2	-1
2	0.8	4.1	0	15	9	0	1.6	0	1	79	26.2	27	0	1	34	1	1	1	90	300	-9	-9	-9	2	-1
2	1	4.1	0	15	9	0	1.6	0	-1	79	26.2	27	0	1	33	1	-1	1	90	300	-9	-9	-9	2	-1
2	0.4	4.1	0	15	9	0	1.6	0	-1	79	26.2	27	0	1	33	1	-1	1	90	300	-9	-9	-9	2	-1
2	0.9	4.3	0	15	9	0	1.6	0	1	79	26.3	27.2	0	1	34	1	1	1	90	300	-9	-9	-9	2	-1
2	1	4.2	0	15	9	0	1.6	0	-1	79	26.2	27	0	1	34	1	-1	1	90	300	-9	-9	-9	1	0
2	0.4	4.4	0	15	9	0	2	0	1	79	26.3	27.2	0	1	35	1	1	1	90	300	-9	-9	-9	1	0

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DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.5	0.8	0	15	5	0	1.6	0	0	74	26.5	26.9	0	1	8	1	0	1	90	380	2	93	105	1	0
2	1.1	0.1	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	1	0	0	1	90	380	-9	-9	-9	2	-1
2	0.9	0.3	0	15	5	0	1.3	0	0	75	26.5	27	1	1	4	1	0	1	90	380	-9	-9	-9	2	-1
2	0.9	0.4	0	15	5	0	1.3	0	0	75	26.5	26.9	1	1	4	1	0	1	90	380	-9	-9	-9	1	0
2	0.1	0.4	0	15	5	0	1.3	0	0	75	26.5	26.9	1	1	4	1	0	1	90	380	-9	-9	-9	2	-1
2	1	0.5	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	6	1	0	1	90	380	-9	-9	-9	2	-1
2	1	0.6	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	7	1	0	1	90	380	-9	-9	-9	2	-1
2	0.6	0.8	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	9	1	0	1	90	380	-9	-9	-9	2	-1
2	1.1	1	0	15	7	0	1.6	0	0	74	26.5	26.8	1	1	12	1	0	1	90	380	-9	-9	-9	2	-1
2	0.7	1.1	0	15	7	0	1.6	0	0	74	26.5	26.8	1	1	12	1	0	1	90	380	-9	-9	-9	1	0
2	1.7	0.7	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	9	1	0	1	90	380	-9	-9	-9	1	0
2	2	0.5	0	15	5	0	1.6	0	0	74	26.5	26.9	-1	1	6	1	0	1	90	380	-9	-9	-9	1	0
2	0.7	0.8	0	15	5	0	1.6	0	0	74	26.5	26.9	1	1	8	1	0	1	90	380	-9	-9	-9	2	-1
2	1.3	0.1	0	15	5	0	1.3	0	0	75	26.5	27	-1	1	1	0	0	1	90	380	-9	-9	-9	1	0
1	0.4	1.7	0	15	7	0	1.6	0	0	79	26.5	26.8	-1	1	18	1	0	1	90	380	2	93	105	2	0
2	1.3	1.2	0	15	7	0	1.6	0	0	74	26.5	26.8	1	1	14	1	0	1	90	380	-9	-9	-9	1	0
2	1.8	1.3	0	15	7	0	1.6	0	0	74	26.5	25.8	1	1	15	1	0	1	90	380	-9	-9	-9	2	-1
2	0.2	1.6	0	15	7	0	1.6	0	0	79	26.5	26.8	1	1	18	1	0	1	90	380	-9	-9	-9	2	-1
2	2	1.8	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	20	1	0	1	90	380	-9	-9	-9	2	-1
2	2	1.8	0	15	7	0	1.6	0	0	79	26.5	26.8	-1	1	19	1	0	1	90	380	-9	-9	-9	1	0
2	0.5	1.8	0	15	7	0	1.6	0	0	79	26.5	26.8	1	1	20	1	0	1	90	380	-9	-9	-9	2	-1
2	1.2	2.1	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	22	1	0	1	90	380	-9	-9	-9	2	-1
2	1.2	1.6	0	15	7	0	1.6	0	0	79	26.5	26.8	1	1	18	1	0	1	90	380	-9	-9	-9	1	0
2	1	1.8	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	20	1	0	1	90	380	-9	-9	-9	1	0
2	0.5	2	0	15	7	0	1.6	0	0	79	26.4	26.8	1	1	22	1	0	1	90	380	-9	-9	-9	2	-1
2	1.6	2.4	0	15	9	0	1.6	0	0	79	26.3	26.8	-1	1	24	1	0	1	90	380	-9	-9	-9	2	-1
2	1.6	2	0	15	7	0	1.6	0	0	79	26.4	26.8	1	1	22	1	0	1	90	380	-9	-9	-9	1	0
2	0.5	2.3	0	15	9	0	1.6	0	0	79	26.3	26.8	-1	1	24	1	0	1	90	380	-9	-9	-9	1	0
2	0.4	2.3	0	15	7	0	1.6	0	0	79	26.4	26.8	-1	1	24	1	0	1	90	380	-9	-9	-9	2	-1
1	0.3	2.5	0	15	9	0	1.6	0	0	79	26.3	26.8	-1	1	27	1	0	1	90	380	2	93	105	2	-1
1	0.4	2.8	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	29	1	0	1	90	380	2	93	105	2	-1
1	0.2	3	0	15	8	0	1.6	0	-1	79	26.2	26.8	0	1	30	1	-1	1	90	380	2	93	105	2	-1
2	1.2	2.5	0	15	9	0	1.6	0	0	79	26.3	26.8	-1	1	27	1	0	1	90	380	-9	-9	-9	1	0
2	1.4	2.8	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	29	1	0	1	90	380	-9	-9	-9	1	0
2	1.6	2.7	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	29	1	0	1	90	380	-9	-9	-9	2	-1
2	1.8	3	0	15	8	0	1.6	0	0	79	26.2	26.8	1	1	30	1	0	1	90	380	-9	-9	-9	2	-1
2	1.9	2.8	0	15	8	0	1.6	0	0	79	26.2	26.8	-1	1	29	1	0	1	90	380	-9	-9	-9	2	-1
2	1.4	3	0	15	8	0	1.6	0	0	79	26.2	26.8	-1	1	30	1	0	1	90	380	-9	-9	-9	1	0
2	1	3.3	0	15	9	0	1.6	0	0	79	26.2	27	1	1	32	1	0	1	90	380	-9	-9	-9	1	0
2	0	3.3	0	15	9	0	1.6	0	1	79	26.2	27	0	1	32	1	1	1	90	380	-9	-9	-9	2	-1
2	1.3	3.5	0	15	9	0	1.6	0	0	79	26.2	27	1	1	33	1	0	1	90	380	-9	-9	-9	2	-1
2	0.5	3.2	0	15	9	0	1.6	0	0	79	26.2	27	-1	1	32	1	0	1	90	380	-9	-9	-9	1	0
2	1	3.6	0	15	9	0	1.6	0	0	79	26.2	27	1	1	33	1	0	1	90	380	-9	-9	-9	1	0