**DEPARTMENT OF THE NAVY**
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5720.9b
AIR-11.4/2017-008080
3 April 2018

**VIA SAME DAY E-MAIL to**
Paul Moser
[redacted]

SUBJECT: FOIA CASE DON-NAVY-2017-008080

Dear Mr. Moser,

This is in response to your Freedom of Information Act (FOIA), submitted 30 June 2017, in which you requested Naval Air Development Center Report No. NADC-AE-6718 of 18 Aug. 1967, "Flight Evaluation and Analysis of An/AAS-10(XE-1), Reconofax VI and Reconofax IX Infrared Mapping Sets (U)."

We have located the responsive documents and you are granted full access to these records. A copy is enclosed.

If you have any questions regarding your request, you can contact Barbara Nimmerrichter by telephone at (301) 995-3089 or by email at kori.l.wilson@navy.mil.

Sincerely,

*//s// Kori Wilson*

Kori Wilson
Attorney

[redacted]

AD 384685

COPY [redacted]

# NAVAL AIR DEVELOPMENT CENTER

Johnsville, Warminster, Pennsylvania

Report No. NADC-AE-6718 18 Aug 1967

## FLIGHT EVALUATION AND ANALYSIS OF AN/AAS-10(XE-1), RECONOFAX VI AND RECONOFAX IX INFRARED MAPPING SETS (U)

FINAL REPORT
AIRTASK NO. A36533804/2021/F001-05-05
Work Unit No. 1

~~In addition to security requirements which apply to this document and must be met, each transmittal outside the Department of Defense must have prior approval of Commanding Officer, Naval Air Development Center.~~



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

Aero-Electronic Technology Department

REPORT NO. NADC-AE-6718

18 August 1967

# FLIGHT EVALUATION AND ANALYSIS OF AN/AAS-10(XE-1), RECONOFAX VI, AND RECONOFAX IX INFRARED MAPPING SETS (U)

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Three experimental infrared mapping systems, the U. S. Air Force Reconofax IX, U. S. Army AN/AAS-10(XE-1), and the U. S. Navy Reconofax VI, were flight-tested simultaneously on RA-3B aircraft, BuNo. 144839. Control ground targets and targets of opportunity were used. The three systems met their respective primary design specifications, but each system has shortcomings that need to be improved before service use. Recommendations are included for further development of infrared mapping systems. (U)

Reported by: L. B. Judge
L. B. Judge
Applied Research Division

Approved by: William S. Lee
W. S. Lee, Superintendent
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D W Mackiernan
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Technical Director



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# SUMMARY


## INTRODUCTION

AIRTASK No. A36533804/2021/F001-05-05, Work Unit No. 1 directed the Naval Air Development Center (NAVAIRDEVCEN) to install and simultaneously flight test the U. S. Army AN/AAS-10(XE-1) and the U. S. Air Force Reconofax IX infrared mappers in U. S. Navy RA-3B aircraft, BuNo. 144839. The purpose of the test was to compare the performance of the two sets for reconnaissance aircraft. The results of these tests were to be used to establish realistic system parameters for reconnaissance aircraft. The NAVAIRDEVCEN installed the Army and Air Force equipments, and a modified Reconofax VI in the RA-3B aircraft. This project became known unofficially as the "JANE TEN IR Flight Program."

## RESULTS

From January to March 1966 flight tests were conducted, both night and day, over controlled targets and targets of opportunity. Film imagery taken at aircraft altitudes of 2000 feet revealed existence of targets such as roads, SAM sites, and bridges. Imagery taken at 1000 feet identified targets such as tanks, self-propelled guns, and automobiles. When targets were covered by heavy foliage, the infrared images were not discernible except when targets were much hotter or colder than the surroundings, or if the targets were very large. There was a noticeable deterioration in angular resolution for all equipments when the flight data was compared to the laboratory data. The temperature control of the thermal resolution targets was less than the designed thermal resolution of the equipments; consequently, accurate determination of thermal sensitivity was not made.

## CONCLUSIONS

Current infrared mappers for reconnaissance aircraft are capable of meeting specific performance requirements such as high thermal sensitivity, high angular resolution, and capability of operation at high velocity to height ratio (V/H). For reconnaissance used in areas similar to those found in Southeast Asia, emphasis should be placed in high thermal and angular resolution capabilities with low to moderate V/H ratios not exceeding one rad/sec.

Inflight operation and performance of the infrared mappers indicated single axis (roll) stabilization was adequate to obtain desirable target imagery. Detector cooling systems employing liquid helium presented serious logistic problems resulting in a lack of standby flight readiness and a relatively short flight duration. Closed cycle coolers proved to be reliable and logistically more suitable than open liquid coolers. The lack of a real-time display made on-the-spot evaluation impossible.

RECOMMENDATIONS

Infrared equipments for reconnaissance aircraft flying from 1000 to 3500 feet altitude should have:

1. Angular resolution 0.5 to 1 milliradian
2. Thermal sensitivity 0.5 to 1 degree centigrade
3. Closed cycle system for detector
4. Availability of real time viewer
5. Single axis (roll) stabilization.



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# D I S C U S S I O N

## DESCRIPTION OF EQUIPMENT

### Reconofax IX (U. S. Air Force, HRB-Singer, Incorporated)

The Reconofax IX is a high velocity to height ratio (V/H) infrared mapping set developed by HRB-Singer, Incorporated (Contract AF33(657)-8870) and is comprised of these basic units (figure 1):

Scanner

Control

Monitor (oscilloscope)

Figure 2 is a block diagram of the Reconofax IX line-scanning system. Both the scanning optics and the recording optics are mounted on the same shaft which rotates at 17,000 rpm. The energy collected by the optical scanner unit is focused on a seven-element array of copper doped germanium infrared detectors. Each detector output is amplified and modulates a crater lamp (glow tube). Light from the crater lamps is put into the proper format (the same as the seven-element detector array) and imaged on the recording film.

The functions of the control unit are to provide:

Responsivity calibration

Average density calibration

Overall gain adjustments

Power (primary) control

Film drive rate control

An oscilloscope monitor provides, in an x-y format, a means to observe the signals from each of the seven detector channels.

The combined requirements of $\frac{V}{H}$ = 4 rad/sec., an instantaneous field of view (I FOV) of 1 milliradian (mv), and the corresponding large number of scans per second (4000) that had to be generated necessitated the use of a multielement detector array (seven channels) and a high speed scanner. Through the use of a two-sided scanner mirror rotating at 17,000 rpm and a seven-element detector array, a scan rate of 4000 lines/sec is achieved. The use of the seven-element detector leads to a number of fundamental design differences between high V/H and conventional IR line-scanning systems. These differences are primarily those required to insure that each channel of the high V/H system possesses the same overall

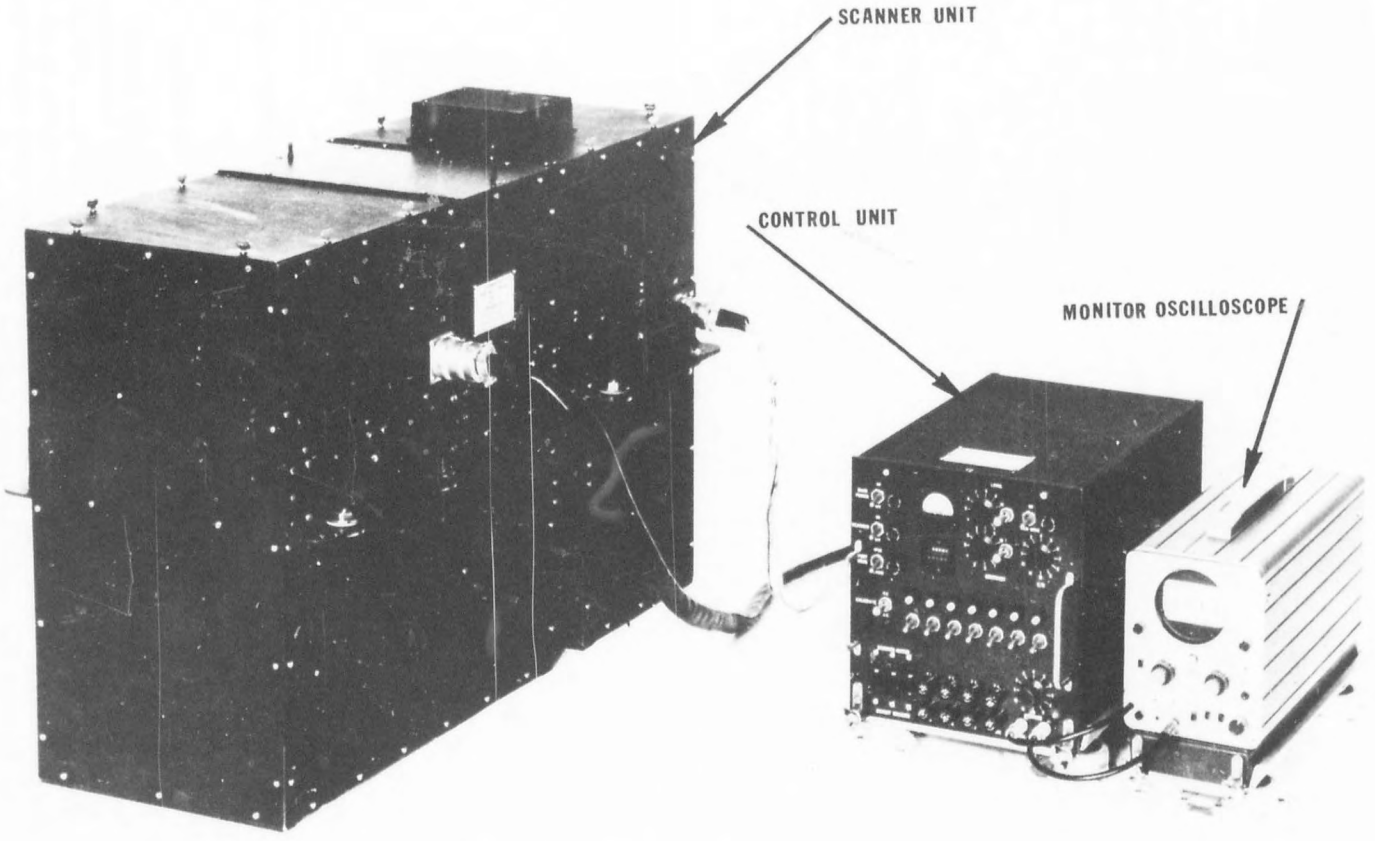


FIGURE 1 - Reconofax IX IR Detecting Set

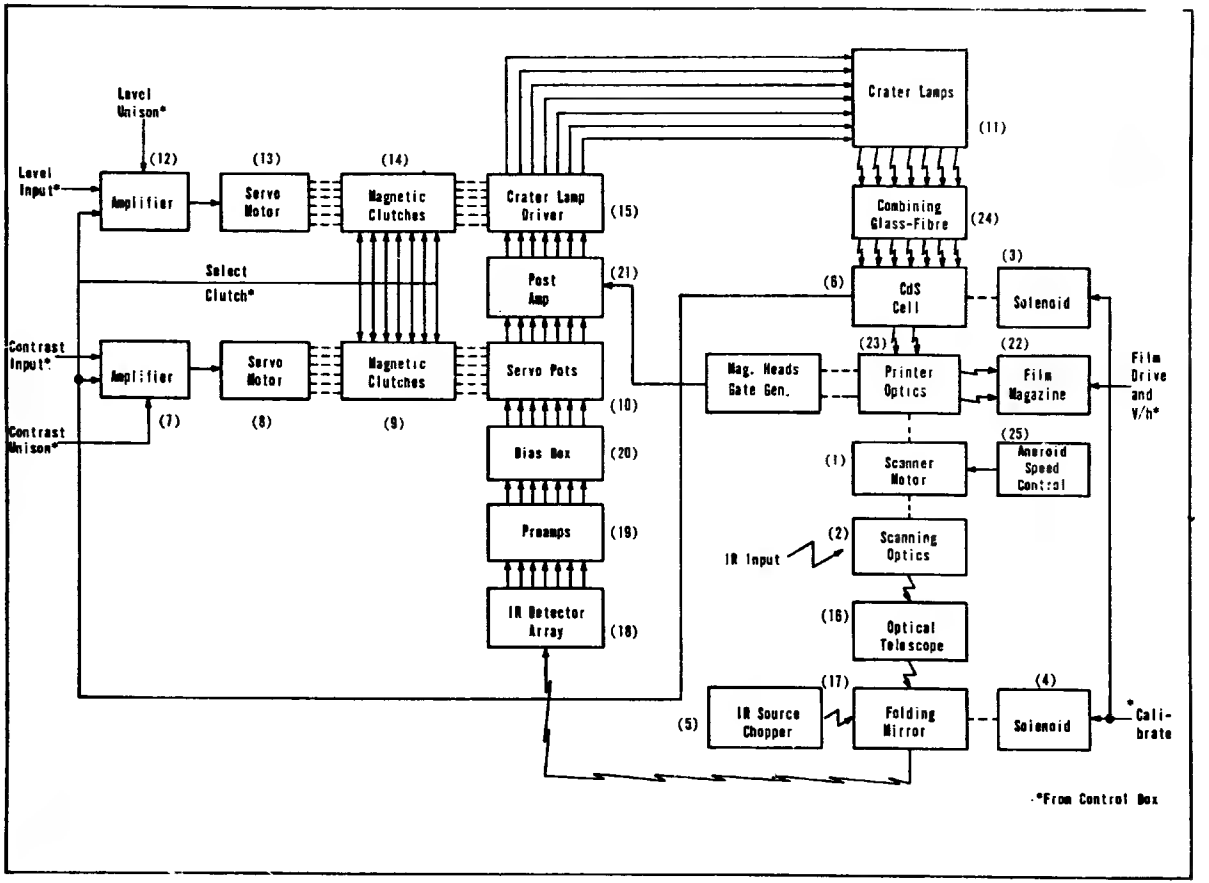


FIGURE 2 - Reconofax IX Scanner - Block Diagram

responsivity and produces the same average density on the recording film; also, the required upper limit of frequency response in each channel is considerably higher than normal, making it necessary to employ special techniques to extend the upper frequency to 1.2 mhz; in addition, a fiber optic bundle is needed to combine the light from the seven crater lamps into the same format as that of the seven-element IR detector array. This particular system employs single-axis (roll) stabilization.

AN/AAS-10(XE-1) (U. S. Army, Texas Instruments, Incorporated)

The AN/AAS-10(XE-1) is a high resolution infrared mapping system developed by Texas Instruments, Incorporated (Contract DA 36-039-AMC-00133CE1). This system is composed of scanner, stabilization, and control units (figure 3). It is a multichannel (5) device which provides good angular (0.5 mr) and temperature (0.5° C) resolutions and operates at relatively high V/H (1 rad/sec) ratios and moderate scan speeds (6000 rpm). Figure 4 shows the detector-cooler assembly, optical scanning assembly, and electronic circuitry.

Energy collected by the rotating four-sided scan mirror (6000 rpm) and an all-reflective Dahl-Kirkman optical system is focused on a five-element mercury-doped germanium detector array. The detector-array outputs, after suitable signal conditioning, modulate glow tubes whose light outputs are focused by an optical-mechanical recorder on the film. The result is a density which is a function of the IR energy level incident upon the detector array. Glow modulator tubes used as light transducers expose the film, and four rotating microscope objectives image the illuminated end of a fiber optic bundle on the film and provide scan motion.

The stabilization system for the AN/AAS-10 is a gyro-controlled, three-axis, self-contained control unit. This unit consists of one directional gyro for azimuth control and one vertical gyro for roll and pitch control.

A control panel, having on-off switches for the system power, electronics, detector-cooler assembly, stabilization unit, scan motor, and film drive, contains a test point control for selecting individual video channels, an input voltage meter and selector switch, and a V/H selector dial.

Reconofax VI, Modified (U. S. Navy, HRB-Singer, Incorporated)

The Reconofax VI infrared mapping set, a high thermal sensitivity device procured from HRB-Singer, Incorporated (Contract N62269-2202), consists of a scanner unit and a remote control unit (figure 5). All major components such as infrared optical system, film magazine, amplifier package, and detector are contained in the scanner unit. A control panel contains fuses, connectors, and all operating controls for the system.

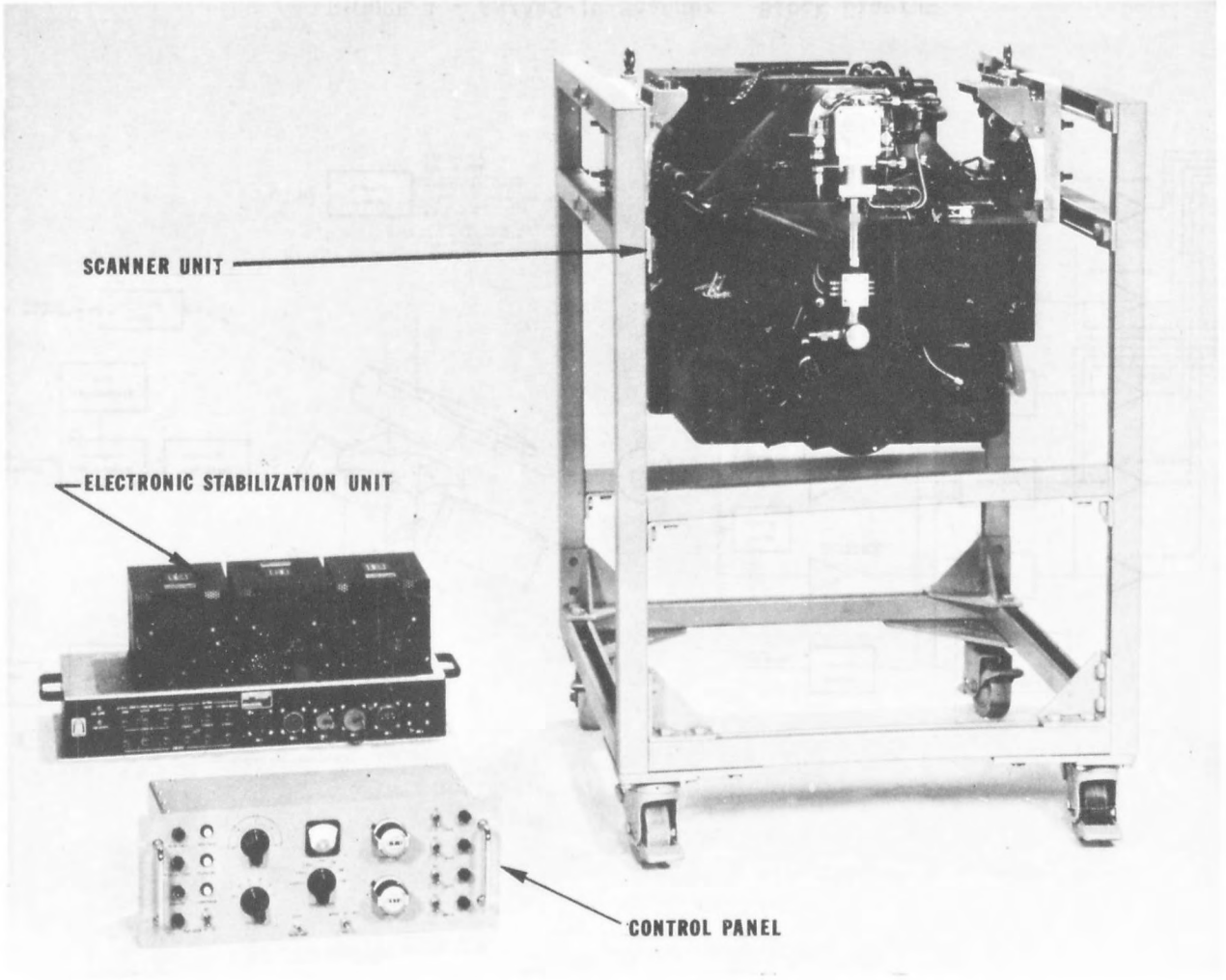


FIGURE 3 - AN/AAS-10 IR Detecting Set

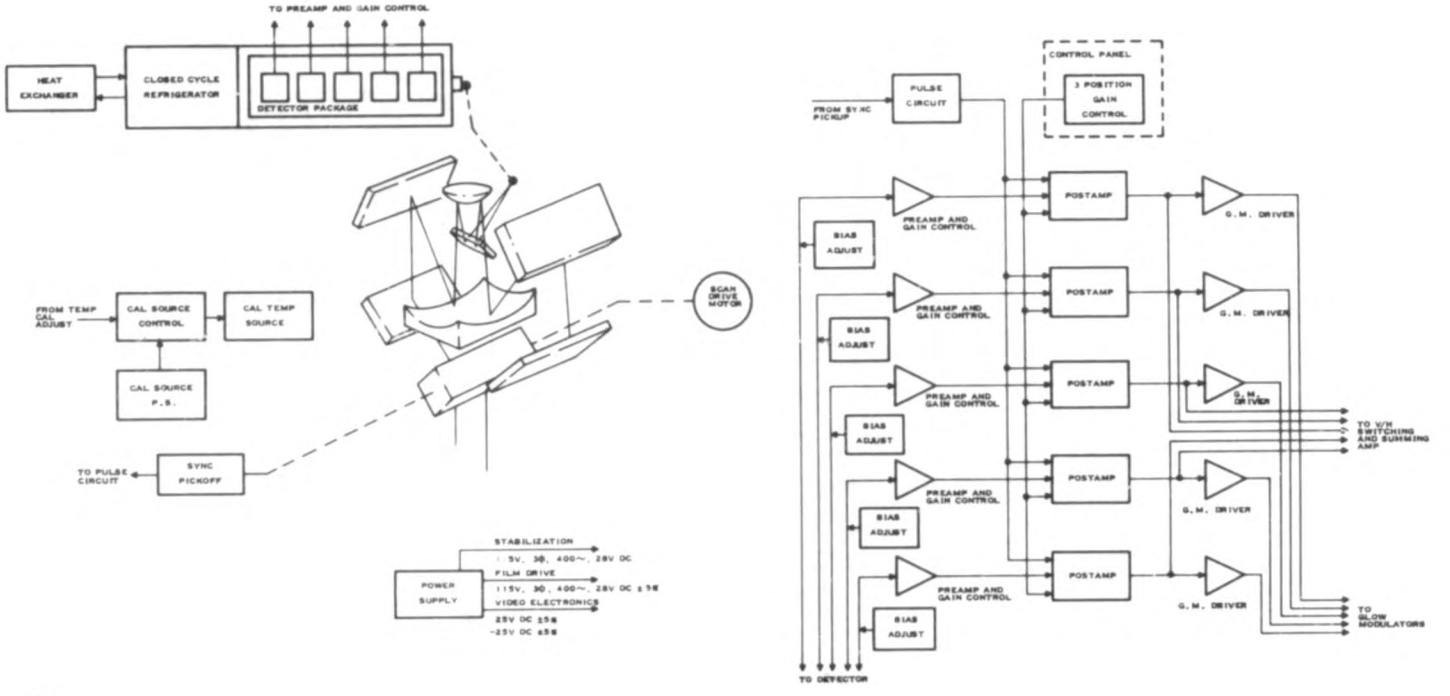


FIGURE 4 - AN/AAS-10 Scanner - Block Diagram

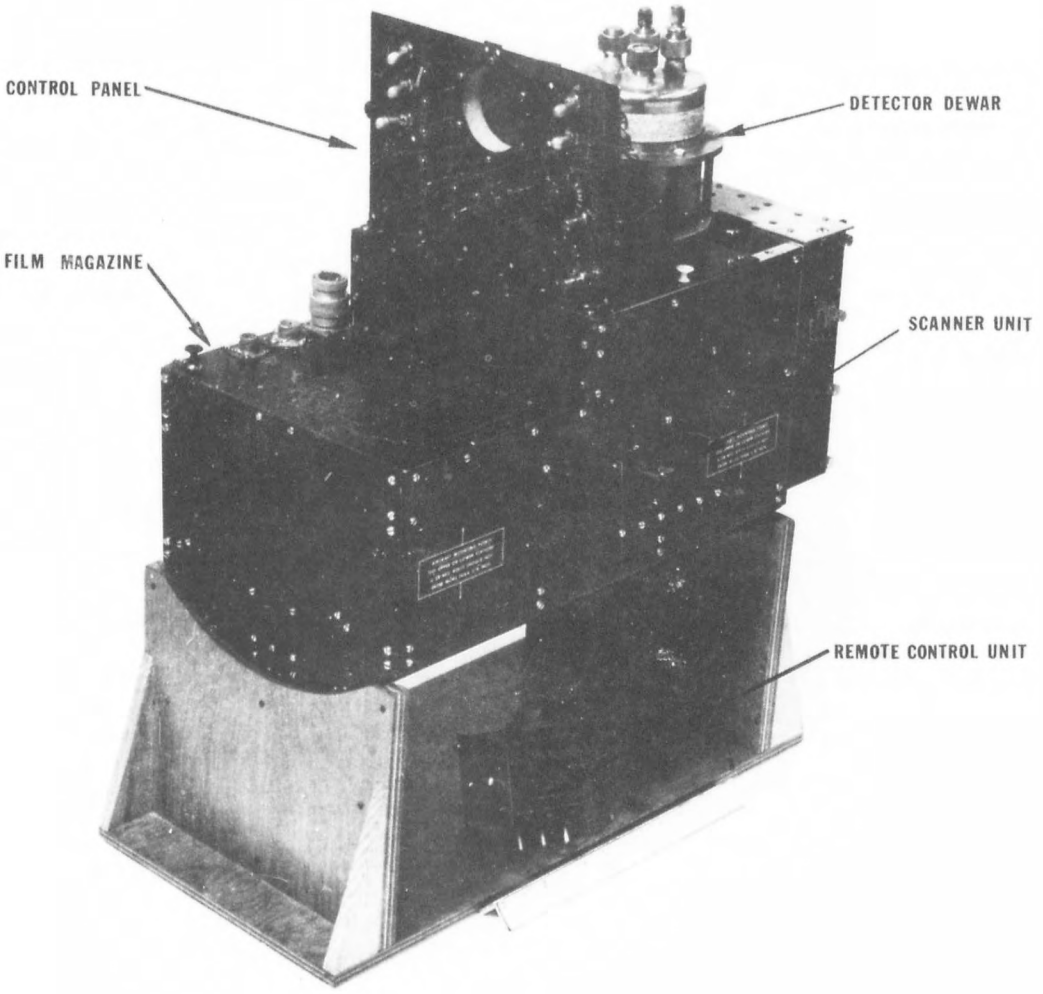


FIGURE 5 - Reconofax VI IR Detecting Set

The major components of the receiving and recording optical systems are:

| Receiving | Recording |
|---|---|
| Double-faced scanner mirror | Glow modulator lamp |
| Parabolic mirror 3-1/4 in. dia. (6 in. focal length) | Field Stop |
| Folding mirror | Folding mirror |
| | Objective lens |

The geometry of the line scan is illustrated in figure 6. The terrain directly beneath the aircraft carrying the equipment is scanned at right angles to the direction of flight by the rotating scanner mirror. Motion of the aircraft provides the forward component of scan. The IR radiation received in this manner is focused on the detector whose video output varies with the amount of energy received from each point in the scan. After suitable signal processing, the video signal modulates the brightness of a glow tube. The light output of the glow tube, after reflection from a double-faced folding mirror, is focused to a small spot on the recording film by a pair of microscope objectives. With the recording and scanning optics on the same shaft, perfect synchronization is assured.

The combination of the line scanning and the recording systems lends itself to a very simple and effective means of gyro stabilization against roll; only the film magazine is stabilized. Since the film magazine is held in an upright position regardless of aircraft roll up to ±30 degrees, any target vertically below the aircraft will be recorded at the center of the film, thus providing roll stabilization.

Characteristics of the AN/AAS-10, Reconofax IX, Reconofax VI (modified) infrared mapping systems are itemized in table I.

Appendix A gives a description of the aircraft modification and installation procedures required to accommodate the three infrared mappers in the RA-3B aircraft.

DETAIL RESULTS

A summary of the flight test program and comments regarding specific equipment problems and corrective measures taken are presented in appendix B.



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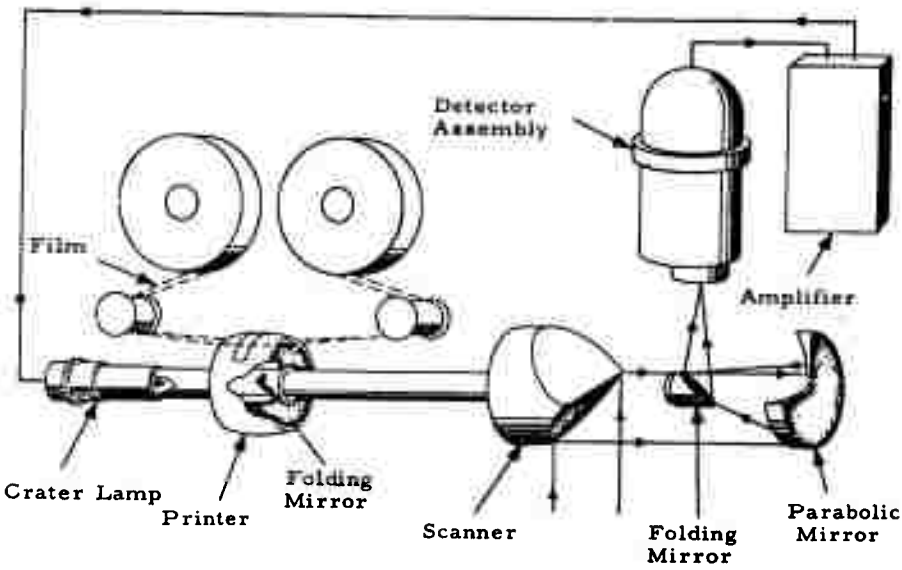


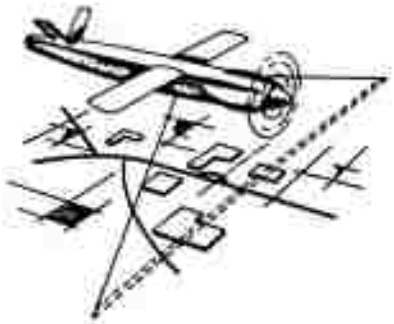



FIGURE 6 - Reconofax VI Optical System and Scanning Method

TABLE I

EQUIPMENT CHARACTERISTICS

| | AN/AAS-10(XE-1) | Reconofax IX | Modified Reconofax VI |
|---|---|---|---|
| IFOV | 0.5 mr | 1.0 mr | 3.3 mr |
| Total FOV | 140 deg | 140 deg | 140 deg |
| V/H | 0.2-1.0 rad/sec | 0.1-4.0 rad/sec | 0.1-1.3 rad/sec |
| Scan mirror angular velocity | 6000 rpm | 17,000 rpm | 12,000 rpm |
| Scan mirror type | 4-sided<br>2 x 8 in. | 2-sided<br>5 in. dia | 2-sided<br>3 1/4 in. dia |
| Scans/second (max) | 2000 | 4000 | 400 |
| Detector type | Ge:Hg<br>5 elements<br>0.64 x 0.64 mm | Ge:Cu, 7 elements<br>0.25 mm dia | Ge:Cu, 1 element<br>0.5 mm dia |
| Detector cooling | Norelco, 2-stage sterling cycle closed loop | liquid helium/nitrogen double dewar | liquid helium/nitrogen double dewar |
| Infrared filter | None used | germanium, 2μ cut-on long pass; daytime only | germanium, 8μ cut-on long pass |

TABLE I (continued)

| | AN/AAS-10(XE-1) | Reconofax IX | Modified Reconofax VI |
|---|---|---|---|
| Responsivity Balancing | all 5 channels balanced by variable control in preamplifiers | all 7 channels balanced with Cds cell against calibrated IR source | not required for single-channel |
| Detectivity (AVG)D (500 deg K) | 1.5-2.0 x $10^{10}\frac{\text{cm-Hz}^{1/2}}{\text{watt}}$ | 2 x $10^{9}\frac{\text{cm-Hz}^{1/2}}{\text{watt}}$ | 8.5 x $10^{9}\frac{\text{cm-Hz}^{1/2}}{\text{watt}}$ |
| Noise equivalent temperature difference (NE $\Delta$T) | 0.68 C° (lab) | 2.5 C° (lab) | 0.15 C° (lab) |
| Stabilization | Scanner: 3-axis ±10 deg pitch, yaw and roll | Recorder: single axis, ±10 deg roll | Recorder: single axis, ±30 deg roll |
| Recording film | 5 in. x 250 ft Kodak Tri-X SO 260 | 70 mm x 125 ft Kodak 2475 | 70 mm x 100 ft Kodak Tri-X 5063 |
| Recording format | 4 in. image, 3/4 flight data block, 6 in. intervals | '0 mm image, no film marking provisions | 70 mm image, manual film marking |
| Recorder type | Glow modulators, fiber optics | Glow modulators, fiber optics | Glow modulator |
| Recording film speed (max) | 8.2 ft/min | 20 ft/min | 6.15 ft/min |

TABLE I (continued)

| | AN/AAS-10(XE-1) | Reconofax IX | Modified Reconofax VI |
|---|---|---|---|
| Recording film processing | EH-38 Versamat | DK-60 "A" Chemistry, hand processed | EH-38 Versamat |
| Weight | Scanner 330 lb<br>3-axis stab. 120<br>stab. elec. 50<br>control unit 5<br>505 lb | Scanner 180 lb<br>Control unit 60<br>Monitor oscill. 17<br>257 lb | Scanner 60 lb<br>Control Unit 1<br>61 lb |
| Size | Scanner/recorder/ 3-axis stabilization 45 x 22 x 45 in.<br><br>Control unit 19 x 7 x 7 in.<br><br>Stab-electronics 12 x 12 x 26 in.<br><br>Total volume = 25.78+74+2.16 = 28.68 cu ft | Scanner/recorder 12 x 23 x 35 in.<br><br>Control unit 10 1/4 x 12 5/16 x 19 5/16 in.<br><br>Monitor oscilloscope 5 7/8 x 11 7/16 x 18 3/4 in.<br><br>Total volume = 5.6+1.4+0.7 = 7.7 cu ft | Scanner/recorder 11 1/4 x 19 x 23 in.<br><br>Control unit 2 3/4 x 4 3/4 x 3 1/2 in.<br><br>Total volume = 2.84 + 0.026 = 2.866 cu ft |

TABLE I (continued)

| | AN/AAS-10(XE-1) | Reconofax IX | Modified Reconofax VI |
|---|---|---|---|
| "Air window" slot size in RA-3B A/C | 23 in. x 66 in. | 3.5 in. x 44 in. | 5 in. x 18 in. |
| Power 28VDC | 10 amp normal<br>30 amp surge | 4 amp normal<br>10 amp surge | 9 amp normal<br>20 amp surge |
| 30 115V 400 cycle | 5 amp/phase normal<br>10 amp/phase surge | 5 amp/phase normal<br>10 amp/phase surge | |
| Approximate procurement cost of one unit | $300,000 | $170,000 | $60,000 |

Table II presents the pertinent parameters measured either in flight or in the laboratory, together with the corresponding ones from the manufacturers' specifications for the three infrared mapping systems.

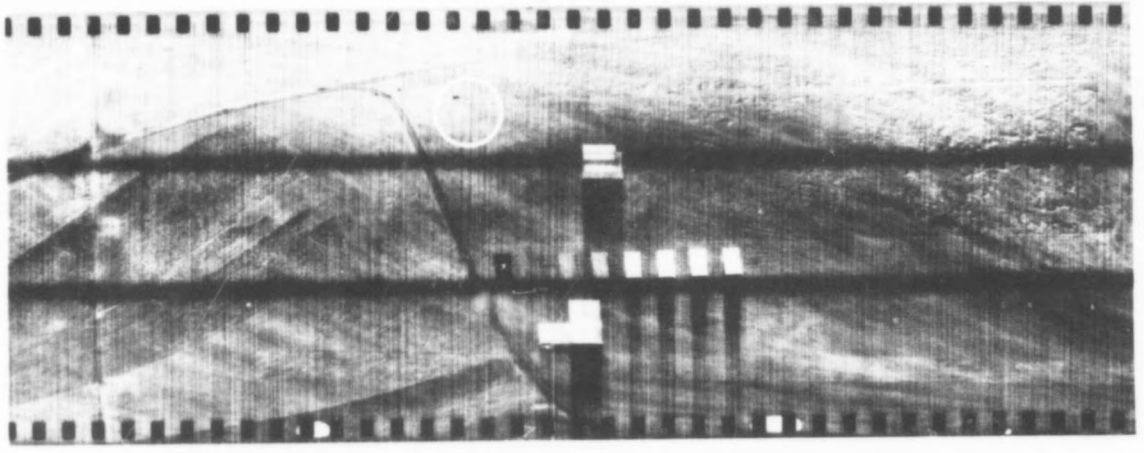
T A B L E I I

MEASUREMENT COMPARISON

| | Reconofax IX | | AN/AAS-10 | | Reconofax VI | |
|---|---|---|---|---|---|---|
| | Mfgrs Spec | Measured | Spec | Measured | Spec | Measured |
| Thermal (C°) Sensitivity | 1 | 2.5* (Lab) | 0.5 | 0.7* (Lab) | 0.15 | 0.15* (Lab) |
| Angular (mr) Resolution | 1 | 2 (Flt) | 0.5 | 0.75 (Flt) | 3.3 | 5.0 (Flt) |
| V/H (max) (rad/sec) | 4 | 4 (Flt) | 1.0 | 1.0 (Flt) | 1.3 | 1.3 (Flt) |

*Laboratory measurement

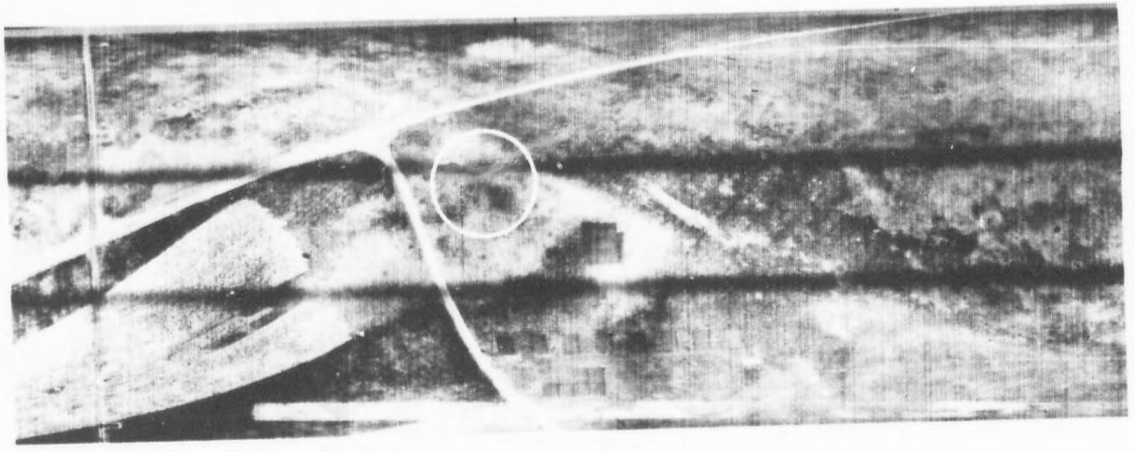
Flight imagery of the three infrared systems is presented in thirty-three photographs (figures 7 through 37). Because the photographs were reproduced from negatives made from positive duplicates of the original films, the copies are greatly degraded from the original imagery. These pictures contain selected imagery from all the target sites, listed in appendix C, and illustrate the operational flight capability of each infrared mapper. In addition to the caption information on each print, amplifying comments pertinent to these pictures are catalogued in the following text.



NADC-AE-6718

| | | |
|---|---|---|
| RECONOFAX IX | DATE: 2/17/66 | AREA: Wright-Patterson Air Force Base, Ohio |
| FLIGHT 10 | TIME: 1427R | TARGET: Resolution targets at Patterson Field |
| RUN 3 | ALTITUDE: 190 ft | WEATHER: Clear, visibility unlimited |
| V/H 4 | SPEED: 450 kn | DETECTORS: All 7; Ge:Cu |

FIGURE 7 - Flight Imagery of the Three IR Systems



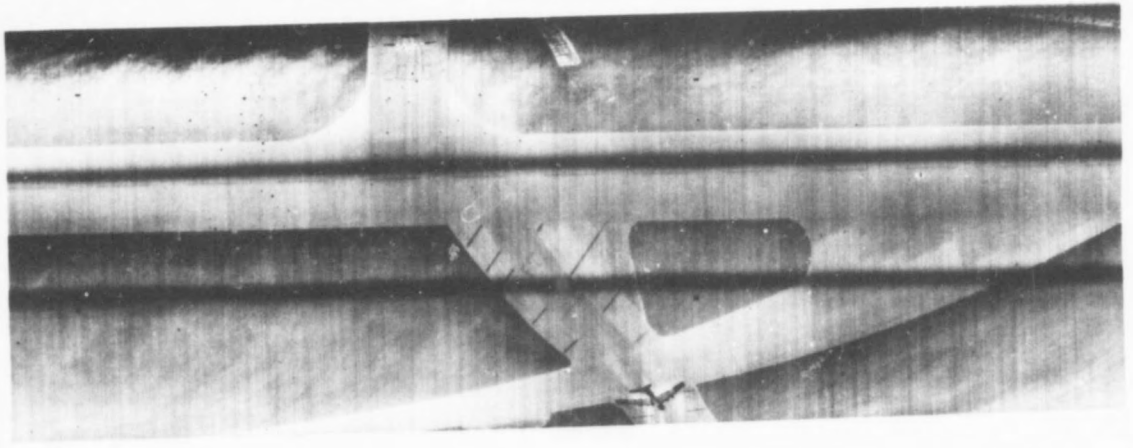
NADC-AE-6718

RECONOFAX IX
FLIGHT 11
RUN 3
V/H 4

DATE: 2/17/66
TIME: 1930R
ALTITUDE: 190 ft
SPEED: 450 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Resolution targets at Patterson Field
WEATHER: Clear, visibility unlimited
DETECTORS: All 7; e:Cu

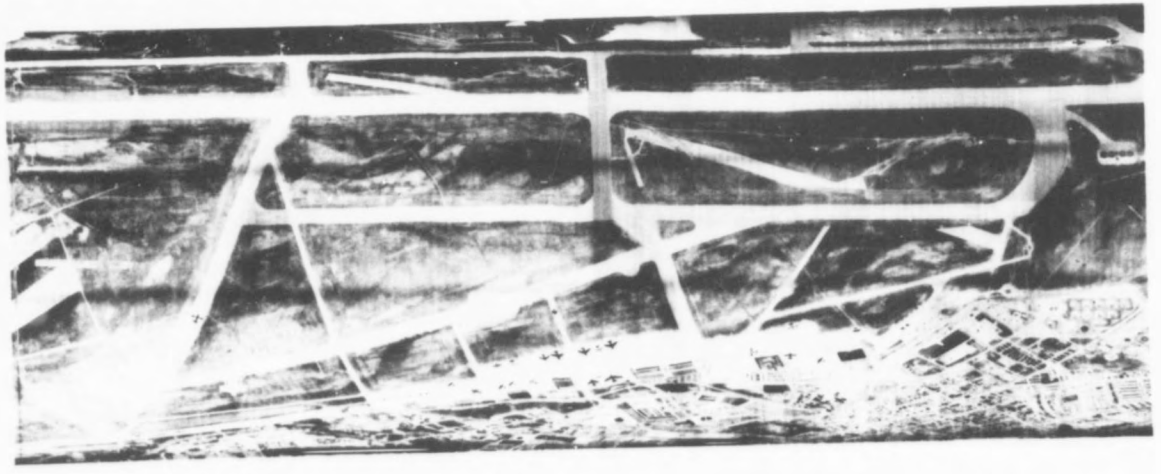
FIGURE 8 - Flight Imagery of the Three IR Systems



NADC-AE-6718

| | | |
|---|---|---|
| RECONOFAX IX | DATE: 2/18/66 | AREA: Wright-Patterson Air Force Base, Ohio |
| FLIGHT 13 | TIME: 1915R | TARGET: Aircraft on Patterson Field |
| RUN 4 | ALTITUDE: 370 ft | WEATHER: 10K broken visibility 15 miles in haze/smoke |
| V/H 2 | SPEED: 450 kn | DETECTORS: #2, 3, 5, 6; Ge:Gu |

FIGURE 9 - Flight Imagery of the Three IR Systems



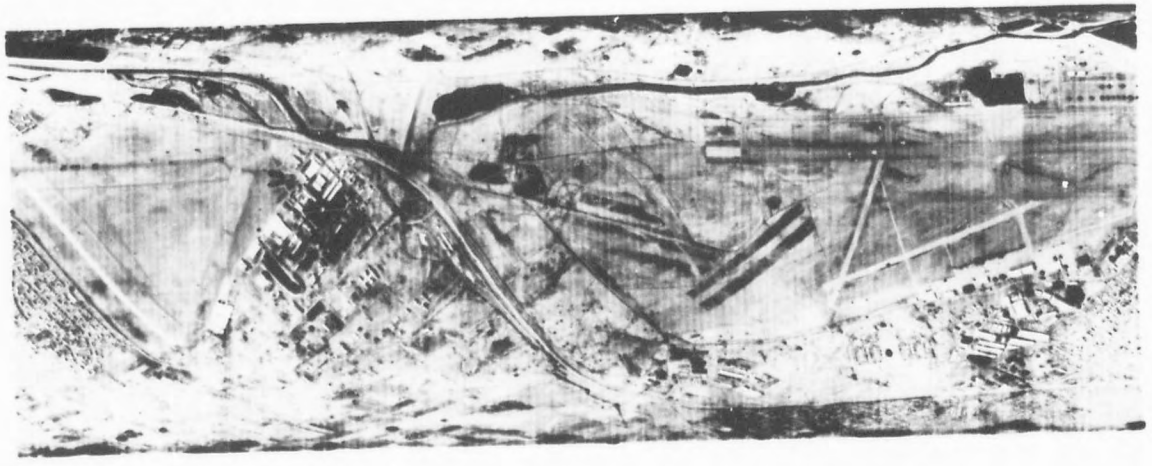
NADC-AE-6718

RECONOFAX IX
FLIGHT 11
RUN 4
V/H 0.25

DATE: 2/17/66
TIME; 1936R
ALTITUDE: 2000 ft
SPEED: 300 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Patterson Field complex
WEATHER: Clear, visibility unlimited
DETECTORS: All 7; Ge:Cu

FIGURE 10 - Flight Imagery of the Three IR Systems

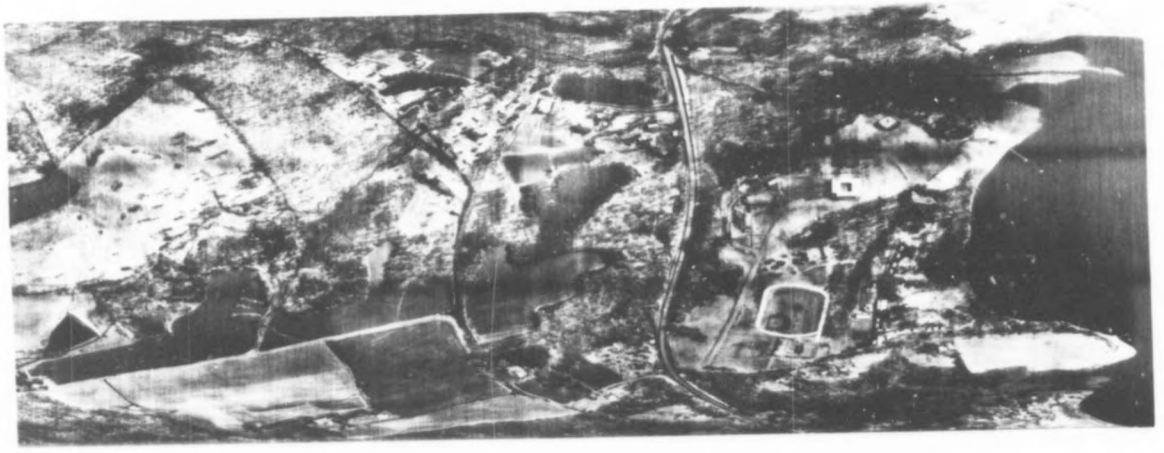


RECONOFAX IX
FLIGHT 12
RUN 9
V/H 0.1

DATE: 2/18/66
TIME: 1450R
ALTITUDE: 5000 ft
SPEED: 300 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Wright and Patterson Fields
WEATHER: 20K scattered, visibility 25 miles, light haze
DETECTORS: #3, Ge:Cu

FIGURE 11 - Flight Imagery of the Three IR Systems



NADC-AE-6718

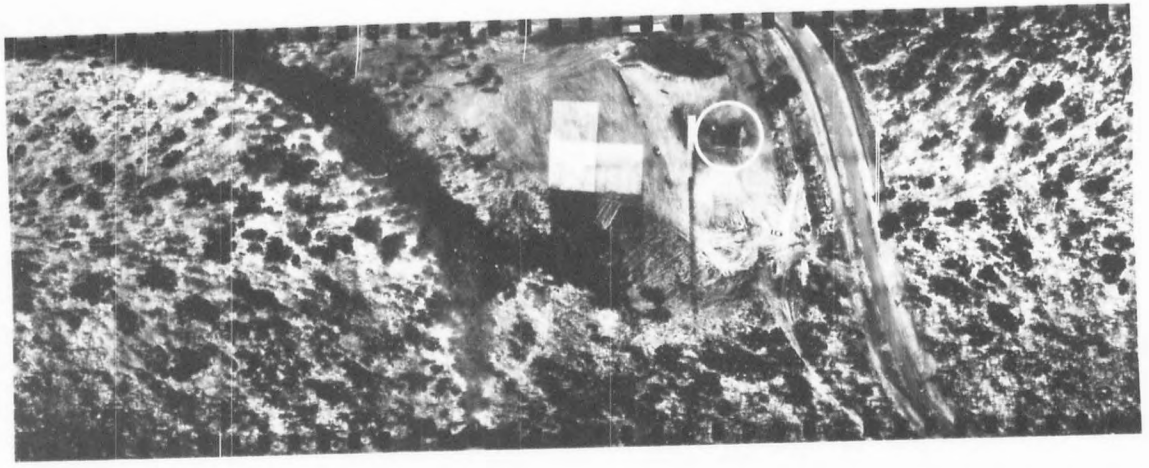
RECONOFAX IX
CHECKOUT
FLIGHT 6
V/H 0.17

DATE: 3/5/66
TIME: 1400R
ALTITUDE: 3000 ft
SPEED: 300 kn

AREA: Enroute NAF Johnsville to NAS Sanford, Florida

TARGET: Countryside (West Virginia)
WEATHER: Hazy, visibility 3 miles
DETECTORS: Single element array; Ge:Cu

FIGURE 12 - Flight Imagery of the Three IR Systems



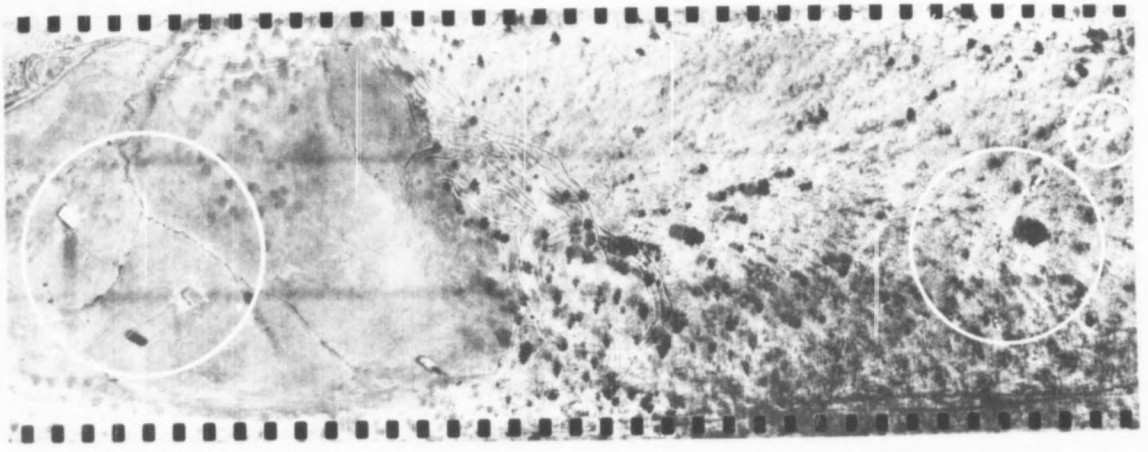
NADC-AE-6718

RECONOFAX IX
FLIGHT 16
RUN 12
V/H 2.7

DATE: 3/11/66
TIME: 1212S
ALTITUDE: 250 ft
SPEED: 400 kn

AREA: Eglin Air Force Base, Florida
TARGET: Resolution targets
WEATHER: 6K, light overcase, visibility 7 miles
DETECTORS: #1, 2, 3, 5, 6; Ge:Cu

FIGURE 13 - Flight Imagery of the Three IR Systems



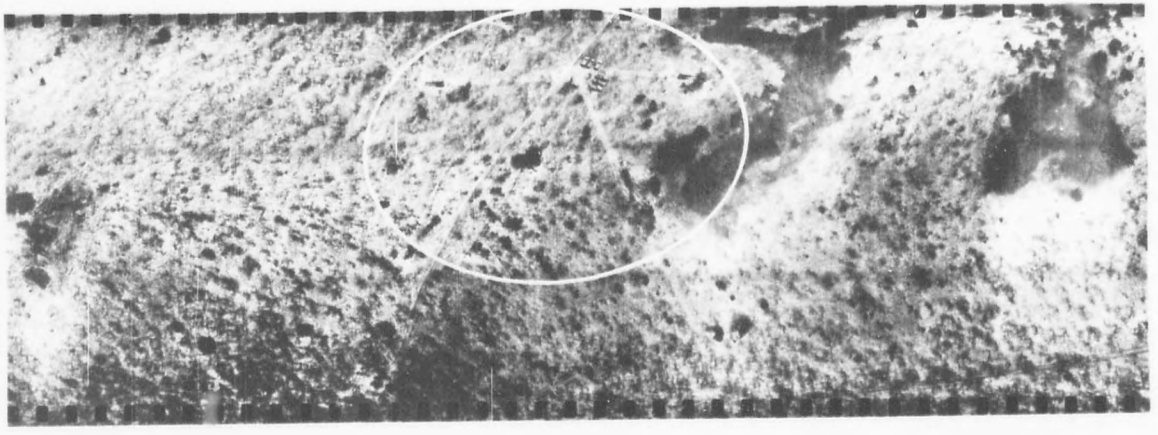
NADC-AE-6718

RECONOFAX IX
FLIGHT 16
RUN 12
V/H 2.7

DATE: 3/11/66
TIME: 1212S
ALTITUDE: 250 ft
SPEED: 400 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site I Village complex
WEATHER: 6K, light overcast, visibility 7 miles
DETECTORS: #1, 2, 3, 5, 6; Ge:Cu

FIGURE 14 - Flight Imagery of the Three IR Systems



NADC-AE-6718

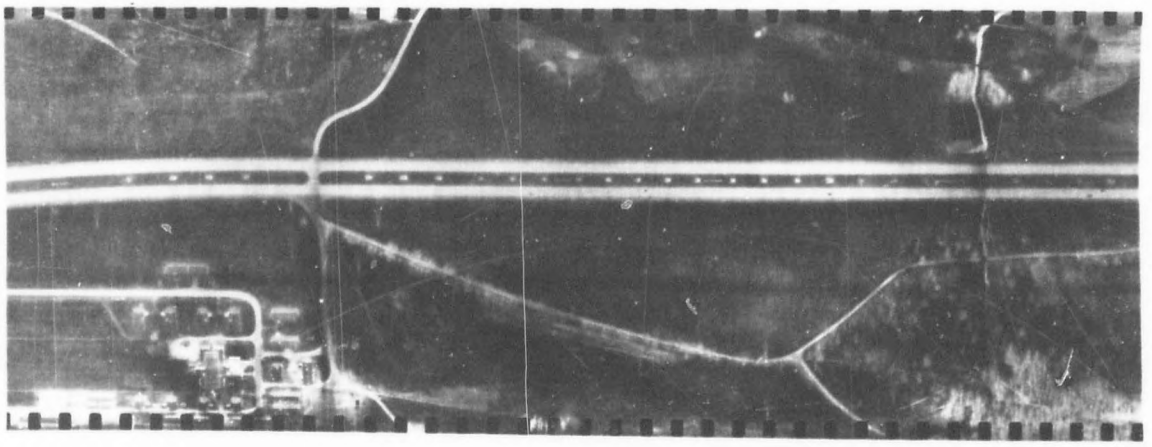
| | | |
|---|---|---|
| RECONOFAX IX | DATE: 3/11/66 | AREA: Eglin Air Force Base, Florida |
| FLIGHT 16 | TIME; 1212S | TARGET: SAM Site |
| RUN 12 | ALTITUDE: 250 ft | WEATHER: 6K, light overcast, visibility 7 miles |
| V/H 2.7 | SPEED: 400 kn | DETECTORS: #1, 2, 3, 5, 6; Ge:Cu |

FIGURE 15 - Flight Imagery of the Three IR Systems

NADC-AE-6718

| | | |
|---|---|---|
| RECONOFAX IX | DATE: 3/25/66 | AREA: Eglin Air Force Base, Florida |
| FLIGHT 20 | TIME: 0043S | TARGET: Site III Village complex and Sampans |
| RUN 10 | ALTITUDE: 750 ft | WEATHER: Clear |
| V/H 1 | SPEED: 450 kn | DETECTORS: #2, 6; Ge:Cu |

FIGURE 16 - Flight Imagery of the Three IR Systems



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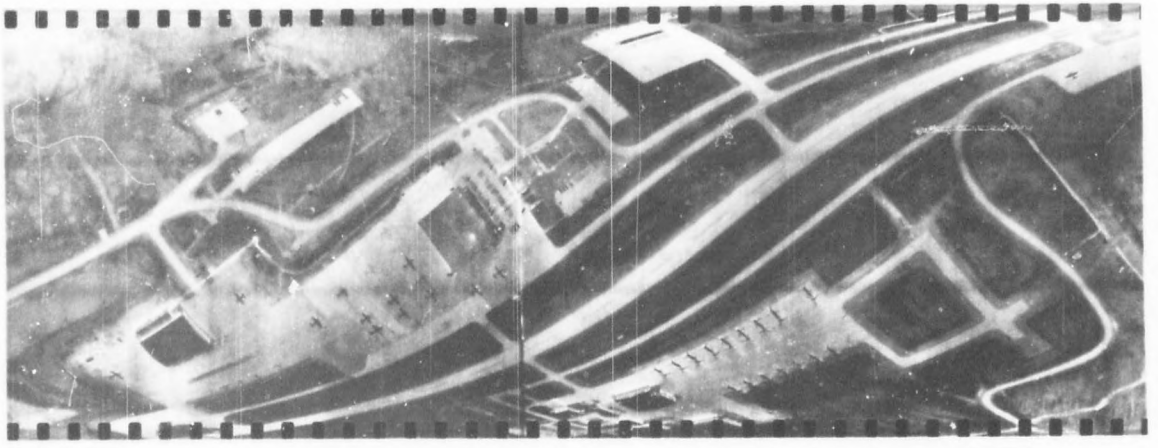
| | | |
|---|---|---|
| RECONOFAX IX | DATE: 3/29/66 | AREA: Aberdeen Proving Ground, Maryland |
| FLIGHT 22 | TIME: 2100R | TARGET: Tanks and armored vehicles |
| RUN 5 | ALTITUDE: 500 ft | WEATHER: Clear |
| V/H 1 | SPEED: 300 kn | DETECTORS: Single element array; Ge:Cu |

FIGURE 17 - Flight Imagery of the Three IR Systems



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RECONOFAX IX
FLIGHT 22
RUN 12
V/H 1

DATE: 3/29/66
TIME: 2147R
ALTITUDE: 500 ft
SPEED: 300 kn

AREA: Ft. Belvoir, Virginia
TARGET: Airfield
WEATHER: Clear
DETECTORS: Single element array; Ge:Cu

FIGURE 18 - Flight Imagery of the Three IR Systems

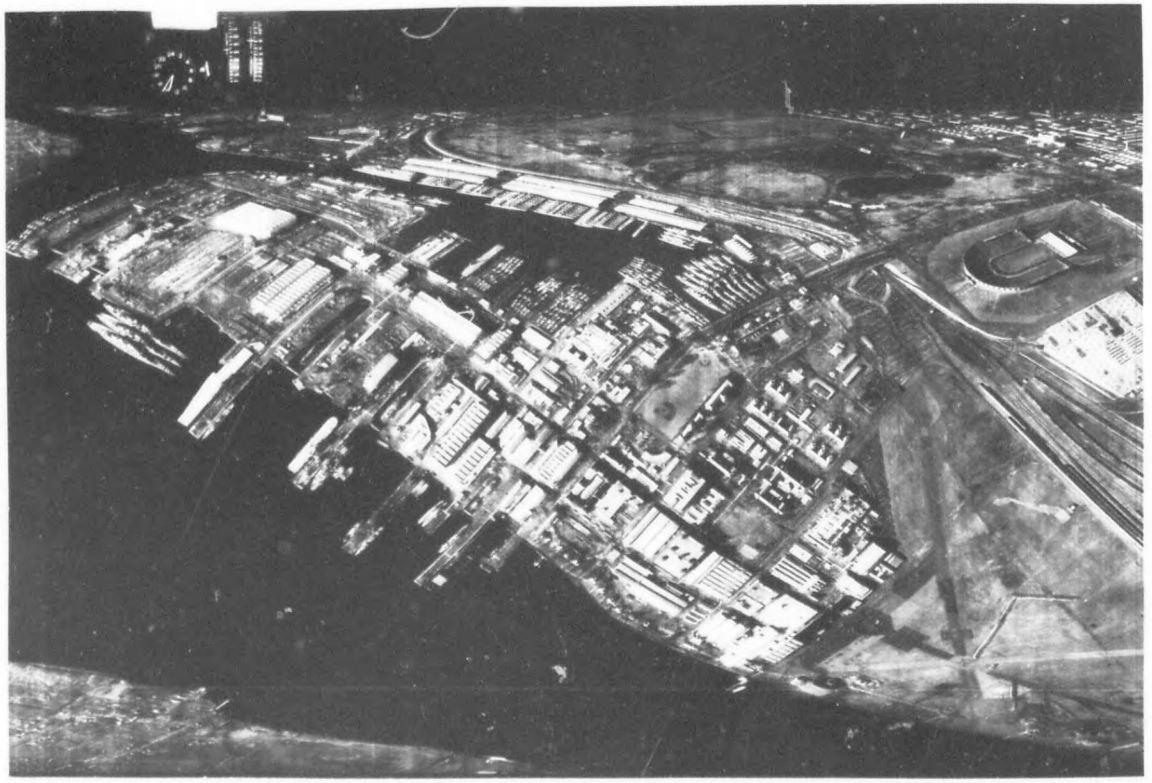
NADC-AE-6718

RECONOFAX IX
FLIGHT 22
RUN 13
V/H 1

DATE: 3/29/66
TIME: 2151R
ALTITUDE: 500 ft
SPEED: 300 kn

AREA: Ft. Belvoir, Virginia
TARGET: Pontoon bridge complex
WEATHER: Clear
DETECTORS: Single element array; Ge:Cu

FIGURE 19 - Flight Imagery of the Three IR Systems

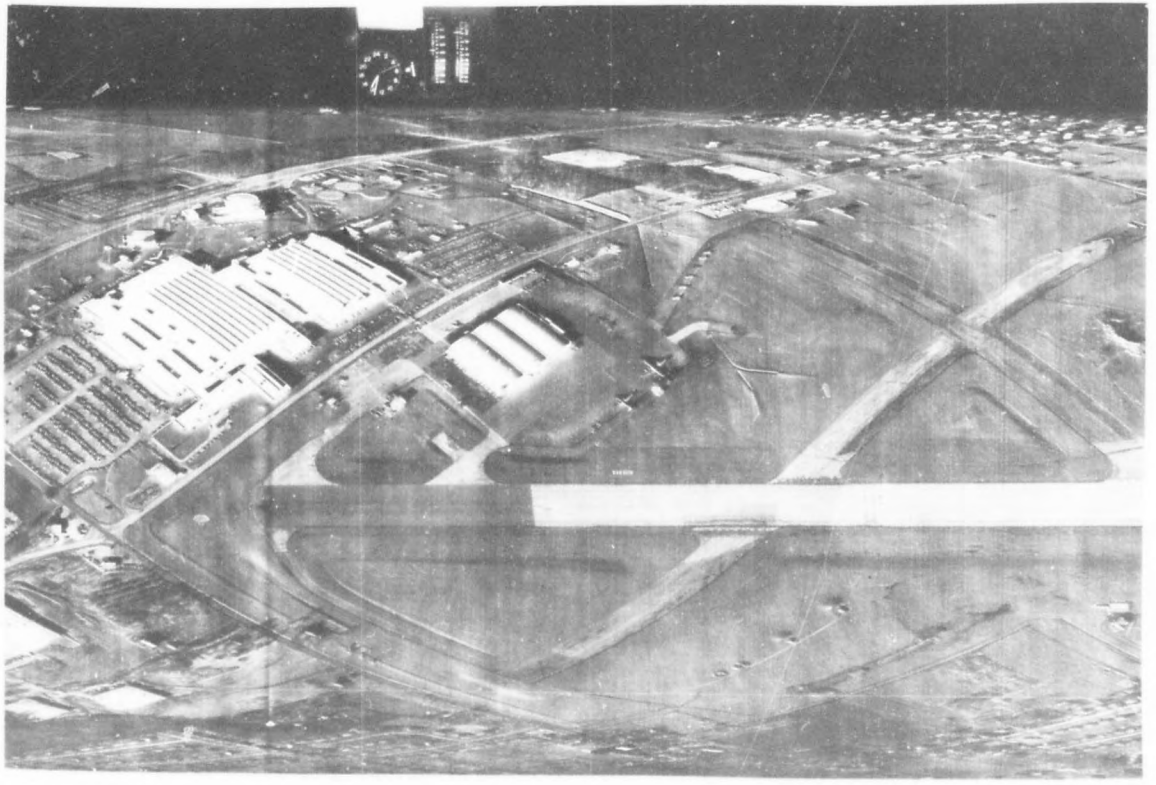


AN/AAS-10(XE-1)
FLIGHT 1
RUN 1
V/H 0.25

DATE: 1/20/66
TIME: 1335R
ALTITUDE: 2000 ft
SPEED: 300 kn

AREA: South Philadelphia industrial complex
TARGET: Philadelphia Naval Shipyard
WEATHER: 4.5K scattered, visibility 10 miles
DETECTORS: 5 Ge:Hg

FIGURE 20 - Flight Imagery of the Three IR Systems

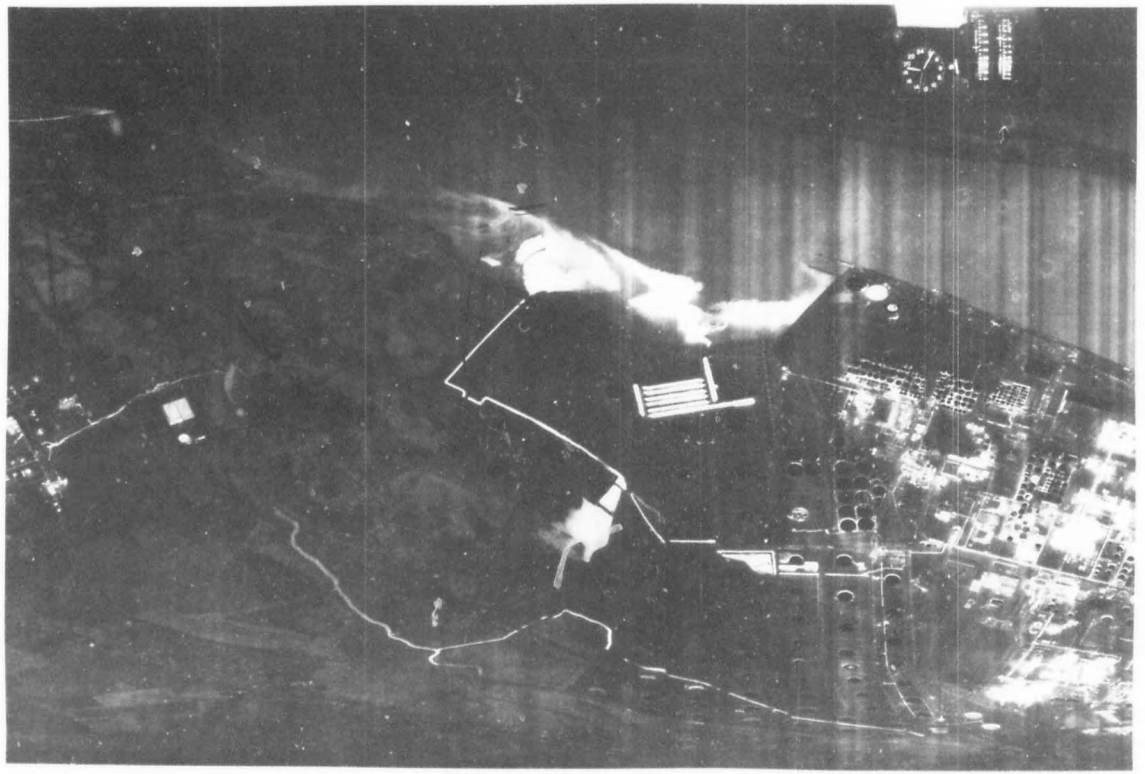


AN/AAS-10(XE-1)
FLIGHT 1
RUN 6
V/H 0.5

DATE: 1/20/66
TIME: 1432R
ALTITUDE: 1000 ft
SPEED: 300 kn

AREA: NAF Johnsville, Pennsylvania
TARGET: Airfield complex and resolution targets
WEATHER: 4.5K scattered, visibility 10 miles
DETECTORS: 5 Ge:Hg

FIGURE 21 - Flight Imagery of the Three IR Systems

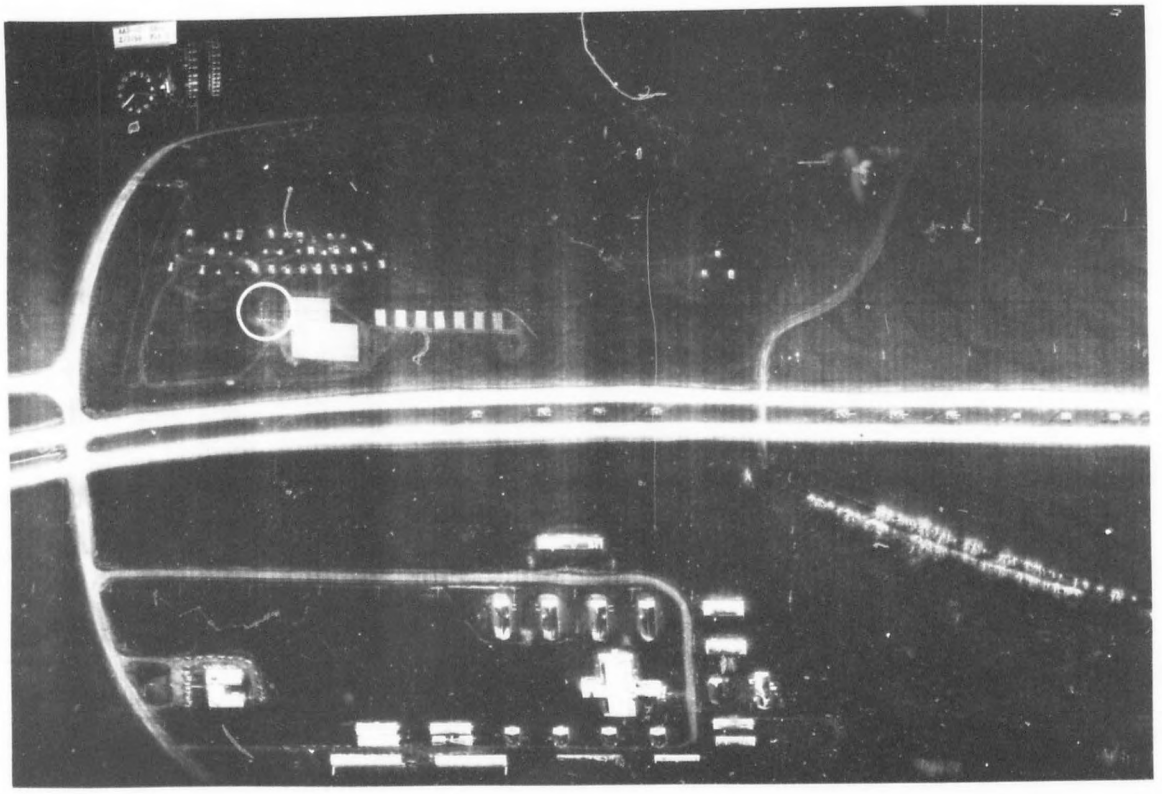


AN/AAS-10(XE-1)
FLIGHT 2
RUN 1
V/H 0.25

DATE: 1/20/66
TIME: 1900R
ALTITUDE: 2000 ft
SPEED: 300 kn

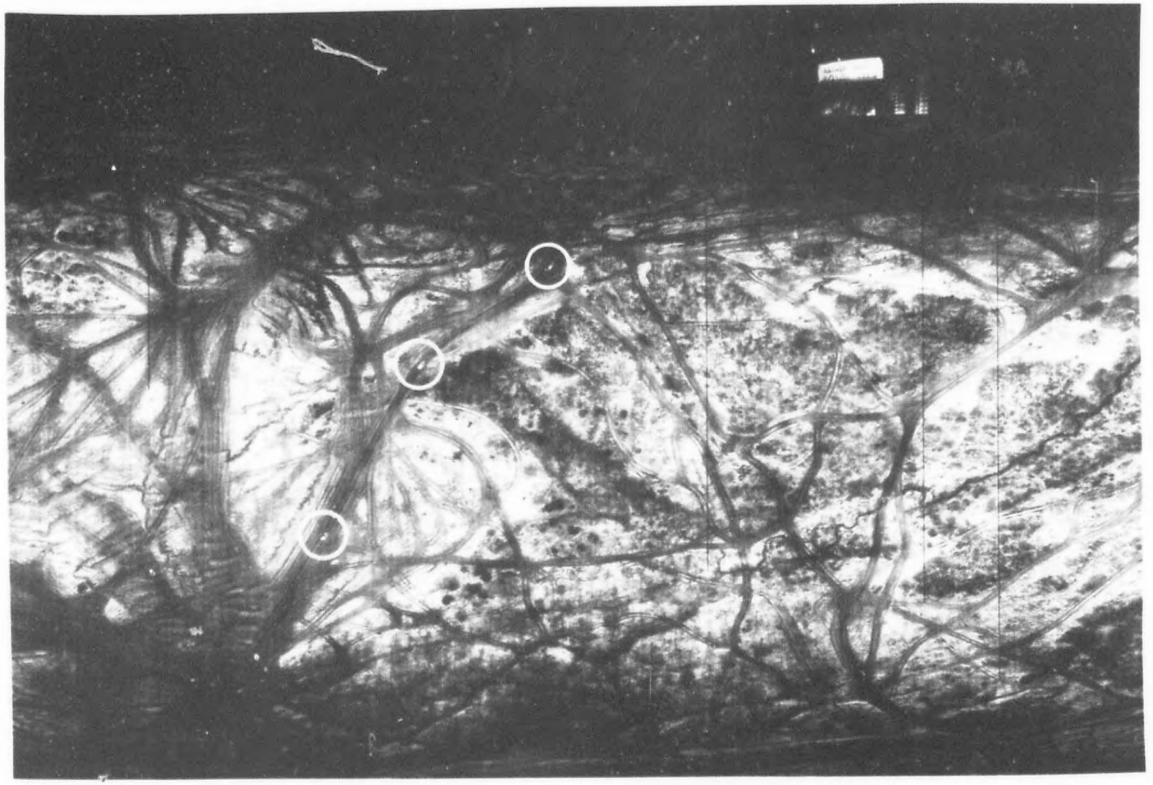
AREA: South Philadelphia industrial complex
TARGET: Oil tank farms
WEATHER: 4K scattered, visibility 10 miles
DETECTORS: 5 Ge:Hg

FIGURE 22 - Flight Imagery of the Three IR Systems



| | | |
|---|---|---|
| AN/AAS-10(XE-1) | DATE: 2/3/66 | AREA: Aberdeen Proving Ground, Maryland |
| FLIGHT 5 | TIME: 1539R | TARGET: Tanks and armored vehicles, resolution targets |
| RUN 5 | ALTITUDE: 500 ft | WEATHER: Broken clouds, visibility fair in haze, snow on ground |
| V/H 1 | SPEED: 300 kn | DETECTORS: 5 Ge:Hg |

FIGURE 23 - Flight Imagery of the Three IR Systems

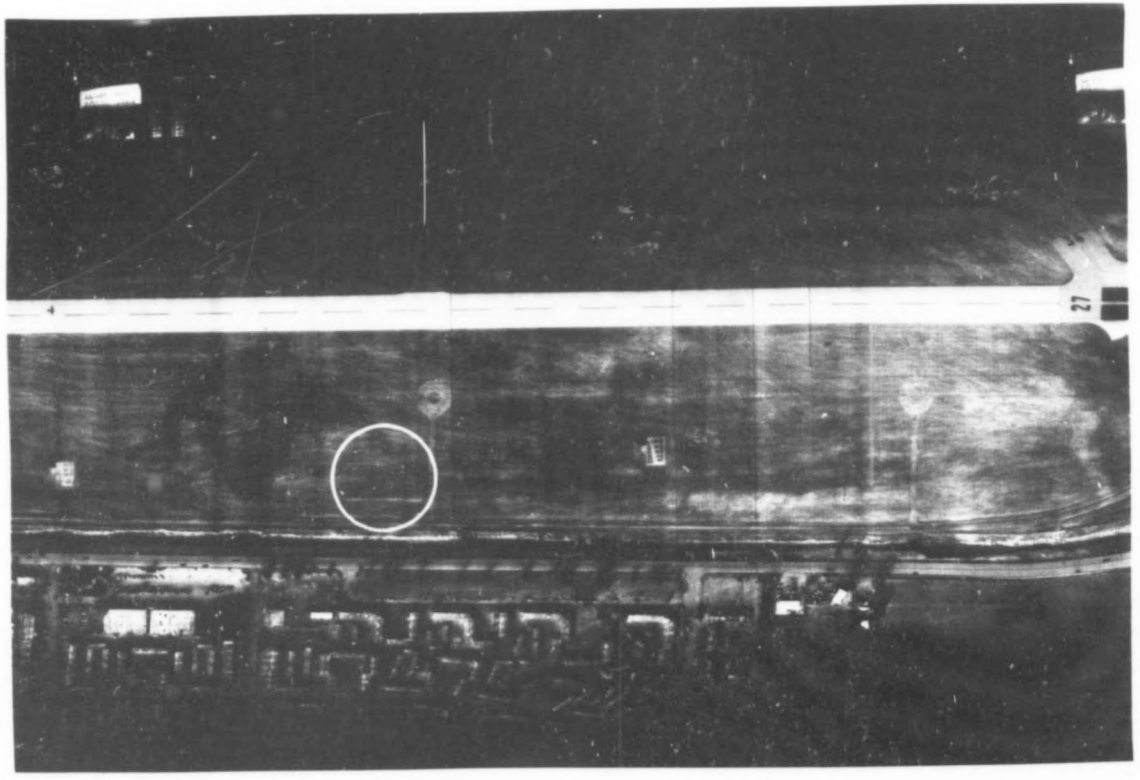


AN/AAS-10(XE-1)
FLIGHT 8
RUN 2
V/H 1

DATE: 2/15/66
TIME: 1337R
ALTITUDE: 500 ft
SPEED: 300 kn

AREA: Ft. Knox, Kentucky
TARGETS: Tanks
WEATHER: 5K scattered, visibility 7 miles in haze
DETECTORS: 5 Ge:Hg

FIGURE 24 - Flight Imagery of the Three IR Systems



AN/AAS-10(XE-1)
FLIGHT 8
RUN 9
V/H 0.5

DATE: 2/15/66
TIME: 1444R
ALTITUDE: 750 ft
SPEED: 220 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Thermal resolution targets on Wright Field
WEATHER: 5K scattered, visibility 7 miles in haze
DETECTORS: 5 Ge:Hg

FIGURE 25a - Flight Imagery of the Three IR Systems

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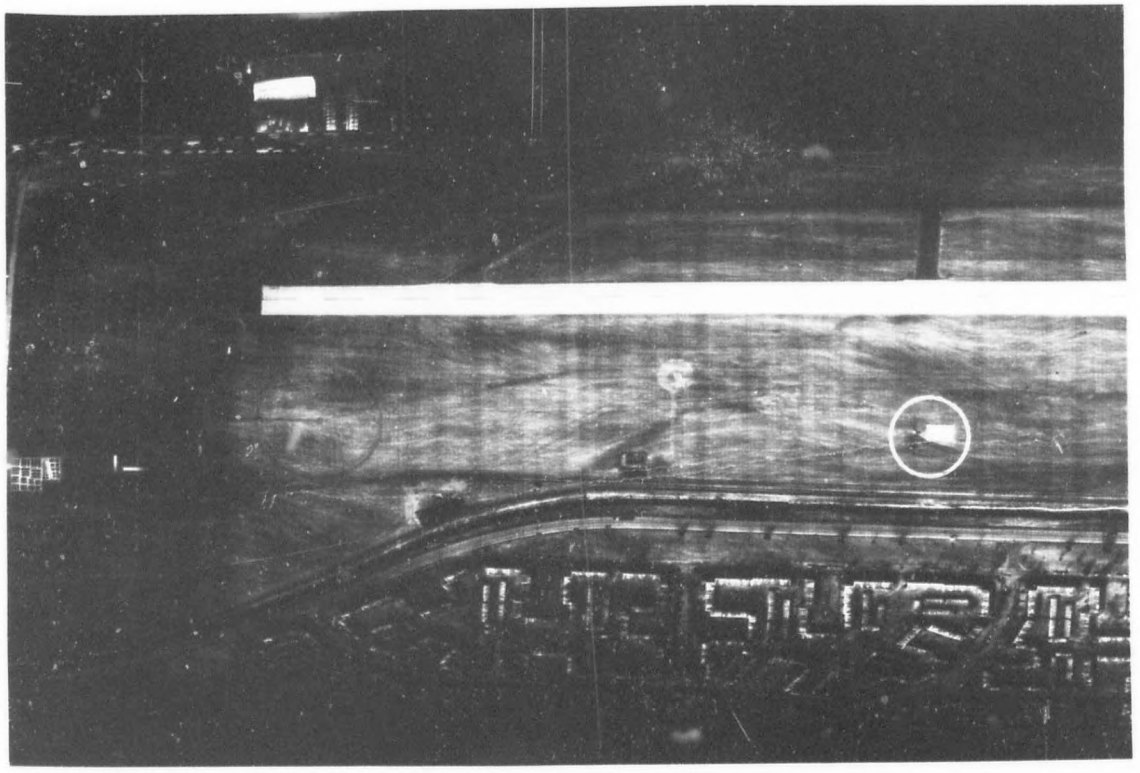


AN/AAS-10(XE-1)
FLIGHT 8

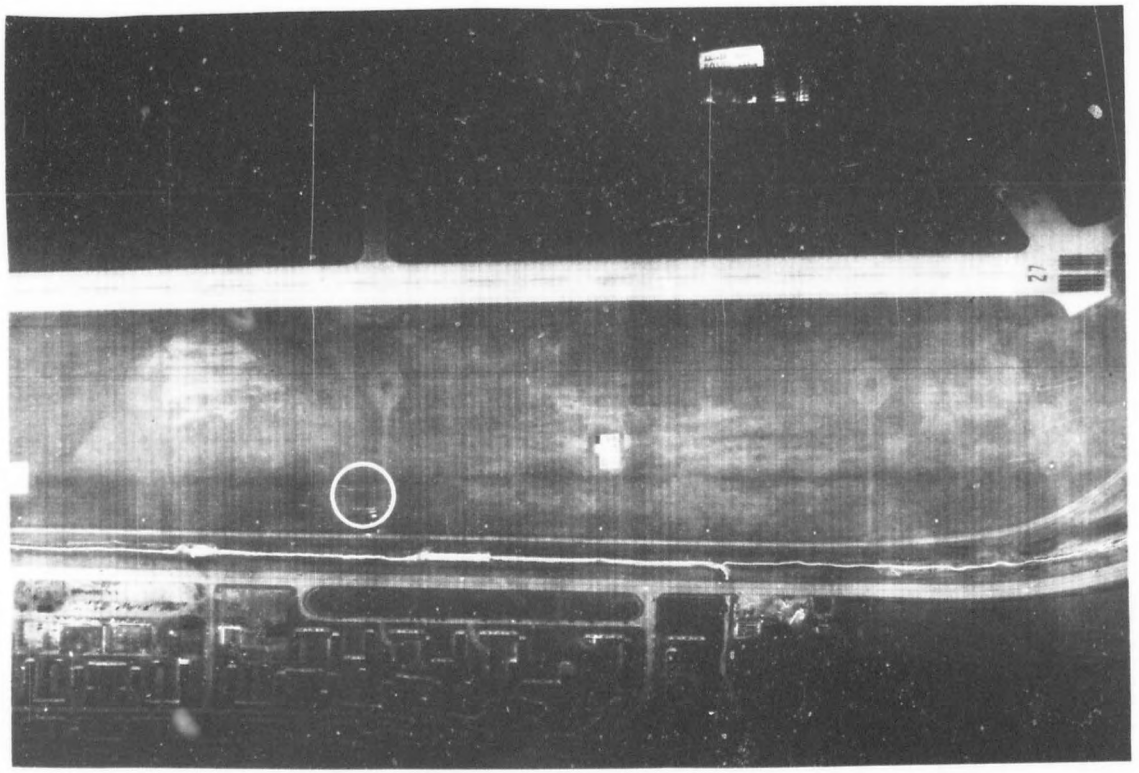
RUN 9
V/H 0.5

DATE: 2/15/66
TIME: 1444R

ALTITUDE: 750 ft
SPEED: 220 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Thermal sensitivity and photographic resolution targets on Wright Field
WEATHER: 5K scattered, visibility 7 miles in haze
DETECTORS: 5 Ge:Hg

FIGURE 25b - Flight Imagery of the Three IR Systems

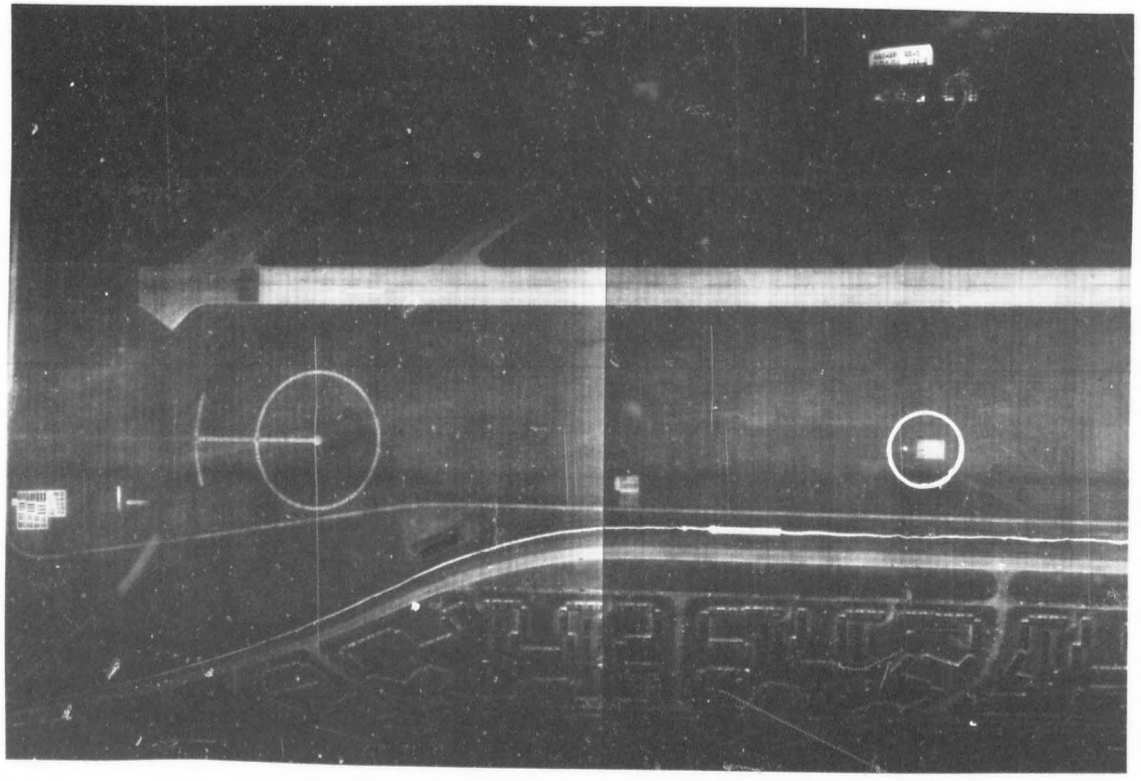



AN/AAS-10(XE-1)
FLIGHT 9
RUN 10
V/H 1

DATE: 2/15/66
TIME: 2031R
ALTITUDE: 750 ft
SPEED: 450 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Thermal resolution targets on Wright Field
WEATHER: 7K scattered, visibility 10 miles in light haze
DETECTORS: 5 Ge:Hg

FIGURE 26a - Flight Imagery of the Three IR Systems



AN/AAS-10(XE-1)
FLIGHT 9

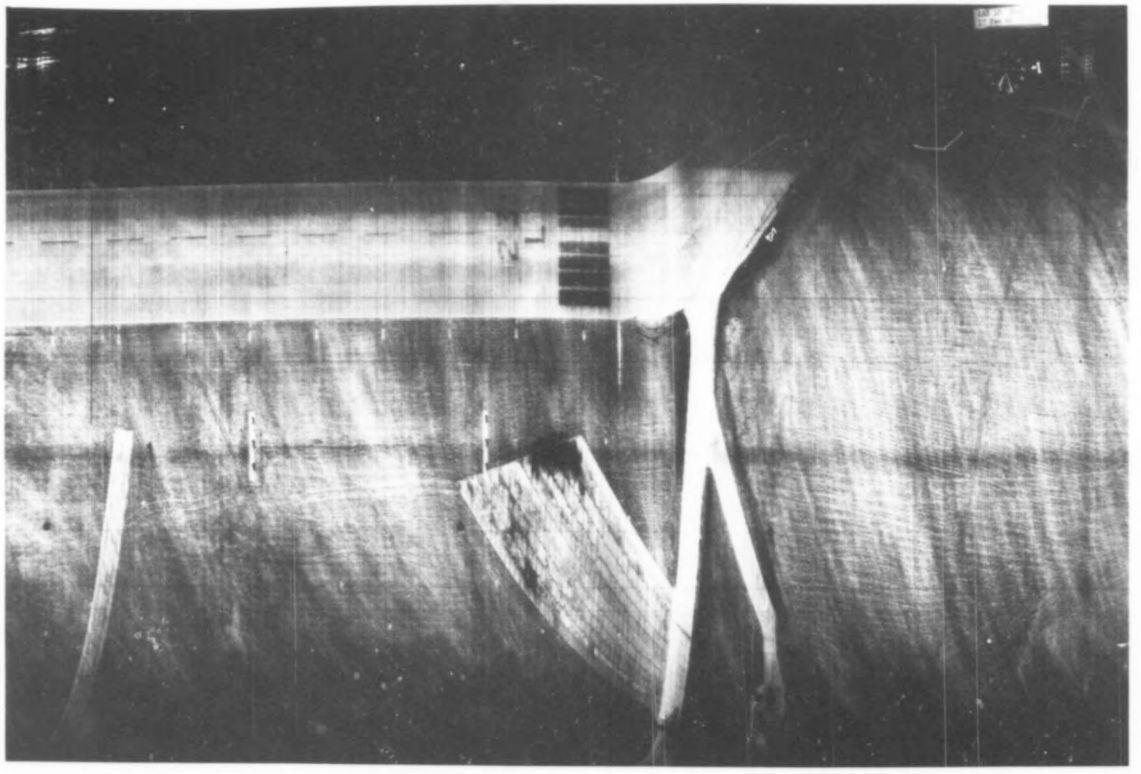
RUN 10
V/H 1

DATE: 2/15/66
TIME: 2031R

ALTITUDE: 750 ft
SPEED: 450 kn

AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Thermal sensitivity and photographic resolution targets on Wright Field
WEATHER: 7K scattered, visibility 10 miles in light haze
DETECTORS: 5 Ge:Hg

FIGURE 26b - Flight Imagery of the Three IR Systems

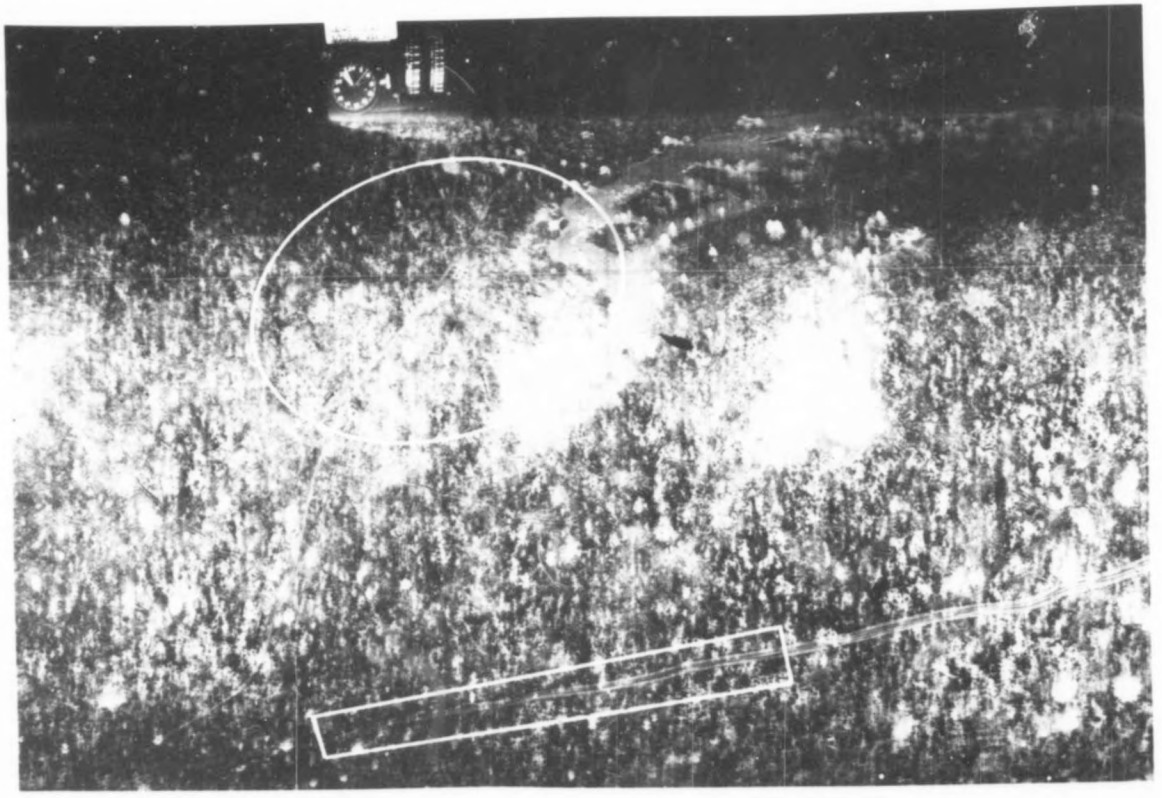


AN/AAS-10(XE-1)
FLIGHT 10
RUN 3
V/H 4

DATE: 2/17/66
TIME: 1427R
ALTITUDE: 190 ft
SPEED: 450 kn

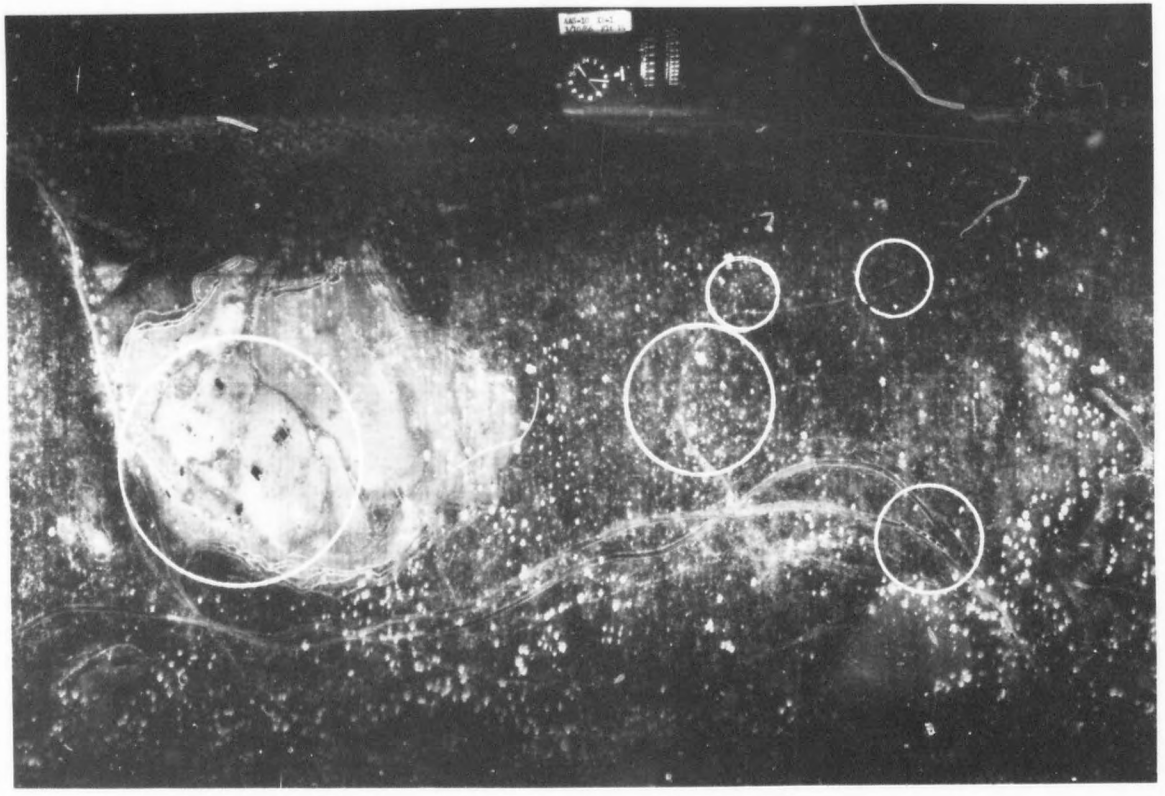
AREA: Wright-Patterson Air Force Base, Ohio
TARGET: Aircraft on Patterson Field
WEATHER: Clear, visibility unlimited
DETECTORS: 5 Ge:Hg

FIGURE 27 - Flight Imagery of the Three IR Systems



| | | |
|---|---|---|
| AN/AAS-10(XE-1) | DATE: 3/10/66 | AREA: Eglin Air Force Base, Florida |
| FLIGHT 15 | TIME: 2055S | TARGET: SAM site |
| RUN 5 | ALTITUDE: 500 ft | WEATHER: Clear, visibility 7 miles |
| V/H 1 | SPEED: 300 kn | DETECTORS: 5 Ge:Hg |

FIGURE 28 - Flight Imagery of the Three IR Systems

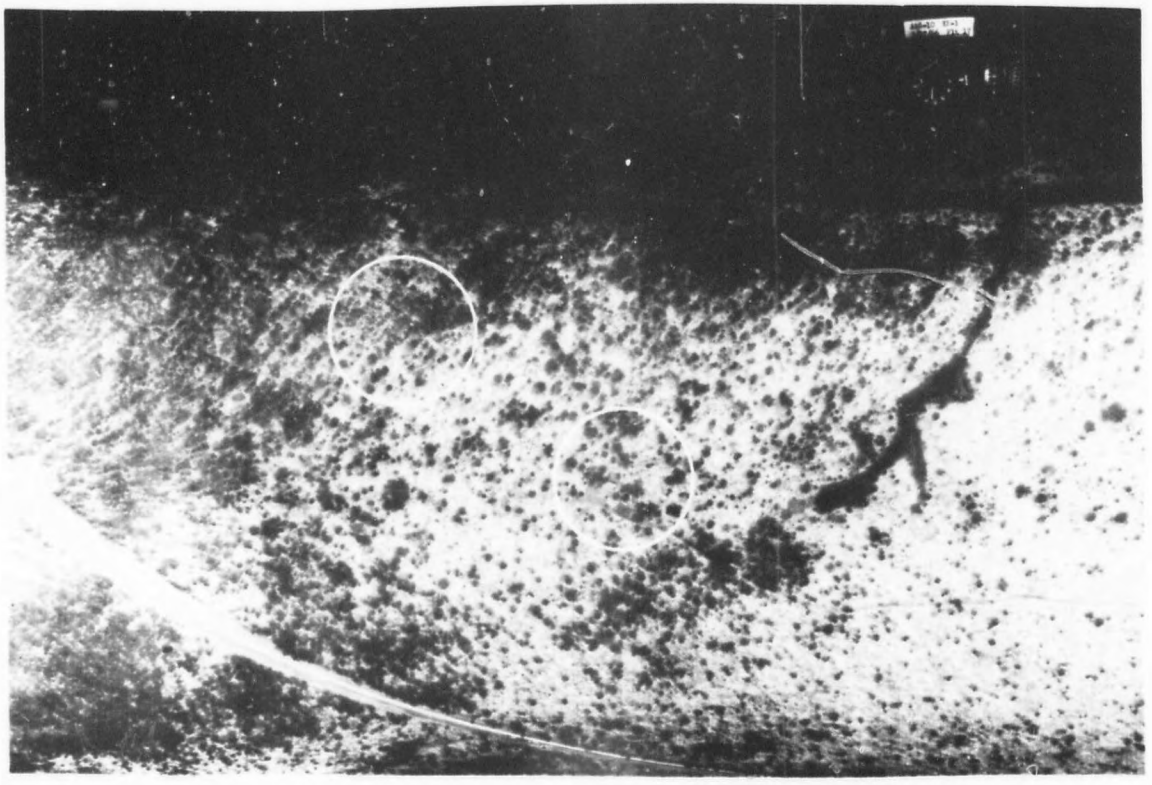


AN/AAS-10(XE-1)
FLIGHT 15
RUN 7
V/H 0.75

DATE: 3/10/66
TIME: 2117S
ALTITUDE: 750 ft
SPEED: 340 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site I Village complex
WEATHER: Clear, visibility 7 miles
DETECTORS: 5 Ge:Hg

FIGURE 29 - Flight Imagery of the Three IR Systems



AN/AAS-10(XE-1)
FLIGHT 17
RUN 4
V/H 0.75

DATE: 3/17/66
TIME: 1225S
ALTITUDE: 670 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site II Village complex
WEATHER: Clear
DETECTORS: 5 Ge:Hg

FIGURE 30 - Flight Imagery of the Three IR Systems

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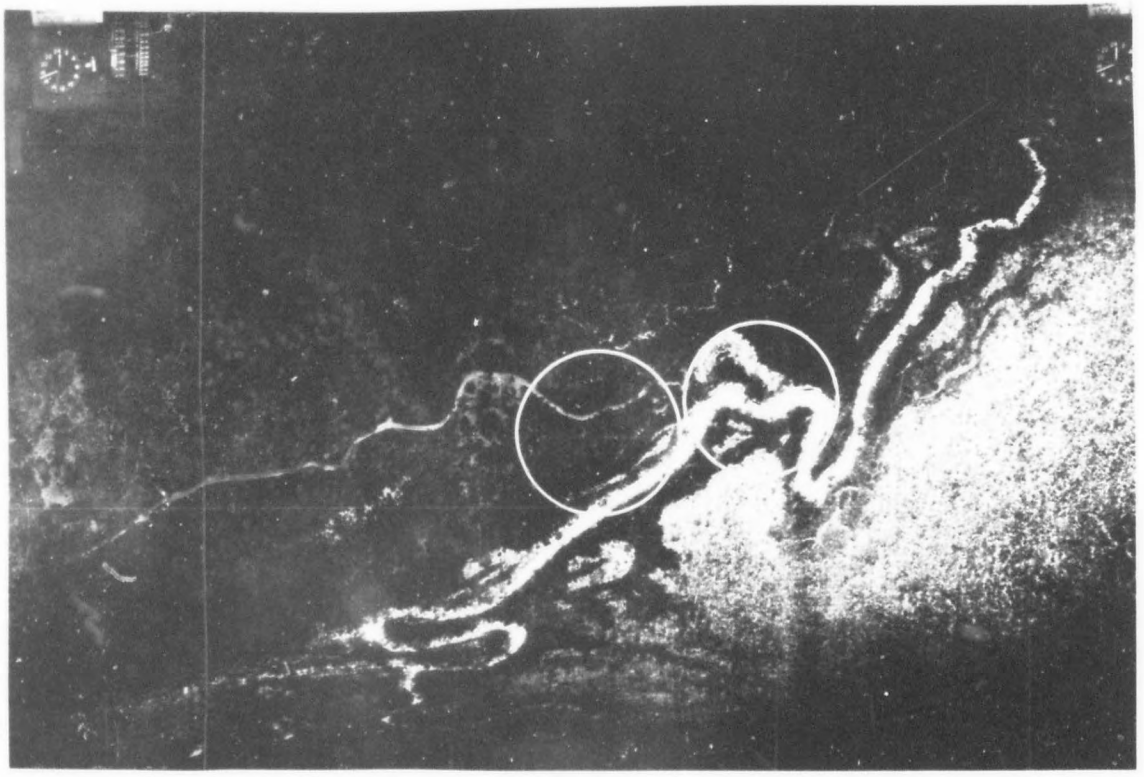
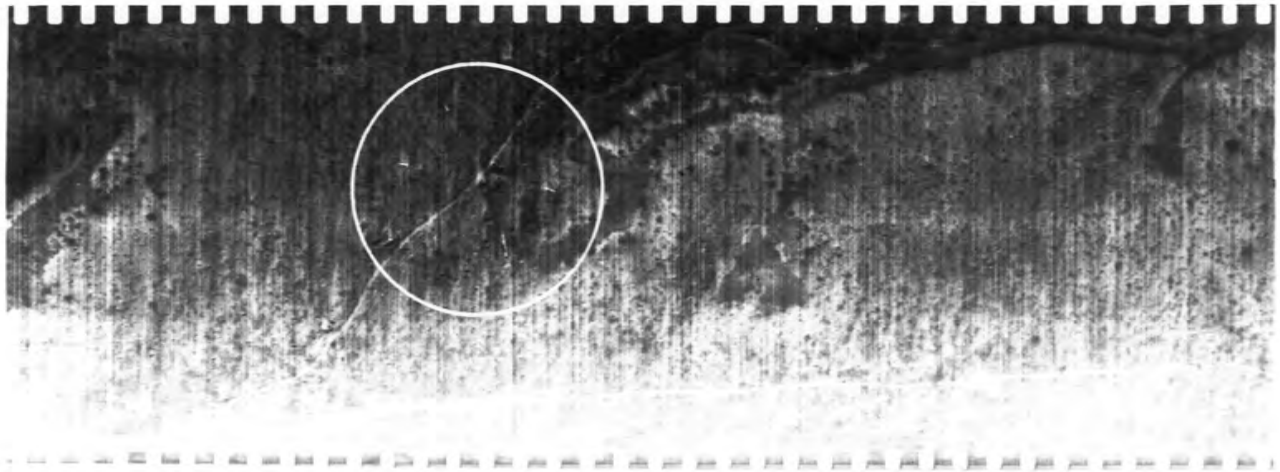


AN/AAS-10(XE-1)
FLIGHT 20
RUN 10
V/H 1

DATE: 3/25/66
TIME: 0043S
ALTITUDE: 750 ft
SPEED: 450 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site III Village complex and Sampans
WEATHER: Clear
DETECTORS: 5 Ge:Hg

FIGURE 31 - Flight Imagery of the Three IR Systems

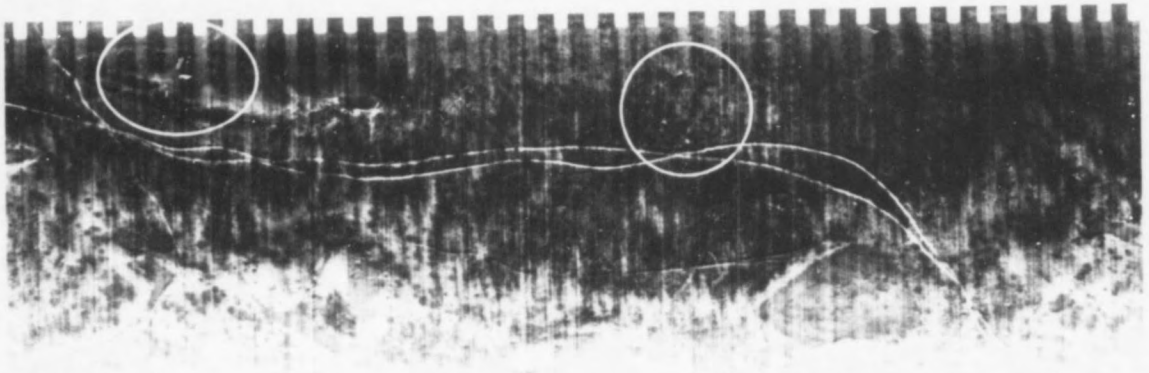


RECONOFAX VI
FLIGHT 14
RUN 6
V/H 0.75

DATE: 3/9/66
TIME: 1656S
ALTITUDE: 670 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: SAM Site
WEATHER: Clear
DETECTORS: 1 Ge:Cu

FIGURE 32 - Flight Imagery of the Three IR Systems



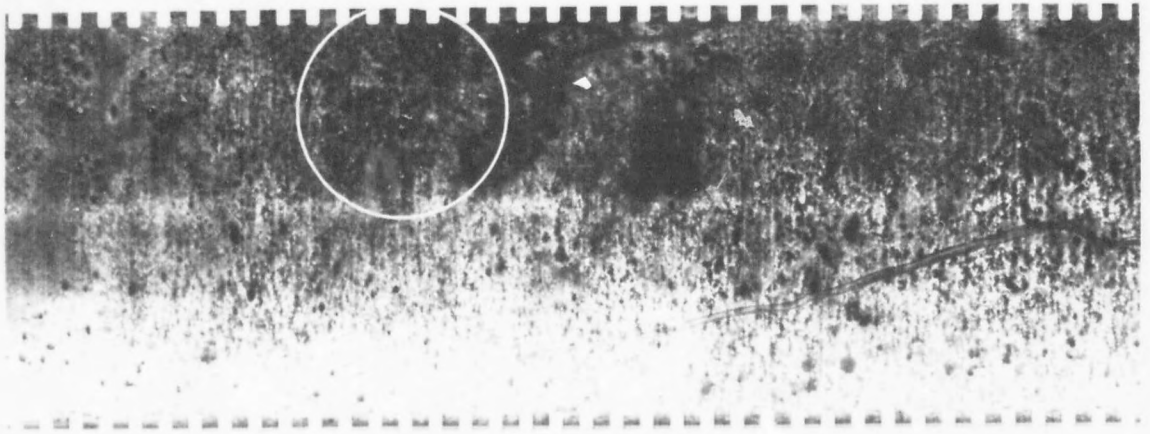
NADC-AE-6718

RECONOFAX VI
FLIGHT 14
RUN 6
V/H 0.75

DATE: 3/9/66
TIME: 1656S
ALTITUDE: 670 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site I Village complex
WEATHER: Clear
DETECTORS: 1 Ge:Cu

FIGURE 33 - Flight Imagery of the Three IR Systems



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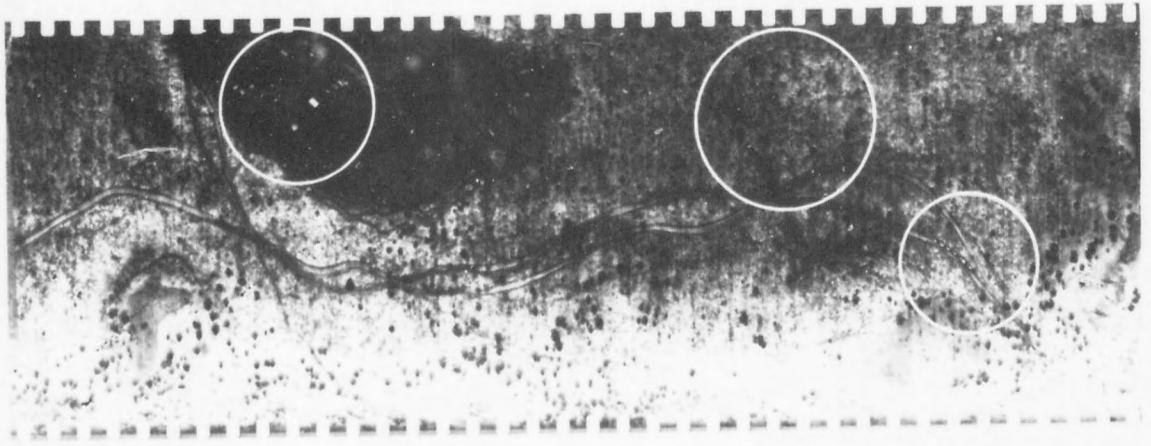
| | | |
|---|---|---|
| RECONOFAX VI | DATE: 3/10/66 | AREA: Eglin Air Force Base, Florida |
| FLIGHT 15 | TIME: 2055S | TARGET: SAM Site |
| RUN 5 | ALTITUDE: 500 ft | WEATHER: Clear, visibility 7 miles |
| V/H 1 | SPEED: 300 kn | DETECTORS: 1 Ge:Cu |

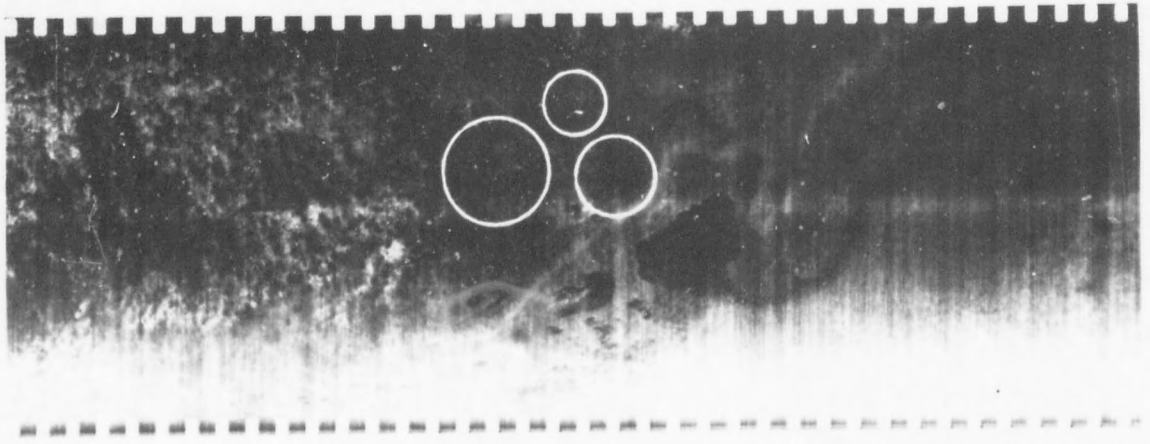
FIGURE 34 - Flight Imagery of the Three IR Systems



NADC-AE-6718

| | | |
|---|---|---|
| RECONOFAX VI | DATE: 3/10/66 | AREA: Eglin Air Force Base, Florida |
| FLIGHT 15 | TIME: 2055S | TARGET: Site I Village complex |
| RUN 5 | ALTITUDE: 500 ft | WEATHER: Clear, visibility 7 miles |
| V/H 1 | SPEED: 300 kn | DETECTORS: 1 Ge:Cu |

FIGURE 35 - Flight Imagery of the Three IR Systems



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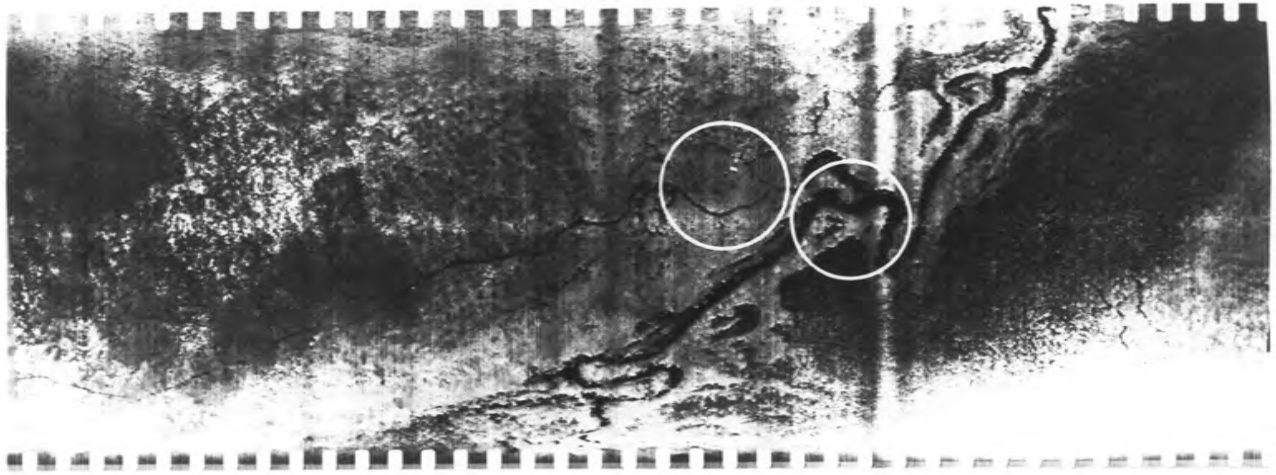
RECONOFAX VI
FLIGHT 18
RUN 7
V/H 1

DATE: 3/23/66
TIME: 1852S
ALTITUDE: 500 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site III Village complex and sampans
WEATHER: 8K broken
DETECTORS: 1 Ge:Cu

FIGURE 36 - Flight Imagery of the Three IR Systems



RECONOFAX VI
FLIGHT 20
RUN 10
V/H 1

DATE: 3/25/66
TIME: 0043S
ALTITUDE: 750 ft
SPEED: 450 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site III Village complex and sampans
WEATHER: Clear
DETECTORS: 1 Ge:Cu

FIGURE 37 - Flight Imagery of the Three IR Systems

Reconofax IX

Figures 7 and 8 - All thermal resolution targets (12 in each direction) can be counted at maximum V/H during the day or night.

Figure 9 - Taxiing aircraft are easily identified at night at a V/H ratio of 2.

Figures 10 and 11 - Day and night presentations at higher than normal altitudes are illustrated.

Figure 12 - Representation of improved sensitivity in flight from NAVAIRDEVCEN to Sanford, Florida, with the use of a new, single, element detector.

Figure 13 - A comparison check of performance with resolution targets at a different location (Eglin Air Force Base) and climate.

Figure 14 - Simulated Vietnam village at site I (light foliage). Huts, firepots, motorized vehicles, horse-drawn carts, and bicycle carts are easily seen; personnel and fox holes, 150 yards to the left and rimming the curved trail, are unidentifiable without prior knowledge of their locations. The same is true for the troop column at the end of this curved trail.

Figure 15 - Simulated SA-2 missile site is easily identified, including SAMS partially covered with foliage.

Figure 16 - Simulated Vietnam village at site III (dense foliage). Sampans along creek are discernible despite overhanging foliage. The fire pots about the village, and larger metal-roofed huts are detectable.

Figure 17 - Compares night flight over Aberdeen's static display of tanks and armored vehicles with previous day flight (figure 23). Site IV area was not available.

Figure 18 - Night photograph of the Fort Belvoir runway and hangar area with an assortment of light aircraft and helicopters and, interestingly, a steam line running under concrete from the hangar runway area to other buildings.

Figure 19 - Pontoon bridge building complex at Fort Belvoir. A new single-element detector was used in place of the seven-element array (figures 17, 18, and 19).

Because the contractor indicated that the copper-doped germanium detector array had insufficient thermal sensitivity, 12 additional flights of the Reconofax IX, with a new detector array (mercury-doped germanium) were conducted over NAVAIRDEVCEN and Eglin Air Force Base. The evaluation of these flights appears in appendix D.



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AN/AAS-10

Figures 20, 21, and 22 - Alternate flights over the Johnsville-Philadelphia area to supplement those cancelled because of bad weather. Figure 20 shows the mothball fleet at aircraft altitudes of 2000 feet. It is interesting to note that the arresting gear cables on the stern of the aircraft carrier Shangri-La can be counted. Figure 21 shows part of the NAF Johnsville area, hangar area, and a steam line (under concrete) running from the hangar area to the laboratory area at NAVAIRDEVCEN.

Figure 23 - Thermal resolution targets (hot and cold), gray scale and edge patterns seen at site IV.

Figure 24 - Tanks and tank tracks are visible throughout the entire area.

Figures 25a, 25b, 26a, and 26b - Thermal resolution targets during day and night operations.

Figure 27 - Although V/H was 4 times greater than the design parameter, resulting in compressed imagery, the runway number is distinguishable.

Figure 28 - All SAMS are easily detected, even those partially covered with foliage.

Figure 29 - Night imagery over site I for comparison with day imagery of same site (figure 14).

Figure 30 - Site II, simulated Vietnam village (medium foliage). Fire pots, large huts, and vehicles are easily detected. Horse-drawn carts, bicycle carts, small huts, fox holes, and troop columns are not discernible.

Figure 31 - Same flight run as figures 16 and 37.

Reconofax VI

Figures 32, 33, 34, and 35 - Compares day and night imagery obtained at site I.

Figure 36 - Presents a dusk flight over site III.

Figure 37 - Night imagery obtained over site III. Same flight run as figures 16 and 31.

SUMMARY OF RESULTS

1. Thermal sensitivity could not be calculated because of the coarse temperature differentials of the thermal targets.

2. Target imagery, used to calculate angular resolution, reveals a 1/3 mr to 1/2 mr loss of resolution caused by film duplication.

3. Operating tanks, armored vehicles, and trucks can be detected from an aircraft altitude of 2000 feet and identified from 1000 feet.

4. Horse drawn carts and bicycle carts can be detected from 750 feet and identified from 500 feet.

5. Large huts with metal roofs can be detected from aircraft altitudes of 2000 feet; small huts with thatched roofs are detectable from 750 feet.

6. Fire pots, sampans, and trails can be detected from aircraft altitudes of 2000 feet.

7. A troop column can be detected from aircraft altitudes of 500 feet.

8. Missile sites can be detected from aircraft altitudes of 1000 feet and identified at 500 feet.

The observations on the various types of targets are given with the understanding that foliage covering is light. When there is heavy foliage coverage, as at site III, Eglin Air Force Base, only the large huts with metal roofs, sampans, fire pots, and large vehicles (running) are detected.

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# APPENDIX A

## AIRCRAFT INSTALLATION

Aircraft modifications and installation mounts for the AN/AAS-10(XE-1) and the Reconofax IX infrared mapping systems in an RA-3B aircraft were completed on schedule at the NAVAIRDEVCEN. On 6 December 1965 an aerodynamic and safety test flight of the aircraft demonstrated that the performance of the aircraft was not affected by the modifications.

The Reconofax IX was installed in the aircraft on 5 January 1966 after HRB-Singer, Incorporated engineers performed a laboratory check-out of the equipment and instructed U. S. Navy crewmen on its inflight operation. Three checkout flights were conducted during 7-10 January 1966.

On 12 January 1966, the RA-3B aircraft was flown to NAS, Dallas, Texas, for the installation of the AN/AAS-10(XE-1). Texas Instruments, Incorporated personnel briefed the U. S. Navy crewmen on the inflight operation of this system and installed the equipment. A checkout flight was conducted 14 January 1966, and the aircraft returned to NAVAIRDEVCEN on 15 January 1966.

A modified Reconofax VI mapping set, was acquired in late September 1965. Installation provisions for the modified Reconofax VI were made in the after-section of the aircraft in the position normally occupied by the AN/ARN-6 low-frequency radio compass antenna. The Reconofax VI was installed on 7 February 1966, and a checkout flight conducted on 10 February 1966.

Figures A-1 through A-6 show the aircraft installation of the AN/AAS-10(XE-1) and the Reconofax IX. Figures A-7 and A-8 illustrate the Reconofax VI installation.

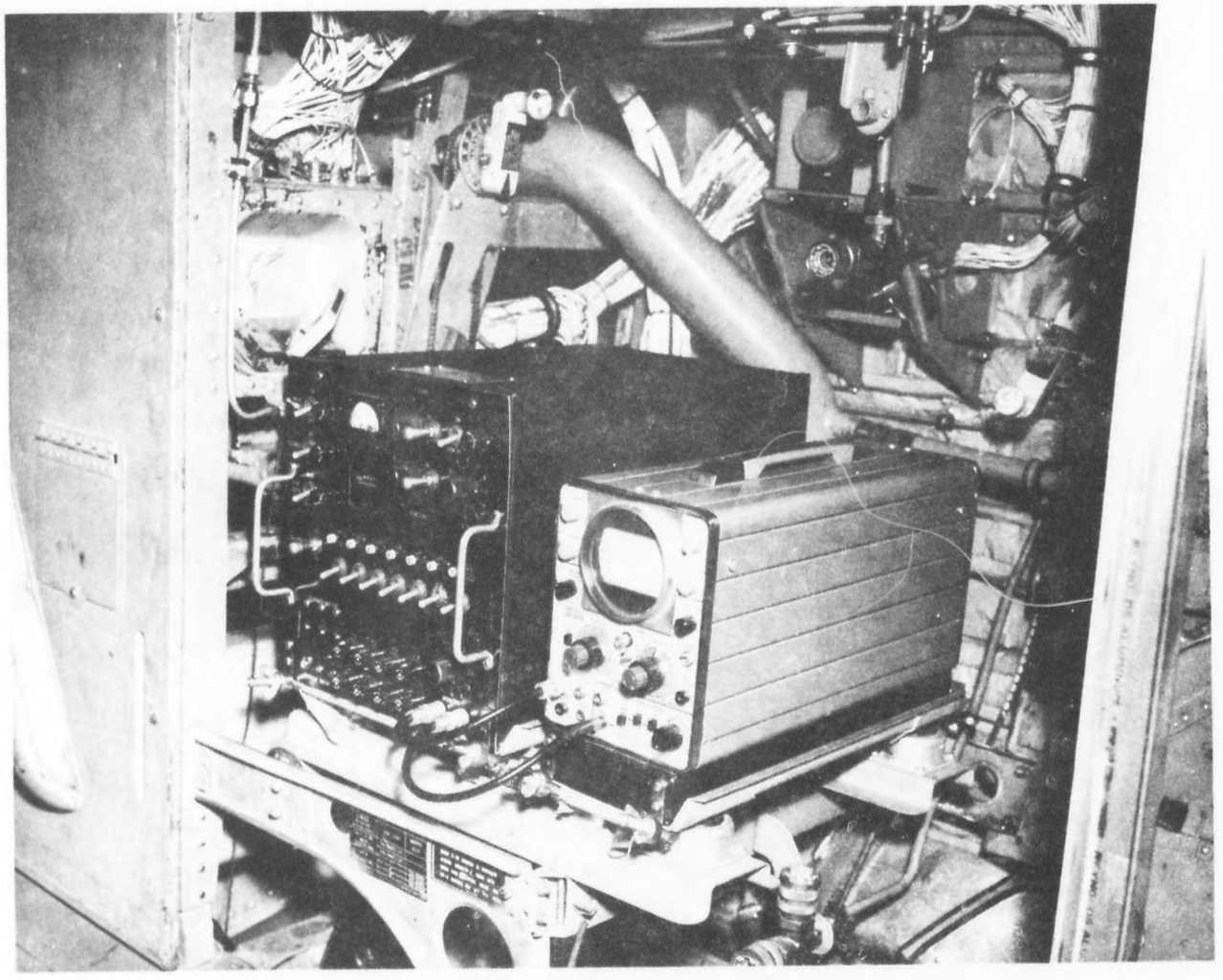

FIGURE A-1 - Reconofax IX Control Unit and Monitor Oscilloscope in Aircraft

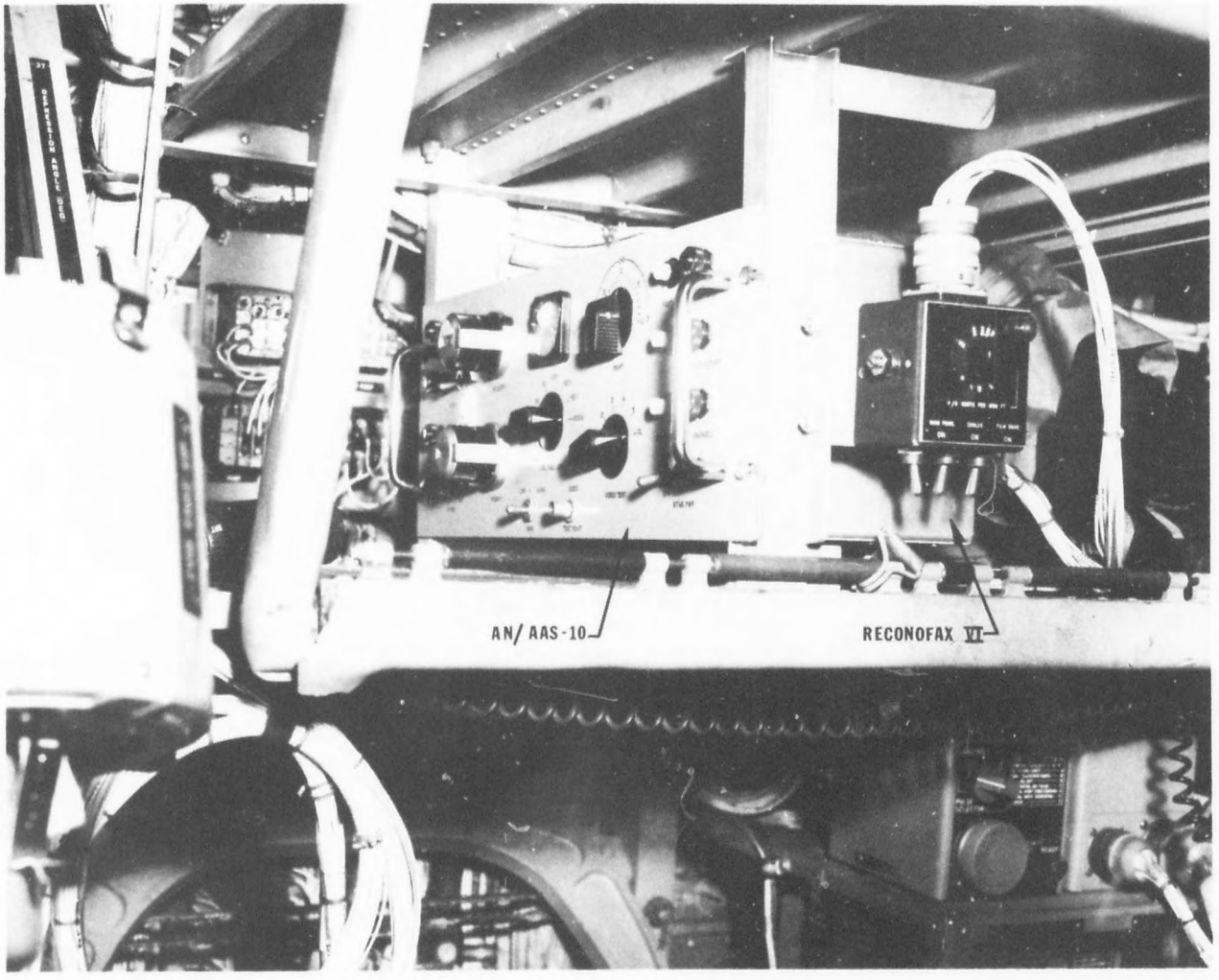


FIGURE A-2 - AN/AAS-10 and Reconofax VI Control Panels in Aircraft

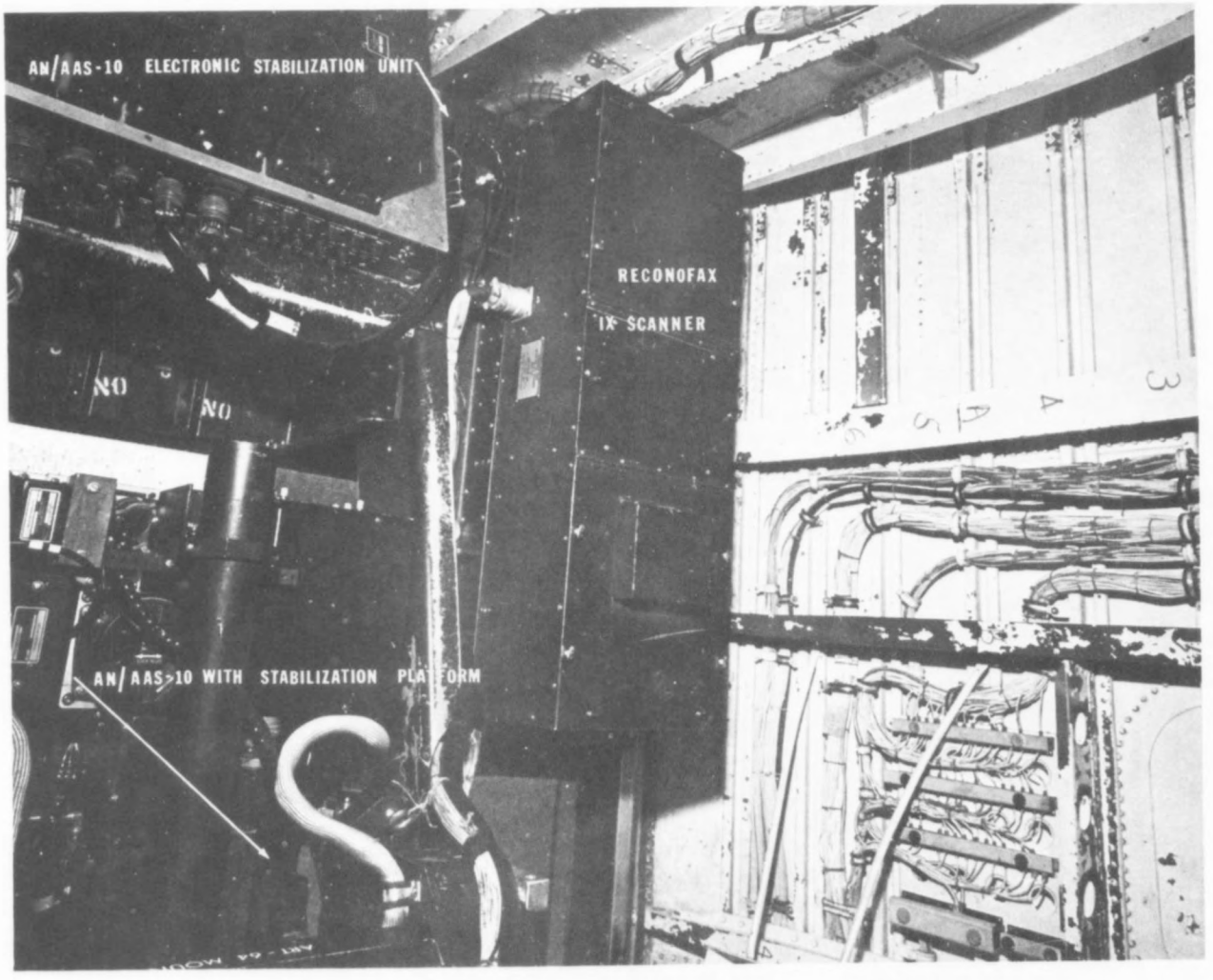


FIGURE A-3 - Reconofax IX and AN/AAS-10 in Aircraft Bomb Bay

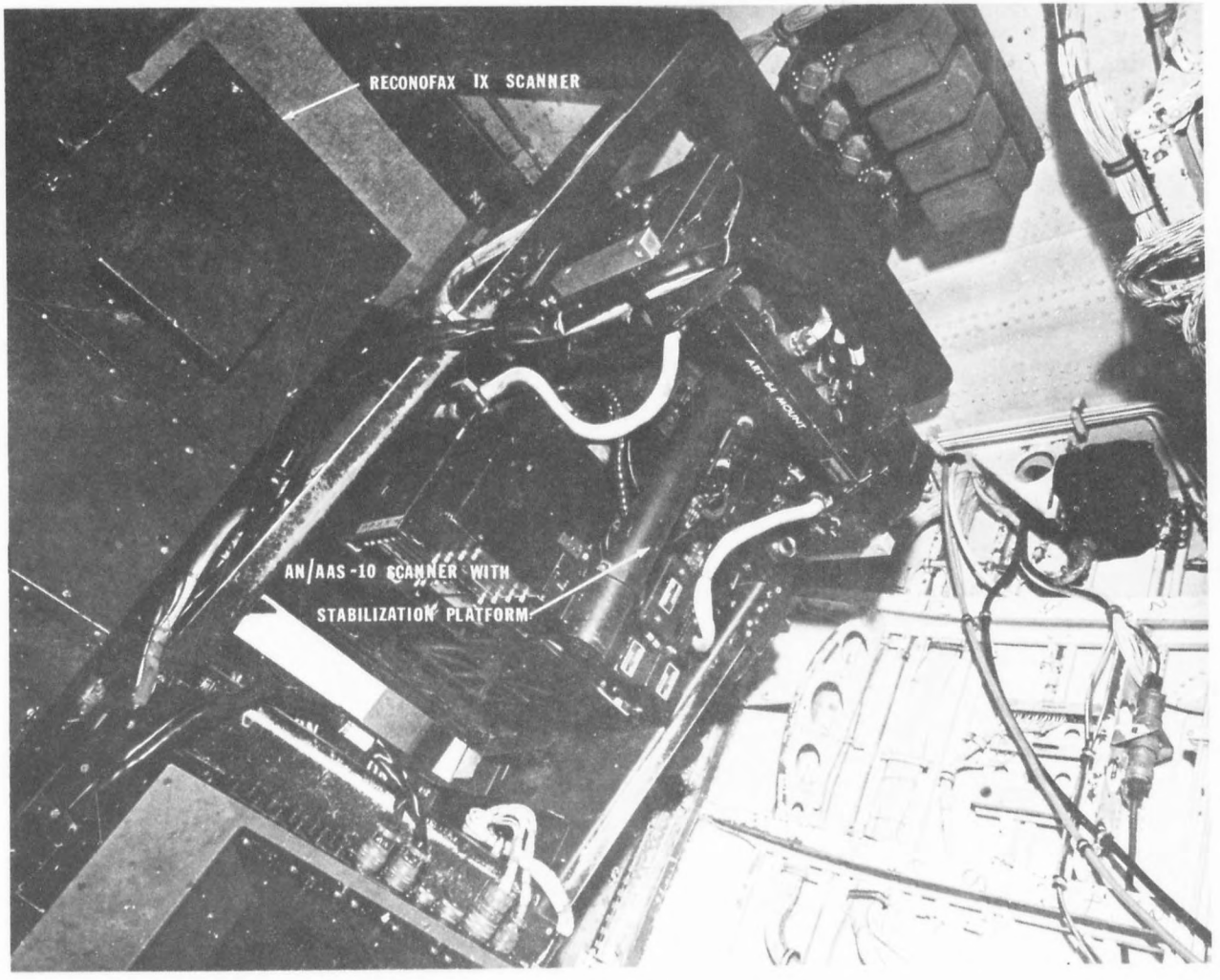


FIGURE A-4 - AN/AAS-10 and Reconofax IX in Aircraft Bomb Bay

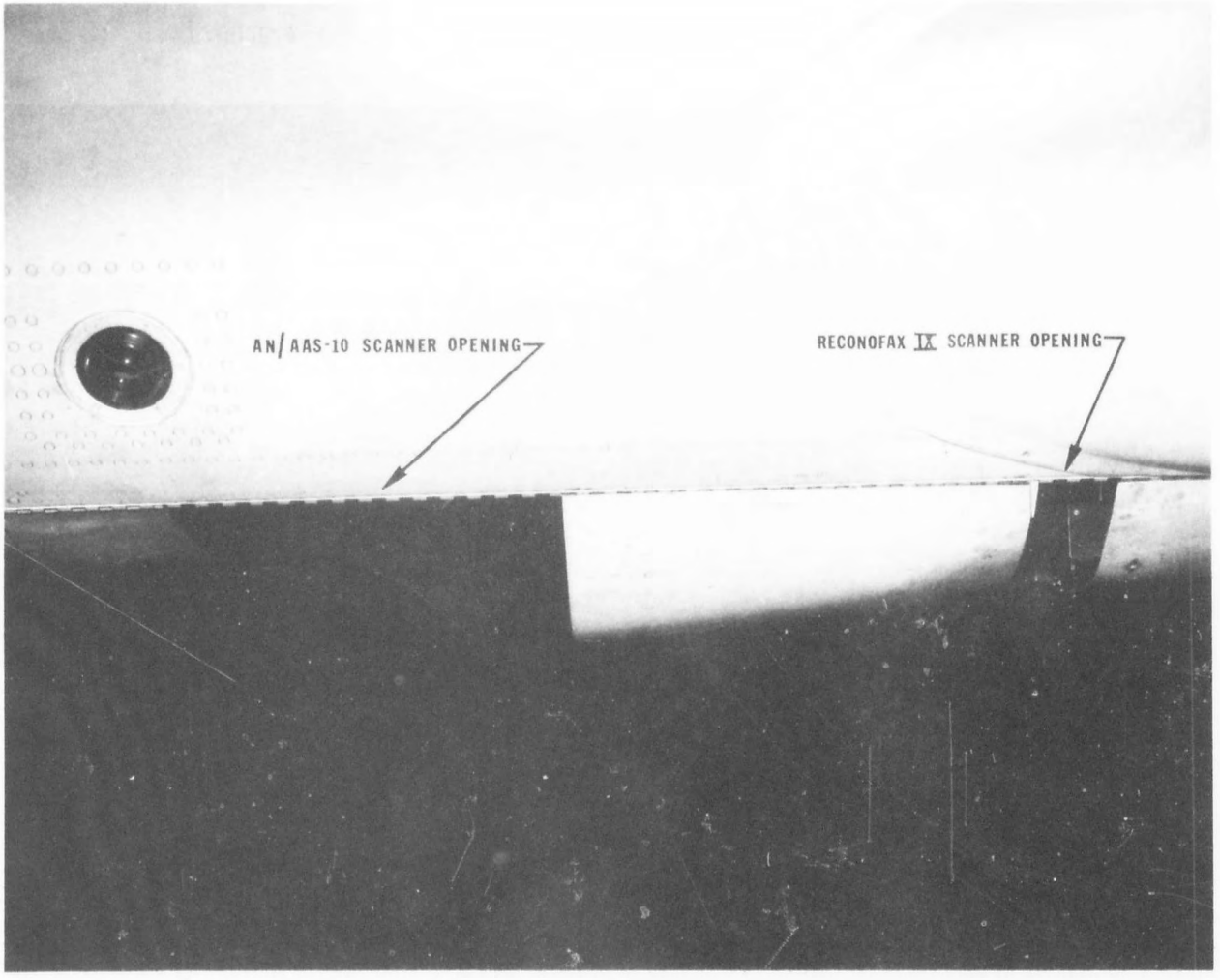


FIGURE A-5 - Modified Fairings and Openings in Aircraft Bomb Bay for IR Sets

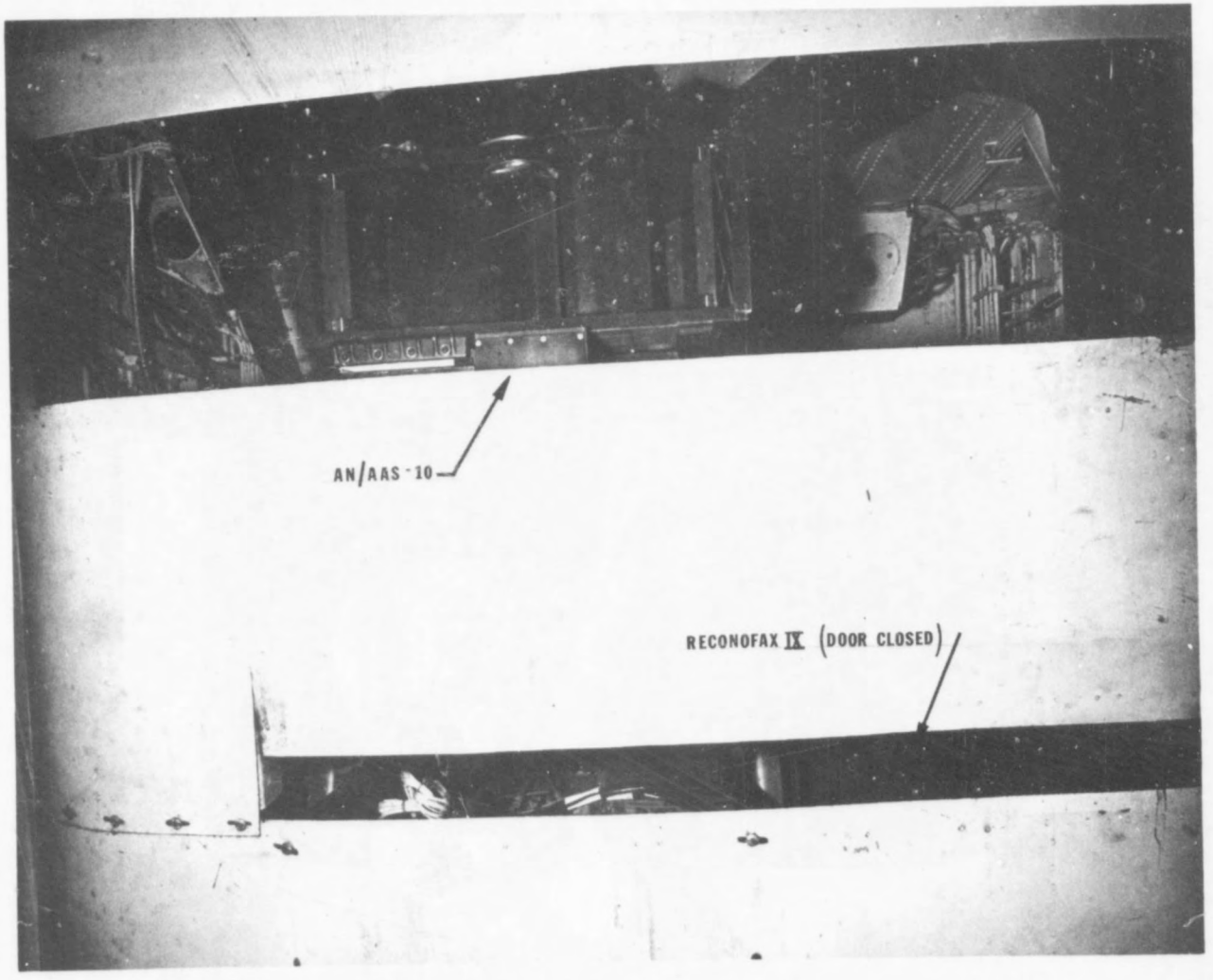


FIGURE A-6 - Underside View of Aircraft Bomb Bay Showing Openings for IR Sets

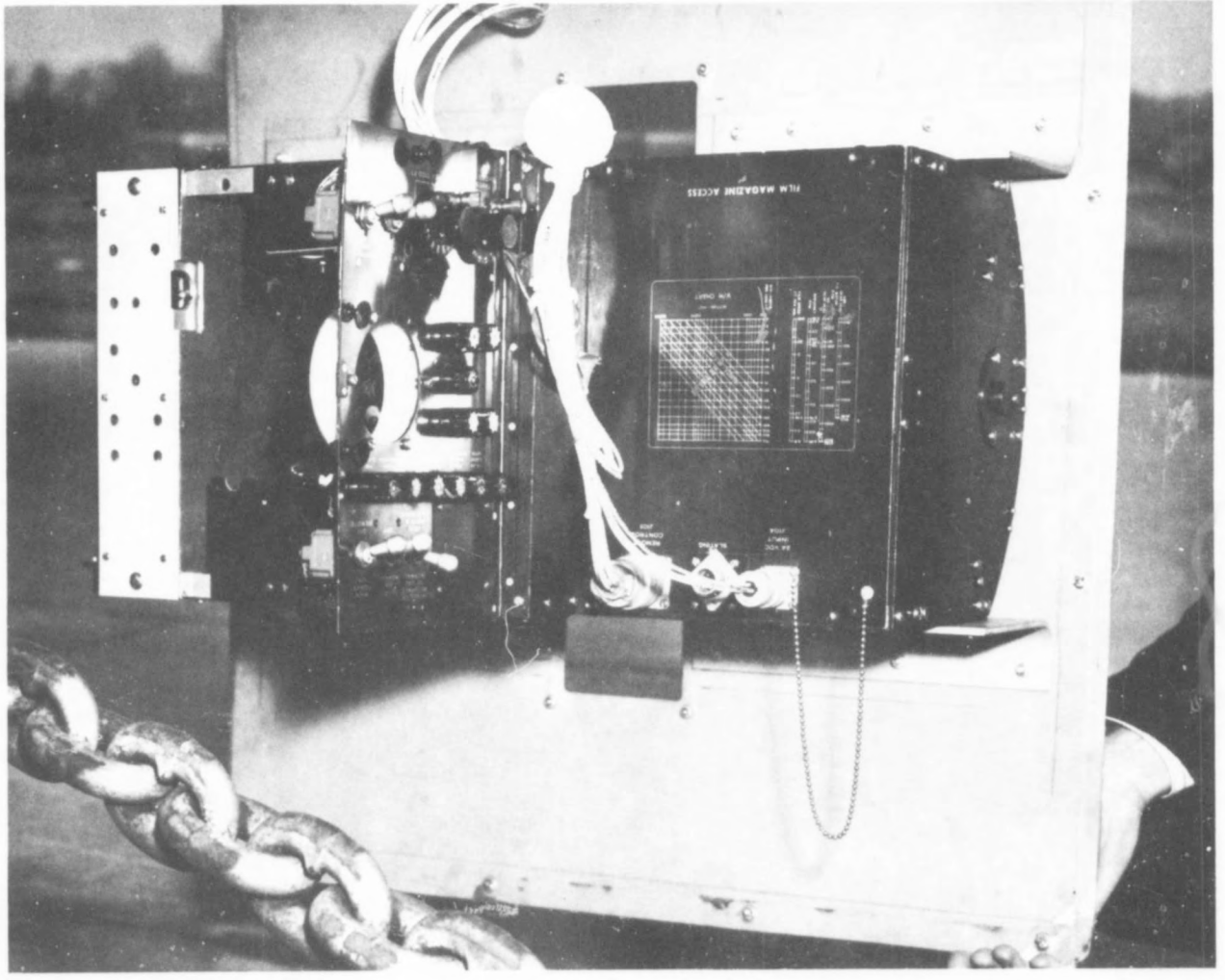

FIGURE A-7 - Reconofax VI Mounted on Aft Access Door of Aircraft
(Detector Dewar Removed and Door Opened)

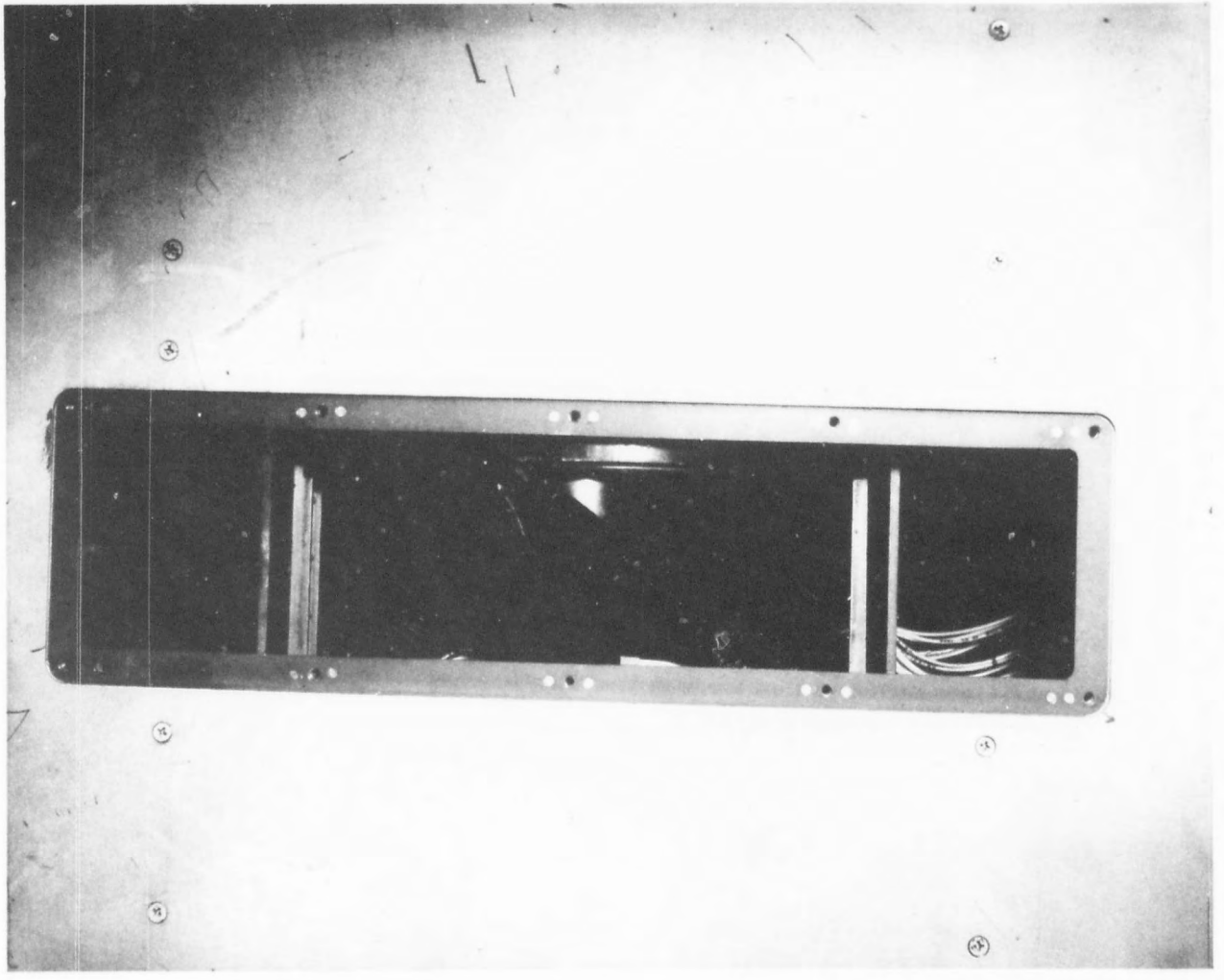

FIGURE A-8 - Underside View of Closed Access Door Showing Opening for Reconofax VI Scanner





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# A P P E N D I X B

## FLIGHT EXERCISES AND COMMENTARY

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Table B-I catalogues the date, flight time, target sites, and operating systems on the 28 "JANE TEN" flights conducted during January-March 1966 (including six checkout flights). The 22 test flights consisted of 1 dusk flight, 8 night flights, and 13 day flights; the check-out flights consisted of 1 night flight and 5 day flights.

Deficiencies encountered during the 22 test flights are summarized chronologically for the three infrared mapping systems.

Reconofax IX

Flights 1 through 4 - Loss of stabilization was caused by malfunction of reference coil in servo drive unit controlling mechanical linkages to stabilization platform. (Problem corrected for remaining flights.)

Flight 6 - Replaced Royal Pan film with Kodak 2475. (Marked improvement in processed film apparent.)

Flight 7 - Under-developed film - caused by impurities in the chemical mix and insufficient hot water at Wright-Patterson Air Force Base.

Flights 12 and 13 - Partial loss of imagery was caused by intermittent loss of video. (Ground short in insulation wire controlling +20 volts in scanner unit replaced.) Installed electric heaters in magazine before flight 14.

Flight 14 - Washed-out imagery resulted from misadjustment of detector(s) operation.

Flight 15 - Detectors were "inactive" because the detector dewar was not filled completely with liquid helium.

Flight 16 - Results obtained were good. Magazine pressure marks still present on imagery despite the installation of electric heaters in the magazine.

Flight 17 - Detectors became inactive after two target runs. (Replaced dewar because of suspected thermal leak. Also replaced three glow tubes.)

Flight 19 - Results were good despite the lack of automatic changing of the d-c level on cell No. 7 caused by a disengaged bound clutch in the d-c servo unit.

Flight 22 - A single element detector dewar, with a hold-time of 2 hours, did not permit the scheduled runs over the Washington, D. C. area.

AN/AAS-10(XE-1)

Flight 3 - Good imagery was obtained despite a bad glow tube. (Glow tube was replaced.)

Flight 4 - Lost two runs because of temperature instability of the drag switch controlling the magazine take-up reel. After this flight, the four microscope objective lenses were adjusted to maximize the recorder resolution. A vacuum leak in the closed-cycle cooler was repaired.

Flight 6 - Intermittent gating, caused by arcing in a glow tube, was observed in the film imagery.

Flight 7 - No imagery was obtained because the V/H control wire, linking the control unit with the scanner unit, was broken.

Flight 10 - Partial loss of imagery resulted from a bad glow tube. Excessive noise in one operating channel was caused by a defective capacitor (vibration breakdown) in the preamplifier.

Flight 11 - Transistor failure in the driver amplifier circuit (caused by a bad glow tube) resulted in the loss of several runs.

Flights 12 and 13 - Equipment was not operated because of suspected slippage of the banding filters in the optical system.

Flight 18 - Bad glow tubes permitted only one acceptable run.

Flight 19 - Bad glow tubes permitted only three acceptable runs.

Flight 20 - The film exhibited too little contrast caused by insufficient light from the glow tubes.

Flight 22 - A magazine jam caused the loss of two runs over Washington, D. C. area.

Reconofax VI

Flights 1 through 6 - Equipment was not installed in the aircraft.

Flights 7 through 13 - (before debugging) - Imagery obtained included the following faults: improper focus, faulty stabilization, ramping, striations caused by nonuniform film drive, and ineffective AGC.

Flights 14 through 22 - (after debugging) - Good results were achieved, and not a single target run was lost because of mechanical and/or electrical problems. Film imagery showed slightly too much contrast.



[redacted]

T A B L E B - I

INFRARED FLIGHT TEST PROGRAM SUMMARY

| Flt No. | Date | Time (Approx) | Sites | EQUIPMENTS OPERATING | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reconofax IX | AN/AAS-10 | Reconofax VI | Camera |
| C-1 | 7 Jan 66 | 1000-1200 | Phila., parts of Del., Md. & N.J., NAVAIRDEVCEN | x | | | |
| C-2 | 7 Jan 66 | 1745-1945 | Same | x | | | |
| C-3 | 10 Jan 66 | 1200-1400 | WPAFB | x | | | |
| C-4 | 14 Jan 66 | 1100-1200 | Dallas, Texas | | x | | |
| 1 | 20 Jan 66 | 1400-1600 | Phila., Lakehurst, NAVAIRDEVCEN | x | x | | KA-45 |
| 2 | 20 Jan 66 | 1800-2000 | Same | x | x | | |
| 3 | 21 Jan 66 | 1400-1600 | Same | x | x | | KA-45 |
| 4 | 24 Jan 66 | 1800-2100 | WPAFB | x | x | | |
| 5 | 3 Feb 66 | 1430-1730 | Aberdeen Proving Ground | x | x | | |
| 6 | 4 Feb 66 | 1230-1400 | Same | x | x | | KA-62 |
| C-5 | 10 Feb 66 | 1400-1500 | NAVAIRDEVCEN | | | x | |
| 7 | 12 Feb 66 | 1400-1600 | WPAFB | x | x | x | |
| 8 | 15 Feb 66 | 1300-1600 | Fort Knox & WPAFB | x | x | x | |

TABLE B-I (continued)

| Flt No. | Date | Time (Approx) | Sites | EQUIPMENTS OPERATING | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reconofax IX | AN/AAS-10 | Reconofax VI | Camera |
| 9 | 15 Feb 66 | 1900-2100 | WPAFB | x | x | x | |
| 10 | 17 Feb 66 | 1400-1600 | Same | x | x | x | |
| 11 | 17 Feb 66 | 1900-2100 | Same | x | x | x | |
| 12 | 18 Feb 66 | 1345-1500 | Same | x | | x | |
| 13 | 18 Feb 66 | 1800-2000 | Fort Knox & WPAFB | x | | x | |
| C-6 | 5 Mar 66 | 1300-1500 | NAVAIRDEVCEN to NAS Sanford | x | x | x | |
| 14 | 9 Mar 66 | 1630-1930 | Eglin AFB, Simulated Vietnam villages | x | x | x | |
| 15 | 10 Mar 66 | 2000-2330 | Same | x | x | x | |
| 16 | 11 Mar 66 | 1115-1515 | Same | x | x | x | |
| 17 | 17 Mar 66 | 1200-1415 | Same | x | x | x | |
| 18 | 23 Mar 66 | 1800-2100 | Same | x | x | x | |
| 19 | 24 Mar 66 | 1630-1915 | Same | x | x | x | |
| 20 | 25 Mar 66 | 0000-0300 | Same | x | x | x | |

TABLE B-I (continued)

| Flt No. | Date | Time (Approx) | Sites | EQUIPMENTS OPERATING | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reconofax IX | AN/AAS-10 | Reconofax VI | Camera |
| 21 | 28 Mar 66 | 1200-1430 | APG, Ft. Belvoir, Washington, D.C. | x | x | x | |
| 22 | 29 Mar 66 | 2000-2245 | Same | x | x | x | |

Flights C-1 through C-6 were equipment checkout flights





[redacted]

# APPENDIX C

## TARGET SITES

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

The following target sites were selected for the evaluation program:

NAVAIRDEVCEN

Wright-Patterson Air Force Base

Aberdeen Target Range

Eglin Air Proving Ground

### NAVAIRDEVCEN

A variety of targets, utilized to determine the inflight spatial and thermal resolutions of infrared mapping systems, was placed adjacent to the runway. These targets included:

1. Two rows of blackened 300-watt light bulbs placed perpendicular to each other. The distances between the bulbs were not uniform.

2. A large photo-resolution chart

3. A 12 x 12-inch extended area, temperature controlled black body source

4. A dual-control electric blanket

5. An array of plywood panels of various sizes blackened on one side and aluminized on the other. For daytime operations, the blackened surfaces were placed up; for nighttime operations, the aluminized surfaces were exposed. These panels were spaced on the airfield at intervals equal to their widths, providing an array of grassy sections and blackened or aluminized sections.

### Wright-Patterson Air Force Base

This site was chosen because of the multisensor target range available at Wright field. Layout of the thermal, geodetic, and resolution target arrays, together with the photographic edge, thermal resolution, high-to-low contrast, and gray scale target arrays are shown in figure C-1a. High V/H flights were permitted over Patterson Field only and the portable thermal resolution targets were located as shown in figure C-1b. Detailed descriptions of the multisensor target range at Wright-Patterson Air Force Base are given in Technical Report AFAL-TR-266.

Aberdeen Target Range

The Aberdeen target range consisted of four areas - outlined in figure C-2. Site I (along Access road) was an ordnance museum display of tanks and self-propelled guns, approximately 45 items. Site II was an ordnance museum display of foreign equipment, approximately 30 tanks and 45 field artillery pieces. Site III was an ordnance museum display of field artillery and missiles, approximately 34 items. Site IV was a special display of current equipment (approximately 37 items) including tanks, armored personnel carriers, field artillery, and rocket launchers. The latter site was most important because many motorized vehicles were operating, and it contained hot and cold resolution targets, gray scale, and edge targets.

Eglin Air Proving Ground

The target arrays at Eglin Air Proving Ground included three simulated Vietnam villages under varying degrees of terrain cover, a simulated Soviet SA-2, a surface-to-air missile complex, and sampans in nearby rivers. The targets were moved and/or changed once per week. The operation schedule of the sites were:

Site I (figure C-3a) - active 7-11 March 1966 (sparsely covered terrain)

Site II (figure C-3b) - active 14-18 March 1966 (medium covered terrain)

Site III (figure C-3c) - active 21-25 March 1966 (heavy covered terrain)

The simulated Vietnam villages included huts with metal, canvas, and thatched roofs; personnel, carts, bicycles, fire pots, fox holes, mortars, horses, and vehicle convoys. In addition, optical and infrared resolution targets were placed near the target area.



[redacted]

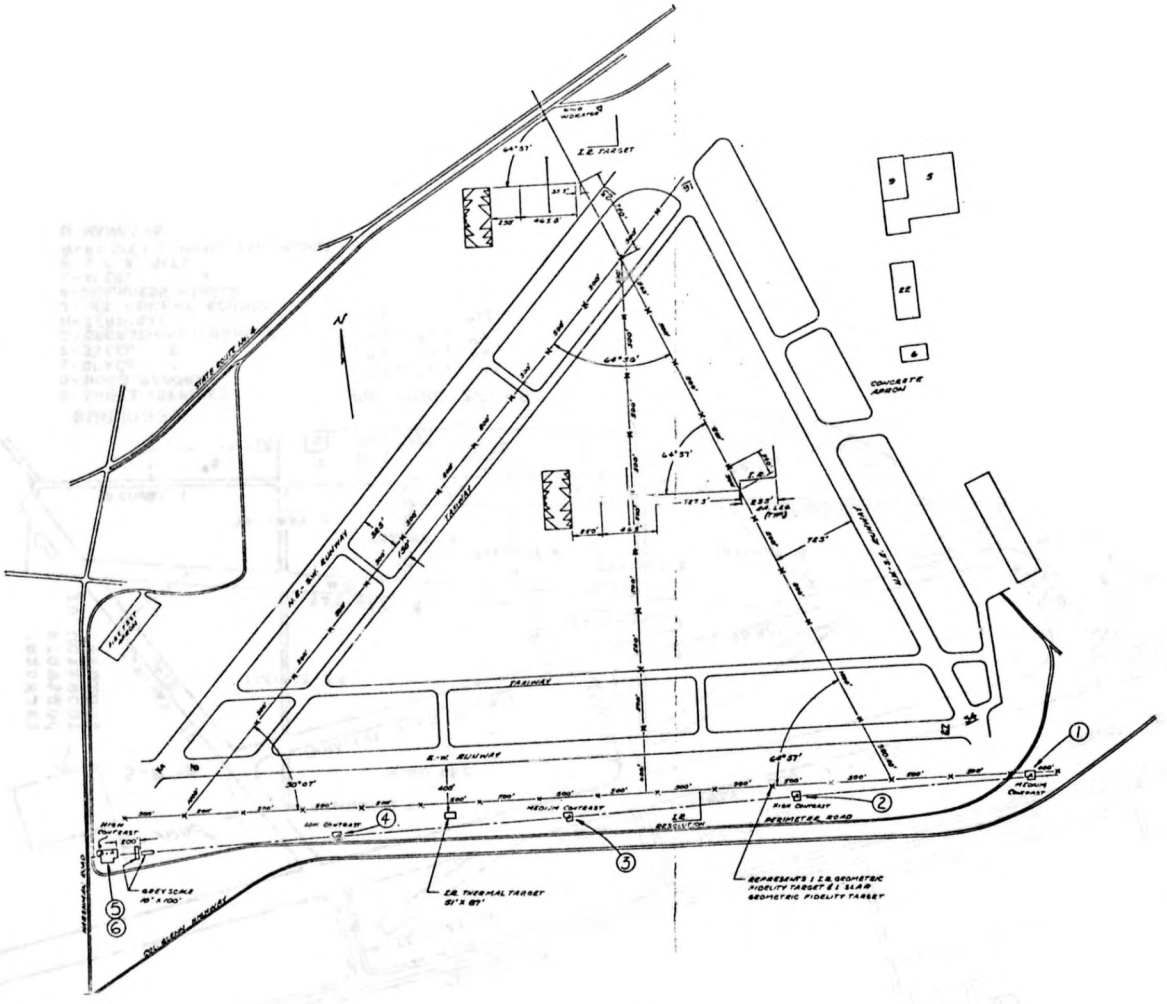
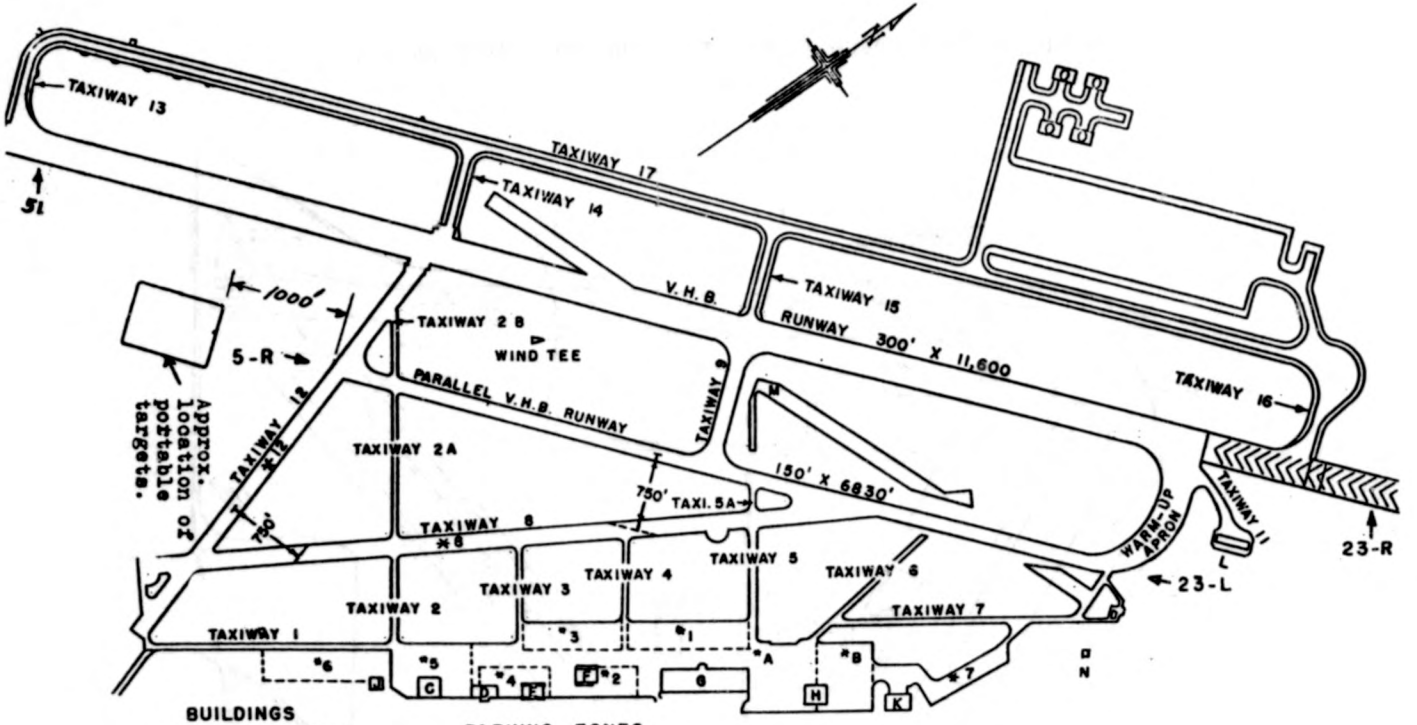



FIGURE C-1a - Wright Field Multisensor Target Range


TAXIWAY 13
TAXIWAY 17
TAXIWAY 14
51
1000'
V. H. B.
TAXIWAY 15
TAXIWAY 2 B
WIND TEE
RUNWAY 300' X 11,600
5-R
PARALLEL V.H.B. RUNWAY
TAXIWAY 9
TAXIWAY 16
Approx. location of pottable targets.
TAXIWAY 12
TAXIWAY 2A
150' X 6830'
750' TAXI. 5A
750'
TAXIWAY 11
TAXIWAY 8
WARM-UP APRON
23-R
TAXIWAY 5
TAXIWAY 4
TAXIWAY 6
TAXIWAY 3
23-L
TAXIWAY 2
TAXIWAY 7
TAXIWAY 1
BUILDINGS
C- SHOPS, -OFFICES
D- WOOD HANGAR
E- BLACK "
F- STEEL "
G- OPERATIONS, - HANGAR
H- TERMINAL
J- INSTRUMENT SCHOOL
K- READINESS HANGAR
L- ALERT "
M- G. C. A. SITE
N- ROCKET STORAGE CHECK-OUT
O- HANGARS
PARKING ZONES
*A, *B, *1,
*2, *3, *4,
*5, *6, *7,
*8 *12

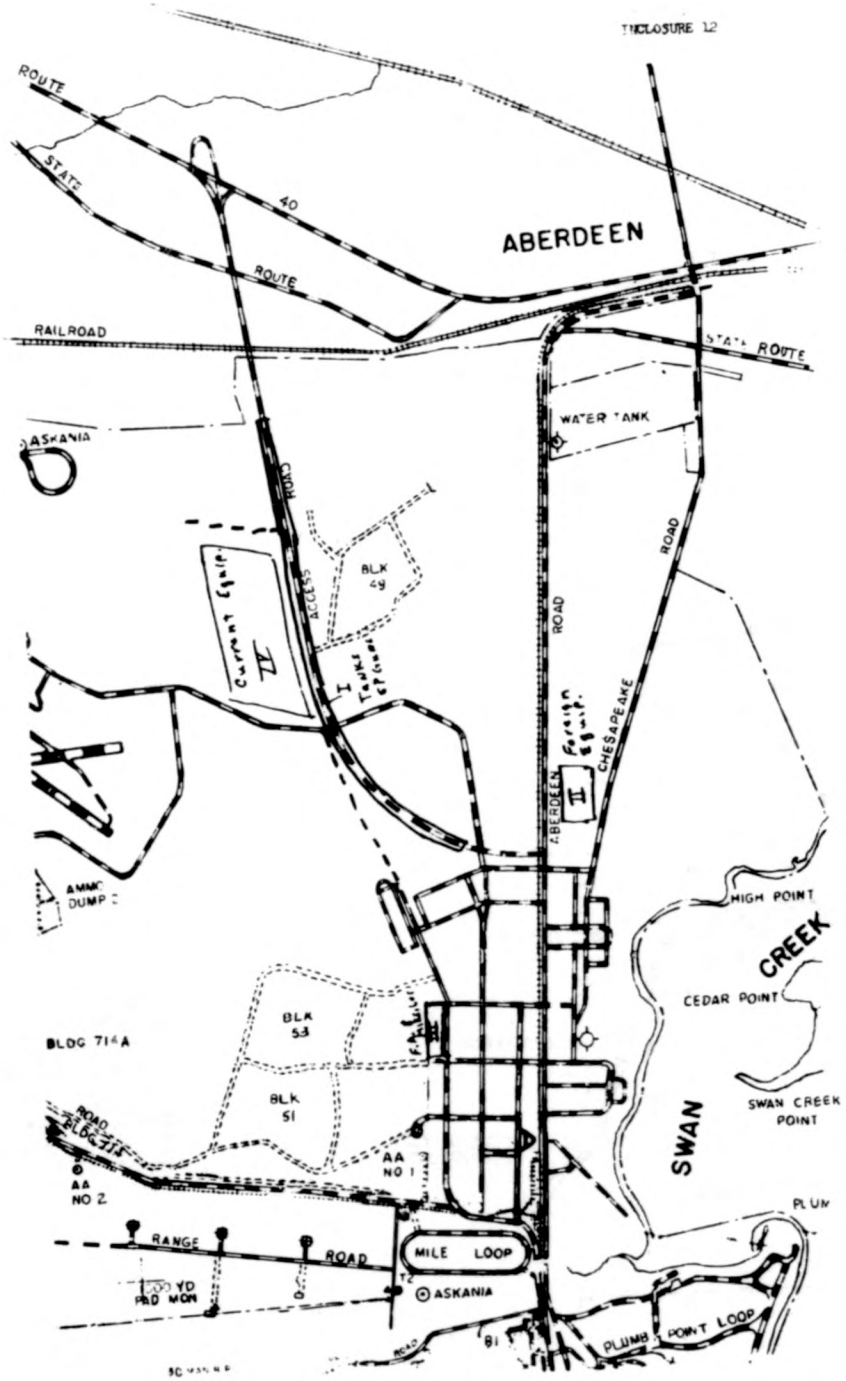



FIGURE C-2 - Location of Four Test Sites at Aberdeen Proving Ground

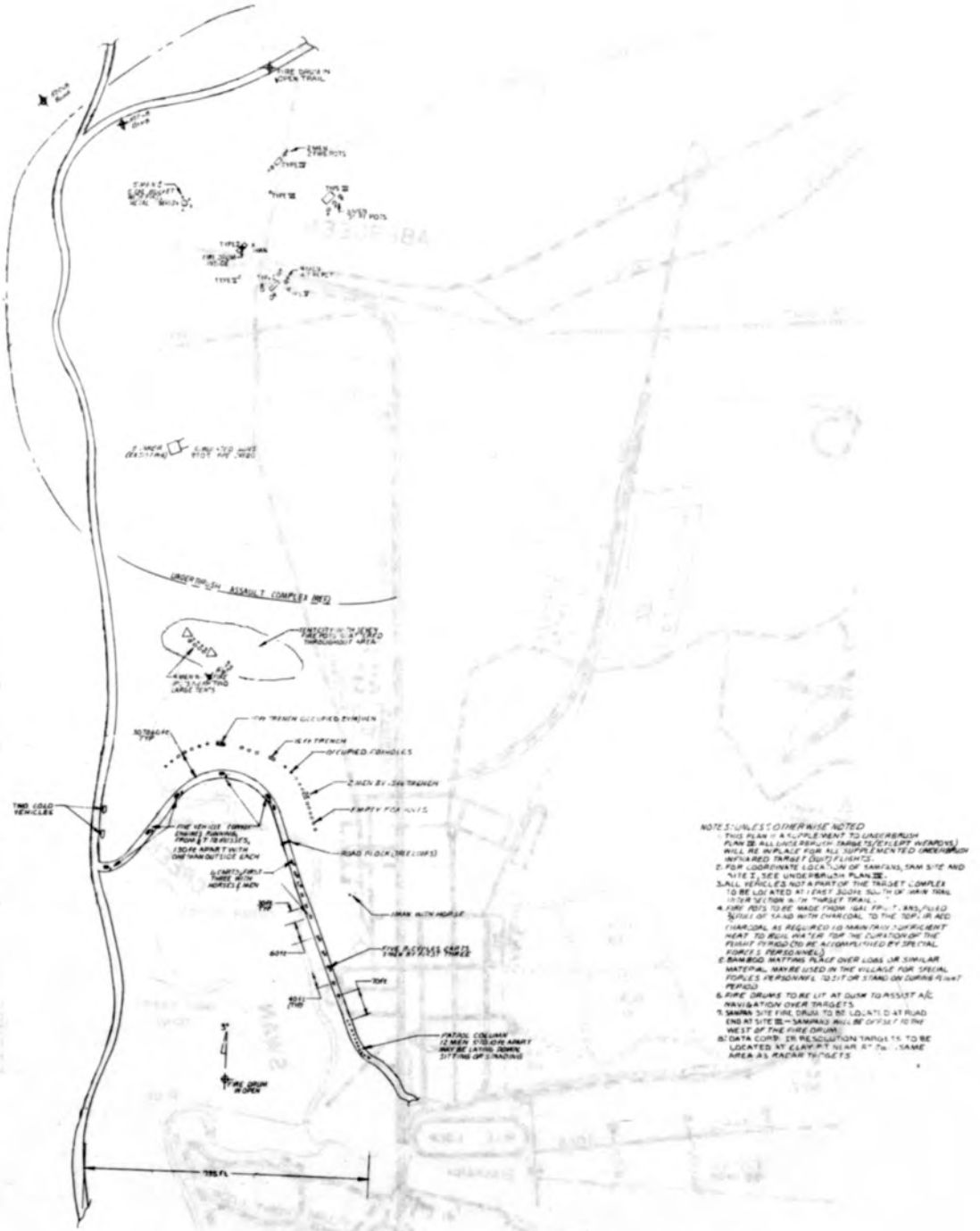
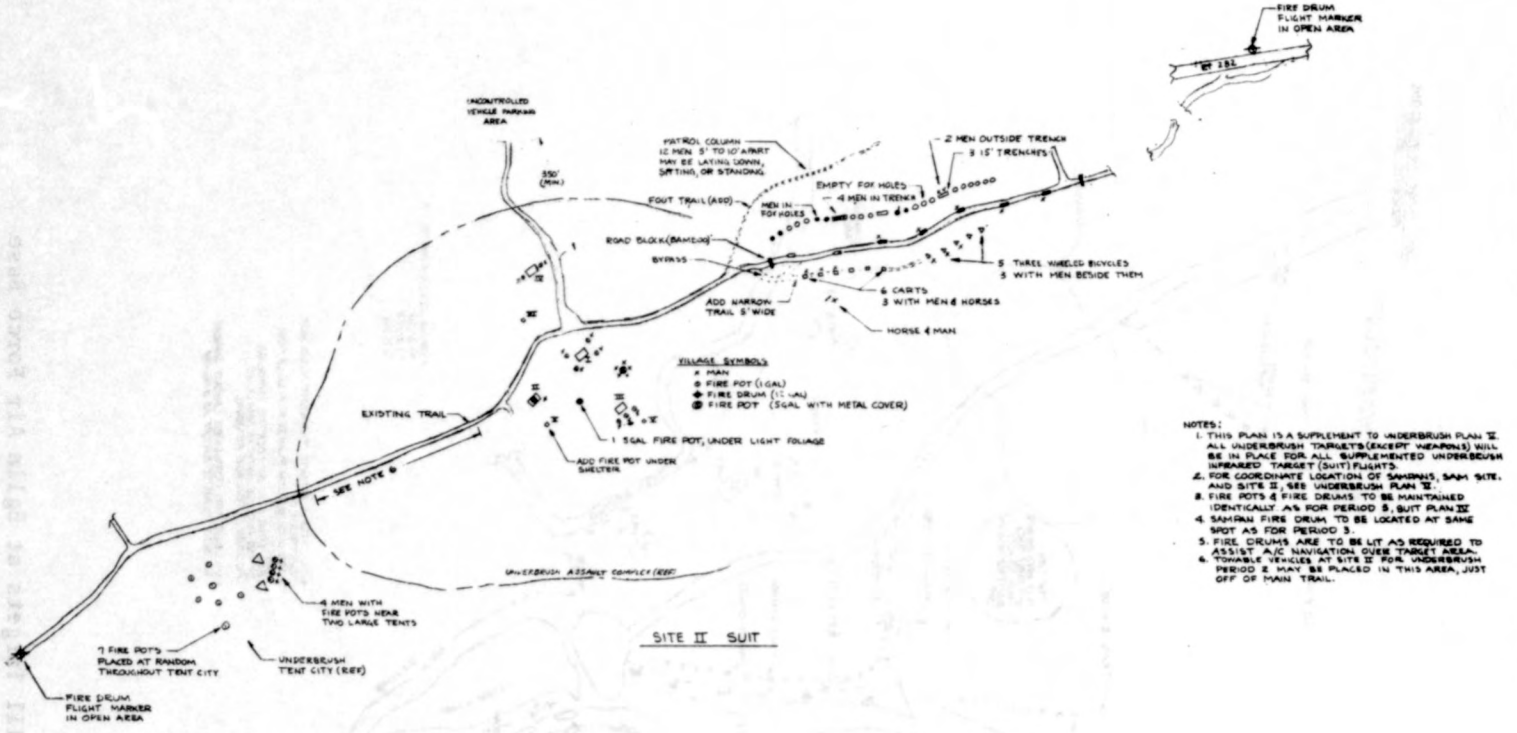


FIGURE C-3a - Site I Target at Eglin Air Force Base




C-3b

FIGURE C-3b - Site II Targets at Eglin Air Force Base

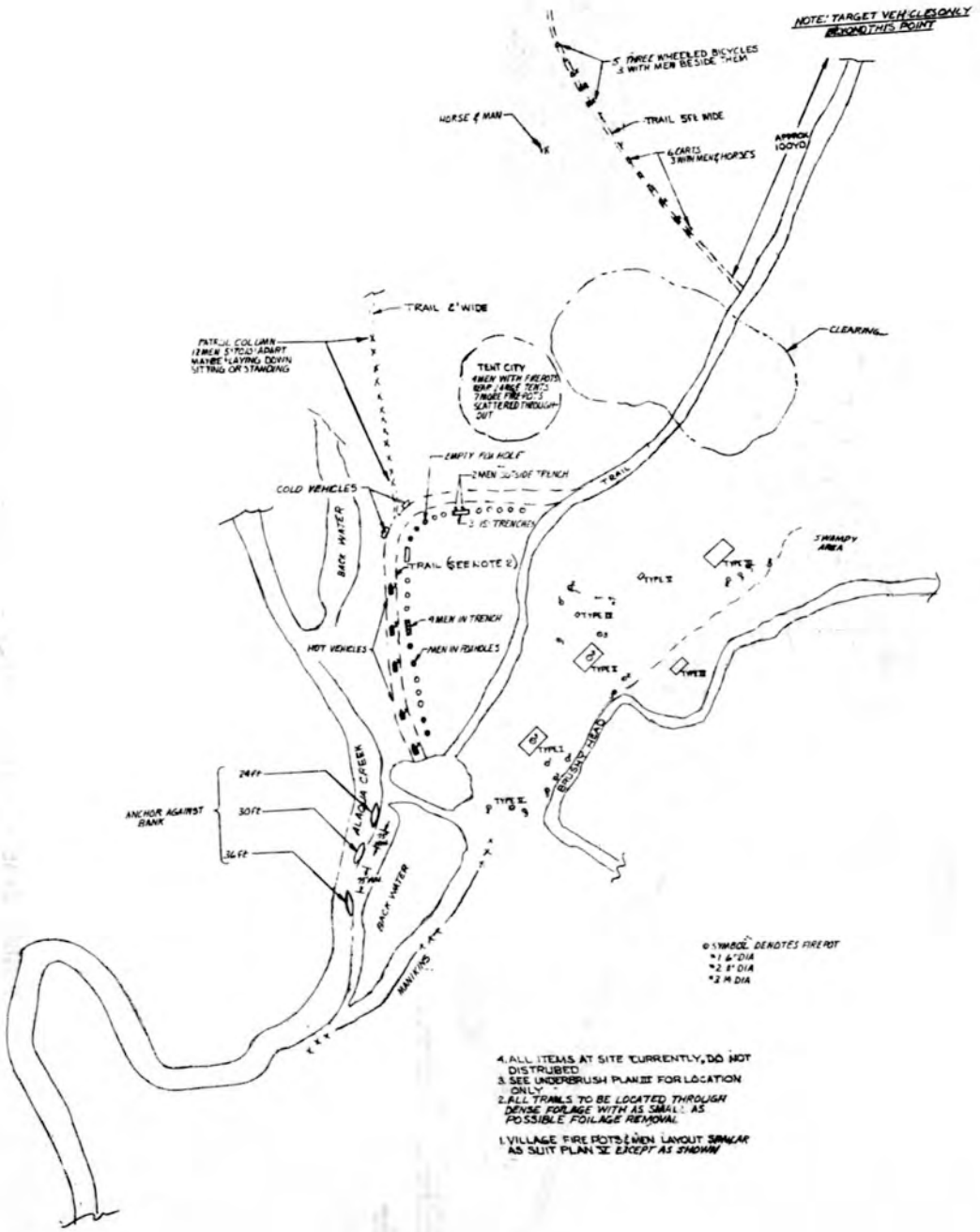



FIGURE C-3c - Site III Targets at Eglin Air Force Base

# APPENDIX D

## RECONOFAX IX SUPPLEMENTARY FLIGHT EVALUATION (MERCURY-DOPED GERMANIUM (GE:HC) DETECTORS)

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

### INTRODUCTION

After the original evaluation of the Reconofax IX Infrared Mapping Set, the equipment manufacturer, H. R. B. Singer, Incorporated, claimed that the IR imagery could be enhanced by replacing the relatively old copper-doped germanium (Ge:Cu) detector array with a new mercury-doped germanium (Ge:Hg) detector array. Cognizant Air Force and Navy personnel agreed to conduct several supplementary test flights during September 1966 over the Eglin Air Force Base IR Test Range in the same Navy RA-3B aircraft. The location and type of ground targets at the Eglin Range are identical to those outlined in appendix C.

### EVALUATION AND RESULTS

A total of twelve flights were flown; the first five were conducted in the local Johnsville area and considered "shake-down" flights for the equipment. The remaining seven flights, upon which this evaluation is based, were conducted over the Eglin Air Force Base IR Test Range. The date, time, flight number and site location of all these supplementary flights are summarized in table D-I.

A comparison of the seven-element detector arrays (Ge:Hg versus Ge:Cu) includes an evaluation of the following:

Thermal and Angular Resolution - There were no suitable thermal resolution targets at Eglin or Johnsville to obtain quantitative thermal sensiviry measurements. Imagery over the Johnsville IR targets, obtained during the shake-down flights of the Ge:Hg detector array, indicated that the angular resolution was the same (1.5-2.0 mr) as that previously measured for the Ge:Cu detector array.

Flight Imagery - Figures D-1 through D-5 show day and night flight imagery over various types of targets at different altitudes (190 to 3000 ft) and speeds (300 to 450 kn). This imagery substiates the earlier results enumerated in the main body of this report; i.e. tactical targets such as trucks, missiles, sampans, village huts, and fire pots can be detected and/or identified at certain altitudes, limited by the denseness of the ground foliage and thermal intensity of the targets.

Velocity-to-Height Ratio - The new detector array (Ge:Hg) did not affect the V/H capability of the equipment. Twelve daytime runs were conducted to verify this fact. However, during flight No. 8, it was discovered that one of the detector elements was defective, causing some degradation to the imagery (figure D-6).

Video Contrast Levels - To insure that flight imagery would be enhanced, the video contrast levels were changed on alternate runs (of flight No. 10) from settings of 8-10 v peak-to-peak to 10-12 v peak-to-peak. Since no apparent improvement was observed with either setting, the original setting (8-10 v peak-to-peak) was utilized for the remaining flights.

CONCLUSIONS

There was no significant overall improvement in the imagery obtained with the Ge:Hg detector array. The night imagery was slightly improved over the Ge:Cu detector array, while the daytime imagery was slightly worse.

Since these detector arrays (Ge:Hg and Ge:Cu) were not compared during simultaneous flights and many variables (time of year, weather conditions, etc.) cannot be correlated, it appears that neither detector array has an advantage over the other.

RECOMMENDATIONS

Since the Ge:Hg detector array is readily adaptable to closed-cycle cooling (a logistic advantage), it would be recommended in view of its equal performance to the Ge:Cu detector array.

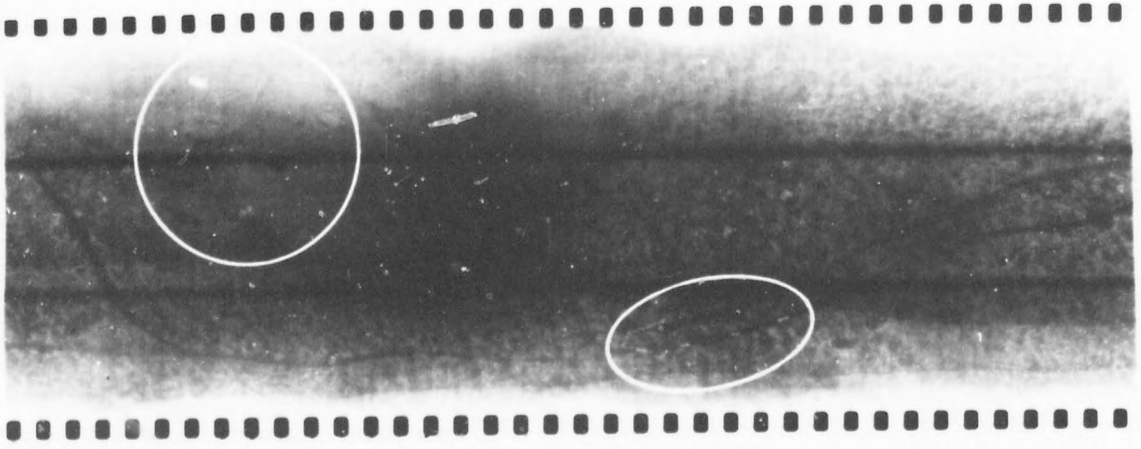


[redacted]

## TABLE D-I

### INFRARED FLIGHT TEST PROGRAM SUMMARY
### RECONOFAX IX SUPPLEMENTARY FLIGHTS

| Flt No. | Date | Time (Approx) | Sites |
|---|---|---|---|
| S-1 | 26 Aug 1966 | 1115-1230Q | NAVAIRDEVCEN Johnsville, Philadelphia area |
| S-2 | 29 Aug 1966 | 1430-1545Q | NAVAIRDEVCEN infrared target range |
| S-3 | 30 Aug 1966 | 1045-1200Q | NAVAIRDEVCEN infrared target range |
| S-4 | 30 Aug 1966 | 2030-2230Q | Aberdeen Proving Ground, Md. and NAVAIRDEVCEN infrared target range |
| S-5 | 2 Sep 1966 | 1000-1145Q | Philadelphia and Wilmington areas and NAVAIRDEVCEN infrared target range |
| S-6 | 7 Sep 1966 | 1300-1530R | Eglin AFB, Simulated Vietnam village - Site I |
| S-7 | 8 Sep 1966 | 2015-2245R | Eglin AFB, Simulated Vietnam village - Site I |
| S-8 | 12 Sep 1966 | 0900-1200R | Eglin AFB, Simulated Vietnam village - Site II |
| S-9 | 12 Sep 1966 | 2000-2215R | Eglin AFB, Simulated Vietnam village - Site II and missile site |
| S-10 | 13 Sep 1966 | 2015-2300R | Eglin AFB, Simulated Vietnam village - Site II and missile site |
| S-11 | 14 Sep 1966 | 0600-0845R | Eglin AFB, Simulated Vietnam village - Site III, Site II (inactive) and missile site |
| S-12 | 14 Sep 1966 | 2015-2300R | Eglin AFB, Simulated Vietnam village - Site III, Site II (inactive) and missile site |



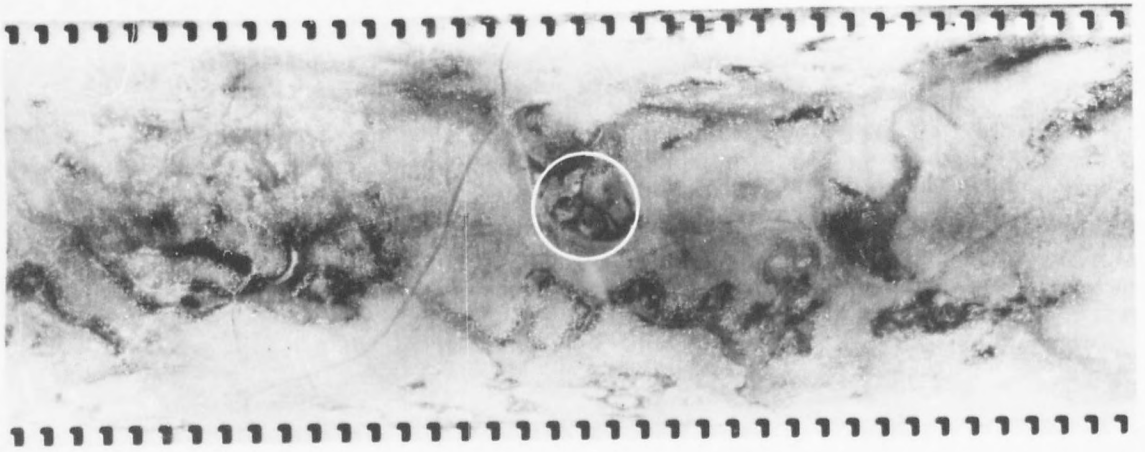
NADC-AE-6718

RECONOFAX IX
FLIGHT 6
RUN 4
V/H 3

DATE: 9/7/66
TIME: 1327S
ALTITUDE: 250 ft
SPEED: 450 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site I complex
DETECTORS: GE:HG #1, 2, 3, 5, 6, 7

FIGURE D-1 - Flight Imagery Using GE:HG Detector Array



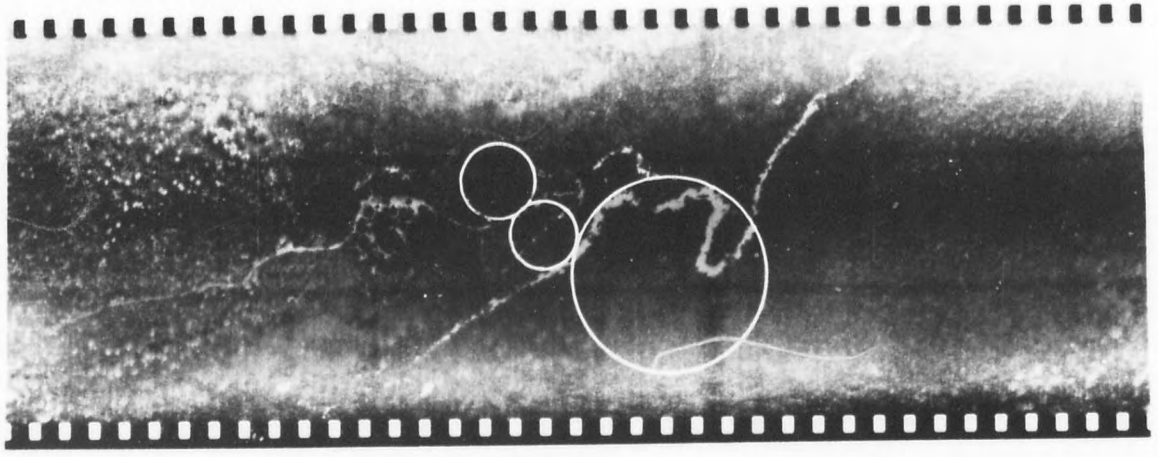
NADC-AE-6718

RECONOFAX IX
FLIGHT 7
RUN 2B
V/H 0.25

DATE: 9/8/66
TIME: 2015S
ALTITUDE: 2000 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site I complex
DETECTORS: GE:HG #1

FIGURE D-2 - Flight Imagery Using GE:HG Detector Array



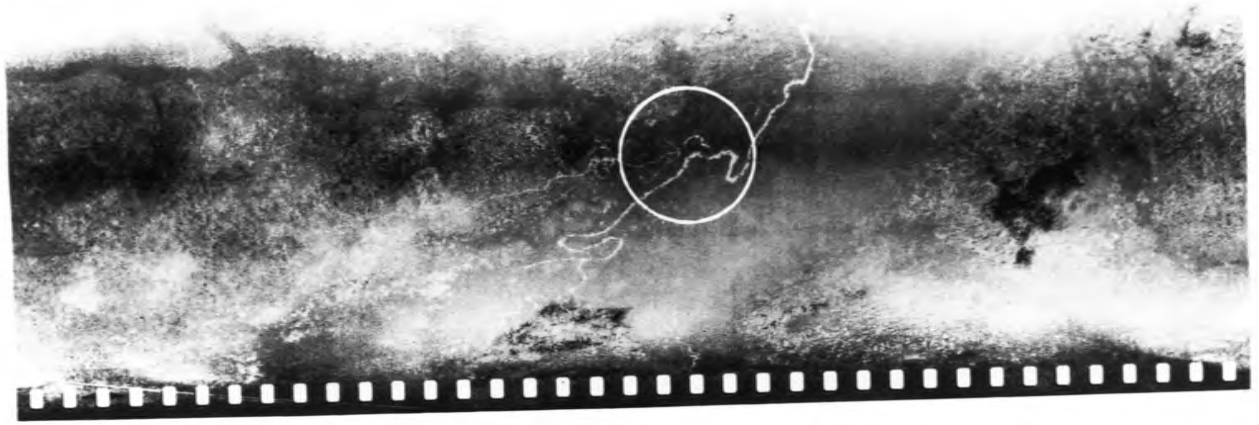
NADC-AE-6718

RECONOFAX IX
FLIGHT 12
RUN 4
V/H 1

DATE: 9/14/66
TIME: 2034S
ALTITUDE: 500 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site III complex and sampans
DETECTORS: GE:HG #1, 7

FIGURE D-3 - Flight Imagery Using GE:HG Detector Array

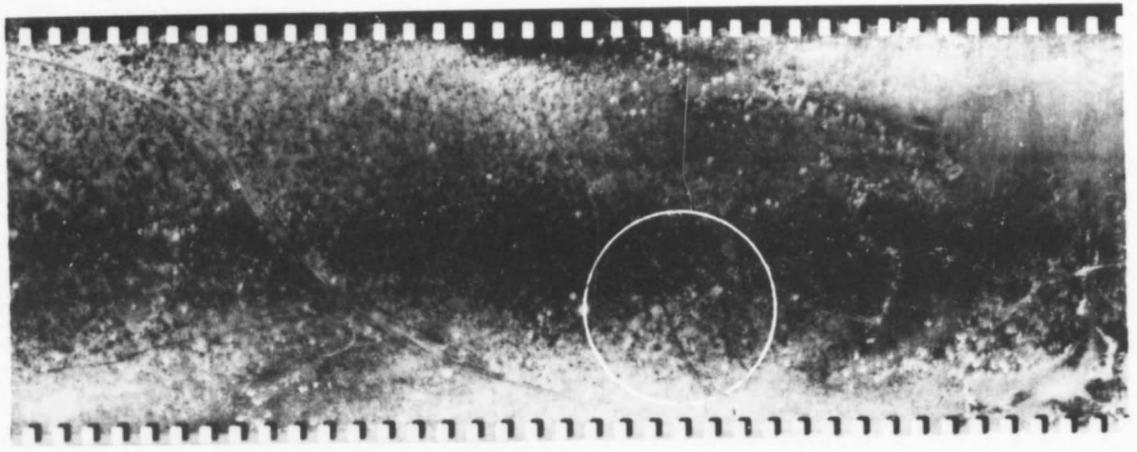


RECONOFAX IX
FLIGHT 12
RUN 2
V/H 0.33

DATE: 9/14/66
TIME: 2018S
ALTITUDE: 1500 ft
SPEED: 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: Site III complex and sampans
DETECTORS: GE:HG #1

FIGURE D-4 - Flight Imagery Using GE:HG Detector Array



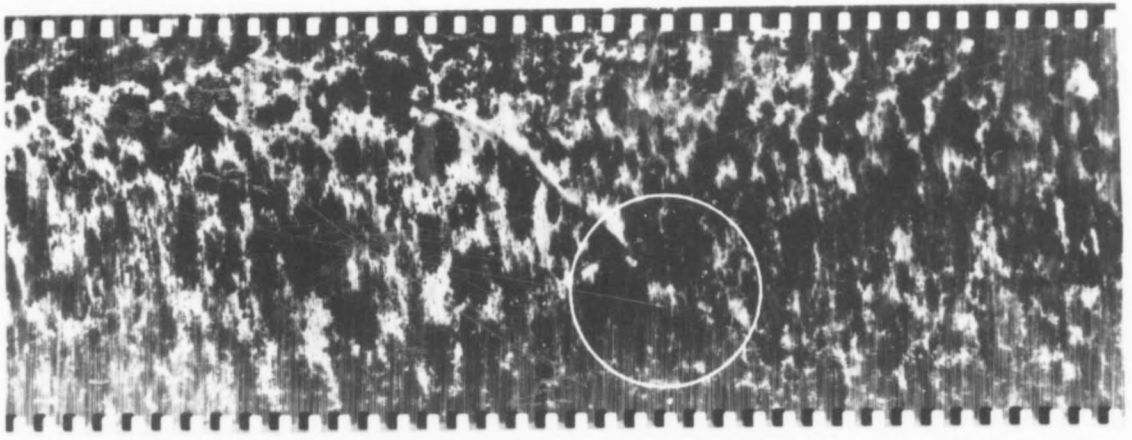
NADC-AE-6718

RECONOFAX IX
FLIGHT 12
RUN 4
V/H 1

DATE: 9/14/66
TIME: 2034S
ALTITUDE 500 ft
SPEED 300 kn

AREA: Eglin Air Force Base, Florida
TARGET: SAM Missile complex
DETECTORS: GE:HG #1, 7

FIGURE D-5 - Flight Imagery Using GE:HG Detector Array



RECONOFAX IX
FLIGHT 8
RUN 6
V/H 4

DATE: 9/12/66
TIME: 0940S
ALTITUDE: 190 ft
SPEED: 450 kn

AREA: Eglin Air Force Base, Florida
TARGET: Vehicles Site II complex
DETECTORS: All seven GE:HG

FIGURE D-6 - Flight Imagery Using GE:HG Detector Array

[redacted]
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12. SPONSORING MILITARY ACTIVITY
NAVAL AIR SYSTEMS COMMAND
DEPARTMENT OF THE NAVY

13. ABSTRACT

Three experimental infrared mapping systems, the U. S. Air Force Reconofax IX, U. S. Army AN/AAS-10(XE-1), and the U. S. Navy Reconofax VI, were flight-tested simultaneously on RA-3B aircraft, BuNo. 144839. Control ground targets and targets of opportunity were used. The three systems met their respective primary design specifications, but each system has shortcomings that need to be improved before service use. Recommendations are included for further development of infrared mapping systems. (U)

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| | ROLE | WT | ROLE | WT | ROLE | WT |
| INFRARED | | | | | | |
| MAPPING SYSTEMS | | | | | | |
| EVALUATION | | | | | | |
| ANALYSIS | | | | | | |

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Security Classification

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Naval Air Development Center, Johnsville, Pa.
Aero-Electronic Technology Department
(Report No. NADC-AE-6718)
FLIGHT EVALUATION AND ANALYSIS OF AN/AAS-10 (XE-1), RECONOFAX VI, AND RECONOFAX IX INFRARED MAPPING SETS (U), By L. Judge. 18 Aug 1967. 60, 10, 6, 8, and 10 p. Final Report.

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Includes appendixes.
Three experimental infrared mapping systems, the U. S. Air Force Reconofax IX, U. S. Army AN/AAS-10(XE-1), and the U. S. Navy Reconofax

1. Infrared
2. Mapping Systems
3. Evaluation
4. Analysis
I. Judge, L.

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