AD NUMBER
AD500493
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; 12 NOV 1968. Other requests shall be referred to Naval Air Systems Command, Washington, DC. This document contains export-controlled technical data.**
AUTHORITY
NAWCAD memo dtd 22 Feb 2017

NAVAL AIR DEVELOPMENT CENTER

Johnsville, Warminster, Pennsylvania

Report No. NADC-AE-6828 12 NOV 1968

MODIFIED AN/AAD-2(XE-2) INFRARED DETECTING SET WITH REAL-TIME INFLIGHT DISPLAY

FINAL REPORT
AIRTASK NO. A05510006/2021/W45220-00
Work Unit No. A5103B1-20

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

Aero-Electronic Technology Department

REPORT NO. NADC-AE-6828

12 November 1968

MODIFIED AN/AAD-2(XE-2) INFRARED DETECTING SET WITH REAL-TIME INFLIGHT DISPLAY

FINAL REPORT
AIRTASK NO. A05510006/2021/W45220-00
Work Unit No. A5103B1-20

An AN/AAD-2(XE-2) Infrared Detecting Set (Reconofax IV, Mark IV) was adapted to operate with a modified IP-806/AAR-32 Terrain Display Indicator, installed in a VAP-61 RA-3B aircraft, and used over North Vietnam for road, waterway, and bridge reconnaissance. Strikes were called against transient targets based on information provided by the inflight display from January to August 1967 when the equipment was lost due to combat.

Reported by: T. R. Trilling, P. M. Moser
Applied Research Division

Approved by: W. S. Lee, Superintendent
Applied Research Division

D. W. Mackiernan
Technical Director

S U M M A R Y

INTRODUCTION

In June 1966 NAVAIRDEVCEN provided and installed in a VAP-61 (Heavy Photographic Squadron SIXTY-ONE) RA-3B aircraft a modified Reconofax VI infrared mapping set with a real-time inflight display as described in reference (a). In references (b) and (c) CINCPACFLT reported the successful utilization of this equipment for road, waterway, and bridge reconnaissance over North Vietnam and requested the procurement of additional similar equipments exhibiting higher reliability, higher resolution and carrier suitability.

On 30 August 1966 the NAVAIRDEVCEN secured, on a six-month loan from USAECOM (U.S. Army Electronics Command), an Infrared Detecting Set AN/AAD-2(XE-2) (Reconofax IV, Mark IV) for use in a continuing development program being conducted under reference (d). Also available at the NAVAIRDEVCEN at that time was a Terrain Display Indicator IP-806/AAR-32, which is one unit of Infrared Detecting Set AN/AAR-32 developed for submarine wake detection under reference (e).

By reference (f), the Naval Air Systems Command authorized the NAVAIRDEVCEN to modify, provide, and install in a VAP-61 RA-3B aircraft the available AN/AAD-2(XE-2) and the IP-806/AAR-32.

RESULTS

Active prosecution of the project commenced with the modification of the IP-806/AAR-32 on 4 October 1966. The unmodified AN/AAD-2 was installed in NP-2E aircraft BuNo 131403 and acceptance flight tests were conducted on 12 and 28 October 1966. On 31 October, modification of the AN/AAD-2 was begun and work commenced on a prototype installation of the equipment in NAVAIRDEVCEN RA-3B aircraft BuNo 144839. Modification of the equipment, which has been informally designated Infrared Recon Set No. 2, and the prototype aircraft installation were completed on 12 November 1966. Local flight tests were conducted on 21 and 29 November. From 30 November to 7 December the infrared equipment and its installation provisions were removed from the NAVAIRDEVCEN aircraft and reinstalled in the VAP-61 aircraft. The equipment was flight tested on the evening of 7 December and carrier-suitability tests, consisting of two catapult launches and arrested landings, were conducted successfully at NAS, Lakehurst on 9 December. RA-3B aircraft BuNo 144840 departed NAVAIRDEVCEN on 10 December 1966 with Infrared Recon Set No. 2 aboard.

NAVAIRDEVCEN provided engineering services to VAP-61 on Guam from 12 to 21 December; continuing services of an HRB-Singer, Incorporated, field service technician were provided to the squadron commencing 27 December 1966 under NAVAIRDEVCEN Contract N62269-3779.

The equipment was put into combat use over North Vietnam commencing 31 December 1966 after correction of difficulties encountered in the tropical environment. In March 1967 RA-3B aircraft BuNo 144840 was damaged on the ground and the Infrared Recon Set No. 2 installation was transferred by VAP-61 personnel to RA-3B aircraft BuNo 144835. Except for March 1967, this equipment was utilized on an average of 12 completed combat missions per month. Flight operations were conducted off the USS ENTERPRISE and out of NAS, Cubi Point, Republic of the Philippines. On 25 August 1967 this aircraft with its infrared equipment aboard was lost due to combat.

CONCLUSIONS

Infrared reconnaissance equipments with real-time inflight displays can be installed in current, carrier-based, Navy jet aircraft and operated successfully in a combat environment by military personnel. Such devices are useful for road, waterway, and bridge reconnaissance, for bomb damage assessment, and for general surveillance. Vehicles can be detected at night on its inflight display and successful air strikes have been conducted against the vehicles based on this information. Infrared imagery recorded on photographic film in such devices complements aerial reconnaissance imagery produced by conventional photographic means.

RECOMMENDATIONS

It is recommended that additional equipments of this same type be procured and installed in additional RA-3B aircraft and that improved display devices be developed.

TABLE OF CONTENTS

LIST OF FIGURES

DESCRIPTION OF EQUIPMENT

Infrared Recon Set No. 2 consisted of five units: Scanner Unit, Scanner Control Unit, Display Unit, Electronic Unit, and Display Control Unit. Figure 1 is a photograph of the equipment. The physical characteristics of the set are summarized in table I. Infrared Recon Set No. 2 was essentially a modification and combination of an Infrared Detecting Set AN/AAD-2(XE-2) and a Terrain Display Indicator IP-806/AAR-32.

The AN/AAD-2 is a small, lightweight, line-scanning, infrared mapping set developed by HRB-Singer, Incorporated, under Contract DA-28-043-AMC-01672(Y) for use in an Army reconnaissance drone aircraft program. The scanner consists of an optical system, a photoconductive infrared detector mounted in a Malaker Mark VII-C closed cycle cryostat, electronic circuitry, glow tube printer, and film magazine all mounted in a single package weighing 79 pounds. The scan rate is 175 scans per second; the total transverse field of view is 120 degrees. It achieves an instantaneous angular field of view (angular resolution) of 2 milliradians and a noise-equivalent temperature difference (thermal resolution) of approximately 0.2 C° when used with a 0.3- by 0.3-mm mercury doped germanium detector. It provides contiguous or overlapping scan for a range of aircraft velocity/altitude ratios from 0.01 to 0.35 radian/second. Its optical system has a focal length of 6 inches and a useful aperture of 47.6 cm^2. Roll stabilization of the film magazine over the range of ±30 degrees is provided.

The IP-806/AAR-32 is a real-time B-scope type display device designed and built by HRB-Singer, Incorporated, under NAVAIRDEVCEN Contract N62269-2858 as a sub-unit of the display/control unit of the AN/AAR-32. It utilizes a rectangular cathode-ray tube with 9-1/2 by 2-1/4 inch format to display infrared video information in picture form. The cathode-ray tube is a magnetic-deflection, low-voltage-electrostatic-focus tube with a P7 phosphor. When used with the AN/AAD-2(XE-2) it provides a display resolution of approximately 8 milliradians. The IP-806/AAR-32 is an L-shaped display sub-unit designed to be mated with a C-6793/AAR-32 control sub-unit to form a rectangular control/display unit known as Control, Indicator Group, OA-7788/AAR-32. The IP-806/AAR-32 was not designed to be used independently of the C-6793; however, other than requiring a sync trigger generator and a power control circuit, the unit contains everything necessary for independent operation.

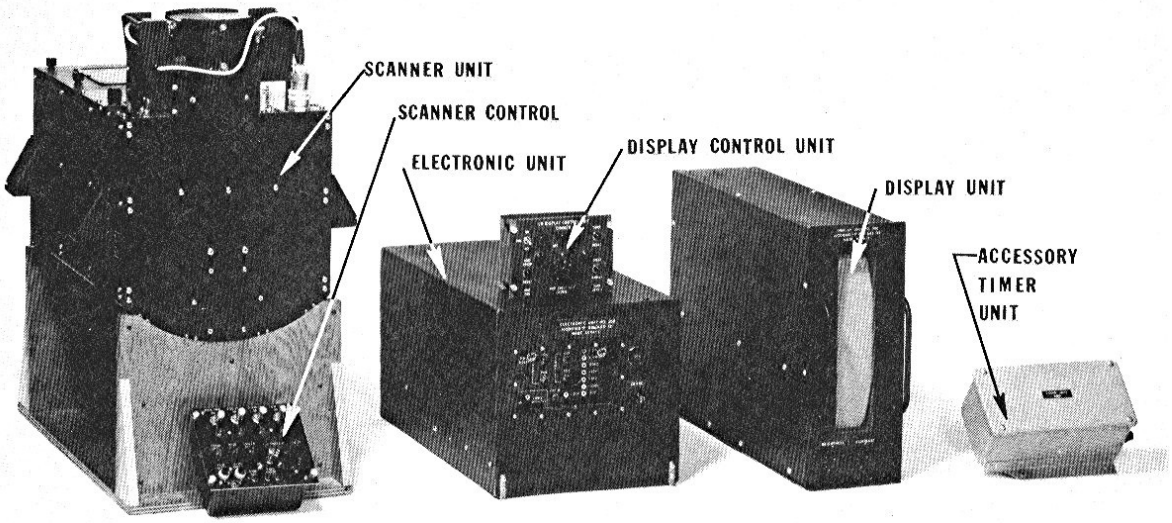


FIGURE 1 - Infrared Recon Set No. 2

NAVAIRDEVCEN MODIFICATIONS TO THE EQUIPMENT

The panel space available for a display device in an RA-3B aircraft is extremely limited. To utilize this space efficiently the IP-806/AAR-32 was divided into two units. The cathode-ray tube with its yoke and mounting hardware were placed in the display unit. All the electronic circuitry, including sync, sweep, blanking, video, and power supplies, was placed in the electronic unit.

A display control unit was designed and fabricated to provide control of the display ON/OFF, vertical sweep speed, sweep reset, event marker, and timer reset. A digital timer was designed and fabricated to provide time marks on the film at 30-second intervals and to count out the number of 5-minute intervals after reset.

The AN/AAD-2 was designed originally to provide a telemetry signal that could be transmitted from a drone aircraft to a ground-based receiver and film recorder. During each revolution of the scanning mirror, video information from the scene below the aircraft is scanned out for 120 degrees followed by 240 degrees of "dead time." At the center of each "dead" period, a magnetic slug mounted in the base of the scanning mirror generates a sync pulse as it passes by a roll-stabilized pulser. In the unmodified equipment, the sync pulse is combined with the video signal, decoded at the receiver, and used to generate sync signals for use in reproducing the video.

For proper B-scope operation it is desirable to generate the sweep-starting sync pulse as close as possible to the start of the video. Therefore, the slug that generates the sync pulses was moved back 120 degrees in the scan cycle. Figure 2(a) shows the timing and phase diagrams of the scanner before modification; figure 2(b) shows the timing and phasing diagrams for the modified equipment.

The sync pulse generated in the AN/AAD-2 scanner prior to its modification had been used to trigger a circuit that formed a large amplitude pulse and added it to the video during the dead time. This circuit was disabled and the sync pulse was routed instead to the scanner control unit to provide sync for the real-time display as shown in figure 3. A line driver was added to the video output stage to reduce the effect of the line capacity on the high frequency response.

The IP-806/AAR-32 sweep circuitry was designed for use with a two-pulse sync system having the start and stop sync pulses on separate lines. For the electronic unit to generate separate start and stop pulses from the AN/AAD-2's original single sync pulse system, a circuit board was added which contained a pulse shaper for the start pulse, a delay multivibrator to generate the stop pulse at the proper time, and a pulse shaper for the stop pulse. A schematic diagram of this new circuit board is shown in figure 4.

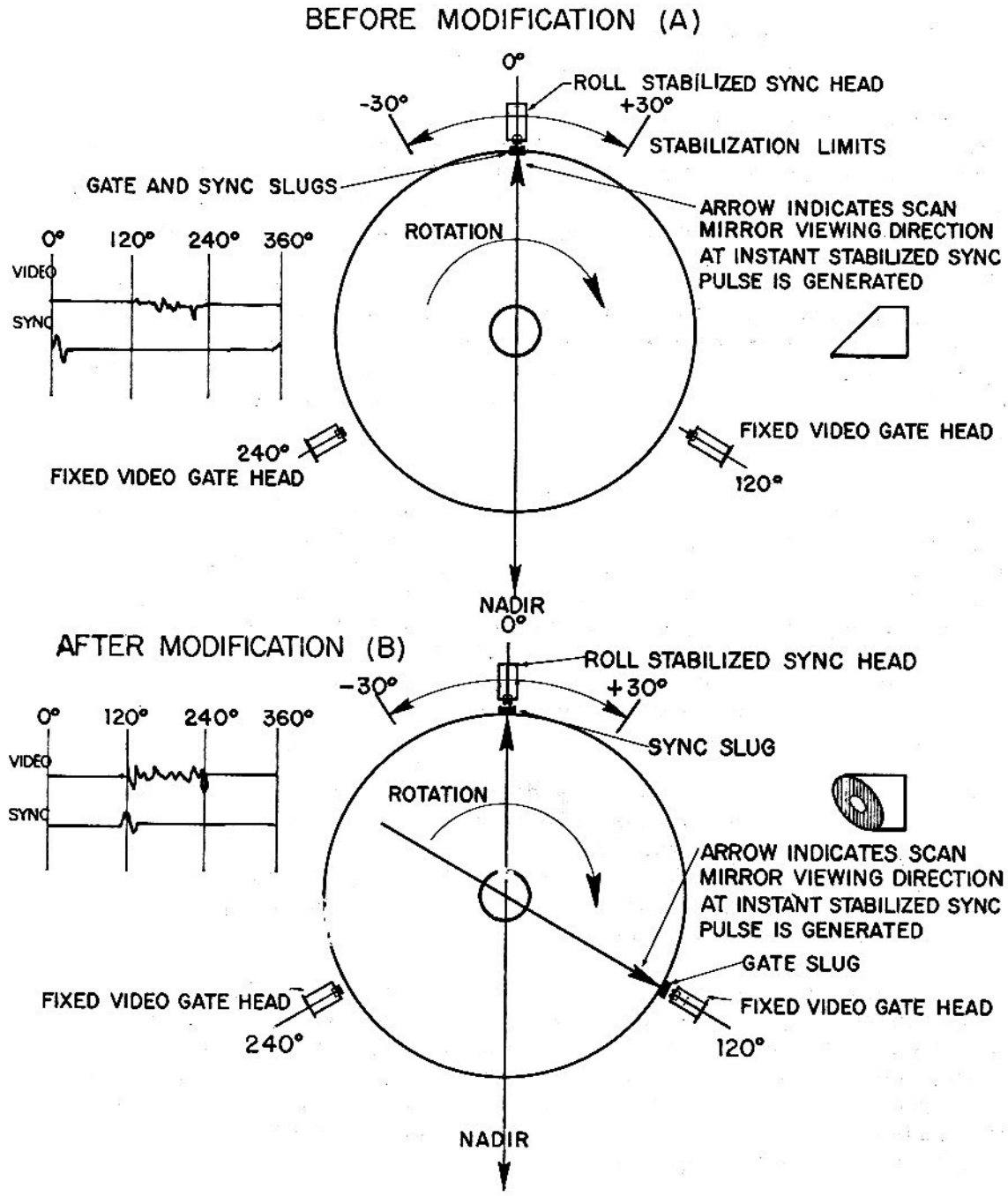


FIGURE 2 - Scanner Sync Phasing and Timing Diagrams

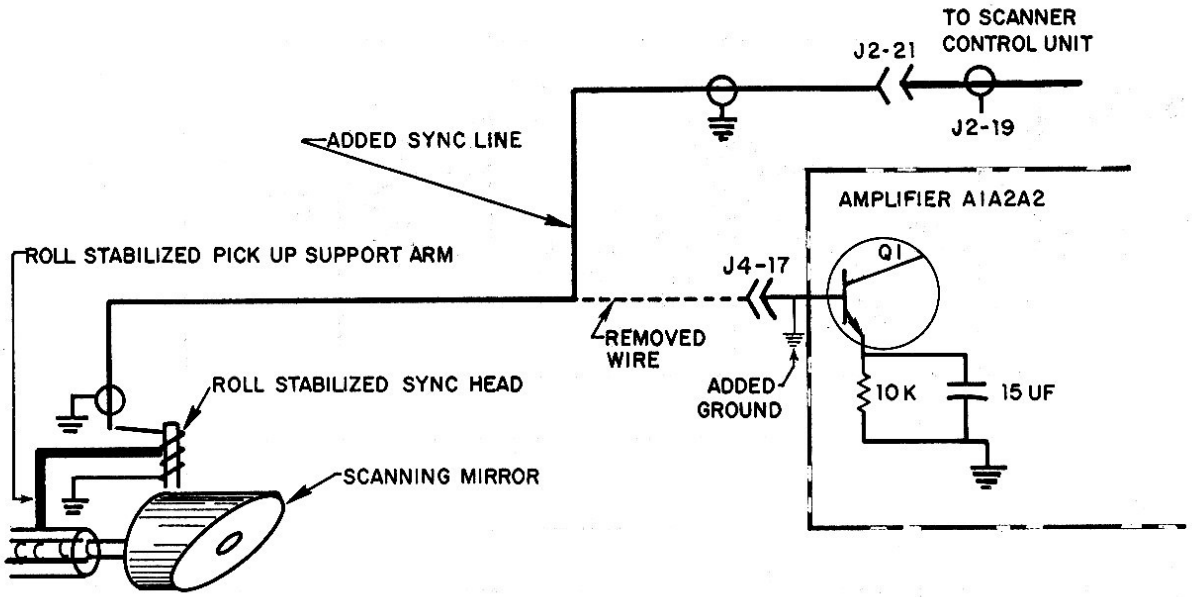


FIGURE 3 - Diagram of AN/AAD-2(XE-2) Sync Circuit Modification

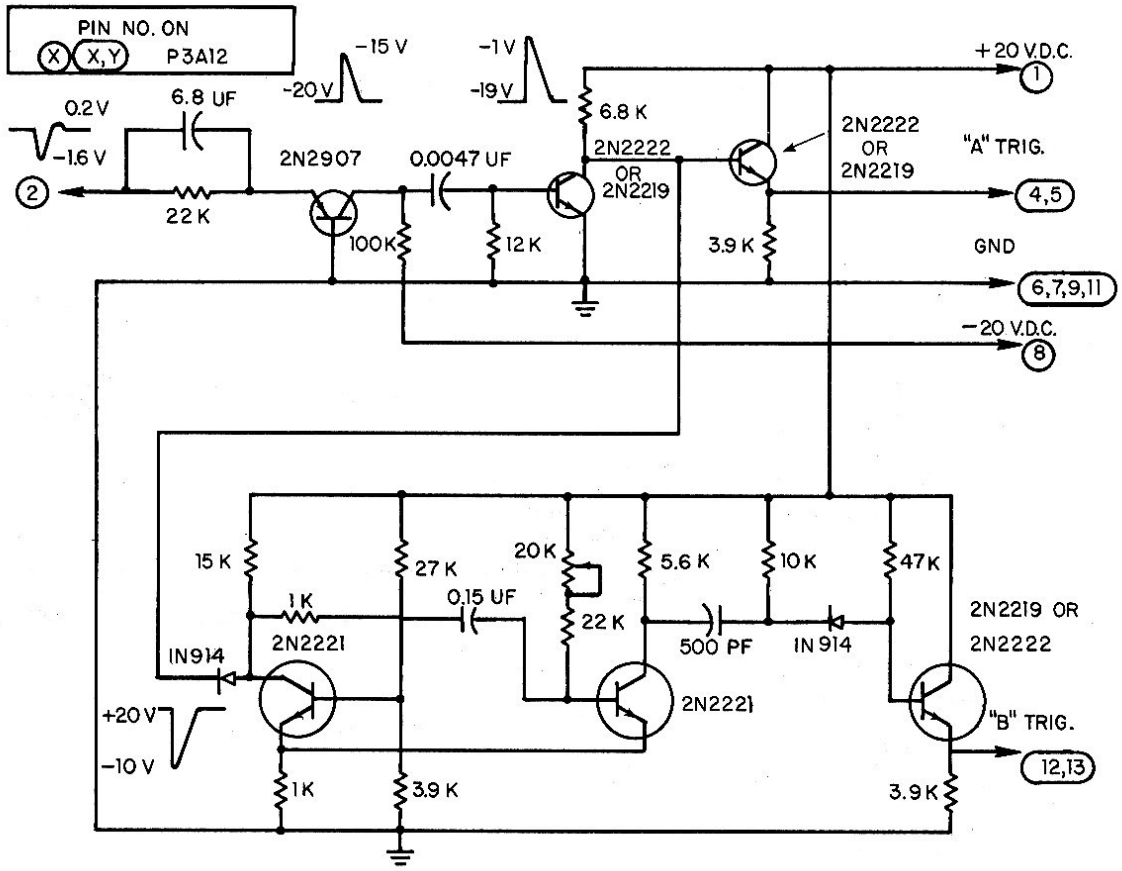


FIGURE 4 - Sync Trigger Generator Schematic Diagram (3A12)

The design of the AN/AAR-32 made use of advanced and retarded sync pulses to generate event and time marker signals at each edge of the video on the cathode-ray tube. The electronic unit was rewired to eliminate these advanced and retarded sync signals.

Modifications were made to some of the circuitry in the electronic unit to generate the proper sweep rates and gate lengths since the AN/AAD-2 scanner generates 175 scans per second and the IP-806/AAR-32 was designed for operation at 100 scans per second.

A block diagram of the electronic unit is shown in figure 5. Figures 6 and 7 are complete schematic diagrams of the display unit and the display control unit.

RA-3B AIRCRAFT INSTALLATION DESIGN

The units comprising Infrared Recon Set No. 2 were installed at various locations in the RA-3B aircraft as shown in figure 8. The scanner was mounted on the port side of the aircraft bomb bay on a hinged door structure that replaced the port bomb bay doors as shown in figure 9. Figure 10 provides an external view of the bomb bay with the scanner mounted on its hinged door, which is open for servicing or removal of the equipment. An access door was provided aft of the scanner to permit easy insertion and removal of the film magazine. The display unit and control units were mounted in the third crewman's instrument console as shown in figure 11. Some rearrangement of the meter panels was necessary to provide space for the display unit.

A block diagram of the entire installation is shown in figure 12. The connectors 1PA and 1PB are pressure-sealed connector sets used to pass the interconnecting wiring between the unpressurized bomb bay and the pressurized cabin area.

FLIGHT TEST PROGRAM

On 12 and 28 October 1966, two acceptance flight tests of the AN/AAD-2 scanner were made in NP-2E aircraft BuNo 131403. The first flight was flown during the daytime with a liquid-nitrogen-cooled 0.5- by 0.5-mm (3.3-milliradian resolution) indium antimonide detector which was filtered to eliminate response at wavelengths shorter than 3 microns. The other flight was flown after dark with a 0.3- by 0.3-mm (2-milliradian resolution) mercury doped germanium detector in a closed cycle cryostat. The scanner appeared to have only one major defect; its roll stabilized film magazine jittered with an average amplitude of about 3.5 milliradians which produced a corresponding waviness in the imagery recorded.

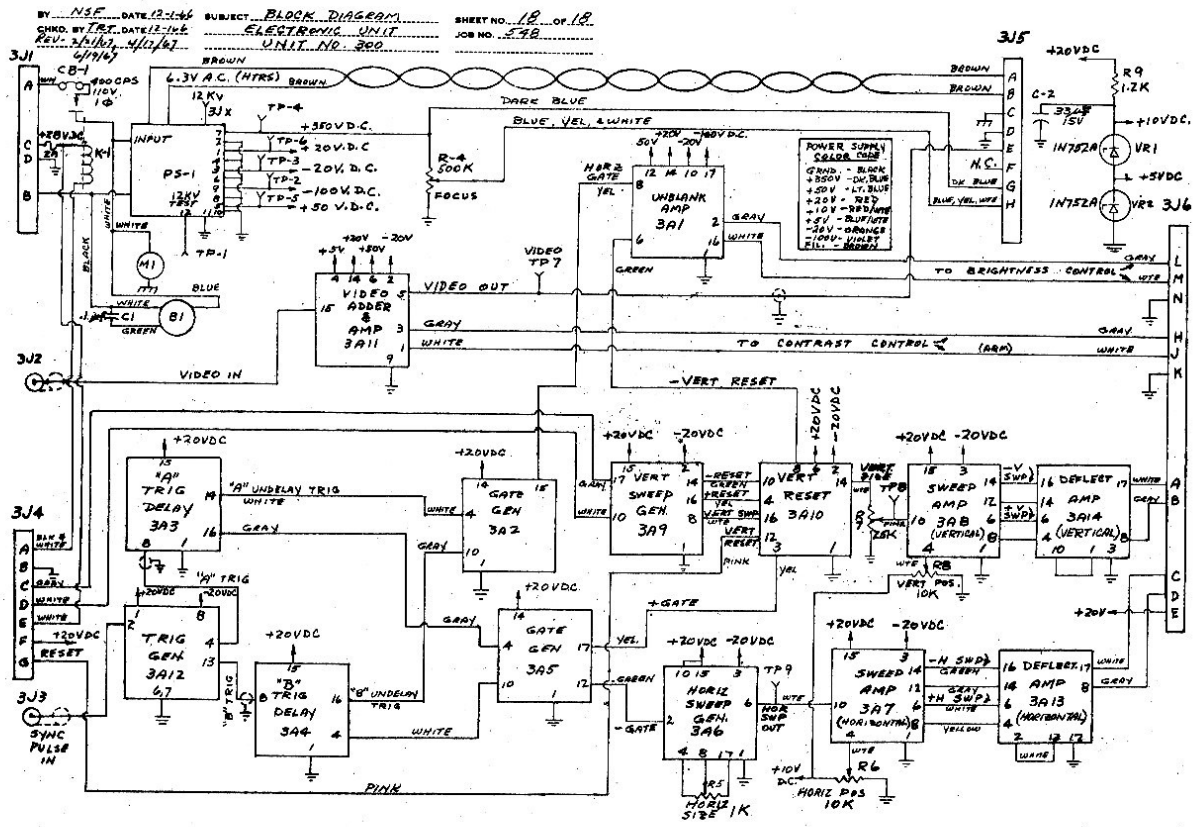


FIGURE 5 - Block Diagram of Electronic Unit

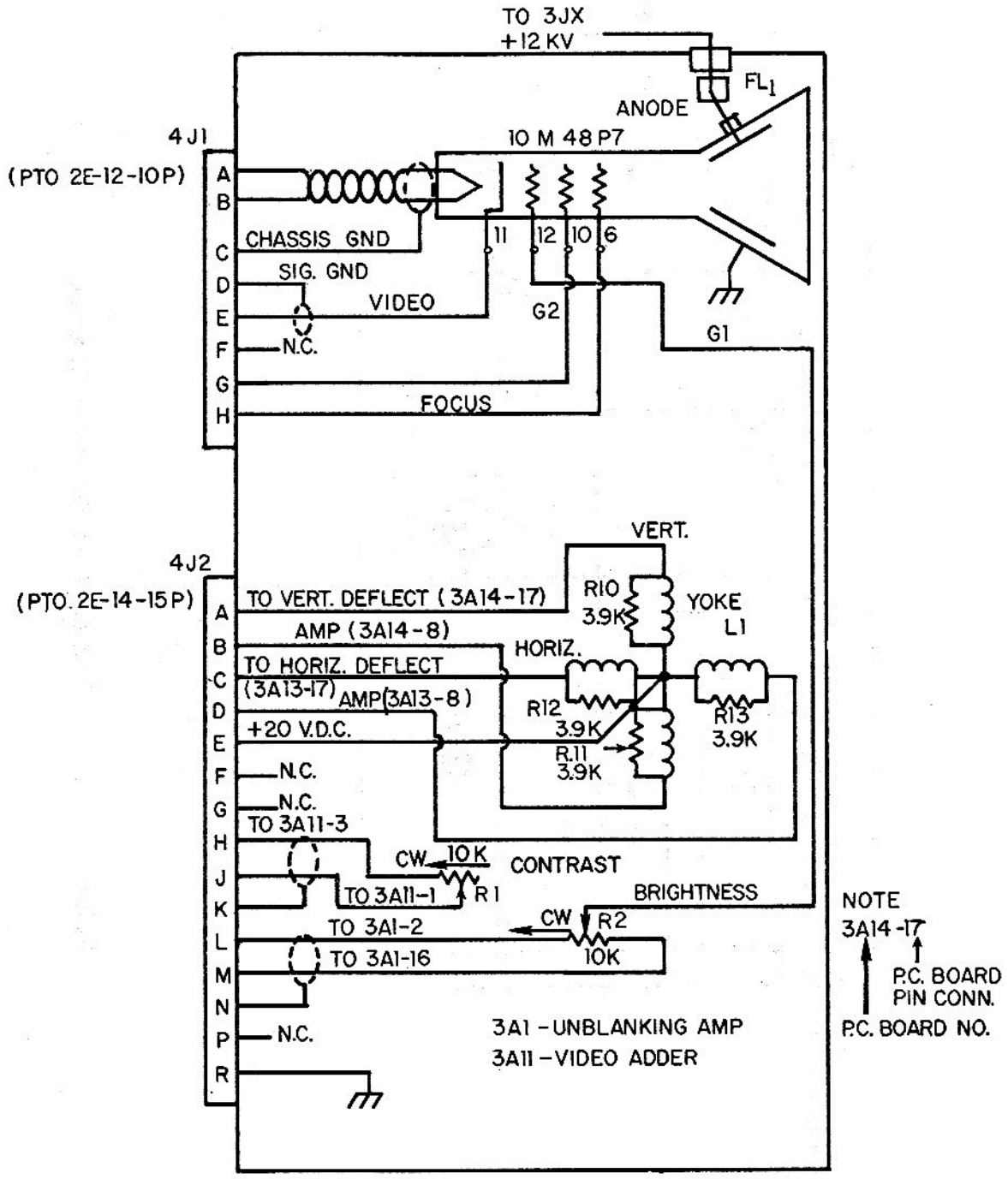


FIGURE 6 - Display Unit Schematic Diagram

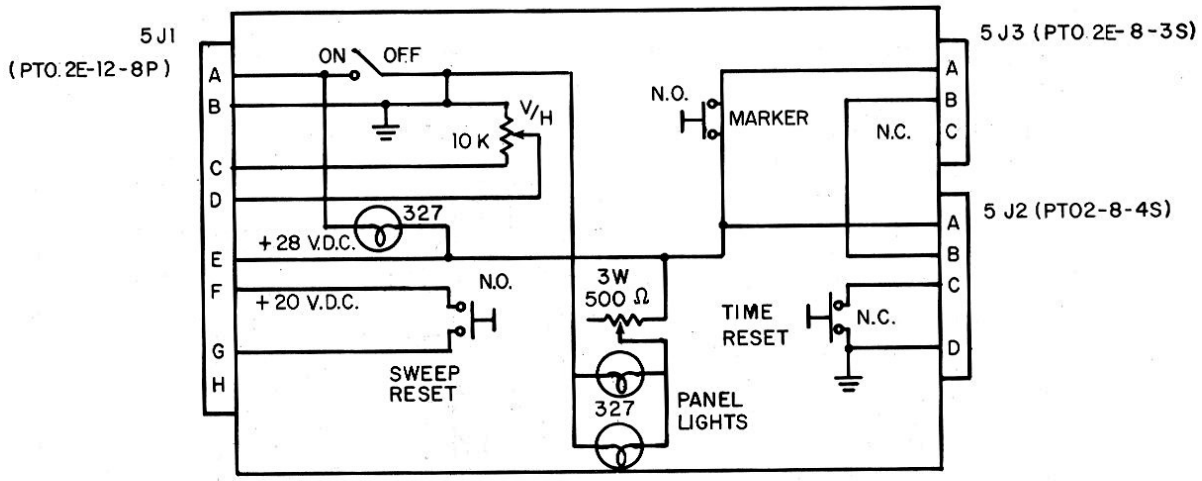


FIGURE 7 - Display Control Unit Schematic Diagram

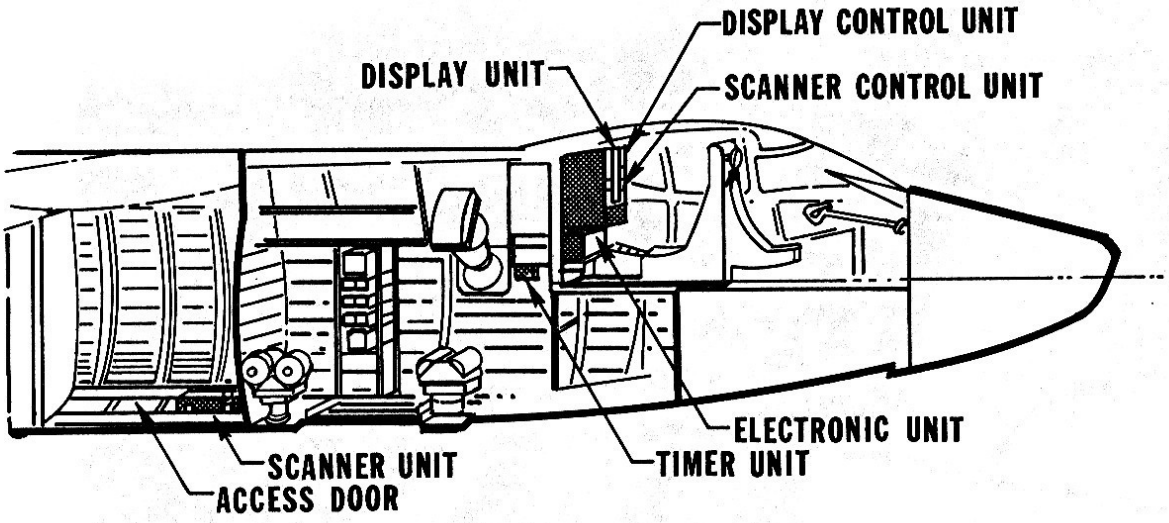


FIGURE 8 - Cutaway Drawing of RA-3B Aircraft With Infrared Recon Set No. 2 Installed

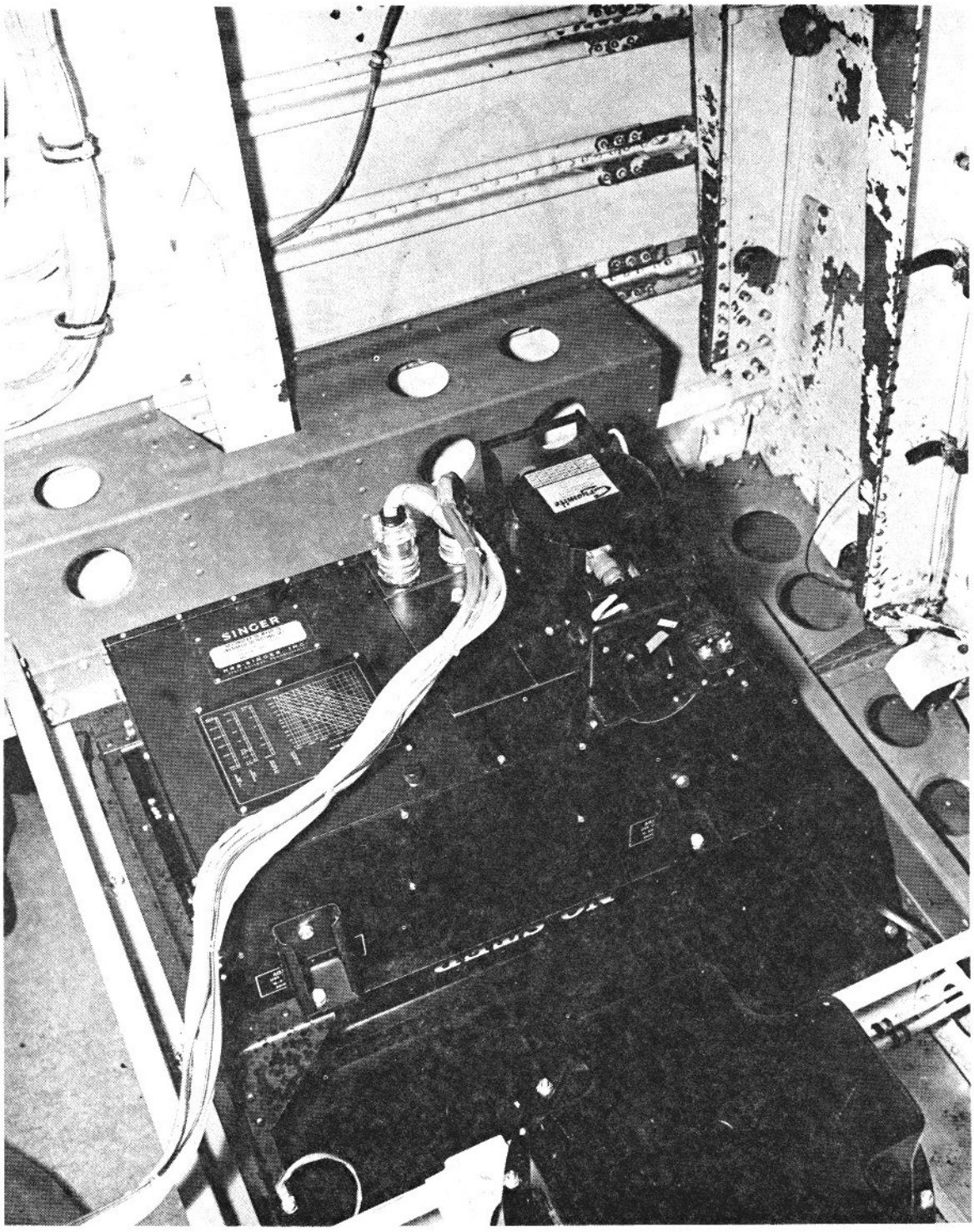


FIGURE 9 - Scanner Unit Installed in Bomb Bay of RA-3B Aircraft

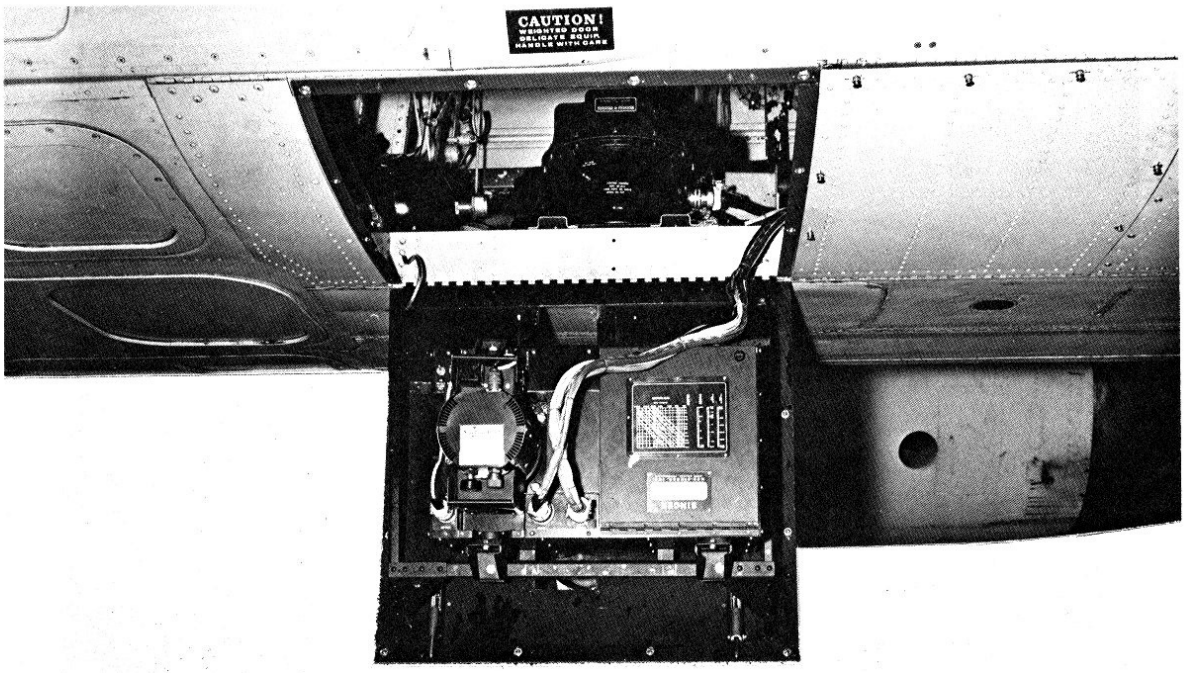


FIGURE 10 - Scanner Unit Mounted on Open Hinged Door

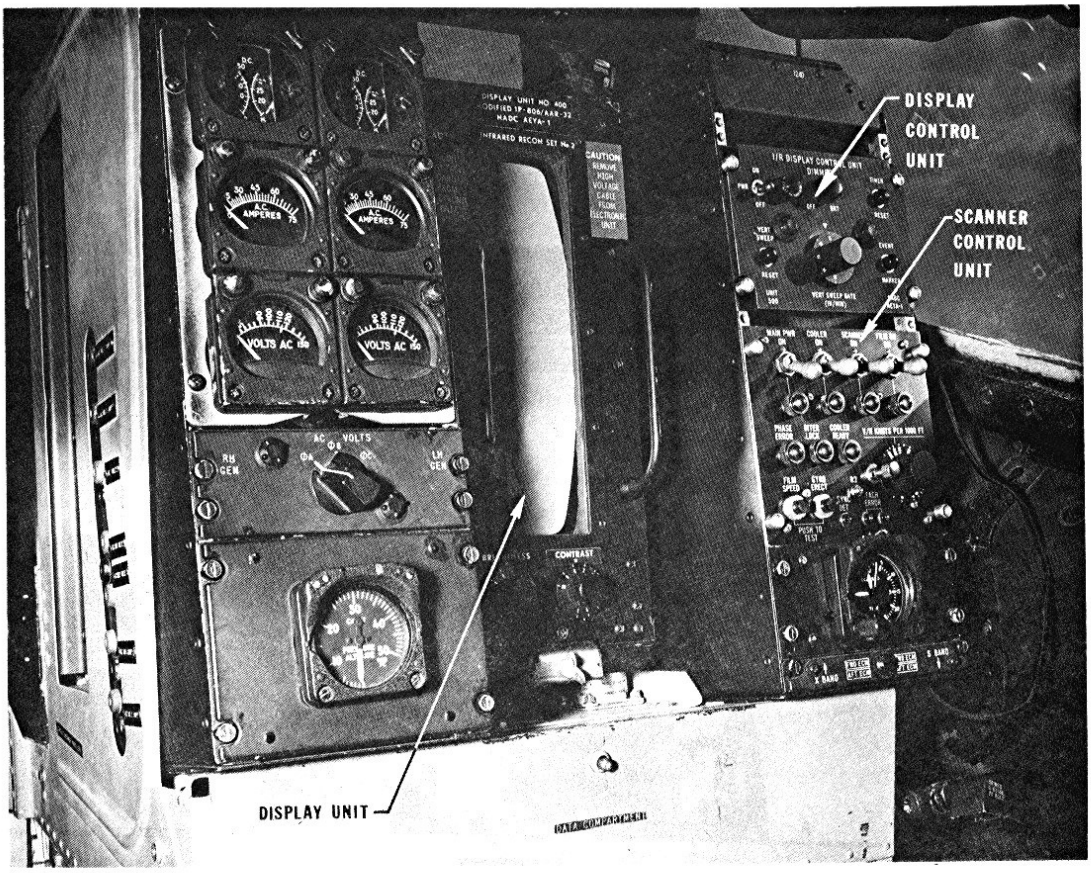


FIGURE 11 - Display Unit, Display Control Unit and Scanner Control Unit Installed in Third Crewman's Instrument Console

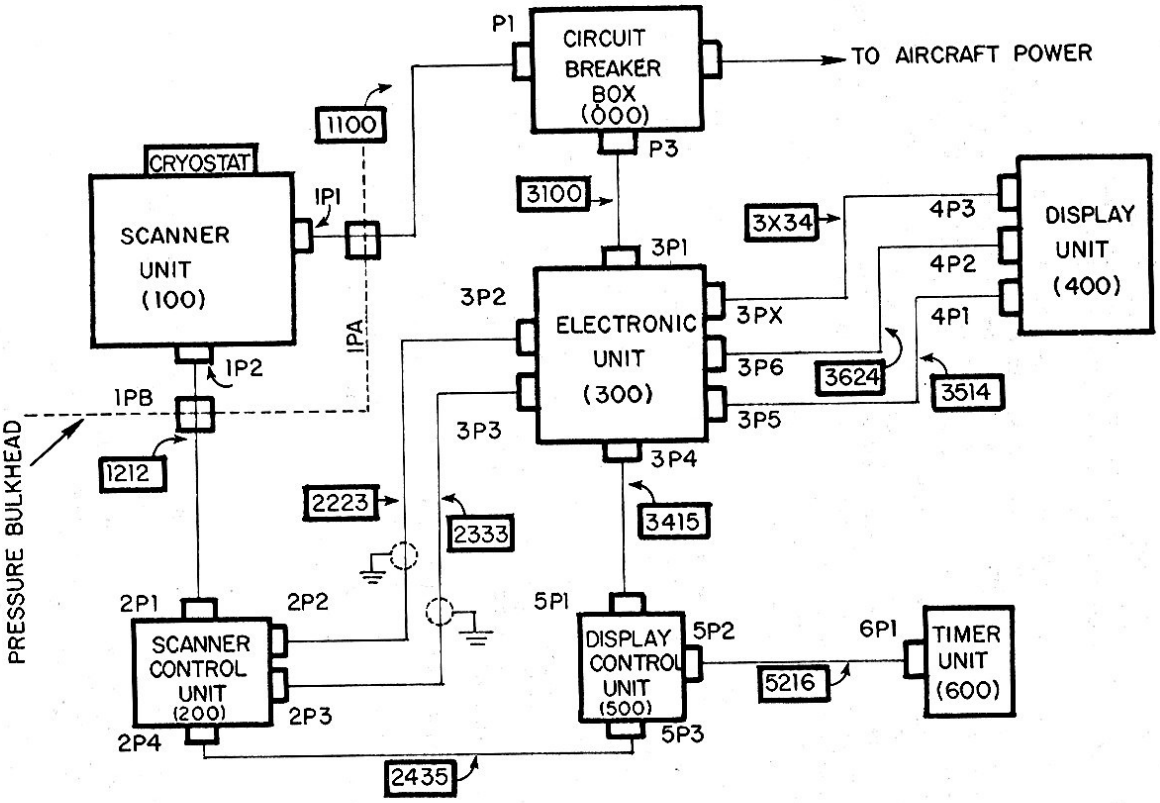


FIGURE 12 - Block Diagram of Infrared Recon Set No. 2 in RA-3B Aircraft

On 21 November 1966 the complete Infrared Recon Set No. 2 was flown in NAVAIRDEVCEN RA-3B aircraft BuNo 144839. The set performed well with the exception of its stabilization system which did not function at all. It was later ascertained that the gear head in the torque motor had stripped and that the stabilization system would require redesign.

A second test flight in RA-3B aircraft BuNo 144839 took place on 29 November 1966. The stabilized platform was locked in an upright position. Because of an aircraft malfunction, the flight test was limited to a maximum airspeed of 240 knots. Vehicles were easily detected on primary and secondary roads by the inflight B-scope observer at aircraft altitudes up to 3000 feet. An inexperienced crewman was able to recognize the vehicles on the road after about 5 minutes of practice. Tests were run to determine the extent of radio frequency interference between the infrared set and the aircraft's other electronic and electrical equipments. Except for the TACAN, which produced its characteristic array of dot pairs on the imagery, no interference problems were noticed. Examples of the imagery from this flight are given in figures 13 and 14.

The film was slightly over-processed making the imagery appear too contrasty. This resulted in the images of roads and vehicles occurring outside the linear range of the film. Therefore, in many areas of the film it is difficult to see the warm vehicles on the warm roads. Cold vehicles or ones with highly reflective upper surfaces show up extremely well.

After transfer of the infrared equipment and its installation provisions from the NAVAIRDEVCEN aircraft to VAP-61 RA-3B aircraft BuNo 144840, a satisfactory flight test (except for lack of roll stabilization) was conducted on the evening of 7 December. Figures 15 and 16 are examples of imagery recorded on this occasion.

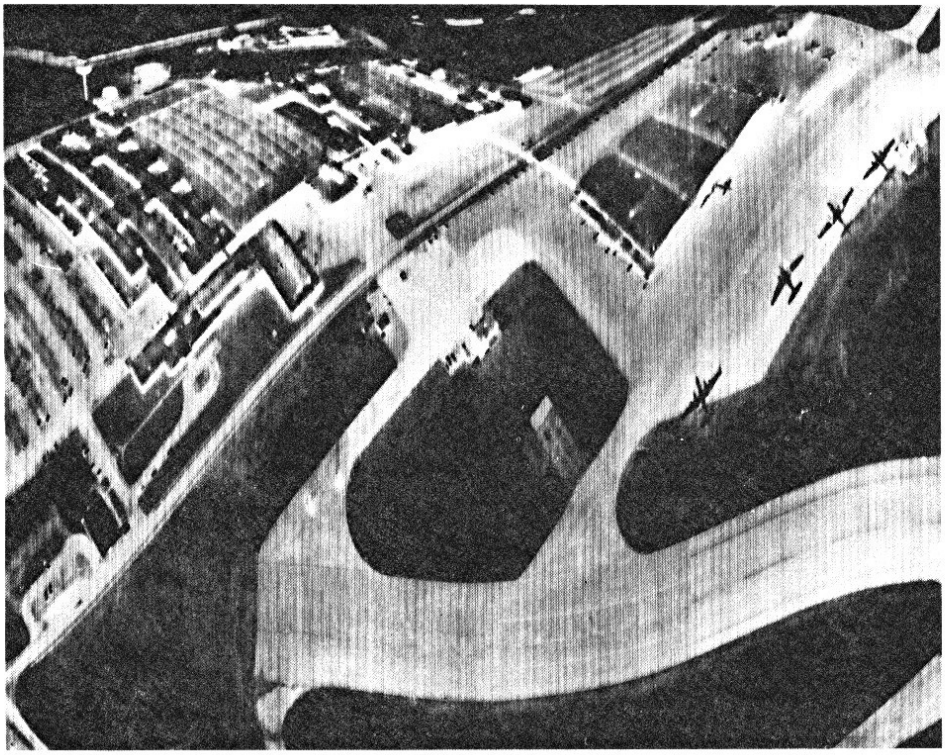
On 8 December the AN/AAD-2 scanner unit was replaced temporarily by an expendable, similar, but less rugged Reconofax IV, Mark II scanner for carrier suitability tests. Two 3.4-g catapult launches and two arrested landings were made at NAS, Lakehurst, on 9 December resulting in no evidence of damage to the equipment.

REFERENCES

(a) Moser, P. M., 16 Jan 1968; Modified Reconofax VI Infrared Mapping Set with Real-Time Inflight Display Report No. NADC-AE-6759

(b) CINCPACFLT msg 190344Z; Aug 1966
(c) CINCPACFLT msg 232331Z; Nov 1966
(d) NAVAIRSYSCOM AIRTASK No. A36533804/2021/F001-05-05, Work Unit No. 2

(e) BUWEPS WEPTASK No. RUDC-4B000/2021/WS 031
(f) NAVAIRSYSCOM AIRTASK No. A05510006/2021/W45220-00, Work Unit No. A5103B1-20

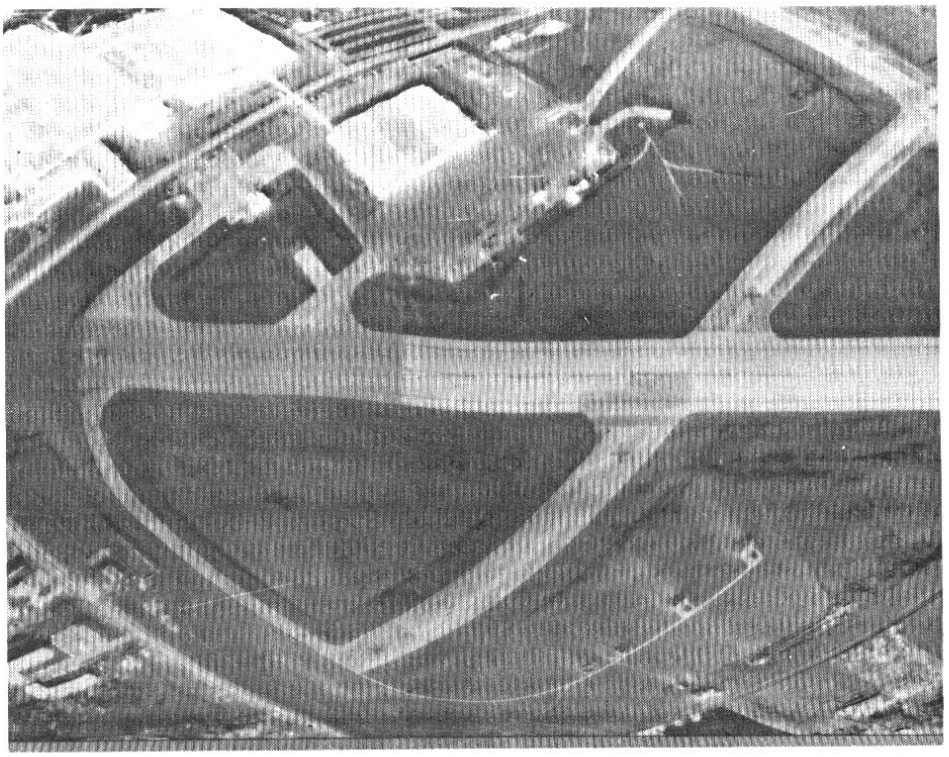


29 Nov 1966 Approx 1850R Sunset 1636R
RA-3B Aircraft BuNo 144839 Altitude 500 ft Speed 240 kn

FIGURE 13 - AN/AAD-2(XE-2) Infrared Picture of NADC and NAF Johnsville, Pa.

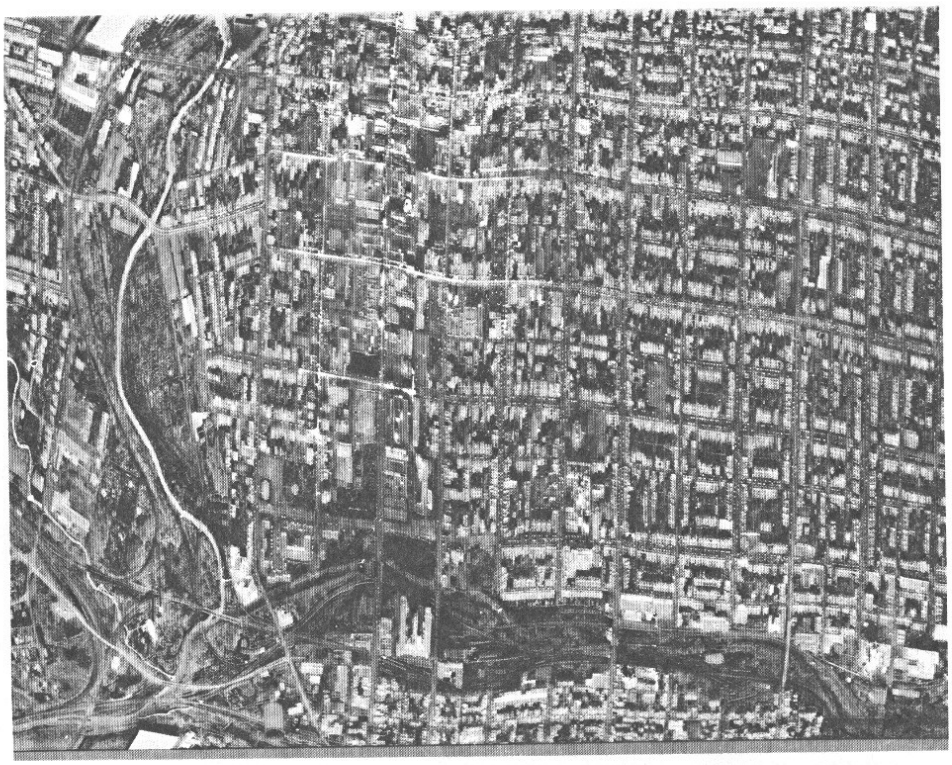
29 Nov 1966 Approx 1835R Sunset 1636R
RA-3B Aircraft BuNo 144839 Altitude 3000 ft Speed 240 kn
Note the hundreds of vehicles.

FIGURE 14 - AN/AAD-2(XE-2) Infrared Picture of the Twin Bridges Area (US 1 and Schuylkill Expressway), Philadelphia, Pa.



7 Dec 1966 Approx 1725R Sunset 1635R
RA-3B Aircraft BuNo 144840 Altitude 1000 ft Speed 360 kn
Infrared resolution target array can be seen near the center of the picture.

FIGURE 15 - AN/AAD-2(XE-2) Infrared Picture of NADC and NAF Johnsville, Pa.



7 Dec 1966 Approx 1750R Sunset 1635R
RA-3B Aircraft BuNo 144840 Altitude 3000 ft Speed 300 kn
On the original picture over one thousand vehicles can be seen lining the streets.

FIGURE 16 - AN/AAD-2(XE-2) Infrared Picture of Allentown, Pa.

T A B L E I

INFRARED RECON SET NO. 2 PHYSICAL CHARACTERISTICS

Unit	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)
Scanner	12	11-1/4	19-1/2	1.53	79
Scanner Control	5-1/4	5	2-1/2	0.04	2
Electronic	9-1/2	10-1/4	19-1/2	1.10	19
Display	12-1/4	5-5/8	19-3/8	0.77	36
Display Control	4-1/2	5-3/4	4	0.06	2
Totals				3.50	138

Electric Power 924 watts

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified

1. ORIGINATING ACTIVITY (Corporate author)

AERO-ELECTRONIC TECHNOLOGY DEPARTMENT
NAVAL AIR DEVELOPMENT CENTER, JOHNSVILLE
WARMINSTER, PENNSYLVANIA 18974

2a. REPORT SECURITY CLASSIFICATION

2b. GROUP

3. REPORT TITLE

MODIFIED AN/AAD-2(XE-2) INFRARED DETECTING SET WITH REAL-TIME INFLIGHT DISPLAY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

FINAL REPORT

5. AUTHOR(S) (First name, middle initial, last name)

T. R. TRILLING
P. M. MOSER

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
12 NOVEMBER 1968	29	6

8a. CONTRACT OR GRANT NO	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO AIRTASK NO. A05510006/2021/W45220-00 WORK UNIT NO. A5103B1-20	NADC-AE-6828
d.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	NAVAL AIR SYSTEMS COMMAND DEPARTMENT OF THE NAVY

13. ABSTRACT

An AN/AAD-2(XE-2) Infrared Detecting Set (Reconofax IV, Mark IV) was adapted to operate with a modified IP-806/AAR-32 Terrain Display Indicator, installed in a VAP-61 RA-3B aircraft, and used over North Vietnam for road, waterway, and bridge reconnaissance. Strikes were called against transient targets based on information provided by the inflight display from January to August 1967 when the equipment was lost due to combat.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

14. KEY WORDS	LINK A					
	ROLE	WT	ROLE	WT	ROLE	WT
INFRARED DETECTING SET INFLIGHT DISPLAY ROAD RECONNAISSANCE AN/AAD-2(XE-2)						

DD FORM 1 NOV 65 1473 (BACK)

S/N 0101-807-6821

22 Feb 2017

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. Releasable Recommendations. The following documents were reviewed by AIR 4.5.6. Each of the following documents were found to be releasable in their entirety:

   a. Document (1) of Subj. NAVAIRDEVCEN Report No. NADC-AW-L5902, 24 Mar 1959, "Investigation of a Towed-capsule Installation of the AN/ASH-2 Condensation Nuclei Detector" (ADB966296)
   b. [redacted]
   c. Document (16) of Subj. NAVAIRDEVCEN Report No. NADC-AE-6759, 16 Jan 1968, "Modified Reconofax VI Infrared Mapping Set with Real Time Inflight Display" (AD-387513)
   d. Document (17) of Subj. NAVAIRDEVCEN Report No. NADC-AE-6828, 12 Nov 1968, "Modified AN/AAD-2(XE-2) Infrared Detecting Set with Real-Time Inflight Display (AD-500493)
   e. Document (18) of Subj. NAVAIRDEVCEN Report No. NADC-72167-AE, 10 Apr 1973, "Index of Performance for FLIR (Forward Looking Infrared) Imaging Devices" (AD-525116)

2. Partially Releasable Recommendations. AIR 4.5.6 recommends pages 27 through 68 are releasable the following report: Document (20) of Subj. Naval Research Laboratory Memorandum Report 3240, Proceedings of the Electro-Optics/Meteorology Meeting on 7 Aug 1975, Mar 1976 "FLIR Performance Modelling and its Dependence upon Climatology and Meteorology "(AD-D516929L). All other data in this report is not under the technical authority of AIR 4.5.6.

3. [redacted]

4. 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.

5. 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 1, Executive Order 13526 Section 3.3(4). 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.

6. 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.

2/28/2017

X Paul W. Reimel

Paul W. Reimel

Signed by: REIMEL.PAUL.W.1229241016

Distribution:

NAWCAD 7.4

NAWCAD 4.5.6

D I S T R I B U T I O N L I S T

REPORT NO. NADC-AE-6828

AIRTASK NO. A05510006/2021/W45220-00
Work Unit No. A5103B1-20

	Copy No.
NAVAIRSYSCOM, AIR-604	1 thru 12
(Copies 1, 2 for retention)	
(Copy 3 for AIR-360)	
(Copy 4 for AIR-370)	
(Copy 5 for AIR-503)	
(Copy 6 for AIR-5103B1)	
(Copy 7 for AIR-5105A2)	
(Copy 8 for AIR-533)	
(Copy 9 for AIR-53303)	
(Copy 10 for AIR-5333E)	
(Copy 11 for AIR-539)	
(Copy 12 for PMA-33)	
CNM	13,14
(Copy 13 for ASW-00)	
(Copy 14 for PM-7)	
CNO	15 thru 20
(Copies 15, 16 for Op-03EG)	
(Copy 17 for Op-03R)	
(Copy 18 for Op-07T)	
(Copy 19 for Op-346)	
(Copy 20 for Op-506E1)	
COMOPTEVFOR	21
NAVSHIPSYSCOM, Code 2021	22
NELCEN, San Diego	23
NAVWPNSCEN, China Lake	24
NRL	25
NOL, White Oak	26
NAVPGSCOL	27
NAVIONICFAC	28
NAVMISCEN	29
ASD (ASAX), WPAFB	30
AFSC STLO-NADC	31
COMNAVAIRLANT, Code 524C	32
COMNAVAIRPAC (J. Sweeney)	33
CINCPAC (Dr. Joel Lawson)	34
CINCPACFLT	35
Joint Reconnaissance Center, Joint Chiefs of Staff, Pentagon, Rm 20921 (LCDR V. B. C. Wolke)	36

DISTRIBUTION LIST (continued)

	Copy No.
ONR, Code 421	37
VAP-61, C.O., Guam, M. I.	38
VAP-62, C.O., NAS Jacksonville, Fla	39
NRTSC, Code 83.	40
NAVAIRTESTCEN, WST Div.	41
OCRD/DA-CE.	42
Army Electronic Command, Ft Monmouth, N. J. (AMSEL-HL-CT-PD).	43
NRDL.	44
MDL	45
AFAL, WPAFB (Copy 46 for AVRO, K. Grimberg) (Copy 47 for AVRS)	46,47
EMIRC, RADC, Griffis AFB (J. A. Stringham).	48
APGC, Eglin AFB, Code PGTOC (B. Toole).	49
DDC	50 thru 69