4 September 2018

MEMORANDUM FOR THE RECORD

FROM: Division Director EO & Special Mission Sensors, Avionics, Sensors and E* Warfare Dept (AIR 4.5.6)

TO: Office of Counsel, Naval Air Warfare Center, Aircraft Division (NAWCAD)

Subj: SECURITY RECOMMENDAION FOR FOIA REQUEST, DON FOIA CASE FILE NUMBER 2018-005937

Ref: (a) SECNAVINST 5720.42F, DON FOIA Program, 06 Jan 99

(b) Executive Order 13526

(c) Security Class Guide SCG 02-293.01

1. Recommendation made that all information contained under File Number 2018-005937, NAVAL Air Development Center Report NADC-AE-6919, Detection of Boats by Airborne Passive Infrared Mapping Sets, 26 august 1968, is found to be unclassified in its entirety. In addition, the contents of this subject document are not subject to export control and the unclassified portions of this subject document are also releaseable. The document is releaseable in its entirety This report should be released based on reference (a) and (b).

2. Basis of Recommendation. All information was reviewed with current class guide. Reference (c) and what is considered open source information. Appropriate recommendations made above with respect to findings.

3. Point of Contact. The point of contact for this security review and recommendation is Mr. Paul W. Reimel, AIR 4.5.6 Division Director, paul.reimel@navy.mil, 301-342-0100.

9/4/2018

X Paul W. Reimel

Paul W. Reimel

Signed by: REIMEL.PAUL.W.1229241016

Distribution:

NAWCAD 7.4

NAWCAD 4.5.6

[redacted]

DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
JOHNSVILLE
WARMINSTER, PA. 18974

Aero-Electronic Technology Department

REPORT NO NADC-AE-6919

26 Aug [redacted] 1969

DETECTION OF BOATS BY AIRBORNE PASSIVE INFRARED MAPPING SETS (U)

FINAL REPORT,
United States Coast Guard
MIPR No. Z-70099-8-82416 of 11 Dec 1967

The AN/AAR-30 and AN/AAR-32 IR detecting sets with their respective accessory rapid-processed film display units, the KD-14 (XA-3) and the AN/ASA-55(XJ-1), were installed in NP-2E aircraft BuNo 131403 and operated during five day and nighttime exercises over an array of U.S. Coast Guard boats anchored off Cape May, New Jersey, during the period 20 October 1967 to 22 July 1968 to investigate this means of detecting non-co-operating boats as part of a search and rescue study program. The IR sets detected the boats from aircraft altitudes up to 8000 ft at area coverage rates of 18.3 sq nmi per min. (U)

(b) (6)

Reported by: _____
Applied Research Division

(b) (6)

Approved by: _____
Superintendent
Applied Research Division

(b) (6)

_____
Technical Director

[redacted]

[redacted]

SUMMARY

INTRODUCTION

(U) The U.S. Coast Guard has the responsibility for locating the many small recreational boats lost annually at sea. The U.S. Coast Guard requested the Naval Air Development Center (NAVAIRDEVCEN) to investigate the feasibility of detecting small water craft by use of available airborne passive IR imaging devices[1].

(U) This report describes results obtained with the AN/AAR-30 and AN/AAR-32 IR detecting sets installed in NP-2E aircraft BuNo 131403 in detecting various boats in the vicinity of Cape May, New Jersey.

SUMMARY OF RESULTS

(U) Tests were performed on the mornings of 20 and 25 October 1967 and 22 July 1968, and on the evenings of 24 October 1967 and 29 April 1968. The tests consisted of a series of passes of the aircraft, in which the two IR detecting sets were installed, at various altitudes and airspeeds over four boats ranging in size from a life raft to a 95-ft patrol boat anchored in the Atlantic Ocean. A total of 83 aircraft passes was made during which IR pictures of the boats were recorded from altitudes as high as 8000 ft with an area coverage rate of 18.3 sq nmi per min. Color visual photographs of the boats were also recorded on each aircraft pass on 22 July 1968.

CONCLUSIONS

(U) Boats ranging in size from a 15-ft 8-in. life raft to a 95-ft patrol boat simulating (temperature-wise) boats adrift at sea can be detected both day and night with existing wide-angle-field-of-view, nonoptimized IR imaging devices operating in the 8- to 14-micron band.

(U) Thermal contrasts of the boats appeared to be more intense during the daytime than at night.

(U) Thermal contrasts of the boats tended to be more intense on clear days than on cloudy days; cloudy nights and clear nights appeared to yield similar results.

(U) Boats as small as the life raft were detected by the AN/AAR-30 at altitudes as high as 8000 ft; above 2000 ft detection by the AN/AAR-32 was marginal.

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1. *U.S. Coast Guard Military Interdepartmental Purchase Request MIPR No. Z-70098-8-82416 of 11 Dec 1967.*

[redacted]

(U) Varying the aircraft speed over the range of 100 to 210 kn did not appreciably affect the detectability of the boats.

(U) Distinguishing the boats from whitecaps was accomplished much more easily on the IR pictures than on the color visual photographs.

(U) Search rates of 1152 sq nmi per hr with positive boat detection were achieved with the AN/AAR-30 at an altitude of 7000 ft and a speed of 180 kn.

(U) Conclusions cannot be drawn regarding the optimum resolution required, limitations that environment may impose, or the magnitude of the false target rate.

(U) A real-time viewer would have been desirable for eliminating the time delay encountered in displaying the imagery on the rapid processed film display units.

RECOMMENDATIONS

(U) Further tests of the AN/AAR-30 and the AN/AAR-32 should be performed to determine:

1. the optimum angular and thermal resolutions needed to satisfy search requirements,

2. the limitations the environment imposes on detection, and

3. the false target rate and its relation to the target detection rate.

(U) A real-time viewing device should be included in any future testing.

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DESCRIPTION OF EQUIPMENT

(U) The AN/AAR-30(XJ-1) is a roll stabilized IR mapping set developed by IRB-Singer, Incorporated, for the NAVAIRDEVCEN for high-sensitivity over-water IR imaging studies. It consists of two units: a Scanner Unit and an Amplifier/Control Unit. It is designed to operate with an accessory rapid-processed film display unit, the KD-14(XA-3) Camera-Processor-Viewer, which was developed by General Aniline and Film Corporation. The Scanner Unit contains the scanning IR optical system, the IR detector and closed cycle cryostat, and the video preamplifiers. The Amplifier/Control Unit contains all the operating controls for the AN/AAR-30 and the electronics to drive a CRT which exposes the film in the KD-14. The KD-14 consists of a CRT, high voltage power supplies, transfer optics which allows the image from the CRT to expose 5-inch wide photographic film, and chemicals which rapidly process the exposed film. IR Detecting Set AN/AAR-32 and Recorder-Display Group AN/ASA-55(XJ-1) are similar in design to the AN/AAR-30 and the KD-14, respectively, and were built by the same respective manufacturers. Some of the technical characteristics of the IR equipments are provided in table I.

(U) The equipments operate in the manner illustrated in figure 1. A small portion of the IR radiation emitted or reflected from the water surface is intercepted by a plane 45-deg angle scanning mirror which is mounted on a rotating shaft whose axis is parallel to the flight path of the aircraft. As this mirror rotates, radiant energy from each object point along a line perpendicular to the flight path is sampled sequentially and focused by means of a parabolic mirror onto a cooled mercury doped germanium IR detector. The electrical signal generated in the detector is amplified and passed on to the display devices. As the aircraft advances, a 140- or 120-deg field of view of the scene below is scanned, recorded on photographic film, rapid-processed and presented to an observer in the form of a continuous strip map.

(U) The film display units provide near-photographic-quality IR imagery within 10 to 80 sec after the aircraft has overflown the scene.

DESCRIPTION OF TESTS

(U) Tests were conducted in the vicinity of Cape May, New Jersey, on 20, 24, and 25 October 1967, 29 April 1968, and 22 July 1968. These tests consisted of a series of passes of NP-2E aircraft BuNo 131403, in which the AN/AAR-30 and AN/AAR-32 IR detecting sets were installed, at various altitudes and airspeeds over four boats spaced at various intervals in the Atlantic Ocean. The boats used in the tests were a 95-ft or an 82-ft patrol boat, a 15-ft 8-in. life raft, a 16-ft fiberglass boat with an outboard motor, and a 30-ft steel-hull utility boat.

(U) The life raft, fiberglass boat, and the steel-hull boat were towed out to the test area by the patrol boat before each test after having remained at rest in an unsheltered area to simulate conditions achieved by boats adrift in the ocean for long periods of time. IR pictures were recorded by the two equipments during all the tests on successive aircraft passes. Visual photographs were also recorded on 22 July 1968 on successive aircraft passes using a Type 30 Omera camera and special Ektacolor film SO-276.

(U) In the latter part of the exercise of 22 July 1968, tests were performed to determine the IR detectability of oils on the surface of the ocean. All of the test boats were removed from the test area except the patrol boat which was used to place three 2-qt samples of diesel fuel in the ocean. A 44-ft motor lifeboat, which was stationed 1/4 of a mile west of the patrol boat, was used to place one 2-qt sample of 9250 slush oil in the ocean.

RESULTS

(U) The results of 83 aircraft passes with both IR equipments operating during the two night and three daytime flights conducted are summarized in tables II through XI.

(U) Tables XII and XIII summarize the target characteristics and environmental conditions. Photographs of some of the boats used in the tests are shown in figure 2.

(U) Figures 3 through 8 are IR pictures recorded by the AN/AAR-30 and AN/AAR-32 IR detecting sets on 24 and 25 October 1967 and 22 July 1968. The IR pictures subtend a lateral angle of 140 and 120 deg, respectively, for the AN/AAR-30 and the AN/AAR-32 equipments unless otherwise indicated. The IR pictures were recorded from altitudes ranging from 1400 to 8000 ft. All of the boats involved in the tests are identified on the pictures and are seen as warm white spots. Figures 3 and 4 are IR pictures recorded by the AN/AAR-30 from altitudes of 1400 and 5000 ft on the night of 24 October 1967.

(U) Figure 5 shows imagery recorded simultaneously by the AN/AAR-30 and the AN/AAR-32 from an altitude of 3000 ft; similar corresponding samples of imagery recorded from an altitude of 7000 ft are shown in figure 6.

(U) Figure 7 is an IR picture recorded by the AN/AAR-30 in the daytime at an altitude of 8000 ft.

(U) Figure 8 provides a comparison of a visual light photograph recorded by a Type 30 Omera camera and an IR picture recorded by the AN/AAR-30. The IR picture has been cropped to provide approximately the same field of view (41 x 41 deg) as the visual light picture.

(U) On the night flight of 24 October 1967 and the two day flights of 20 and 25 October 1967, all of the boats were detected by both equipments on all valid passes from aircraft altitudes up to 3000 ft. At altitudes above 3000 ft, detection by the 16.4-milliradian resolution AN/AAR-32 equipment became marginal. The 7.4-milliradian resolution AN/AAR-30 detected all boats on all valid passes from aircraft altitudes up to 7000 ft and speeds up to 210 kn. The sweep width achieved by the AN/AAR-30 at this altitude was 6.4 nmi and the rate of area coverage at this speed was 19.2 sq nmi per min.

(U) On 29 April 1968 the AN/AAR-30 and the AN/AAR-32 were able to detect repeatedly all the boats except the life raft at aircraft altitudes up to and including 3000 ft. On this particular night the raft was unmanned and not fully inflated. In some cases, electronic problems in the AN/AAR-30 appeared to interfere with its detection capability. An unidentified warm object which appeared between the patrol boat and the life raft was detected repeatedly.

(U) On 22 July 1968 all the boats were detected repeatedly by the AN/AAR-30 equipment from altitudes up to and including 8000 ft. The sweep width achieved by the AN/AAR-30 at this altitude was 7.3 nmi and the rate of area coverage at an aircraft speed of 150 kn was 18.3 sq nmi per min. Above 2000 ft, the AN/AAR-32 equipment could detect only the patrol boat and the utility boat. The life raft was unmanned and was partially inflated on this day.

(U) Both IR equipments showed a capability for detecting the small amounts of oils placed in the ocean. The IR imagery recorded on six aircraft passes indicated that all of the samples of oils were equally detectable. Figure 9 is an IR picture recorded on one of the six aircraft passes. Three oil spots are indicated; the spots from two of the four samples had merged into one. Additional testing would be necessary to ascertain the value of IR equipments for the detection of oil in the ocean.

(U) The data presented in tables II through XI were obtained during controlled operations. Analysis of the data consisted of determining under what conditions a known collection of boats at some known location could be detected on the film recordings. Accordingly, no quantitative estimate of the possible problem of false targets (such as white caps, patches of oil, seaweed, etc) can be made from the present data.

D I S C U S S I O N

(U) Boats simulating those that have been adrift at sea can be detected both day and night. This detection is basically dependent on the temperature contrast between the boats and the sea and the angular and thermal resolutions of the IR equipments.

(U) Temperature contrasts experienced by boats adrift in the ocean are dependent on the environment. Major factors in the environment affecting temperature contrasts are the intensity and duration of the sunlight, sea state, and time of day and year. Sea state tends to affect detection in two ways. The higher state seas tend to wet the boats more, bring them closer to the sea temperature and decrease the contrast. Higher state seas also exhibit numerous white caps which act as false targets.

(U) Time of day and year is important in the detection of the boats. For instance, on a clear day in the summer the heating of the surface of a boat by the sun is significant. Temperature differences between the boat surface and the water as high as 23.8° C were experienced on 22 July 1968. Such a temperature difference creates a tremendous signal. It is difficult to predict what difference in temperature would exist and what its polarity would be on a summer night. After the sun sets, the boats would continue to radiate and eventually could reach the temperature of the water and continue to cool below that point. Conceivably, during the course of a night the boat could appear warm, neutral, and cool. In the winter on a clear, cold day, the cold air could nullify the heating of the sun so that a boat could appear cold. On a night following this type of day, the boat could continue being a cold target during the entire night. This problem is compounded further if sea states, weather, and the variety of boat construction materials are considered.

(U) In any particular IR imaging system, thermal and angular resolution must be considered jointly. If the size of an IR detector is decreased, thermal resolution can be traded-off for an improvement in angular resolution. Two IR equipments were used during these tests and, as the results point out, the AN/AAR-32 having the coarser angular resolution experienced marginal detection at altitudes above 2000 ft. The AN/AAR-30 IR detecting set with the finer resolution was able to detect the boats from aircraft altitudes up to 8000 ft. During all these tests, the temperature differences between the boats and the water were well above the thermal sensitivity limit of the systems. A conclusion that can be drawn from this is that the coarse angular resolution of the AN/AAR-32 system caused the marginal detection experienced above 2000 ft. If the detector of the AN/AAR-32 were smaller, the angular resolution would have been improved but not without a loss in thermal sensitivity. Experimentation must be done with the equipments to determine the optimum resolutions for a particular search application.

(U) In these experiments, when the results of the AN/AAR-30 IR equipment are considered, its detectability of the boats is very high. However, it must be understood that the location of the boats was known and they were positioned in a predetermined pattern. These two factors make detection much easier. If the boats were set in no particular array and their positions were not known a priori, the question arises, how difficult would detection be? Future tests should include a specific area, free from boat traffic and containing the test boats in no particular array, which can be searched to determine the severity of the false target problem.

(U) A significant point was observed from the results of the experiment on 22 July 1968. On this day both visual and IR imagery were recorded. In figure 8, which compares the two types of imagery, note the large "images" of the boats on the IR picture. This type of "enhancement" of the targets produced by the tremendous temperature difference of the boat surface and the ocean could be a definite aid in an ocean search and rescue mission.

(U) The tests indicate that IR methods employed in the detection of small boats in the ocean can be of significant value in the search and rescue mission. To determine the magnitude of this value, unknowns such as the false target rate and optimum system resolutions must be solved; this can only be accomplished by conducting more tests.

A C K N O W L E D G M E N T

(U) The author wishes to acknowledge the contributions of his co-workers (b) (6) carrying out these tests.

(U) TABLE I

CHARACTERISTICS OF IR SCANNERS

	AN/AAR-30	AN/AAR-32
Total angular field of view (deg)	140	120
Scan rate (scans per sec)	33	100
Optical aperture (cm^2)	456	47
Focal length (mm)	381	152
Detector type	Ge:Hg	Ge:Hg
Detector size (mm)	2.8 (dia)	2.5 x 2.5
Spatial resolution (milliradians)	7.4	16.4
NEΔT for a single scan (C °)	0.002	0.01
V/H for contiguous scan (kn per ft)	160/1200	160/160
Spectral region (microns)	2-14	2-14
Spectral region with optical filter (microns)	8-14	8-14

(U) TABLE II

DETECTION OF BOATS BY AN/AAR-30 IR DETECTING SET

Date: 20 Oct 1967
Weather: Clear
Wind - 318°, 12 kn
Angular Resolution: 7.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1030	500	130	x		x	x
1033	500	130	x		x	x
1035	500	180	x		x	x
1040	500	180	x		x	x
1043	500	180	x	x*	x	x
1046	1000	130	x	x	x	x
1050	1000	130	x	x	x	x
1054	1000	180	x	x	x	x
1057.5	1000	183	x	x	x	x
1101.5	1500	130	x	x	x	x
1105	1550	125	x	x	x	x
1108.5	1500	183	x	x	x	x
1112	1550	180	x	x	x	x
1115	3000	190	x	x	x	x
1119	5000	180	x	x	x	x

Legend

x - boat detected
* - boat arrived on station at time indicated

(U) TABLE III

DETECTION OF BOATS BY AN/AAR-32 IR DETECTING SET

Date: 20 Oct 1967
Weather: Clear
Wind - 318°, 12 kn
Angular Resolution: 16.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1030	500	130	x		x	x
1033	500	130	x		x	x
1035	500	180	x		x	x
1040	500	180	x		x	x
1043	500	180	x	x*	x	x
1046	1000	130	x	x	x	x
1050	1000	130	x	x	x	x
1054	1000	180	x	x	x	x
1057.5	1000	183	x	x	x	x
1101.5	1500	130	x	x	x	x
1105	1550	125	x	x	x	x
1108.5	1500	183	x	x	x	x
1112	1550	180	x	x	x	x
1115	3000	190	x	x	x	x
1119	5000	180	x	0	0	0

Legend

x - boat detected
* - boat arrived on station at time indicated
0 - boat not detected

(U) TABLE IV

DETECTION OF BOATS BY AN/AAR-30 IR DETECTING SET

Date: 24 Oct 1967
Sunset: 1810Q
Weather: Clear
Wind - 110°, 12 kn
Angular Resolution: 7.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1950	500	160	x	x	x	x
1954	700	160	x	x	x	x
1956.5	500	130	x	x	x	x
2000	500	130	x	x	x	x
2003	500	180	x	x	x	x
2005	575	180	x	x	x	x
2010	1000	130	x	#	x	x
2014	1000	130	x	x	x	x
2017.5	1000	180	x	x	x	x
2020	1000	180	x	x	x	x
2025	1500	130	x	x	x	x
2028	1500	130	x	x	x	x
2031	1400	180	x	x	x	x
2034	1500	180	x	x	x	x
2040	5000	180	x	x	x	x
2045	5000	175	x	x	x	x
2058	10,000	180	+	x	x	x
2107	8000	180	x	*	*	x

Legend

x - boat detected
- life raft was beyond detecting set's field of view on this pass
+ - cutter obscured by a thermal pattern in the water
* - boat not in position (pass made after completion of exercise)

(U) TABLE V

DETECTION OF BOATS BY AN/AAR-32 IR DETECTING SET

Date: 24 Oct 1967
Sunset: 1810Q
Weather: Clear
Wind - 110°, 12 kn
Angular Resolution: 16.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1950	500	160	x	x	x	x
1954	700	160	x	x	x	x
1956.5	500	130	x	x	x	x
2000	500	130	x	x	x	x
2003	500	180	x	x	x	x
2005	575	180	x	x	x	x
2010	1000	130	x	#	x	x
2014	1000	130	x	x	x	x
2017.5	1000	180	x	x	x	x
2020	1000	180	x	x	x	x
2025	1500	130	x	x	x	x
2028	1500	130	x	x	x	x
2031	1400	180	x	x	x	x
2034	1500	180	x	x	x	x
2040	5000	180	x	0	0	0
2045	5000	175	x	0	x	x
2058	10,000	180	0	0	0	0
2107	8000	180	x	0	0	0

Legend

x - boat detected
- life raft was beyond detecting set's field of view on this pass
0 - boat not detected

(U) TABLE VI

DETECTION OF BOATS BY AN/AAR-30 IR DETECTING SET

Date: 25 Oct 1967
Weather: Cloud cover 0.4 to 0.7; cloud base 8000 ft
Wind - 130°, 12 to 15 kn
Angular Resolution: 7.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1102	500	130	x	x	x	x
1105	500	130	x	x	x	x
1109	450	180	x	x	x	x
1111	475	180	x	x	x	x
1115	1000	130	x	x	x	x
1118	950	130	x	x	x	x
1122	1000	180	x	x	x	x
1125	1000	180	x	x	x	x
1130	1500	130	x	x	x	x
1134	1500	130	x	x	x	x
1138	1500	180	x	x	x	x
1142	1500	180	x	x	x	x
1148	3000	160	x	x	x	x
1152	3000	100	x	x	x	x
1200	7000	120	x	x	x	x
1205	7000	180	x	x	x	x
1215	150	210	x	x	x	x

Legend

x - boat detected

(U) TABLE VII

DETECTION OF BOATS BY AN/AAR-32 IR DETECTING SET

Date: 25 Oct 1967
Weather: Cloud cover 0.4 to 0.7; cloud base 8000 ft
Wind ~ 130°, 12 to 15 kn
Angular Resolution: 16.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1102	500	130	x	x	x	x
1105	500	130	x	x	x	x
1109	450	180	x	x	x	x
1111	475	180	x	x	x	x
1115	1000	130	x	x	x	x
1118	950	130	x	x	x	x
1122	1000	180	x	x	x	x
1125	1000	180	x	x	x	x
1130	1500	130	x	x	x	x
1134	1500	130	x	x	x	x
1138	1500	180	x	x	x	x
1142	1500	180	x	x	x	x
1148	3000	160	x	x	x	x
1152	3000	100	x	x	x	x
1200	7000	120	x	x	0	x
1205	7000	180	x	0	0	x
1215	150	210	x	x	x	x

Legend

x - boat detected
0 - boat not detected

(U) TABLE VIII

DETECTION OF BOATS BY AN/AAR-30 IR DETECTING SET

Date: 29 Apr 1968
Weather: Cloudy
Wind - 158°, 10 kn
Angular Resolution: 7.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
2046	500	180	x	#	#	#
2102	500	190	x	x	0	x
2107.5*	500	180	x	0	x	x
2113	500	145	x	#	x	x
2119	500	125	x	0	x	x
2124.5	500	180	x	#	x	x
2130	1000	180	x	0	0	x
2140	1000	180	x	0	x	x
2145	1000	130	x	x	x	x
2150	1000	130	x	x	x	x
2155	1500	180	x	0	x	x
2200	1500	180	x	x	x	x
2204	1500	130	x	x	x	x
2209	1500	130	x	x	x	x
2217	3000	180	x	0	x	x
2222	3000	180	x	0	0	x
2230	9000	180	0	0	0	0

Legend

* - indicates time tests started
x - boat detected
0 - boat not detected
- boat was beyond detecting sets field of view

(U) TABLE IX

DETECTION OF BOATS BY AN/AAR-32 IR DETECTING SET

Date: 29 Apr 1968
Weather: Cloudy
Wind - 158°, 10 kn
Angular Resolution: 16.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
2046	500	180	x	#	#	#
2102	500	190	x	x	0	x
2107.5*	500	180	x	0	x	x
2113	500	145	x	#	x	x
2119	500	125	x	0	x	x
2124.5	500	180	x	#	x	x
2130	1000	180	x	0	0	x
2140	1000	180	x	0	x	x
2145	1000	130	x	x	x	x
2150	1000	130	x	0	x	x
2155	1500	180	x	0	x	x
2200	1500	180	x	0	x	x
2204	1500	130	x	0	x	x
2209	1500	130	x	0	x	x
2217	3000	180	x	0	x	x
2222	3000	180	x	0	0	0
2230	9000	180	x	0	0	0

Legend

* - indicates time tests started
x - boat detected
0 - boat not detected
- boat was beyond detecting set's field of view

(U) TABLE X

DETECTION OF BOATS BY AN/AAR-30 IR DETECTING SET

Date: 22 Jul 1968
Weather: Clear
Wind - light and variable
Angular Resolution: 7.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1008	500	170	x	x	x	x
1013	500	180	x	x	x	x
1017.5	1000	180	x	x	x	x
1022	1000	180	x	x	x	x
1028	2000	180	x	x	x	x
1033.5	2000	180	x	x	x	x
1040	4000	165	x	x	x	x
1045.5	4000	170	x	x	x	x
1053.5	6000	170	x	x	x	x
1058.5	6000	160	x	x	x	x
1105	8000	150	x	x	x	x
1112.5	8000	150	x	x	x	x
1145	8000	150	x	x	x	x
1150	6000	160	x	x	x	x
1156	4000	170	x	x	x	x
1200	2000	170	x	x	x	x

Legend

x - boat detected

(U) TABLE XI

DETECTION OF BOATS BY AN/AAR-32 IR DETECTING SET

Date: 22 Jul 1968
Weather: Clear
Wind - light and variable
Angular Resolution: 16.4 milliradians

Time (Q)	Aircraft Altitude (ft)	Indicated Airspeed (kn)	Patrol Boat	Life Raft	Small Boat	Utility Boat
1008	500	170	#	#	#	#
1013	500	180	x	x	x	x
1017.5	1000	180	x	x	x	x
1022	1000	180	x	x	x	x
1028	2000	180	x	x	x	x
1033.5	2000	180	x	x	x	x
1040	4000	165	x	0	0	x
1045.5	4000	170	x	0	0	x
1053.5	6000	160	x	0	0	x
1058.5	6000	170	x	0	0	x
1105	8000	150	0	0	0	0
1112.5	8000	150	x	0	0	x
1145	8000	150	x	0	0	0
1150	6000	160	x	0	0	x
1156	4000	170	x	0	0	x
1200	2000	170	x	0	0	x

Legend

x - boat detected
0 - boat not detected
- equipment was not adjusted properly

(U)

TABLE XII

SUMMARY OF TARGET CHARACTERISTICS

Date	Boat Type	Persons on Deck	Attire of Persons on Deck	Degree of Wetness of Deck During Test	Average Deck Temperature (° C) Begin	End	Deck Material	Deck Color	Boat Size	Remarks
20 Oct 1967	Patrol	4-5	Life jacket	Wet	NA	NA	Steel	Gray	95'x19'10"	Spacing between boats was 300 yd.
	Life raft	2	Wet suit and life jacket	Wet	18	21	Rubber	Yellow	15'8"x7'4"	Men on raft were under a canopy.
	Small	2	Wet suit and life jacket	Wet	17	22	Fiberglass	Spar	16'x5'6"	
	Utility	0		Wet	25.5	25	Steel	Gray	30'x8'11"	
24 Oct 1967	Patrol	4-5	Life jacket	Dry	NA	NA	Steel	Gray	95'x19'10"	Spacing between boats was 600 yd.
	Life raft	0		Dry	17	17	Rubber	Yellow	15'8"x7'4"	
	Small	2	Wet suit and life jacket	Dry	18	18	Fiberglass	Spar	16'x5'6"	
	Utility	0		Dry	12.5	12.5	Steel	Gray	30'x8'11"	
25 Oct 1967	Patrol	4-5	Life jacket	Dry	NA	NA	Steel	Gray	95'x19'10"	Spacing between boats was 300 yd.
	Life raft	0		Dry	23	25	Rubber	Yellow	15'8"x7'4"	
	Small	1	Wet suit and life jacket	Dry	24	26	Fiberglass	Spar	16'x5'6"	
	Utility	0		Dry	23	24.5	Steel	Gray	30'x8'11"	
29 Apr 1968	Patrol	4-5	Life jacket	Dry	NA	NA	Steel	Gray	95'x19'10"	Spacing between boats was 600 yd.
	Life raft	0		Dry	NA	NA	Rubber	Yellow	15'8"x7'4"	
	Small	1	Wet suit and life jacket	Dry	12	6	Fiberglass	Spar	16'x5'6"	
	Utility	0		Dry	11	6	Steel	Gray	30'x8'11"	
22 Jul 1968	Patrol	4-5	Life jacket	Wet	NA	NA	Steel	Gray	82'x7'7"	Spacing between boats was 200 yd and 300 yd.
	Life raft	0		Wet	NA	NA	Rubber	Yellow	15'8"x7'4"	
	Small	1	Life jacket	Wet	46	45.5	Fiberglass	Spar	16'x5'6"	
	Utility	0		Wet	46	47.0	Steel	Gray	30'x8'11"	

NA - not available.

(U)

TABLE XIII

SUMMARY OF ENVIRONMENTAL CONDITIONS

Date	20 Oct 1967	24 Oct 1967	25 Oct 1967	29 Apr 1968	22 Jul 1968
Time interval of tests	1030 to 1119Q	1950 to 2058Q	1102 to 1215Q	2046 to 2230Q	1008 to 1200Q
Sunset time	1814Q	1809Q	1808Q	1957Q	2023Q
Water wave height range (ft)	1	2	3 to 4	1.5 to 1	1 to 1.5
Wind speed range (kn)	8 to 12	12	10 to 22	6 to 8	5 to 10
Air surface temperature range (° C)	10.5 to 11.6	15.5 to 16.6	17.8 to 18.3	10.8 to 11.1	27.8 to 29.5
Sky conditions	0.2 cloud cover	clear	0.4 to 0.9 cloud cover	cloudy	clear
Water surface temperature range (° C)	14.4	13.9 to 14.4	14.4	10.5	23.2

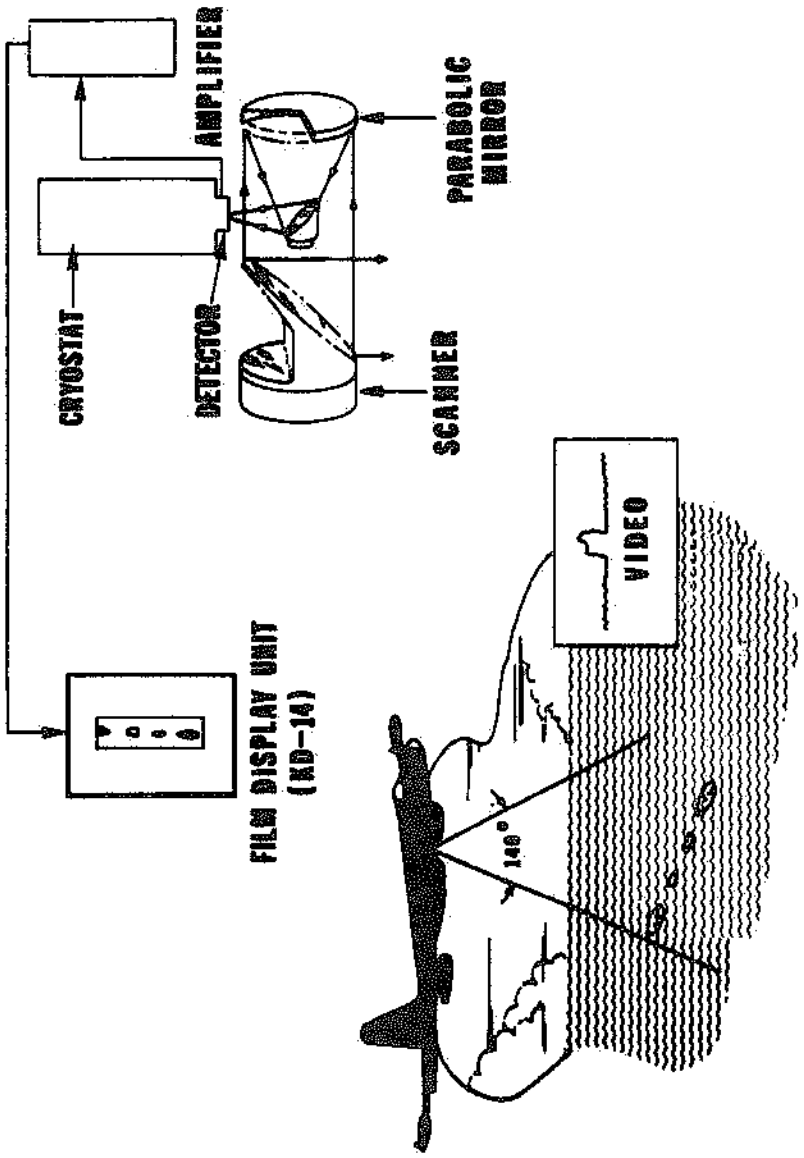


FIGURE 1 - Diagram Showing the Major Components and Operation of the AN/AAR-30 IR Detecting Set

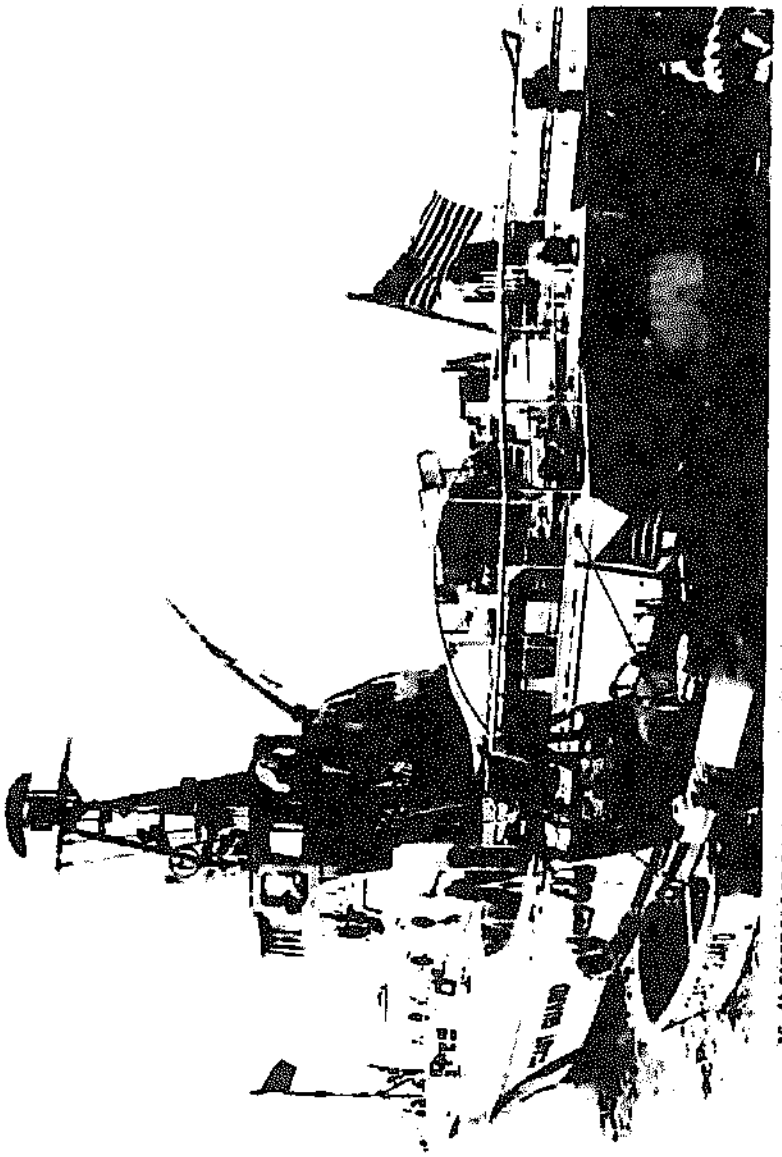


FIGURE 2a - U.S. Coast Guard Boats Used in the Tests

FIGURE 2b - U.S. Coast Guard 15-Ft 8-In. Life Raft Used in the Tests

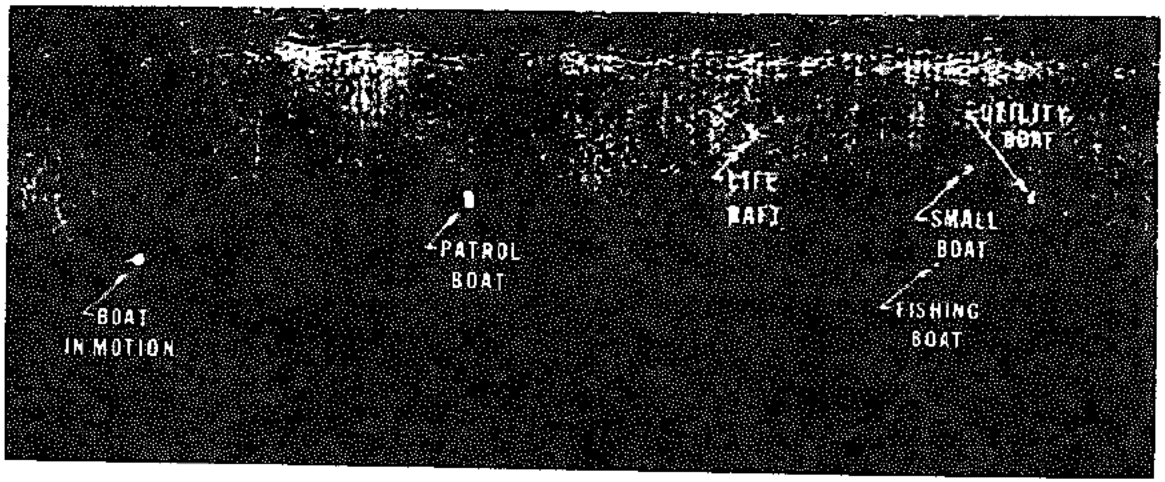


FIGURE 3 - IR Picture Showing Six Boats Recorded at Night by the AN/AAR-30 from an Altitude of 1400 Ft (U)

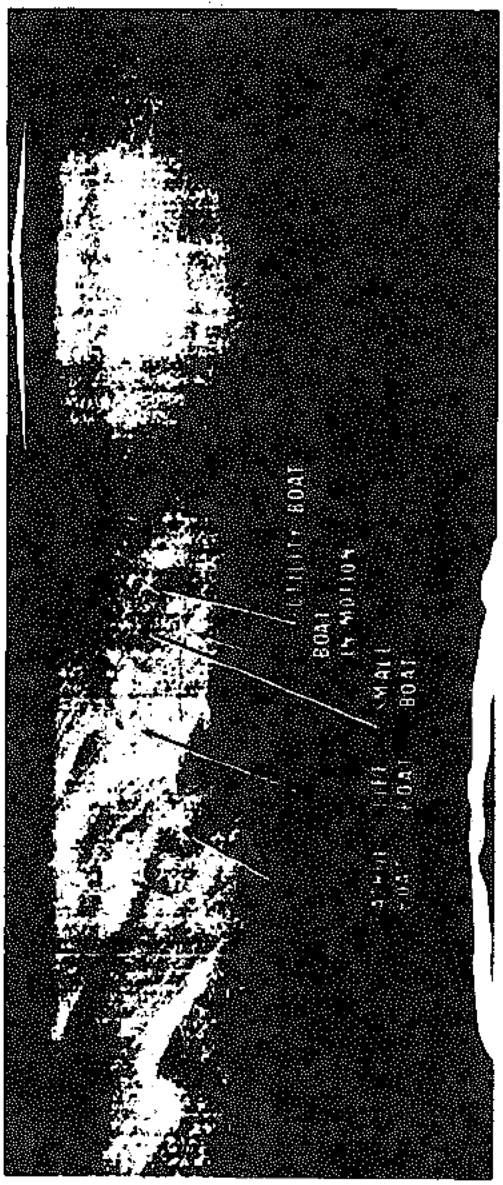
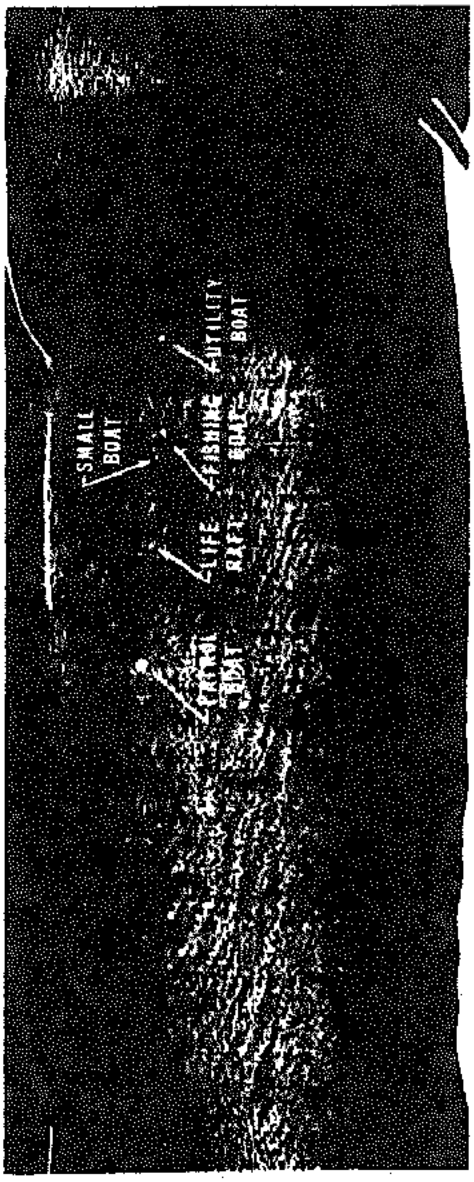


FIGURE 4 - IR Picture Showing Boats Recorded at Night by the AN/AAR-30 from an Altitude of 5000 Ft (U)



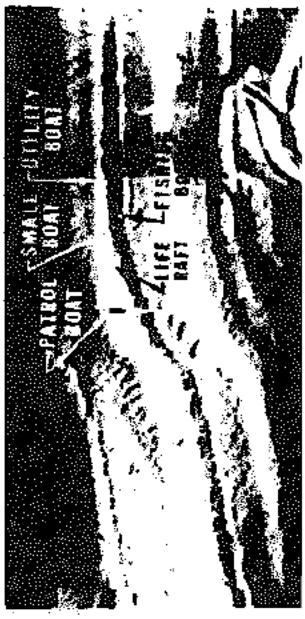


FIGURE 5 - IR Pictures Showing Five Boats Recorded During Daytime by the AV/AAR-30 and the AV/AAR-32 from an Altitude of 3000 Ft

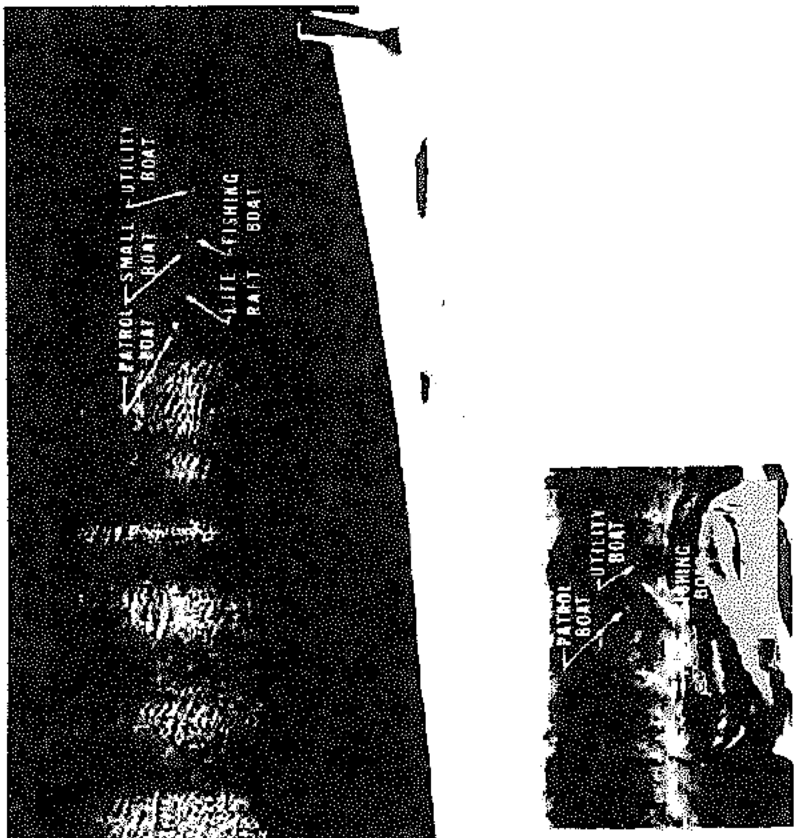


FIGURE 6 - IR Pictures Showing Five Boats Recorded During Daytime by the AN/AAR-30 and AN/AAR-32 from an Altitude of 7000 Ft

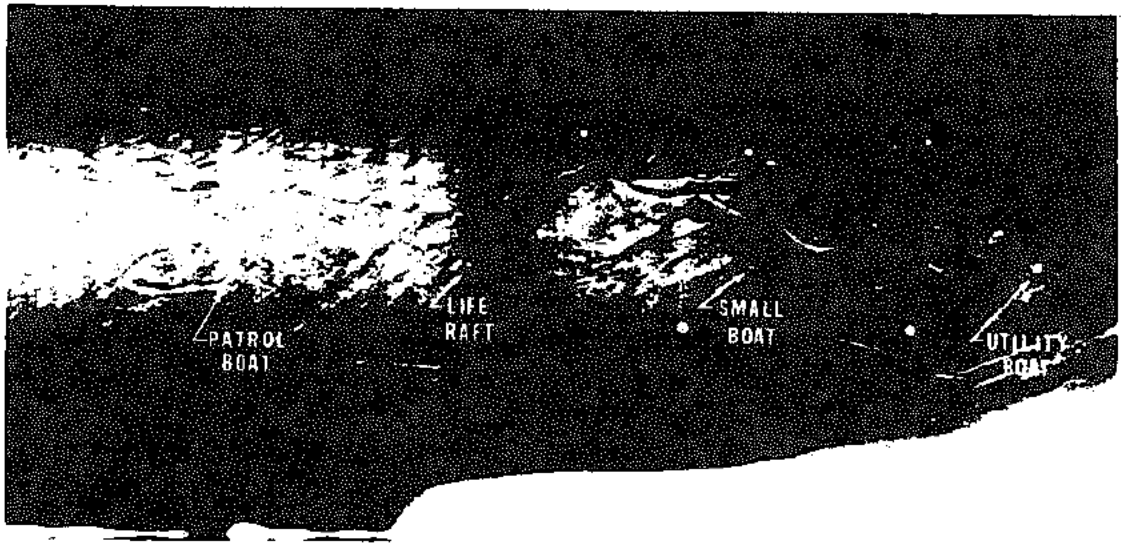


FIGURE 7 - IR Picture of Boats Recorded During Daytime by the AN/AAR-30 from an Altitude of 8000 Ft (U)

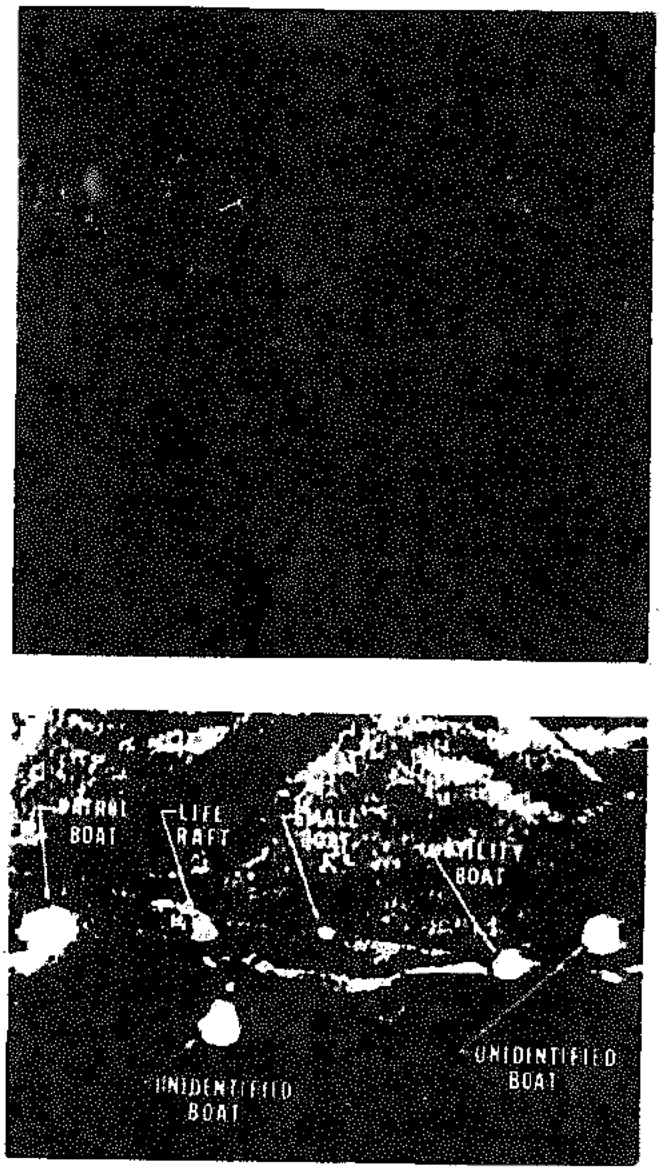


FIGURE 8 - Pictures Recorded During Daytime by the AN/AAR-30 IR Detecting Set and a Type 30 Omera Camera from an Altitude of 8000 Ft (U)

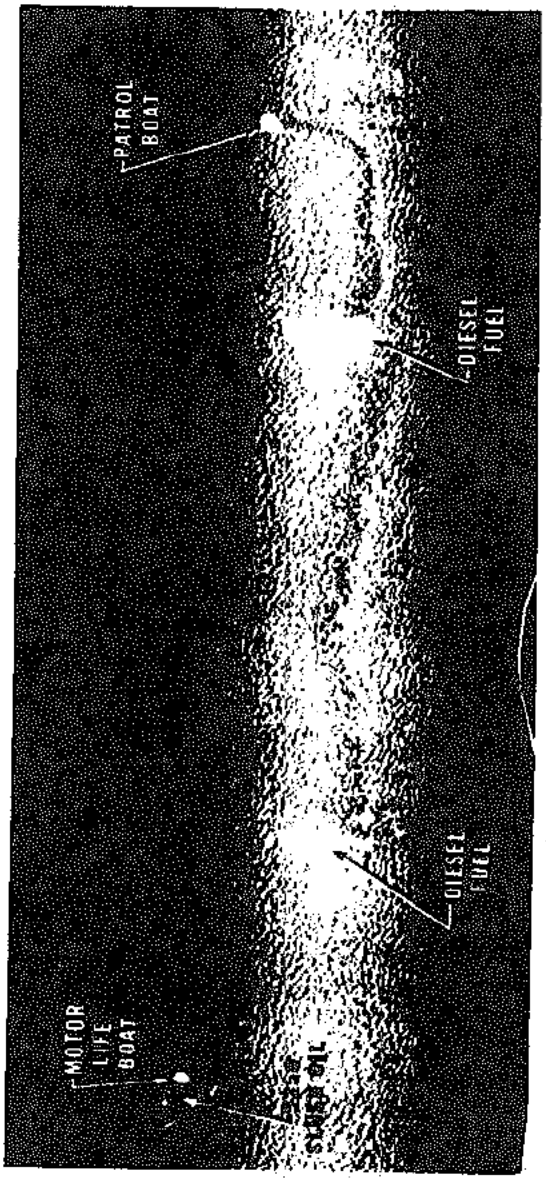


FIGURE 9 - IR Picture Showing Oil Spots Recorded by the AN/AAR-30 from an Altitude of 500 Ft (U)

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11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

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13. ABSTRACT

The AN/AAR-30 and AN/AAR-32 IR detecting sets with their respective accessory rapid-processed film display units, the KD-14 (XA-3) and the AN/ASA-55(XJ-1), were installed in NP-2E aircraft BuNo 131403 and operated during five day and nighttime exercises over an array of U.S. Coast Guard boats anchored off Cape May, New Jersey, during the period 20 October 1967 to 22 July 1968 to investigate this means of detecting non-co-operating boats as part of a search and rescue study program. The IR sets detected the boats from aircraft altitudes up to 8000 ft at area coverage rates of 18.3 sq nmi per min. (U)

[redacted]

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