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APPLICATIONS OF AIRBORNE PASSIVE INFRARED MAPPING DEVICES TO MILITARY OCEANOGRAPHY(U)

by
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28 OCTOBER 1987

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First U.S. Navy Symposium on Military Oceanography, Volume II,
17-19 June 1964

Prepared for
NAVAL AIR DEVELOPMENT CENTER
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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

(U) The Naval Air Development Center has been conducting over-water flight trials of passive infrared mapping devices as part of an ASW program to study the possibility of detecting submarines by detecting effects they may produce on the surface of the water. While infrared pictures of ships, submarines, and their wakes were being obtained, infrared pictures of many interesting oceanographic phenomena were recorded. This report consists of a description of a typical passive infrared line-scanning equipment used in conducting these studies, a brief resume of results obtained against submarines and ships, and a description of results that suggest its application to air-dropped mine detection, to nighttime air-sea rescue work, to underwater sound propagation prediction, for general nighttime surveillance and for use as an oceanographic tool.

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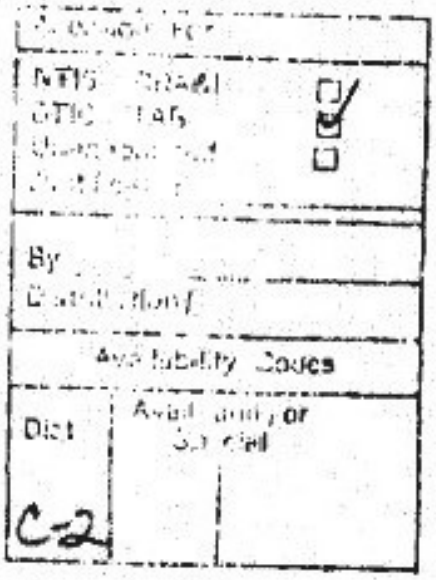
19. ABSTRACT (Continued)

The report includes imagery from modified AN/AAD-2 and AN/AAR-30 infrared detecting sets of wakes from snorkelling and surfaced submarines and from completely submerged submarines leaking air, discharging diesel oil, operating in a positively buoyant condition, and in the process of surfacing. Also included are infrared pictures of persistent surface scars produced by air-dropping simulated mines into the Gulf of Mexico, a 3500-ft slick produced by dropping about 50 ml of corn oil into the ocean, and the surface expressions of an oceanic front, a field of convection cells, water flow patterns around Florida keys, the flow of water from an inlet into the ocean, an eddy in St. Andrew Bay, and a 4-mile diameter eddy 200 nmi east of Boston.



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APPLICATIONS OF AIRBORNE PASSIVE INFRARED MAPPING DEVICES TO MILITARY OCEANOGRAPHY

by

Paul M. Moser
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(U) INTRODUCTION

(U) Every object radiates electromagnetic energy at a rate which is proportional to the fourth power of its absolute temperature and which is proportional to the radiant efficiency (emissivity) of the radiating object. For objects at room temperature, approximately 37% of this energy is radiated in the 8 to 14 micron portion of the infrared spectrum. In general, objects in a given scene will exhibit differences in temperature and emissivity. Accordingly, it is possible for an imaging device operating in this portion of the spectrum to record pictures of objects by virtue of their infrared incandescence even in absolute darkness.

(U) The Naval Air Development Center has been conducting over-water flight trials of passive infrared mapping devices as part of an ASW program to study the possibility of detecting submarines by detecting effects they may produce on the surface of the water. In conducting these investigations more than one hundred thousand square miles of ocean surface have been mapped. While infrared pictures of ships, submarines, and their wakes were being obtained, infrared pictures of many interesting oceanographic phenomena were recorded. The purpose of this paper is to present a broad range of these results that demonstrate applications of airborne passive infrared mapping devices to military oceanography. This paper will consist of a description of a typical infrared equipment used in conducting these studies, a brief resume of results obtained against submarines and ships, and a description of results that suggest its application to air-dropped mine detection, to nighttime air-sea rescue work, to underwater sound propagation prediction, for general nighttime surveillance and for use as an oceanographic tool.

(U) DESCRIPTION OF EQUIPMENT

(U) The infrared equipments used to obtain the results to be described were built by HRB-Singer, Incorporated and are designated the AN/AAD-2

[redacted]

(U) and AN/AAR-30. Because of their great similarity the design of only one will be described.

(U) Figure 1 illustrates the optical system of the AN/AAD-2 infrared mapping set which was designed originally for use in U. S. Army Signal Corps drone aircraft and modified by the Naval Air Development Center for high sensitivity over-water use. It operates in the following manner. A small portion of the infrared radiation emitted or reflected by the objects under surveillance is intercepted by the plane 45^0-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 at a rate of 100 revolutions per second, 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 infrared detector. The electrical signal generated in the detector is amplified and passed on to a glow tube which emits light whose intensity is proportional to the electrical signal impressed upon it. Light from the glow tube is focused to a small spot by means of a microscope objective, which is also mounted on the rotating shaft. The intensity-modulated spot of light scans across a piece of slowly advancing photographic film in synchronism with the scanning mirror. As the aircraft advances, a 120^0 field of view of the terrain below is swept out by the scanner and recorded on photographic film in the form of a continuous strip map.

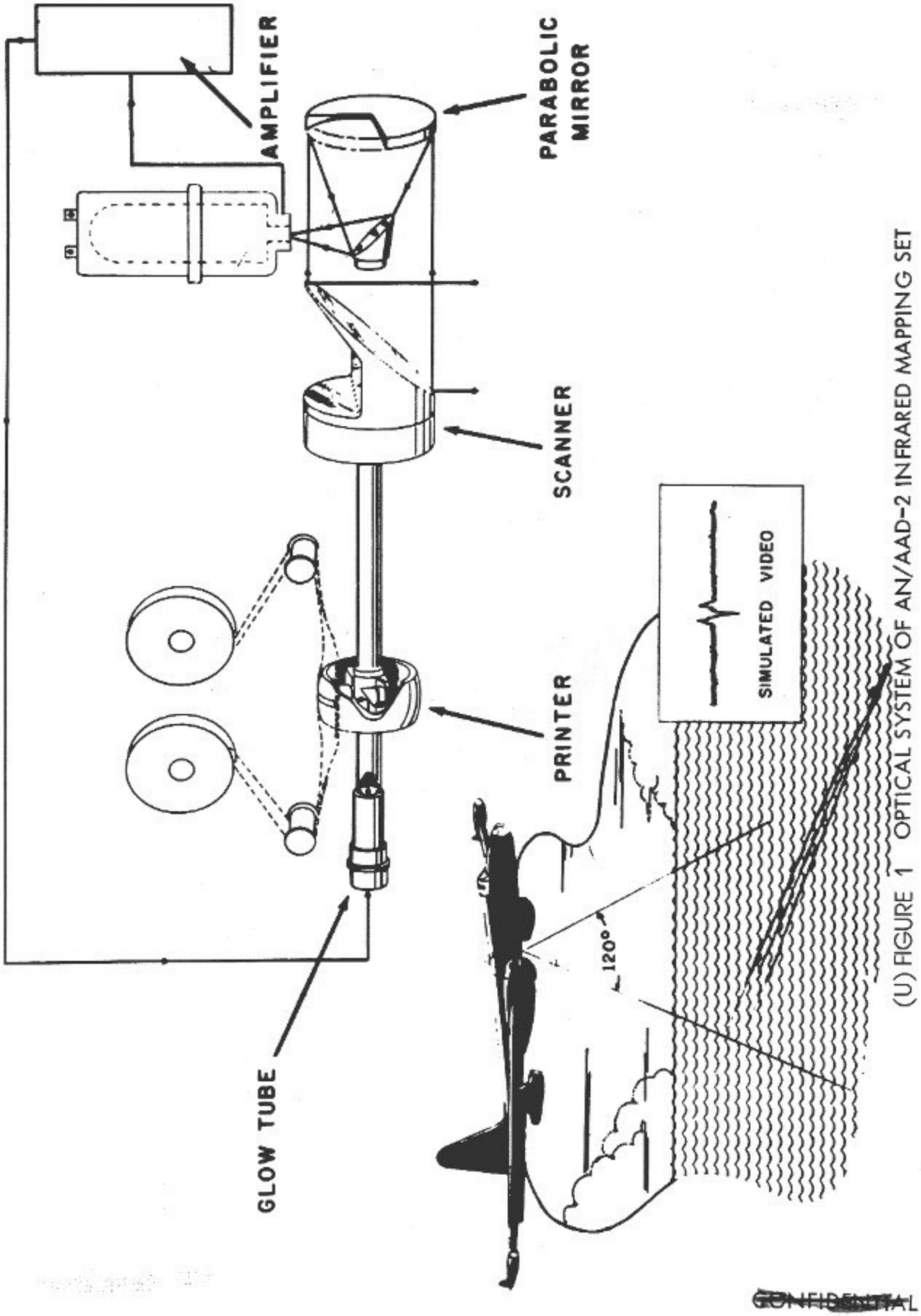
(U) For the results to be described, a liquid-helium-cooled copper doped germanium detector was used most commonly in the AN/AAD-2. This detector yielded an instantaneous angular field of view of about 1° and a noise-equivalent temperature difference of about 10^{-3}C°.

(U) Figure 2 shows the AN/AAD-2 installed in the closed-off bomb bay of a P-2 type aircraft. Figure 3 illustrates the observer's station in the same aircraft. The item of principal interest here is an Ansco KD-14 camera-processor-viewer in which video information from the scanner is printed on photographic film by means of an intensity-modulated cathode ray tube, processed continuously by a two-solution "arrested development" technique, and presented to the observer on a back-lighted viewer with a typical total delay time of about 15 seconds.

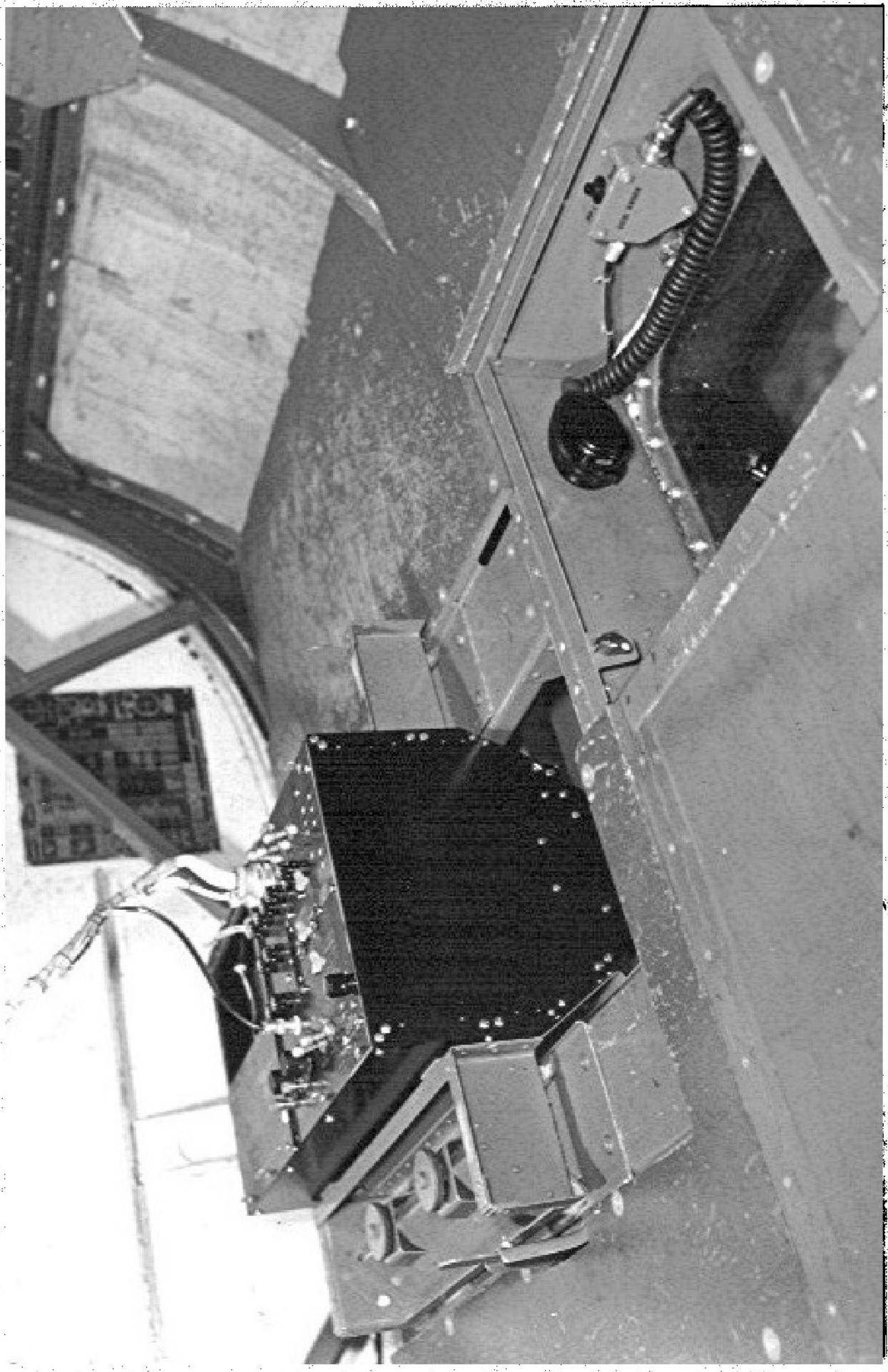
(U) DETECTION AND TRACKING OF SUBMARINES

(C) The modified AN/AAD-2 has demonstrated a consistent ability to record wakes from submarines operating at keel depths as great as 65 feet in seas as high as state 4.

(C) In general, the persistence of these wakes appears to be primarily a function of sea state. In calm seas, wakes as long as 22 miles and as



(U) FIGURE 1 OPTICAL SYSTEM OF AN/AAD-2 INFRARED MAPPING SET



(U) FIGURE 2 INSTALLATION OF AN/AAD-2 IN CLOSED-OFF BOMB BAY OF A P-2 AIRCRAFT

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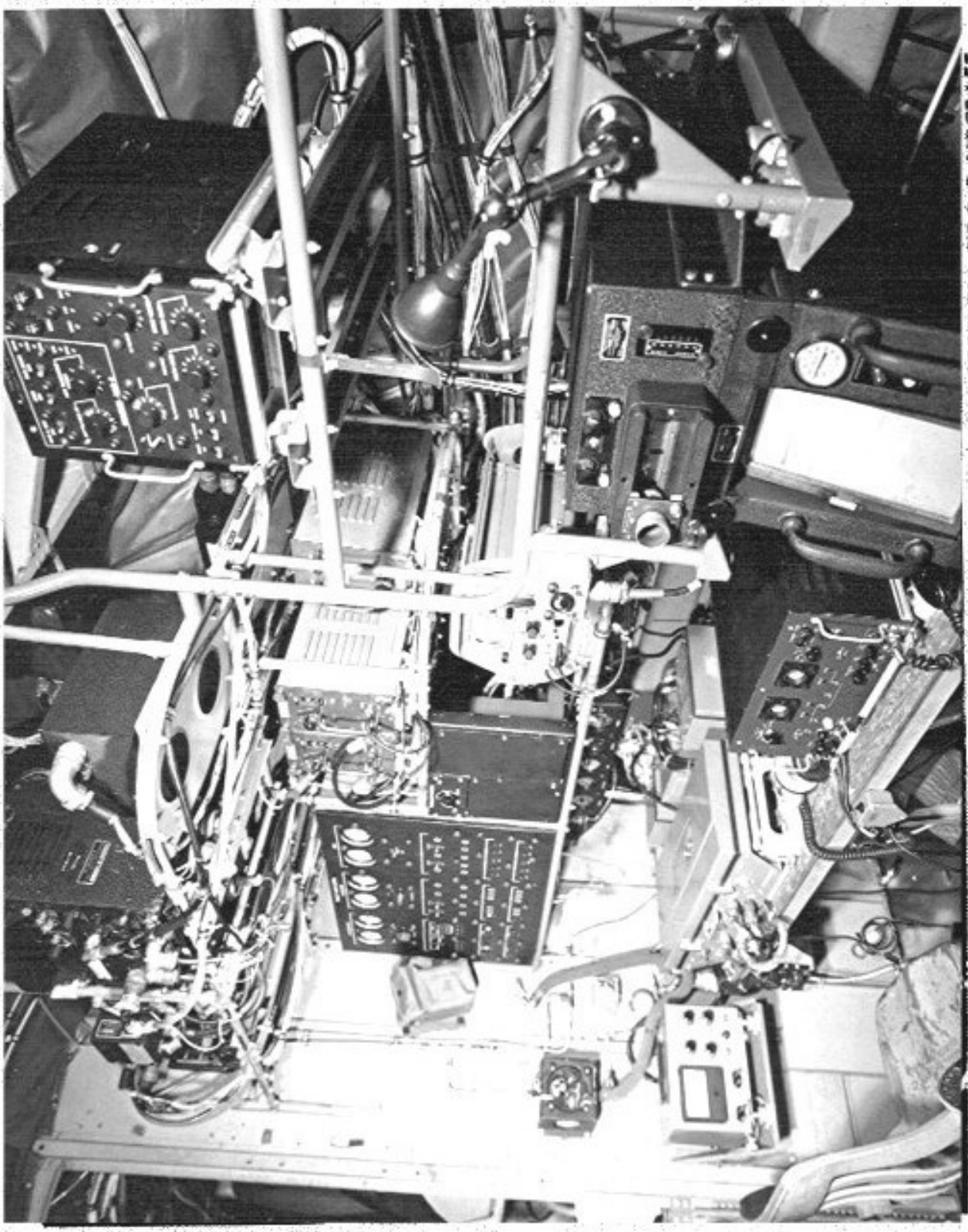

(U) FIGURE 3 INSTALLATION OF AN/AAD-2 ACCESSORIES IN AFTER-SECTION OF P-2 AIRCRAFT. KD-14 CAMERA-PROCESSOR-VIEWER APPEARS IN RIGHT FOREGROUND.

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old as 3 hours have been recorded; in state 4 seas they have been observed to dissipate within 10 minutes.

Figure 4 shows a submarine's hot snorkel and wake as recorded at night by the AN/AAD-2. In this, as in subsequent pictures, effectively warm targets are represented as light and effectively cold ones as dark. The length of the area shown corresponds to 1.0 nautical mile; the vertical dimension of the picture corresponds to about 100° of scan perpendicular to the direction of aircraft travel. The altitude was 1300 feet.

Figure 5 shows the wake left by a submarine which had been snorkeling but which had secured its snorkel and dived to a greater depth. The abrupt termination of the wake indicates the point of submergence. Beyond this point can be seen an effectively cold elliptical patch which was produced on the surface of the water by a deliberate discharge of oil from the advancing submerged submarine. This picture was recorded 84 minutes after the submarine had dived. It indicates the wake persistences to be expected under calm sea conditions. The length of this picture corresponds to 2.8 nautical miles.

The character of the wakes depends greatly upon the local oceanographic conditions and the mode of operation of the submarine. Figure 6 shows an area marked by a striking natural background pattern through which a submerged submarine has passed. In the right half of the picture a series of cold upwellings is seen in the region where the submarine was in the process of surfacing.

Figure 7 shows two distinctly textured contiguous water masses through which a submarine has passed on the surface. In the left half of the picture, it appears the submarine has homogenized the natural surface texture in its wake, whereas in the right half, a wake consisting of a dark line bordered by light lines has been produced.

If the submarine is leaking air, the rising bubbles may bring materials suspended in the body of the water to the surface and form a smooth slick. Figure 8 shows a 1.0-mile long area through which a 100-foot deep submarine was passing at a speed of 4 knots while releasing air at an estimated rate of 80 cubic feet per minute. An effectively warm wake about 60 feet in width is seen.

It has been found in other experiments that operation of the submarine in a positively buoyant, out-of-trim condition can often impart to the water sufficient upward momentum to overcome a moderately stable stratification of the water and produce effects on the surface. Figure 9 shows a line of cold upwellings produced by a 6-knot, 130-foot deep

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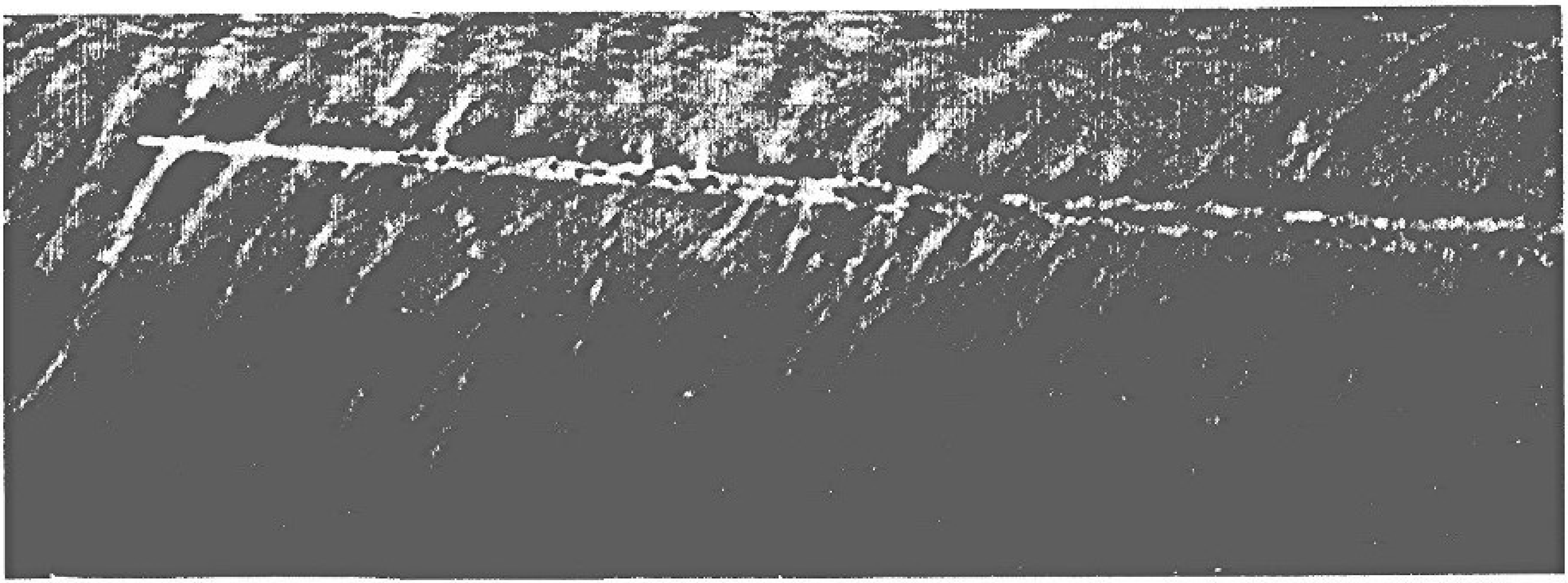
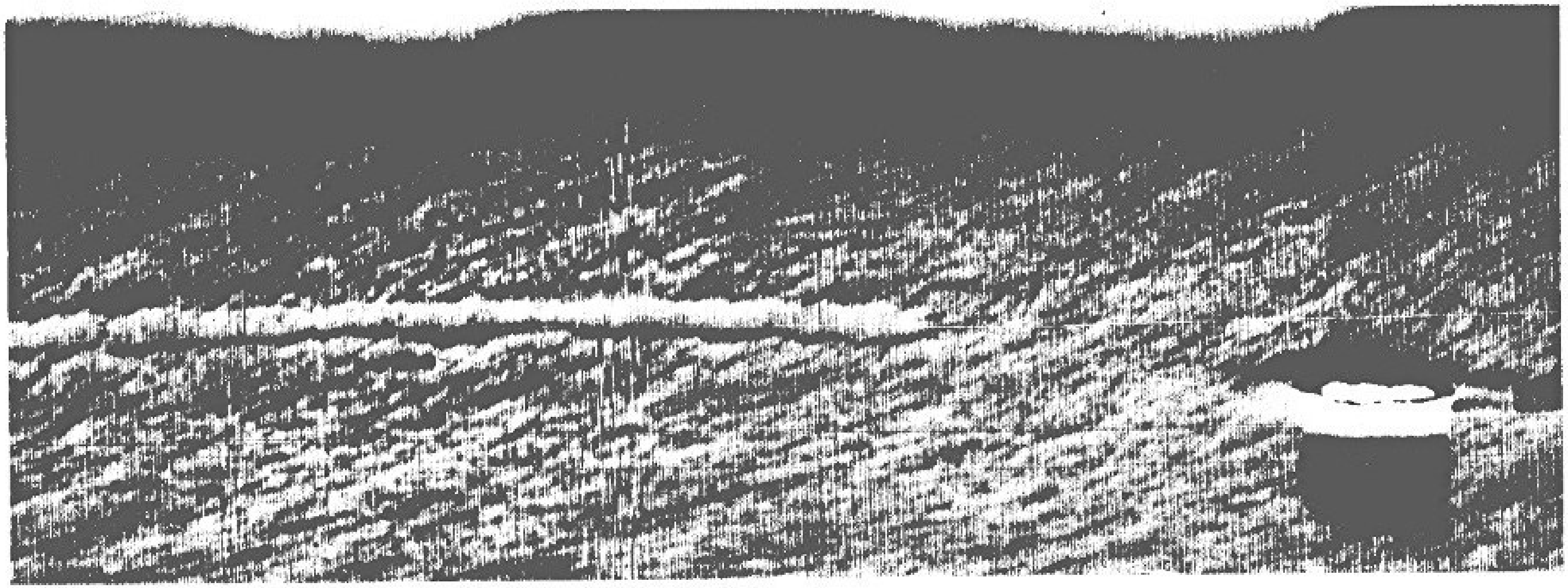
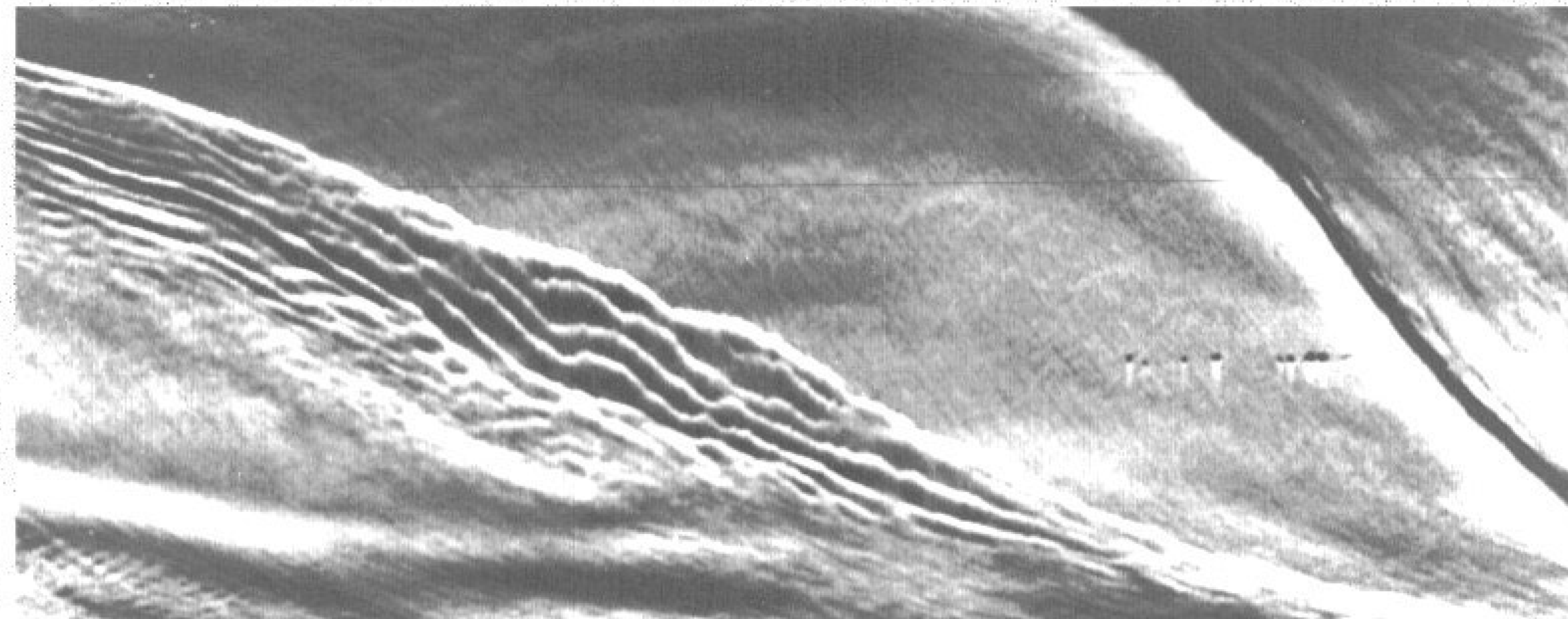


(C) FIGURE 4 HOT SUBMARINE SNORKEL AND WAKE RECORDED BY AN/AAD-2. DATE: 15 MARCH 1962; TIME: 1939 R; COORDINATES: 24°00'N, 83°45'W; AIRCRAFT ALTITUDE: 1300 FEET; LENGTH OF AREA SHOWN: 1.0 NAUTICAL MILE.



(C) FIGURE 5 WAKE LEFT BY SNORKELLING SUBMARINE RECORDED BY AN/AAD-2 84 MINUTES AFTER SNORKEL HAD BEEN SECURED. SPREADING PATCH OF OIL APPEARS ON THE RIGHT. THE WHITE AND BLACK "SHADOWS" BENEATH THE OIL PATCH ARE THE RESULT OF OVERLOADING OF THE SYSTEM'S AMPLIFIER. DATE: 9 AUGUST 1962; TIME: 0035 Q; COORDINATES: 40°29'N, 71°40'W; AIRCRAFT ALTITUDE: 2500 FEET; LENGTH OF AREA SHOWN: 2.8 NAUTICAL MILES.



(U) FIGURE 6 WAKE OF A SUBMARINE RECORDED WHILE THE SUBMARINE WAS IN THE PROCESS OF SURFACING. DATE: 28 MARCH 1962; TIME: 2139 R; COORDINATES: 40°25'N, 71°53'W; SEA STATE: 1; AIRCRAFT ALTITUDE: 2600 FEET; LENGTH OF AREA SHOWN: 2.0 NAUTICAL MILES.

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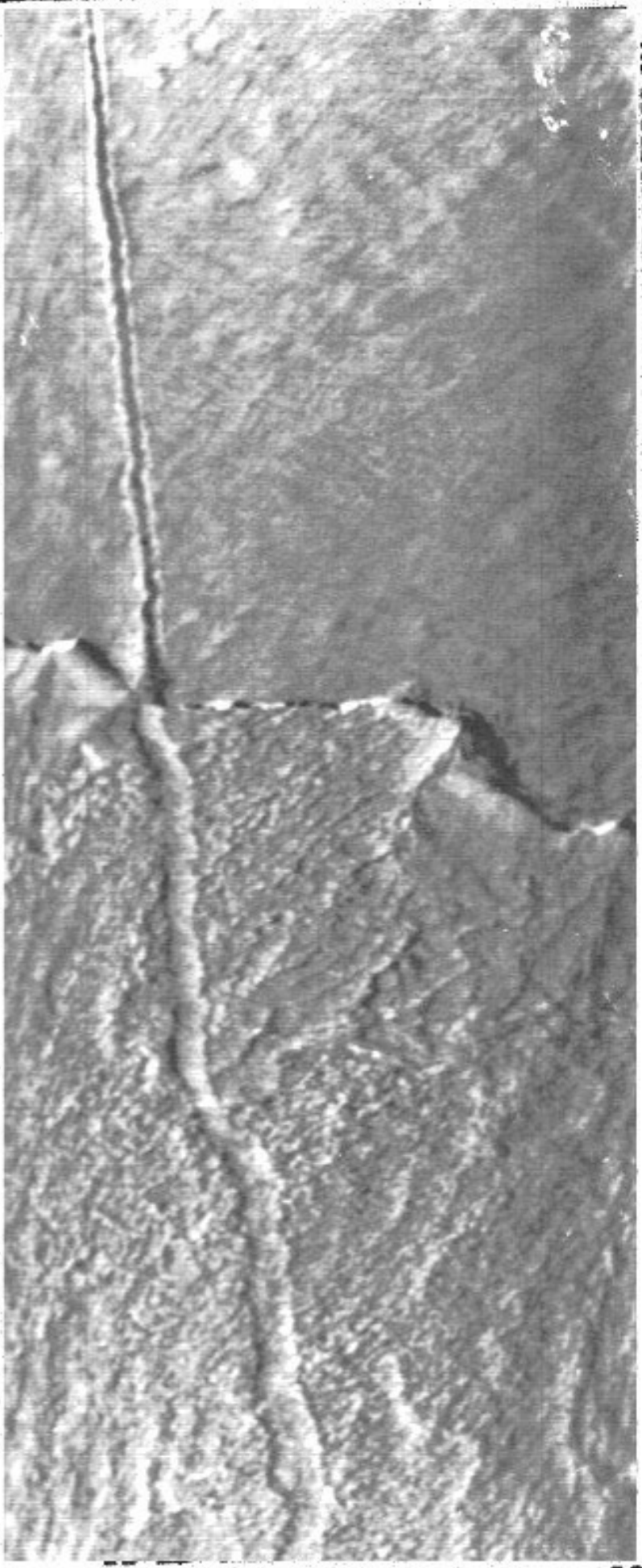

FIGURE 7 WAKE OF A SURFACED SUBMARINE AND THERMALLY TEXTURED DISTINCT WATER MASSES RECORDED BY AN/AAD-2. DATE: 12 MARCH 1962; TIME: 2119 R; COORDINATES: 24°15'N, 82°05'W; AIRCRAFT ALTITUDE: 2000 FEET; LENGTH OF AREA SHOWN: 2.0 NAUTICAL MILES.

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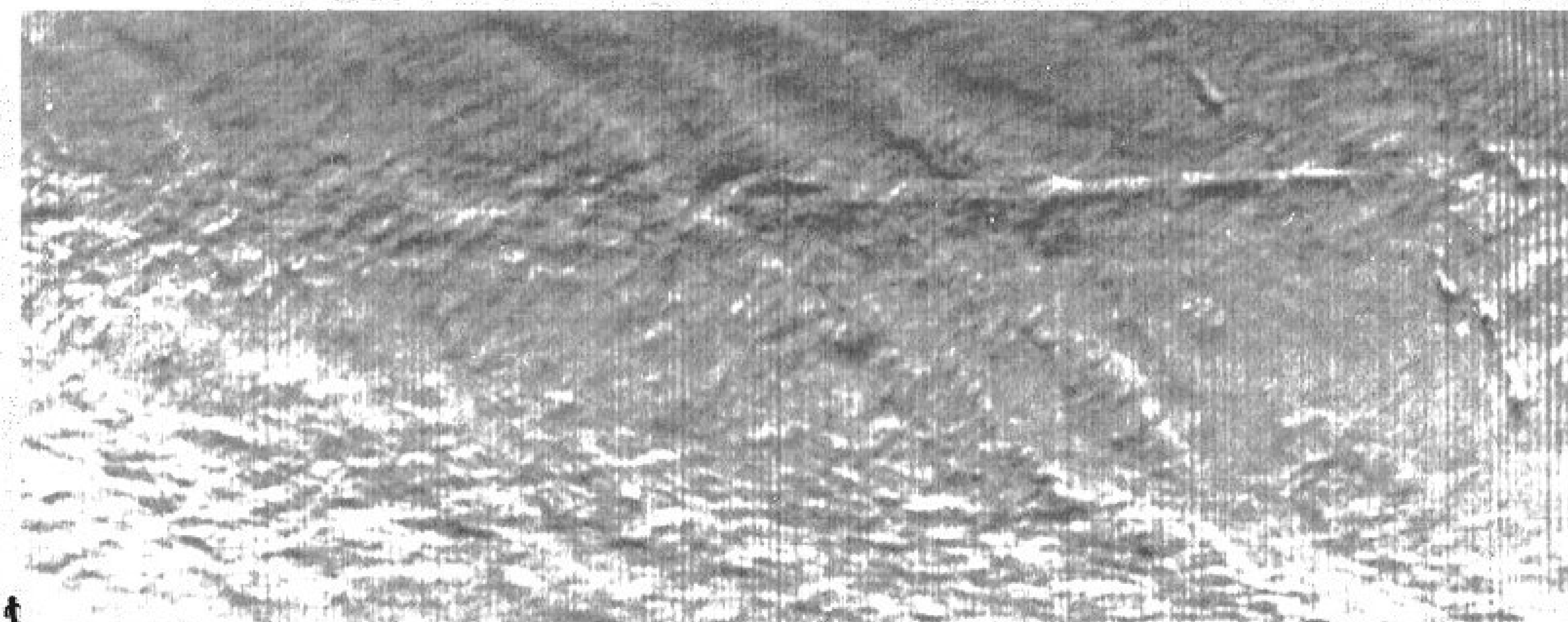
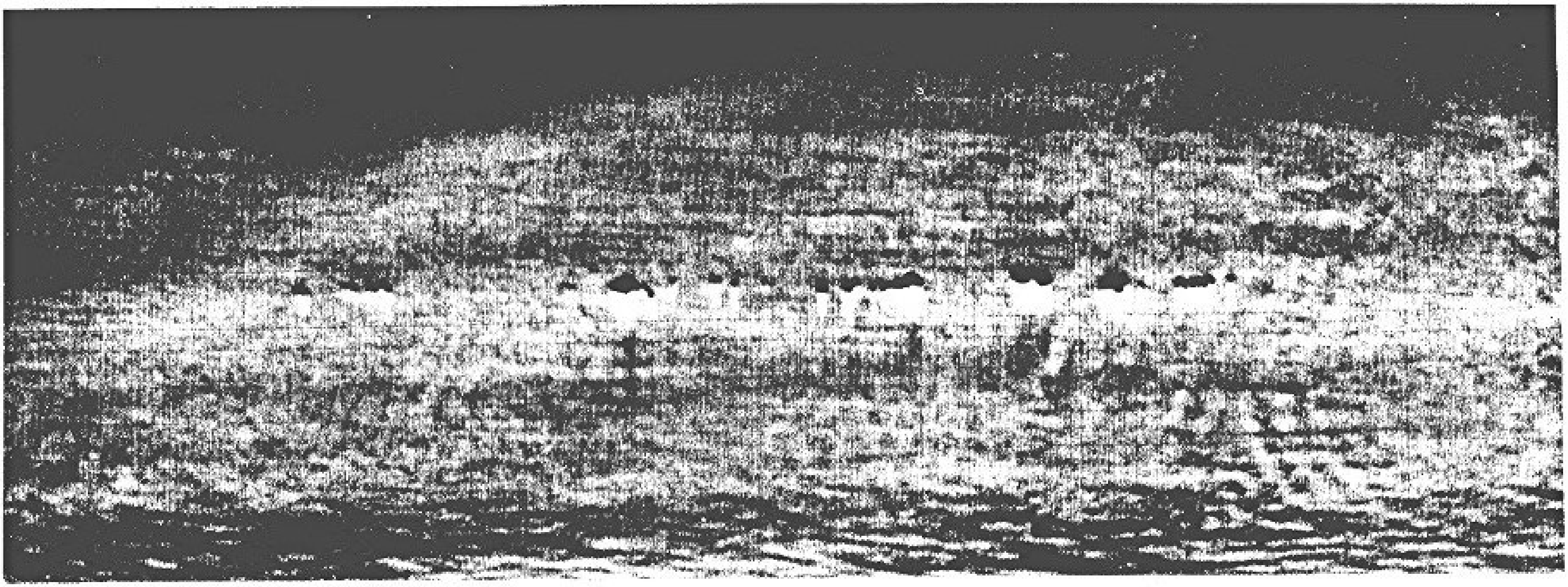


(C) FIGURE 8 AN/AAD-2 RECORDING OF THE WAKE GENERATED BY A 4-KNOT, 100-FOOT KEEL DEPTH SUBMARINE RELEASING AIR AT 80 CUBIC FEET PER MINUTE. DATE: 15 MARCH 1962; TIME: 2033 R; COORDINATES: 24°04'N, 83°47'W; SEA STATE: 0-1; AIRCRAFT ALTITUDE: 1300 FEET; LENGTH OF AREA SHOWN: 1.0 NAUTICAL MILE.



(C) FIGURE 9 AN/AAD-2 RECORDING OF THE WAKE OF A 6-KNOT, 130-FOOT KEEL DEPTH SUBMARINE OPERATING 7° BOW DOWN AND 20,000 POUNDS LIGHT. DATE: 28 MARCH 1962; TIME: 2326 R; COORDINATES: 40°20'N, 71°51'W; SEA STATE: 1; AIRCRAFT ALTITUDE: 1600 FEET; LENGTH OF AREA SHOWN: 1.5 NAUTICAL MILES.

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(U) submarine operating 20,000 pounds light. The submarine maintained constant depth by operating in a 7° bow-down attitude.

(U) If the submarine is operating at shallow depth at high speed, detectable Kelvin wake patterns are produced as shown in Figure 10.

(U) In general, wakes generated by submarines that are effectively breaking the surface are recorded on about 99% of the opportunities. A number of activities in the United States, Canada, and the United Kingdom are studying effects produced by submarines with intentions of predicting under what oceanographic conditions they are produced and of improving methods by which they may be detected.

(U) SURVEILLANCE AND CLASSIFICATION OF MARITIME TARGETS

(U) Another application of infrared mapping devices that appears to have military significance is the passive nighttime surveillance and classification of potentially hostile vessels. Even when relatively low spatial resolution is used, the pictures recorded provide information on the dimensions of the target and the number and location of its stacks. In addition, the wake from such a vessel, which may extend many miles astern, provides information on the course of the vessel even though it may suddenly change its heading when the surveillance aircraft approaches. Figure 11, which was recorded from an altitude of 1600 feet, shows deck structure of a surfaced submarine. Typically, a portion of the after section of the hull, where the engines are located, appears relatively warm. Figure 12 is a higher resolution, lower sensitivity picture of a destroyer recorded from an altitude of 500 feet.

(U) AIR-DROPPED MINE DETECTION

(U) Limited tests to determine the feasibility of detecting, by means of airborne infrared devices, surface scars produced by the splashes of air-dropped mines have been conducted in cooperation with the U. S. Navy Mine Defense Laboratory. Figure 13 shows scars produced by dropping three simulated mines from low altitude helicopters into the Gulf of Mexico near Panama City, Florida. The mines were dropped near an observation stage and appear near the center of the picture as three circles of approximately 50-foot diameter. This picture also shows a portion of the interesting tidal phenomenon of a thin fan-shaped sheet of relatively warmer, relatively less saline water from St. Andrew Bay flowing over the more dense water of the Gulf.

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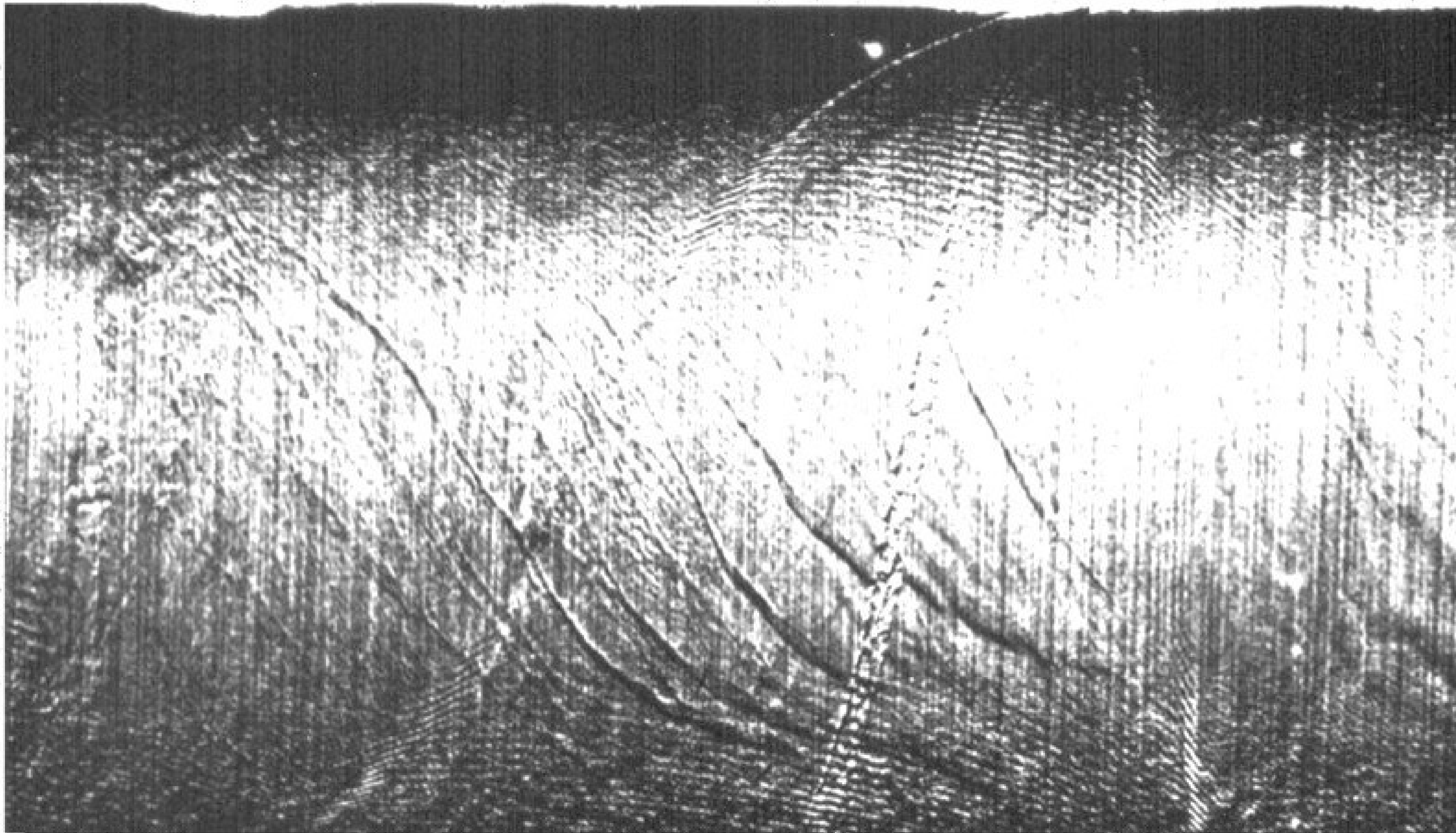

(C) FIGURE 10 AN/AAR-30 RECORDING OF WAKE GENERATED BY A SURFACED SUBMARINE. "CORE" WAKE APPEARS WITH RELATIVELY UNIFORM INTENSITY FROM BOTTOM TO TOP OF PICTURE BUT TRANSVERSE AND DIVERGING KELVIN WAKE PATTERNS APPEAR ONLY AT POSITIONS CORRESPONDING TO LARGE VIEWING ANGLES RELATIVE TO THE VERTICAL. DATE: 26 APRIL 1963; TIME: 1803 R; COORDINATES: 40°30'N, 71°40'W (APPROX); SEA STATE: 1; AIRCRAFT ALTITUDE: 1900 FEET; SUBMARINE SPEED: 15 KNOTS (ESTIMATED); LENGTH OF AREA SHOWN: 2.3 NAUTICAL MILES.

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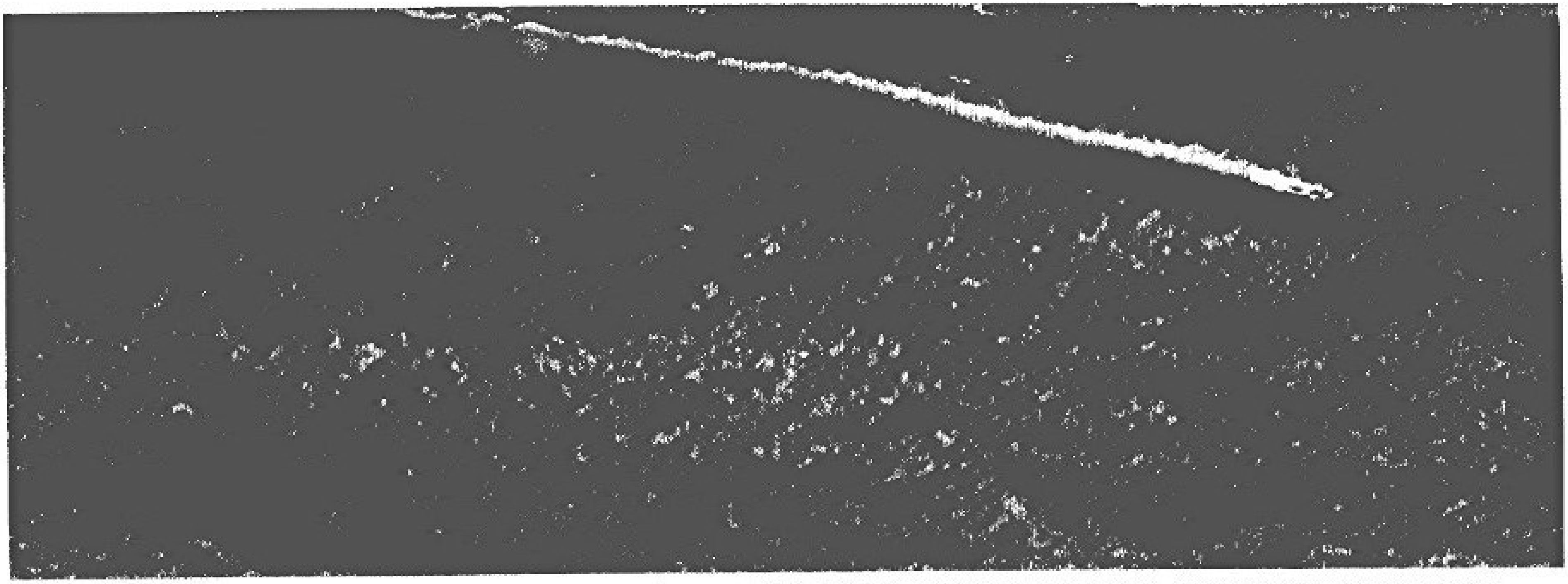

(C) FIGURE 11 SURFACED SUBMARINE AND ITS WAKE. NOTE DECK STRUCTURE FORWARD AND WARM ENGINE AREA AFT. DATE: 15 MARCH 1962; TIME: 2127 R; COORDINATES: 24°10'N, 83°55'W; AIRCRAFT ALTITUDE: 1600 FEET; LENGTH OF AREA SHOWN: 1.0 NAUTICAL MILE.

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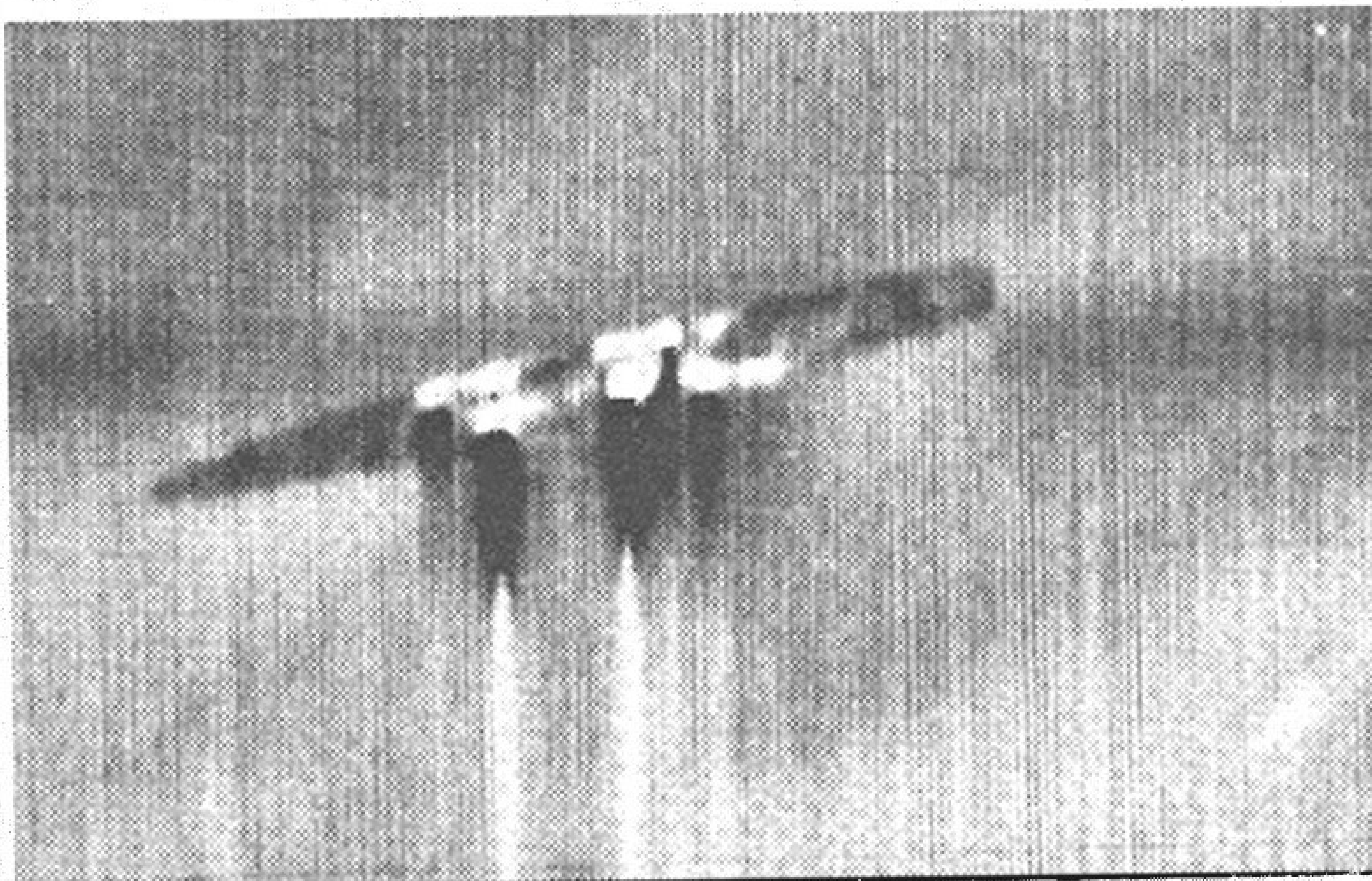

(U) FIGURE 12 A U. S. DESTROYER (DDR 878) PATROLLING THE STRAITS OF FLORIDA. DATE: 10 NOVEMBER 1962; TIME: 1950 R; AIRCRAFT ALTITUDE: 500 FEET.

(C) FIGURE 13 INFRARED PICTURE OF SCARS PRODUCED BY DROPPING THREE SIMULATED MINES NEAR AN OBSERVATION STAGE IN THE GULF OF MEXICO. THE WHITE LINE DEFINES THE EDGE OF A FAN-SHAPED SHEET OF WATER FLOWING OVER THE GULF FROM ST. ANDREW BAY. DATE: 5 MARCH 1964; TIME: 2204 S; COORDINATES: 30°07'N, 85°47'W; AIRCRAFT ALTITUDE: 1600 FEET; LENGTH OF AREA SHOWN: 1.5 NAUTICAL MILES.

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(U) NIGHTTIME AIR-SEA RESCUE

(U) Infrared mapping devices could be applied to the problem of locating survivors of disasters at sea at night. The site of the disaster could be localized, in general, by searching for readily detectable oil films. In addition, survivors' life jackets could be provided with a simple nighttime equivalent of a dye marker, such as a small container of ordinary corn oil. Figure 14 shows a readily detectable slick produced by dropping a paper cup containing about 50 cubic centimeters of corn oil from an aircraft onto the ocean. The length of the Y-shaped slick shown was about one-half mile.

(U) CORRELATION WITH UNDERWATER SOUND PROPAGATION CHARACTERISTICS

(U) Although most of the radiation detected by an infrared mapping device operated over water originates from depths of less than one tenth of a millimeter, it is apparent that the resulting pictures often reveal surface expressions of bulk water phenomena. Figure 15 is a nighttime thermal picture which reveals a rather awesome view of an oceanic front. In such a region one might expect peculiar sonar conditions to prevail in which the sound propagation characteristics would be a strong function of the position of the transducer and the direction of sound projection.

Figure 16 shows a field of convection cells resulting from the formation and breakdown of a dense surface layer over a less dense body of water. When viewed from above, the cells appear as closed irregular polygons having warm centers and cool edges. One can infer the size of the cells to be of the order of 100 to 200 feet by comparing them with the 300-foot long surfaced submarine which has homogenized the cells in its wake.

(U) In situations such as these last two, it would appear likely that the underwater sound propagation characteristics would be more dependent upon horizontal temperature profiles than upon the vertical. Correlation of these phenomena is suggested as an area for detailed study.

(U) CURRENTS AND EDDIES

(U) Successful amphibious landings of troops on enemy-held islands and the safe entry of ships into ports of hostile nations require detailed knowledge of local currents. Infrared mapping devices can provide information that may be of value in such situations. Figure 17 reveals currents in the vicinity of Boca Grande Key. Figure 18 is a portion of a Coast and Geodetic Survey chart of Loggerhead Key and Reef. Figure 19

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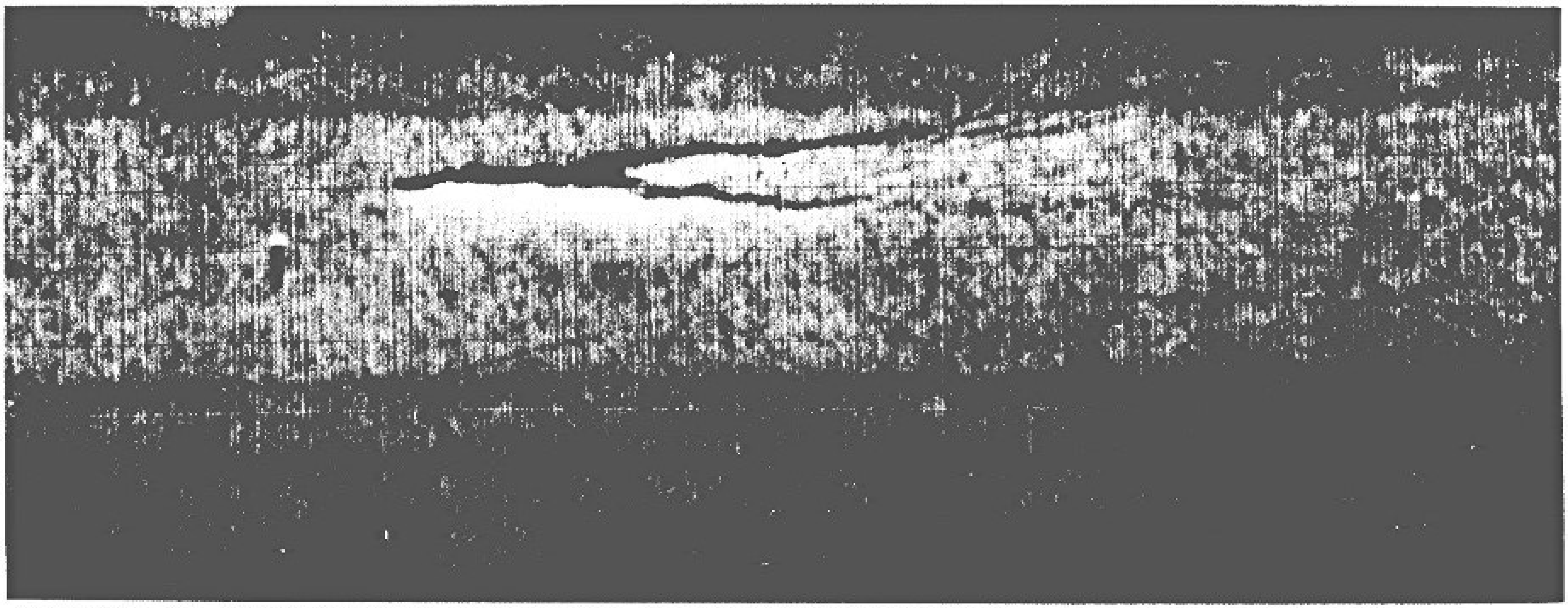
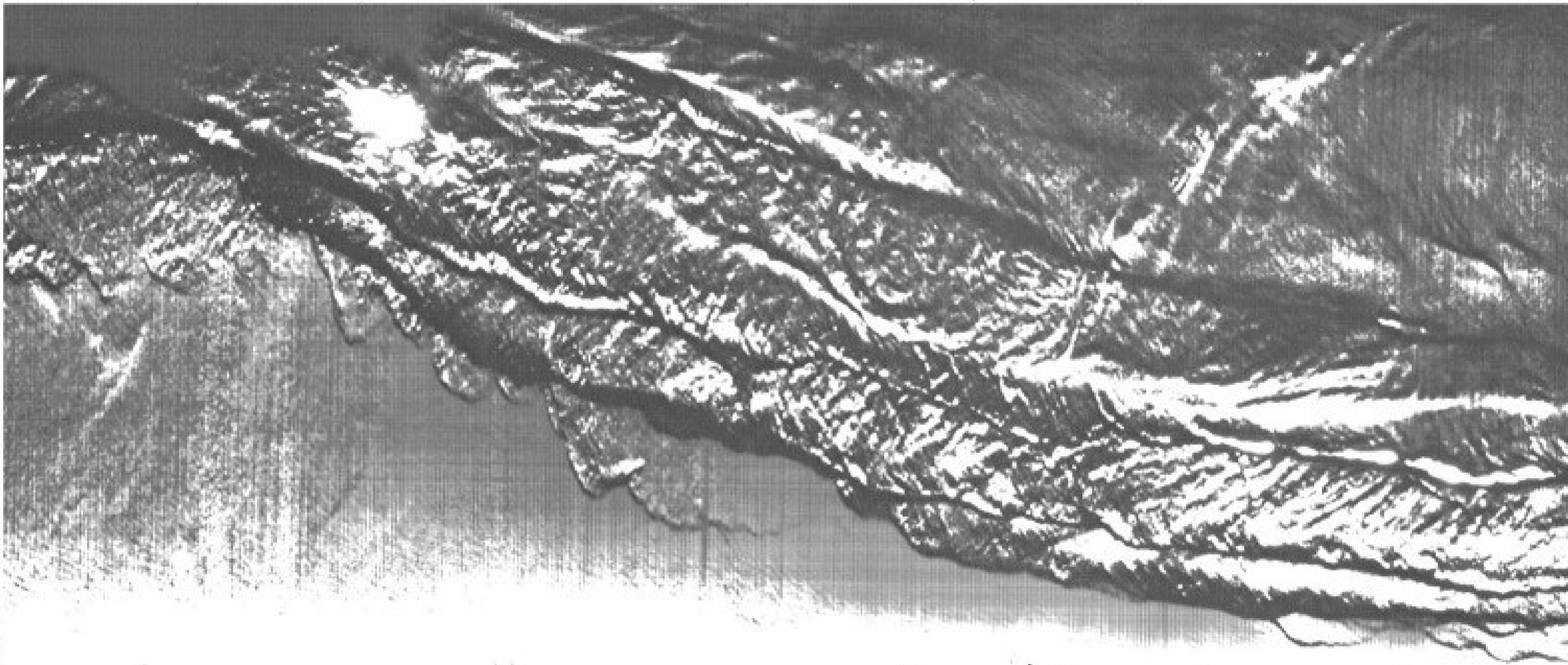


(U) FIGURE 14 SLICK PRODUCED BY DROPPING APPROXIMATELY 50 MILLILITER OF CORN OIL FROM A LOW-FLYING AIRCRAFT ONTO THE OCEAN. THE WHITE DOT ON THIS INFRARED PICTURE REPRESENTS A FLOATING SMOKE LIGHT WHICH WAS USED AS A REFERENCE. DATE: 7 FEBRUARY 1963; TIME: 2029 R; TIME OIL WAS DROPPED: 2015 R; AIRCRAFT ALTITUDE: 1500 FEET; SEA STATE: 0-1; LENGTH OF AREA SHOWN: 1.3 NAUTICAL MILES.



(U) FIGURE 15 INFRARED PICTURE OF AN OCEANIC FRONT RECORDED BY THE AN/AAR-30. DATE: 26 APRIL 1963; TIME: 2152 R; COORDINATES: 41°23'N, 64°28'W; AIRCRAFT ALTITUDE: 6800 FEET; LENGTH OF AREA SHOWN: 7.8 NAUTICAL MILES.

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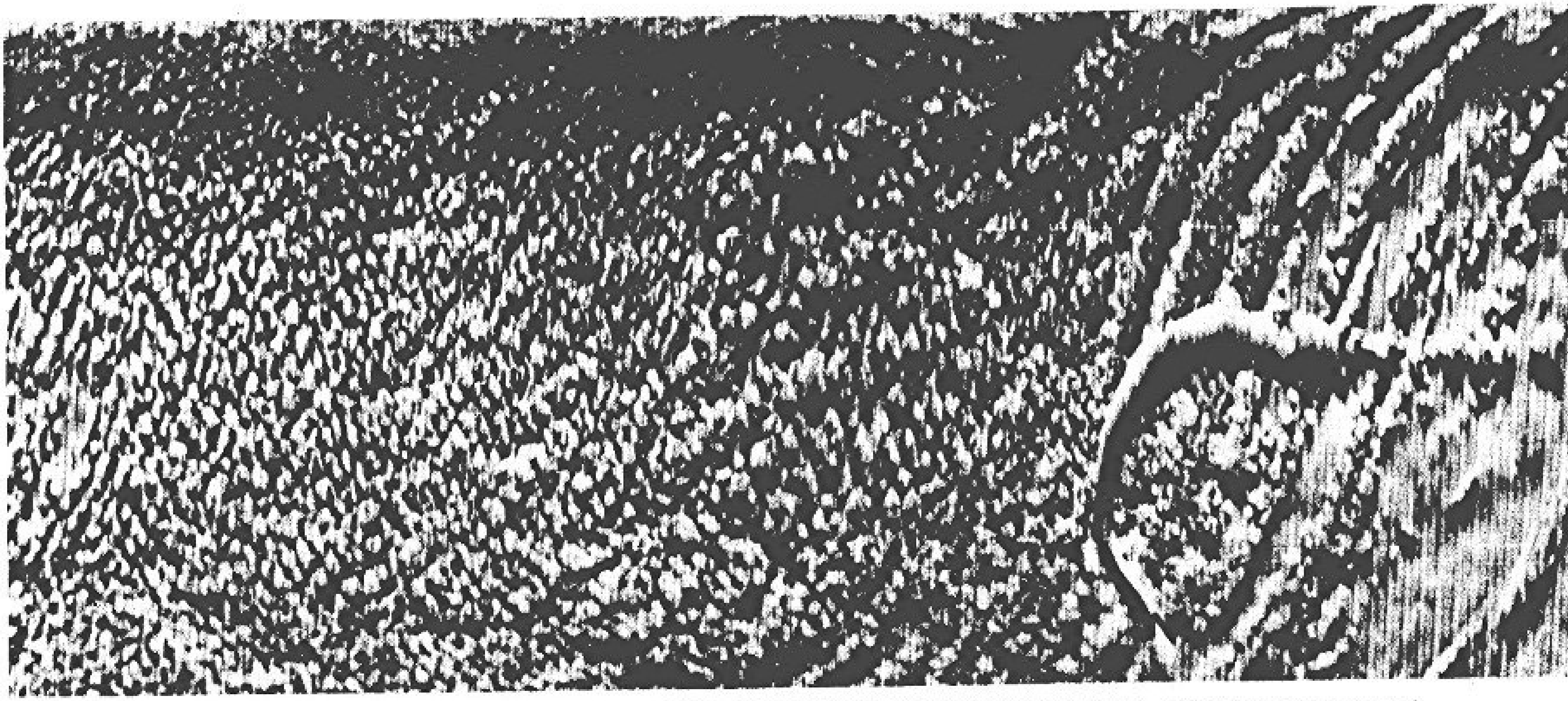
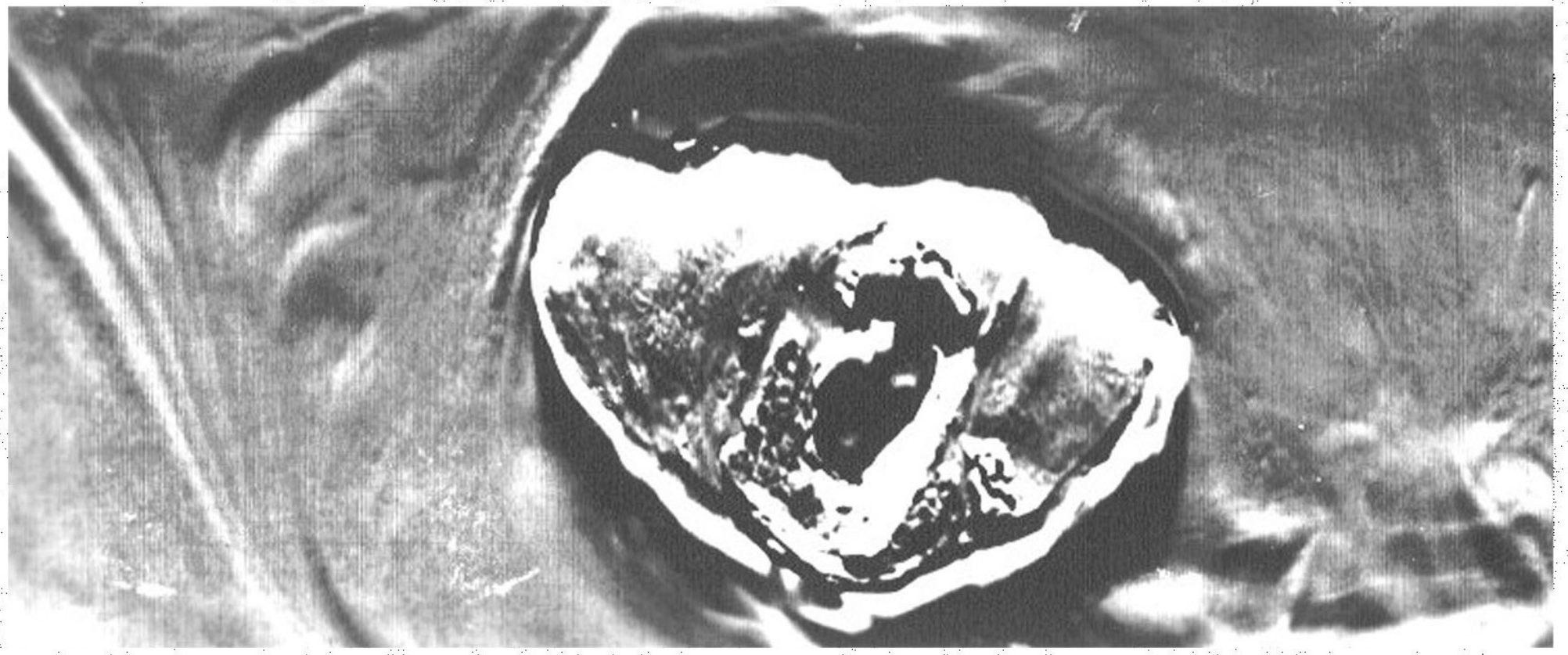
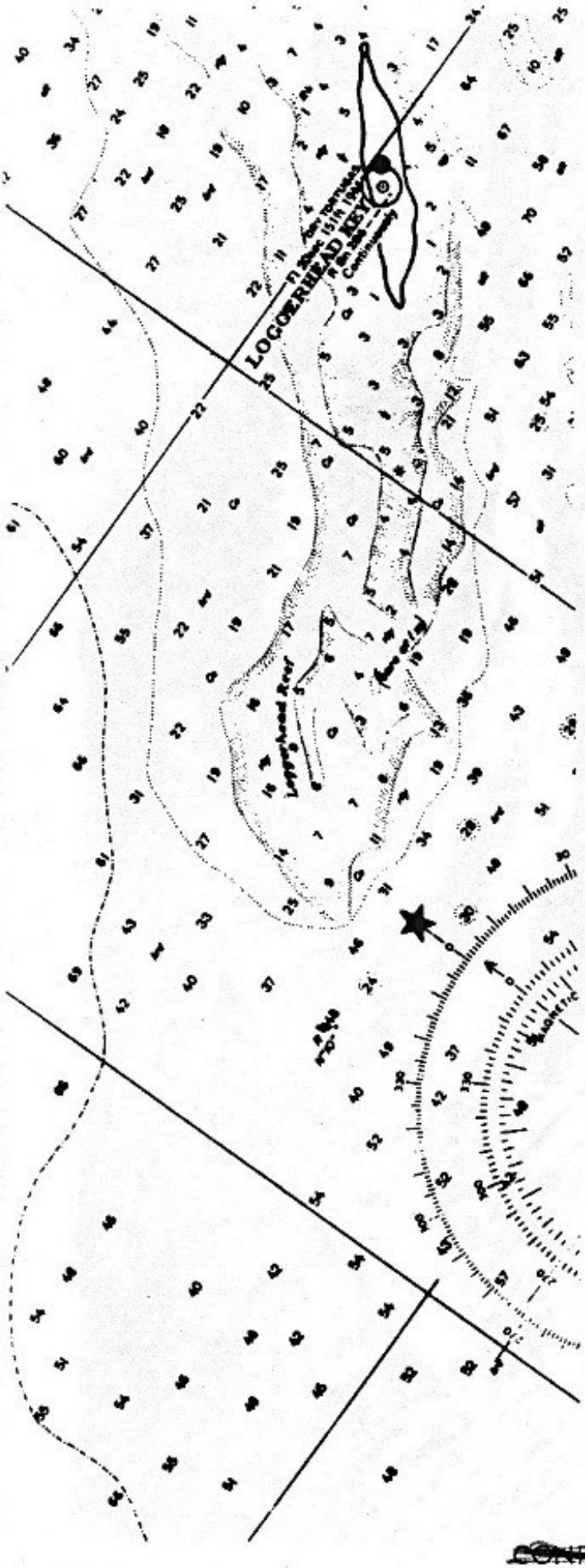


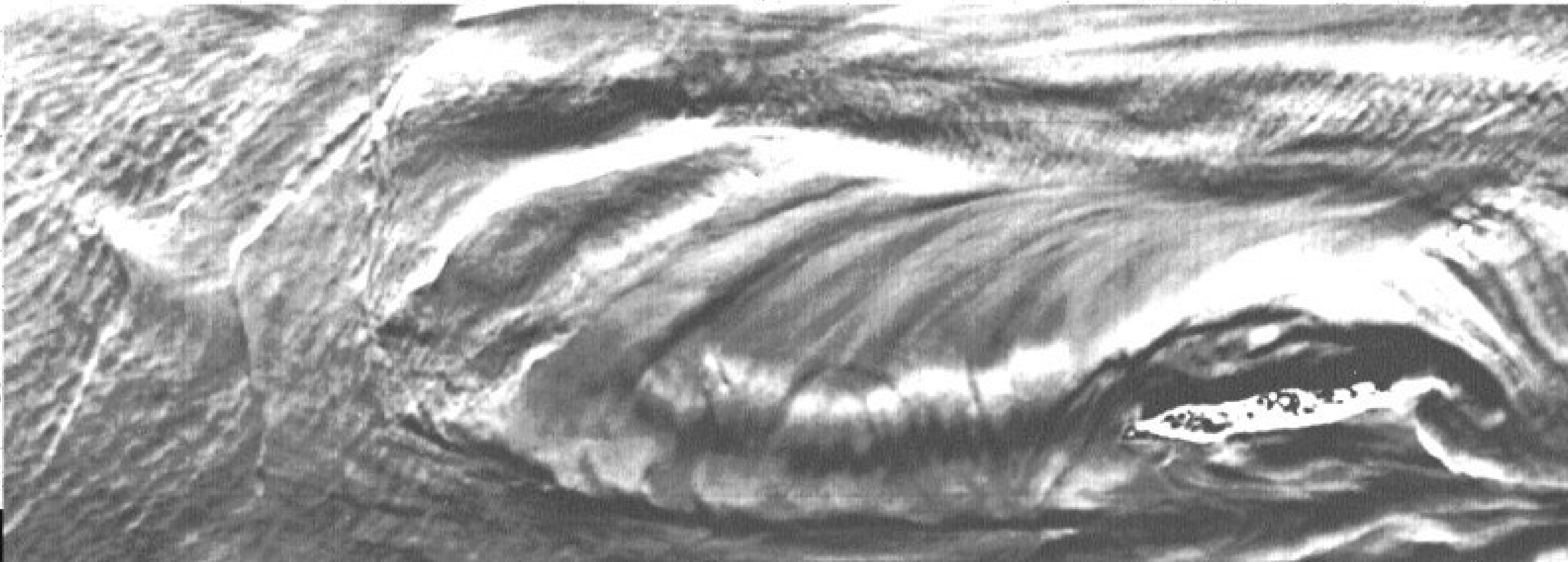
(U) FIGURE 16 INFRARED PICTURE OF A SURFACED SUBMARINE PASSING THROUGH A REGION MARKED BY CONVECTION CELLS. DATE: 4 DECEMBER 1962; TIME: 2300 R (APPROX); LOCATION: VICINITY OF KEY WEST, FLORIDA.



(U) FIGURE 17 INFRARED PICTURE OF BOCA GRANDE KEY AND SURROUNDING WATERS RECORDED BY AN/AAD-2. DATE: 15 MARCH 1962; TIME: 2222 R; COORDINATES: 24°32'N, 82°00'W; AIRCRAFT ALTITUDE: 1900 FEET; LENGTH OF AREA SHOWN: 0.9 NAUTICAL MILE.



(U) FIGURE 18 PORTION OF COAST AND GEODETIC SURVEY CHART NO. 585 SHOWING LOGGERHEAD KEY AND LOGGERHEAD ROOF. DEPTHS ARE GIVEN IN FEET.



(U) FIGURE 19 INFRARED PICTURE OF LOGGERHEAD KEY AND SURROUNDING WATERS RECORDED BY AN/AAD-2. DATE: 15 MARCH 1962; TIME: 1833 R; COORDINATES: 24°38'N, 82°56'W; AIRCRAFT ALTITUDE: 4500 FEET; LENGTH OF AREA SHOWN: 4.2 NAUTICAL MILES.

(U) is an infrared picture of the same area which shows the flow of water over the reef. Figure 20 reveals the flow of cool, relatively fresh water from Barnegat Inlet over the warmer but more dense water of the Atlantic Ocean. Figure 21 shows an eddy in St. Andrew Bay where waters of the east and west branches of the Bay converge before flowing into the Gulf of Mexico. Figure 22 shows an eddy of approximately 4-mile diameter beyond the mouth of the channel between Browns Bank and Georges Bank and between the countercurrents of the Gulf Stream and the Labrador Current.

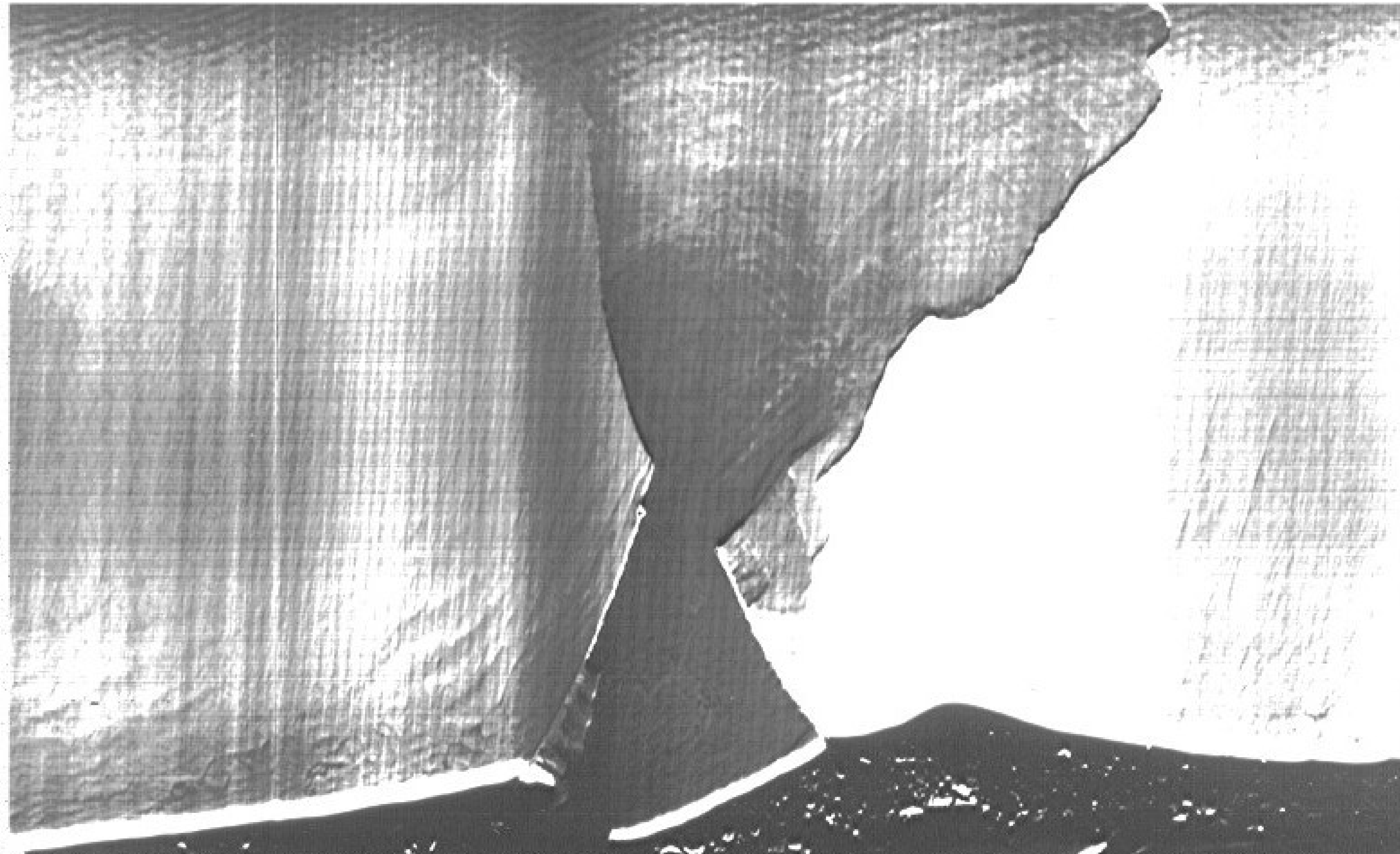
(U) CONCLUSIONS

(U) Airborne, passive infrared mapping devices provide a consistent capability of tracking, detecting, and classifying ships and shallow depth submarines. Poor trim, leakage of air and oil, and discharges from the submarine render it more vulnerable to detection.

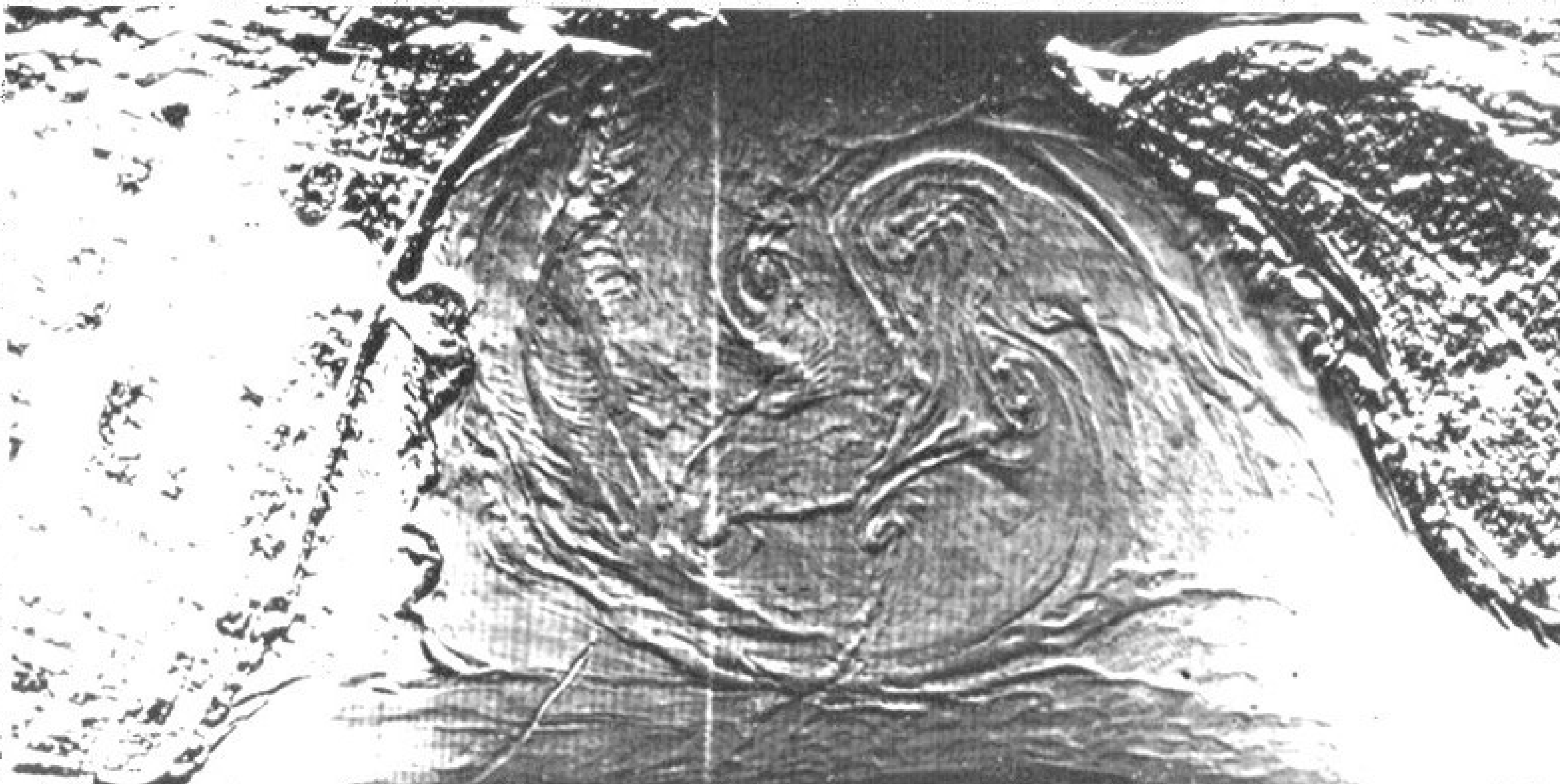
(U) Infrared mapping devices appear to have value for general nighttime over-water surveillance and in particular for locating survivors of disasters at sea.

(U) Further studies should be conducted to evaluate the application of infrared mapping devices to the detection of air-dropped mines and to the prediction of underwater sound propagation characteristics.

(U) Airborne passive infrared mapping devices are well suited for use as instruments for studying currents over vast areas of the oceans in relatively short periods of time.

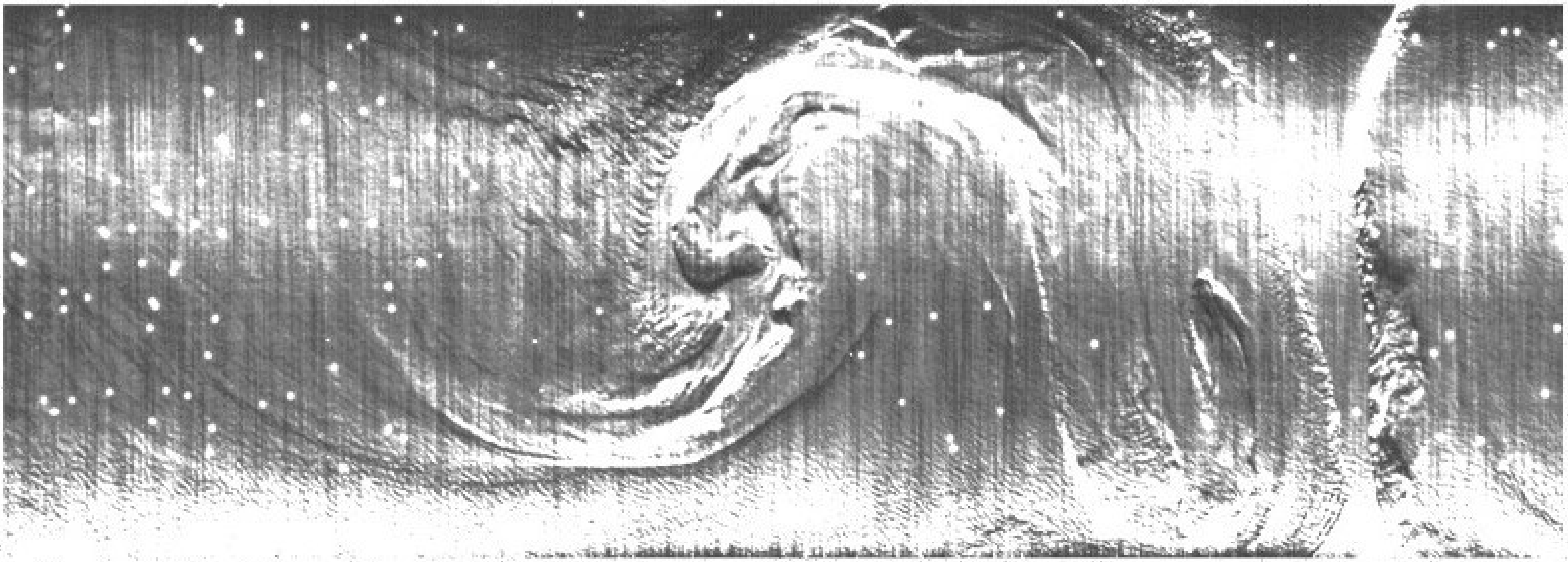


(U) FIGURE 20 INFRARED PICTURE OF FLOW OF COOL WATER FROM BARNEGAT INLET INTO THE ATLANTIC OCEAN. DATE: 30 JANUARY 1964; TIME: 1850 R; COORDINATES: 39°45'N, 74°06'W; AIRCRAFT ALTITUDE: 3600 FEET; LENGTH OF AREA SHOWN: 4.0 NAUTICAL MILES.



(U) FIGURE 21 INFRARED PICTURE OF AN EDDY IN ST. ANDREW BAY. PANAMA CITY, FLORIDA APPEARS ON THE LEFT. DATE: 5 MARCH 1964; TIME: 2234 S; COORDINATES: 30°09'N, 85°41'W; AIRCRAFT ALTITUDE: 2600 FEET; LENGTH OF AREA SHOWN: 3.3 NAUTICAL MILES.

CONFIDENTIAL



(U) FIGURE 22 INFRARED PICTURE OF AN EDDY IN THE ATLANTIC OCEAN. THE WHITE DOTS ARE INSTRUMENTAL ARTIFACTS WHICH SHOULD BE DISREGARDED. DATE: 26 APRIL 1963; TIME: 2225 R; COORDINATES: 41°48'N, 64°40'W; AIRCRAFT ALTITUDE: 6800 FEET; LENGTH OF AREA SHOWN: 11 NAUTICAL MILES.

CONFIDENTIAL

26 Aug 2016

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 2015-008952

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

(b) Executive Order 13526

1. Recommendation. AIR 4.5.6 reviewed each document and has the following recommendations listed by each separate document covered under the subject:

   a. Document (2) of Subj. NAVAIRDEVCEN Report No NADC-AW-N5916, 5 Jun 1959, "Submarine Wake Detection Program" (AD-C955796). Information found to be unclassified and releasable in its entirety.

   b. Document (3) of Subj. NAVAIRDEVCEN Report No NADC-AW-N5917, 8 Oct 1959, "Infrared Wake Detection" (AD-C955804). Information found to be unclassified and releasable in its entirety.

   c. Document (4) of Subj. NAVAIRDEVCEN Report No. NADC-AW-L5932, 23 Feb 1960, "Submarine Wake Detection" (AD-C955797). Portions of the report found to be classified under Section 3.3(4) under reference (b). Remaining portions of the document found to be unclassified and releasable.

   d. Document (5) of Subj. NAVAIRDEVCEN Report No. NADC-AW-L6005, 30 Mar 1962, "Submarine Wake Detection, Flight Trials of the Reconofax Camera" (AD-C955798). Information found to be unclassified and releasable in its entirety.

   e. Document (6) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6207, 3 May 1962, "Airborne Infrared Oceanographic Mapping" (AD-C955799). Information found to be unclassified and releasable in its entirety.

   f. Document (7) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6208, 8 Jun 1962, "NAVAIRDEVCEN Airborne Infrared Developments" (AD-C955801). Information found to be unclassified and releasable in its entirety.

   g. [redacted]

[redacted]

h. Document (11) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6304, 20 Jun 1963, "Use of an Airborne Passive Infrared Mapping Set for Submarine Wake Studies" (AD-338356L). Portions of the report are found to be exempted under reference (b) Section 3.3(6). Remaining portions of the document found to be unclassified and releasable.

i. Document (12) of Subj. NAVAIRDEVCEN Report No. NADC-AW-6303, 31 Jul 1963, Submarine Wake Detection, Flight Trials of the AN/AAD-2 Infrared Mapping Set in a Cessna 310-B Aircraft" (AD-340804). Information found to be unclassified and releasable in its entirety.

j. [redacted]

k. Document (14) of Subj. NAVAIRDEVCEN Report No. NADC-87161-50, 28 Oct 1987, "Applications of Airborne Passive Infrared Mapping Devices to Military Oceanography" (Reprinted from Proceedings of the First U.S. Navy Symposium on Military Oceanography, Volume II, 17-19 June 1964) (AD-C042316). Information found to be unclassified and releasable in its entirety.

l. Document (15) of Subj. NAVAIRDEVCEN Report No. NADC-AW-6421, 27 Aug-1964, "Infrared Radiation from Ships" (AD-353610L). Portions of the report found to be exempt under reference (b) Section 3.3(6). Remaining portions of the document found to be unclassified and releasable.

m. [redacted]

n. [redacted]

o. [redacted]

2. Basis of Recommendation. All information was reviewed with current class guides and what is considered open source information. Appropriate recommendations made above with respect to findings. Documents found with portions releasable were sanitized based on class guides and reference (b). Such disclosure of Department of the Navy classified information would give potential adversaries insight that would present a significant threat to national security.

3. Exemptions Utilized. Two separate exemptions were utilized in the determination of what information should be sanitized or exempted from release via Freedom of Information Act (FOIA) request process. All current Classified Military Information (CMI) has been sanitized out of the document under FOIA Exemption 3, Executive Order 13526 Sections 3.3(4) and 3.3(6). This Executive Order Section covers CMI that was originally classified over 25 years ago from date of this memorandum. Subject matter experts within AIR 4.5.6 were utilized in making the exemption determinations.

4. 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.

8/30/2016

X Paul W. Reimel

Paul W. Reimel

Signed by: REIMEL.PAUL.W.1229241016

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