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December 1977

QUICK STRIKE RECONNAISSANCE/RECONNAISSANCE REPORTING FACILITY (QSR/RRF) RAPID EXPLOITATION ORIENTATION

Mr. Richard R. Petroski

Rome Research Corporation

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents several tasks accomplished under the title, "Quick Strike Reconnaissance/Reconnaissance Reporting Facility (QSR/RRF) Rapid Exploitation Orientation." It is intended to provide a brief summary of the planning, development, and delivery of a training program designed to familiarize imagery interpreters with those aspects of imagery exploitation unique to the QSR concept. Detailed information on any of the tasks completed during the contract may be obtained from Capt. W. Rogers, RADC/IRRE, GAFB, NY 13441.

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EVALUATION

The training materials prepared and presented to the Quick Strike Reconnaissance Image Interpreters will be used in support of TPO R2C, Ground Target Detection and Identification. These materials and the presentation of these materials will form the basis for defining the structure and content for future training courses prepared for real time reconnaissance exploitation systems.

William S Rogers Jr

WILLIAM S. ROGERS, JR.
Captain, USAF
Project Engineer

SECTION 1

INTRODUCTION

Documented in this report are the activities performed under Contract F30602-76-C-0454, during the period October 1976 through August 1977. Two phases of the contractual effort are discussed in the report. These phases are:

1.1. QUICK STRIKE RECONNAISSANCE (QSR) ORIENTATION COURSE PREPARATION

The basic objective of this first phase of the program was to establish a training course outline and prepare the materials to be used in the delivery of the training course. Four separate tasks were accomplished under this phase. These tasks are:

1.1.1. Course Outline Preparation

The foundation of any training course is to grasp an understanding of the course objectives, and tailor the course to meet these objectives. This task was accomplished early in the program; however, revisions to the course outline were made during different stages of course material preparation. These changes came about to insure thorough coverage of instructional material and to avoid redundancy between the various blocks of instruction.

1.1.2. Review, Select and Prepare Course Materials

AN/AAD-5 infrared imagery, and PAVE TACK FLIR data was reviewed and selected for use in the QSR Orientation Course. All materials were prepared in viewgraph form, incorporated into Practical Exercises (PE's), or were used in scenarios devised for particular blocks of instruction.

As part of this task, a visit to Air Force Training Command (AFTC), Lowery AFB, Colorado was made to monitor the infrared imagery interpretation instruction blocks offered by the command, and to review their course materials. This visit provided an insight into the infrared training that the QSR interpreters previously received, and was an invaluable aid in establishing the course outline for QSR training.

1.1.3. AN/AAD-5 Exploitation Manual Update

It was determined that since the AN/AAD-5 infrared system was not yet operational, many of the QSR interpreters would be unfamiliar with its characteristics and the imagery collected by the system. Therefore, it was decided to update the existing AN/AAD-5 Infrared Exploitation Manual and include it as part of the training materials provided in the QSR Orientation Course. The existing manual was reviewed, and necessary changes pertaining to the production hardware were noted. Current operational imagery examples to include common types of distortions and sensor malfunctions were incorporated into the manual. In addition, documentation of the LORAN/Geographic coordinate conversions (provided by USAF TAWC/ERR) were included as a separate section to the updated manual.

1.1.4. QSR Orientation Course "Dry Run"

Prior to delivering the training course at Eglin AFB, Florida, all instruction blocks were reviewed at RADC. Each Practical Exercise (PE) was presented to image interpreters working in the RADC/IRRE Reconnaissance Data Base, Rome Research Corporation, and Pattern Analysis and Recognition (PAR) Corporation to insure that the content of each exercise was of high quality for the training course.

1.2. PRESENTATION OF THE QUICK STRIKE RECONNAISSANCE ORIENTATION COURSE

The second phase of the program was the course delivery. The QSR Orientation Course classroom was set up in Hanger #68, Eglin AFB, Florida. During the period 6-17 June 1977 the orientation course was presented to twelve USAF image interpreters. Upon completion of the course each interpreter was asked to complete a course evaluation sheet. The results of this evaluation, including comments noted on the sheets by the students, are included in this report.

This report contains a description of the work performed under both phases of the program during the eleven months of the contractual effort.

SECTION 2

PROGRAM TASKS

2.1. PHASE I - TASK 1 - COURSE OUTLINE PREPARATION

After gaining a thorough understanding of the Quick Strike Reconnaissance concept and the QSR Orientation Course objectives, work commenced on preparing a Course Outline/Schedule. Based on personal experience resulting from completion of various imagery interpretation courses, and the information obtained from the Air Force Training Command staff at Lowery AFB, it was decided that training should not exceed a six-hour classroom day. The outline/schedule established for the training course is shown in Table 2-1. The objectives of each instruction block that were accomplished during the training course are included in the paragraphs that follow.

2.1.1. Day 1, Instruction Block 1 - Introduction

The objective of this block of instruction was to introduce the student interpreter to 1) the Quick Strike Reconnaissance Concept; 2) the role of the image interpreter in this concept; 3) the physical layout of the Quick Strike Reconnaissance, Reconnaissance Reporting Facility Exploitation Shelter (QSR, RRF/ES); and, 4) the objectives of the Orientation Course.

During this block of instruction the interpreter was made aware of the QSR reconnaissance cycle as compared to the conventional "recce-cycle" that

Table 2-1 Quick Strike Reconnaissance Near-Real Time Infrared Training Course Outline/Schedule

Class #	Instruction Block #	Subject	Subject Duration
1	1	Introduction	2-3 Hours
	2	History of Real Time and Near-Real Time Interpretation	3 Hours
2	3	Infrared Principles	2 Hours
	4	Infrared Imagery Characteristics/ I.R. Signatures	4 Hours
3	5	Characteristics of the AN/AAD-5 Infrared System	3 Hours
	6	Characteristics of the PAVE TACK FLIR System	3 Hours
4	7	* Target Detection and Identification Techniques - AN/AAD-5, Near-Real Time	6 Hours
5	7	* Target Detection and Identification Techniques - PAVE TACK FLIR, Near-Real Time	6 Hours
	Saturday	- - - No Classes	
	Sunday	- - - No Classes	
6	8	* Interrelated Variables Affecting Interpreter Performance in Near-Real Time and Quick Strike Reconnaissance	3 Hours
	9	* Data Base Preparation and Utilization	1 Hour
	10	Mission Planning Considerations	1 Hour
	11	Lab Work, Study Period	1 Hour
7	11	Lab Work, Study Period	2 Hours
	11	* Practical Examination (P.E.)	2 Hours
	12	* Practical Exercise in Near-Real Time - AN/AAD-5 and PAVE TACK FLIR	2 Hours

Table 2-1 (Continued)

8	13	* Scenario 1, Mission Planning and Preparation	1 Hour
	14	* Scenario 2A and 2B Near-Real Time Target Detection, Identification and Reporting on AN/AAD-5 Imagery	5 Hours
9	15	* Scenario 3, Near-Real Time Target Detection, Identification and Reporting on PAVE TACK FLIR Video	4 Hours
	16	* Scenario 4, Near-Real Time Target Detection and Identification on PAVE TACK FLIR and AN/AAD-5 Imagery	2 Hours
10	17	* Final Exam	1 Hour
	17	Exam Correction and Review	1 Hour
	18	Closing Remarks	1 Hour

* To include practical exercises

he is familiar with. He was introduced to various jargon that he would be hearing throughout the course. The meaning of real time and near-real time interpretation was made clear during the first hour or so of the training program. Each interpreter became aware of what is meant by "time-sensitive" targets and understood his responsibility for the rapid detection, identification and reporting of these targets.

A "Quick Strike Reconnaissance" training film prepared by Aeronautical Systems Division (ASD) of Air Force Systems Command (AFSC) was shown to the class. Several viewgraphs were presented as training aids during this first block of instruction, and th ughout the course.

2.1.2. Day 1, Instruction Block 2 - History of Real Time and Near-Real Time Interpretation

During this block of instr interpreter gained an understanding of the value and effectiveness ime and near-real time infrared imagery interpretation.

The history of real time and near-real time interpretation studies, along with operational employment of the concept was presented. Several viewgraphs of infrared imagery examples collected by earlier systems were used to pictorially illustrate the vast advances made in the stat of the art of real time int rpretation.

A 16mm FLIR movie of an actual combat reconnaissance/strike mission flown in Southeast Asia was shown to the class. The film was of a Gunship mission fragged against several time-sensitive targets. It is felt that this film stimulated the interpreter's confidence in the real time/near-real time concept. To conclude this instruction block and the first day of instruction, the class was introduced to a 15-minute PAVE TACK video tape displayed on CONRAC RBQ-17c video monitors.

2.1.3. Day 2, Instruction Block 3 - Infrared Principles

Infrared theory, to include the infrared spectrum (with concentration on the spectral regions attendant to the AN/AAD-5 and PAVE TACK FLIR systems), atmospheric transmission of IR, basic radiation laws, and infrared physics was covered at this time. The theory was reenforced by presenting theoretical examples on actual infrared imagery in viewgraph forms.

2.1.4. Day 3, Instruction Block 4 - Infrared Imagery Characteristics/IR Signatures

Techniques used in the interpretation of infrared imagery were presented during this block of instruction. The interpreter became aware of the relationship that exists between the apparent temperature of an object and its image tone. The "Inverse Square Law," and Lambert's "Law of Cosines" was reviewed from Instruction Block 3 using infrared imagery examples to give each interpreter a more thorough understanding of infrared theory. Emphasis was placed on familiarizing the class with the basic IR signatures of a selected class of targets (time-sensitive) and indicating dissimilarities that arise due to variances that can and will occur in the data collection, information processing and display cycle. Since a given type of target appears differently when imaged by a line-scan sensor system (such as the AN/AAD-5) scanning in a nearly vertical mode than when imaged by a FLIR system in a slant-range mode, imagery samples from both types of sensors were presented to the class.

2.1.5. Day 3, Instruction Block 5 - Characteristics of the AN/AAD-5 Infrared System

The objective of this block of instruction was to familiarize the interpreter with the AN/AAD-5 infrared system.

Scanning, processing, and subassemblies and techniques were discussed and illustrated. Daytime and evening imagery examples were presented, along with examples depicting the results of various system malfunctions.

To offer the student a better understanding of how the AN/AAD-5 system operates, a briefing on the system was provided by Honeywell Radiation Corporation's field representative. The student saw the system bench operated during a thirty-five minute briefing session.

2.1.6. <u>Day 3, Instruction Block 6 - Characteristics of the PAVE TACK FLIR System</u>

Because the PAVE TACK FLIR System is a newly-developed reconnaissance tool, a major portion of this instruction block dealt with the characteristics and operating parameters peculiar to the system. In addition, the PAVE TACK display elements were presented to the interpreter in viewgraph form and explained in detail. Various target scenes photographed off the CONRAC video monitor were also presented in viewgraph form. These scenes displayed targets imaged under a variety of collection conditions to include image degradation resulting from system malfunctions, and data collected during adverse weather conditions. The students were shown a thirty-minute PAVE TACK tape during this instruction block.

2.1.7. <u>Day 4, Instruction Block 7 - Target Detection and Identification Techniques - AN/AAD-5, Near-Real Time</u>

The key ingredient to effective real time interpretation or near-real time interpretation is rapid target detection and accurate target recognition. The ability to perform in these areas is the result of training and experience. During this block of instruction the students were taught to scan AN/AAD-5 imagery employing all techniques of image interpretation. The majority of the instruction took place in the form of "Practical Exercises" (PE's). Imagery containing annotated targets was presented to the interpreters at various speeds. The interpreters were asked to record their interpretations of the annotated targets. Upon completion of this exercise, a "Free Search

Exercise" was conducted. During this exercise one interpreter was required to detect and annotate all "time-sensitive" targets found on the film, while the second interpreter assumed responsibility for accurate interpretation of the annotated targets. Each interpreter was allotted a limited amount of time to detect and identify the targets.

These Practical Exercises served as a tool to teach the interpreter rapid target detection and identification techniques. They also familiarized the interpreter with the QSR "team concept" i.e., one interpreter detects targets, the other identifies the detected targets. During the exercises each student had the opportunity to work at a "detection station" and an "identification station." Six hours were allocated to detecting and identifying targets on AN/AAD-5 infrared imagery.

2.1.8. Day 5, Instruction Block 7 - Target Detection and Identification Techniques - PAVE TACK FLIR, Near-Real Time

The objective of this second part of Instruction Block 7 was to teach the student interpreter to rapidly detect and identify "time-sensitive" targets off video monitors displaying PAVE TACK FLIR data.

Each interpreter became familiar with the CONRAC RBQ-17c video monitor, and was instructed to experiment with the brightness control, contrast control, and polarity and magnification switches. They were asked to use the controls available on the CONRAC to enhance the data presented to them and thus improve their interpretation capability.

Four 40-minute PAVE TACK tapes were presented in the form of Practical Exercises. These exercises were conducted in a manner similar to the AN/AAD-5 exercises; however, target detection and identification were done simultaneously. After completing each exercise, the interpreters were "talked through" each tape, and their answer sheets were corrected.

2.1.9. Day 6, Instruction Block 8 - Interrelated Variables Affecting Interpreter Performance, Instruction Block 9 - Data Base Preparation and Utilization, and Instruction Block 10 - Mission Planning Considerations

The objective of Instruction Block 8 was to familiarize the interpreter with conditions that can adversely affect his performance in near-real time interpretation. Two main variables were discussed:

1 - Stimulus Variables (Display Conditions), and

2 - Response Variables (Interpretation Conditions)

Two techniques available to the QSR interpreter that can effect both stimulus and response variables are data base preparation and mission planning/preparation. Because of this, Instruction Blocks 8, 9, and 10 were dealt with together. By presenting the material in this manner each interpreter became aware of the importance of thorough mission planning/preparation. He also recognized the value of a data base when preparing for a QSR mission, and while performing during a QSR mission.

In addition to a thirty-minute FLIR tape, several viewgraphs were used during these instruction blocks.

2.1.10. Day 6, Day 7 Instruction Block 11 - Lab Work, Study Period

The intent of this three-hour study period was to allow the student interpreters adequate time to read the AN/AAD-5 Infrared Exploitation Manual (updated under the scope of this contract). In addition, all instructors made themselves available to answer questions the students had concerning any material covered during previous blocks of instruction.

2.1.11. Day 7, Instruction Block 11 - Practical Examination

This two-hour block of instruction was comprised of a one-hour practical examination in detecting and identifying specific targets on AN/AAD-5 infrared imagery under simulated near-real time conditions. During the second hour the interpreters were given an examination in detecting and identifying specific targets on PAVE TACK FLIR. The results of this examination provided the instructors with information concerning the student interpreter's progress to date.

2.1.12. Day 7, Instruction Block 12 - Practical Exercise in Near-Real Time Target Detection and Identification - AN/AAD-5 Imagery and PAVE TACK FLIR

The objective of this practical exercise was to offer the interpreters additional experience working in teams. Data was presented in the form of "hardcopy" AN/AAD-5 infrared imagery viewed over RICHARDS 9x40 light tables, and PAVE TACK FLIR data displayed on the CONRAC video monitors. Two senior ranking NCO's acted as QSR team chiefs and supervised the exercise. Each exercise was timed to give the teams experience in rapid target detection and identification.

2.1.13. Day 8, Instruction Block 13 - Scenario 1, Mission Planning/Preparation

This scenario served as a practical exercise and complemented the material covered during Instruction Block 10.

During this one-hour scenario the QSR interpretation team was notified that a QSR mission had been fragged to fly in a designated target area against specific types of targets. The team then prepared for the mission.

2.1.14. Day 8, Instruction Block 14 - Scenario 2A and 2B, Near-Real Time Target Detection, Identification and Reporting on AN/AAD-5 Imagery

The three primary functions to be accomplished in near-real time ground exploitation of imagery were covered during this instruction block with emphasis on report preparation. The student interpreter became thoroughly familiar with the QSR "Quick Report" format, and QSR reporting procedures.

Working in teams, the interpreters participated in practical exercises presented in scenario form. During these exercises targets were reported on QSR "Quick Report" forms.

This provided the interpreter with experience using this type of report, and with the abbreviations used in the report format.

AN/AAD-5 imagery was used during this scenario.

2.1.15. <u>Day 9, Instruction Block 15 - Scenario 3, Near-Real Time Target Detection, Identification and Reporting on PAVE TACK FLIR Video</u>

This scenario was conducted in the same manner as scenarios 2A and 2B; however, PAVE TACK FLIR data was used rather than AN/AAD-5 imagery.

2.1.16. <u>Day 9, Instruction Block 16 - Scenario 4, Near-Real Time Target Detection, Identification and Reporting on PAVE TACK FLIR and AN/AAD-5 Imagery</u>

This scenario was conducted in the same manner as those presented during Instruction Blocks 14 and 15. PAVE TACK FLIR data and AN/AAD-5 imagery was used in this scenario, providing additional experience to the student interpreters.

2.1.17. Day 10, Instruction Block 17 - Final Examination

A final examination was prepared to test the interpreters on their understanding of the QSR Concept, and their ability to perform interpretation tasks in near-real time conditions. Because of the knowledge displayed throughout the course by the interpreters, the examination was not administered. Each student was asked to evaluate the course during this scheduled one hour block of instruction. The results of this evaluation will be discussed later in this report.

2.2. PHASE I - TASK 2 - REVIEW, SELECT, AND PREPARE COURSE MATERIALS

While preparing the QSR Orientation Course Outline, an estimate was made as to the amount of AN/AAD-5 infrared imagery, and PAVE TACK FLIR data needed for the various instruction blocks. USAF and other Government agencies were contacted in an effort to obtain adequate training materials. Described in the paragraphs that follow are the procedures used to review, select, and prepare these materials.

2.2.1. Review, and Selection of Training Materials

Training materials reviewed for use in the orientation course were:

- o AN/AAD-5 Infrared Imagery
- o PAVE TACK FLIR Tapes

o Viewgraphs, and

o Imagery Interpretation Manuals and Related Imagery Interpretation Keys and Technical Reports

2.2.1.1. AN/AAD-5 Infrared Imagery

It was determined during the early months of the contractual effort that a large amount of AN/AAD-5 infrared imagery would be required to provide the QSR interpreters with sufficient data for optimum training.

Imagery was obtained from four major sources. These sources were:

1. Rome Air Development Center (RADC/IRR) Reconnaissance Data Base
2. 17th Tactical Reconnaissance Squadron (TRS), USAFE
3. USAF TAWC/ERR, and the
4. Defense Intelligence Agency (DIA)

Emphasis was placed on selecting imagery containing targets of a "time-sensitive" nature, since these are the types of targets that a QSR mission will be flown against. In addition, it was necessary to select imagery flown at altitudes comparable to those flown during a Quick Strike Reconnaissance mission.

Seventeen AN/AAD-5 missions (approximately 800 linear feet of imagery) were located in the RADC/IRRL Reconnaissance Data Base, Griffiss AFB, New

York. These missions were reviewed, and imagery collected at the appropriate altitudes that contained target examples was selected for use.

The 17th TRS located in USAFE was contacted in an effort to obtain additional AN/AAD-5 imagery. Due to aircraft altitude limitations in USAFE, a limited amount of imagery was made available. Fifteen examples containing targets of a time-sensitive nature were received from the 17th TRS. All of this material was reviewed and used in the training course.

The bulk of AN/AAD-5 imagery was procured from USAF TAWC/ERR, Eglin AFB, Florida. Over 8,000 linear feet of imagery was reviewed at TAWC, and 4,350 linear feet was selected as training material.

In an effort to obtain a wider variety of target types, additional AN/AAD-5 imagery was requested from DIA. Over 500 linear feet was received and reviewed for target selection.

2.2.1.2. PAVE TACK FLIR

All PAVE TACK FLIR used in the QSR Orientation Course was obtained from TAWC/ERR. Over 50 FLIR tapes were reviewed in the PAVE TACK office at Eglin AFB. Forty-three tapes were dubbed for use in the training program. Selection of the tapes was based on overall image quality and the number of time-sensitive targets available on each mission.

2.2.1.3. Viewgraphs

The viewgraph file in the RADC/IRR Reconnaissance Data Base was researched for viewgraphs that could be used in the training course. Several viewgraphs documenting the history of near-real time and real time interpretation were selected as training aids. In addition, the file contained viewgraphs pertaining to infrared theory. These were also selected for the training course.

2.2.1.4. Imagery Interpretation Manuals and Related Imagery Interpretation Keys and Technical Reports

The RADC/IRR Reconnaissance Data Base was the primary source for obtaining interpretation manuals, keys, and technical reports. Over 75 different documents pertaining to infrared theory, interpretation of infrared imagery, real time and near-real time interpretation of infrared, and FLIR were reviewed and researched for training data. S the bibliography for a listing of the primary documents in which information was extracted for the training program.

2.2.2. Preparation of Training Materials

A Quick Strike Reconnaissance Training Manual (Appendix A) was prepared and provided to each interpreter participating in the QSR Orientation Course.

Preparation of training material included:

- Textual data composition for each training block,
- Viewgraph construction,
- AN/AAD-5 imagery annotation, "mock-up," and reproduction,
- Editing and dubbing of PAVE TACK FLIR data
- Development of Practical Exercises and Practical Examinations,
- Scenario development, and
- Construction of Instruction Block Training Packets

2.2.2.1. Textual Data Composition

Each training block of instruction was researched and written for inclusion into the QSR Training Manual. All textual material was typed on magnetic cards and "played back" on reproducible masters.

2.2.2.2. Viewgraph Construction

All illustrations and imagery examples included in the training manual were prepared in viewgraph form, and included in the appropriate Instruction Block Training Packets (refer to Section 2.2.2.6.).

Over 200 viewgraphs were prepared as instruction aids for the course.

2.2.2.3. AN/AAD-5 Imagery Annotation, Mock-Up and Reproduction

AN/AAD-5 imagery selected for use in the training course was interpreted in detail. Appropriate targets were annotated by image scene, and keyed to overlays and answer sheets. Duplicate negative transparencies were "mocked up" to simulate the AN/AAD-5 data as it would be received in the RRF/ES, and were reproduced in quantity for use in Practical Exercises. Six Practical Exercises and scenarios were prepared for interpreter training. Adequate "filler" (imagery containing no significant target activity) was included in each exercise and scenario to typify an actual QSR mission.

Over 1,000 linear feet of imagery was prepared for reproduction and for use in training.

2.2.2.4. Editing and Dubbing of PAVE TACK FLIR Data

Data from forty-three PAVE TACK FLIR tapes were reviewed utilizing the CONRAC RBQ-17c video monitors and the IVC 825A video recorder. Tapes containing QSR target examples were dubbed for use in the training course. In addition, tapes depicting the effects of adverse weather conditions on FLIR were dubbed along with examples of data acquired in the display modes listed in Table 2-2.

Table 2-3 lists the duration of each tape dubbed by instruction block and subject.

A total of 330 minutes of PAVE TACK FLIR data was dubbed and used in the training course.

Table 2-2 PAVE TACK FLIR Display Modes

Display Letters	Mode
TRK	Track
SP	Snow Plow
TM	Terrain Monitor
MPT	Memory Point Track
FWD	Forward Acquire
R	Right Acquire
L	Left Acquire
CUE	Cue

Table 2-3 PAVE TACK FLIR Data

Instruction Block	Subject	Tape Duration
1	Introduction	15 Minutes
6	Characteristics of the PAVE TACK FLIR System	30 Minutes
7	Target Detection and Identification Techniques - PAVE TACK FLIR, Near-Real Time	120 Minutes
8	Interrelated Variables Affecting Interpreter Performance in Near-Real Time and Quick Strike Reconnaissance	30 Minutes
11	Practical Examination	20 Minutes
12	Practical Exercise in Near-Real Time AN/AAD-5 and PAVE TACK FLIR	30 Minutes
15	Scenario #3, Near-Real Time Target Detection, Identification and Reporting on PAVE TACK FLIR Video	55 Minutes
16	Scenario #4, Near-Real Time Target Detection and Identification on PAVE TACK FLIR and AN/AAD-5 Imagery	30 Minutes

2.2.2.5. Development of Practical Exercises and Practical Examinations

Practical Exercises and Practical Examinations were developed using the AN/AAD-5 infrared imagery and the PAVE TACK FLIR tapes. Each exercise was designed to train the interpreter in rapid target detection and recognition. In addition, two scenarios were developed as practical exercises in report generation.

All exercises typified QSR missions in that: 1) imagery was presented in short segments with clear acetate leader (in the case of "hardcopy" AN/AAD-5) separating each image scene, 2) imagery was collected at altitudes peculiar to actual QSR missions, 3) targets depicted on the imagery were of a time-sensitive nature, and 4) the image interpreters were required to complete their interpretations in a time frame consistent with the QSR cycle.

Over 57% of the QSR training was presented in the form of Practical Exercises. The objective of each exercise can be found in the appropriate instruction blocks of the Quick Strike Reconnaissance Training Manual (Appendix A).

2.2.2.6. Scenario Development

Scenarios were prepared in the form of Practical Exercises. Each scenario was designed to familiarize the interpreter with his duties and responsibilities when working in the RRF/ES. During each exercise the interpreter was informed of the specific types of targets he would be responsible to report. Table 2-4 depicts the instruction blocks that were presented in scenario form. The objective of each scenario can be found in the appropriate instruction block of the Quick Strike Reconnaissance Training Manual (Appendix A).

2.2.2.7. Construction of Instruction Block Training Packets

Instruction block training packets were prepared for each block of instruction. In addition to the textual information contained in the Quick Strike Training Manual, each packet also included an instructor's outline, instructor's notes, viewgraphs, answer sheets (where appropriate), and other training aids pertinent to each individual instruction block. All training materials and packets were appropriately labeled and incorporated into the RADC/IRR Reconnaissance Data Base at the completion of the course.

2.3. PHASE I - TASK 3 - AN/AAD-5 EXPLOITATION MANUAL UPDATE

During the training material preparation phase of the program, ASD and RADC determined that the AN/AAD-5 Infrared Reconnaissance Set Exploitation Manual should be included as part of the course training materials; however, the existing manual pertained to the XA-2 (preproduction) units. It was therefore decided that the manual should be updated to a format which would pertain to the "production" hardware, which will become operational in mid-1977. This operational system is employed in the QSR configuration.

Table 2-4 List of Scenarios

Instruction Block	Subject	Scenario Duration
13	Scenario 1, Mission Planning and Preparation	1 Hour
14	Scenarios 2A and 2B, Near-Real Time Target Detection, Identification, and Reporting on AN/AAD-5 Imagery	5 Hours
15	Scenario 3, Near-Real Time Target Detection, Identification and Reporting on PAVE TACK FLIR Video	4 Hours
16	Scenario 4, Near-Real Time Target Detection and Identification on PAVE TACK FLIR and AN/AAD-5 Imagery	2 Hours

The task to update the manual commenced on 1 March 1977, and was completed on 1 June 1977, with the end results being one-hundred copies of the updated document. A description of the areas revised and updated are described in the following paragraphs.

2.3.1. Identification of Revisions

Four major areas to be revised were identified in the Statement of Work. These revisions included:

1. Incorporation of all changes necessary to the textual and illustrative material necessary to reflect changes pertaining to the production hardware version of the AN/AAD-5 system;

2. Review and selection of current operational examples of AN/AAD-5 infrared imagery to be incorporated as examples in the revised manual;

3. Selection of representative samples of imagery depicting distortions resulting from sensor and other "system" malfunctions to be incorporated into the manual, with a description of the causes of these distortions; and

4. Preparation of documentation describing the LORAN/Geographic coordinate conversions.

Results of the work listed above were to be provided as new or modified pages for insertion in the revised version of the manual; however, after reviewing the existing manual, it was determined that the revisions were too extensive and it would be more advantageous to prepare an entirely new updated manual.

2.3.1.1. Changes to Textual and Illustrative Material

All textual and illustrative material was reviewed and necessary changes were made. Technical input for the changes was provided by the Laser Optical Branch of Aeronautical Systems Division, Wright Patterson AFB (WPAFB), Ohio, Honeywell Radiation Corporation, Lexington, Massachusetts and the QSR Program Office, WPAFB, Ohio. Eight updated illustrative pages and eight photographs of the AN/AAD-5 components were included in the revised manual.

2.3.1.2. Imagery Review and Selection of Imagery Examples

Approximately 9,000 linear feet of AN/AAD-5 imagery was reviewed, and selected examples were "mocked-up" for printing and incorporation in the revised manual. In addition, six imagery examples received from the 17th TRS USAFE were included. A list of selected examples can be found in Table 2-5a.

2.3.1.3. Selection of Imagery Depicting Distortions

Imagery examples illustrating the various aspects of mission planning to include target orientation, altitude, FOV, smoke penetration, day-night

Table 2-5a Table of AN/AAD-5 Imagery Examples comparisons and the use of obliquity as it relates to mission planning were selected and incorporated into the manual. In addition, imagery depicting numerous malfunctions and distortions was selected and included to aid the interpreter and mission planner.

Assistance in identifying the causes of distortions on the AN/AAD-5 imagery was provided by Honeywell Radiation Corporation. A list of selected examples can be found in Table 2-5b.

2.3.1.4. LORAN/Geographic Coordinate Conversions

The revised manual includes an entire section describing LORAN/Geographic coordinate conversions. This information was prepared by USAF TAWC/ERR, Eglin AFB, Florida. RRC program personnel reviewed, edited and reformatted the data prior to its input.

The updated AN/AAD-5 Infrared Reconnaissance Set Exploitation Manual was used when preparing and delivering the QSR Training Course. Each student interpreter was required to read the manual in its entirety during a specified training block.

2.4. PHASE I - TASK 4 - QUICK STRIKE TRAINING COURSE "DRY RUN"

To insure that all training material was of high quality for the course, all Practical Exercises and Practical Examinations were administered to image interpreters prior to delivery of the course at Eglin AFB, Florida.

Table 2-5b Table of AN/AAD-5 Imagery Examples

2.5. PHASE II - TASK 1 PRESENTATION OF THE QUICK STRIKE RECONNAISSANCE ORIENTATION COURSE

During the period 6-17 June 1977 the Quick Strike Reconnaissance Orientation Course was presented to twelve USAF image interpreters. The "Course Outline/Schedule" (Table 2-1) was followed throughout the duration of the training program. Two instructors from RRC participated in presenting material during each block of instruction. During Practical Exercises, and Practical Examinations RRC provided three instructors to administer each exercise and assist the student interpreters. In addition, RADC/IRRE provided an instructor to assist during selected blocks of instruction.

The classroom was set up in Hanger #68, Eglin AFB, Florida. The room was air-conditioned, well lighted, and had ample floor space to insure an adequate training environment. Figures 2-1 and 2-2 depict the classroom configuration.

2.5.1. Presentation Techniques/Methods of Instruction

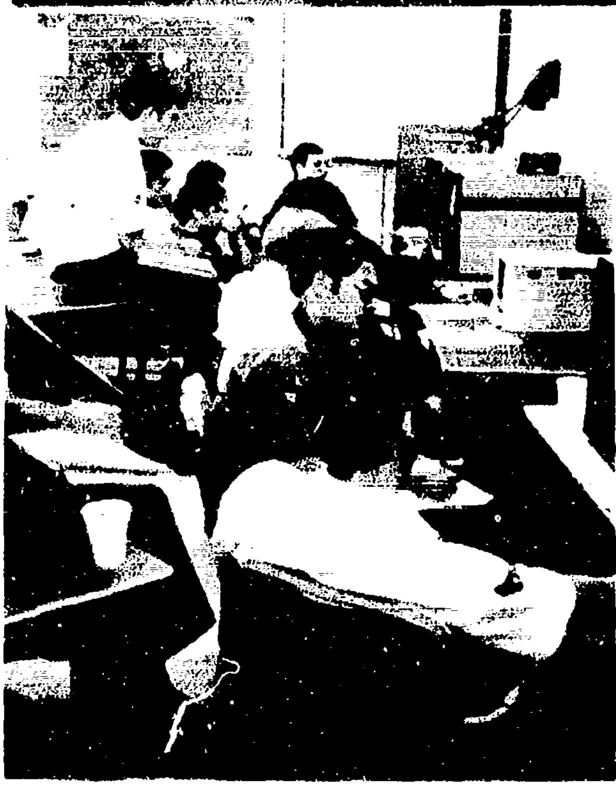
The course schedule was set up for a six-hour classroom day. Students were allowed a ten-minute rest break after each hour of instruction, and an hour lunch period. A relaxed atmosphere was established early and prevailed throughout the duration of the course.

The importance of the role of each team member in the QSR concept was emphasized during the introduction, and was reiterated throughout the course. Each student interpreter was made to realize that his contribution to the

Figure 2-1 Quick Strike Reconnaissance Classroom Presentation of Lecture Material

Figure 2-2 Quick Strike Reconnaissance Classroom Practical Exercises

Practical Exercise Work Area - Interpretation of AN/AAD-5 IR Imagery on Richard's 9x40 Light Tables



Practical Exercise Work Area - Interpretation of PAVE TACK FLIR Data Off CONRAC Video Monitors

IOT&E of the Quick Strike Reconnaissance Concept was essential to insure a successful program.

2.5.1.1. Lecture Presentation

Approximately 43% of the orientation course consisted of lecture material. During the first meeting an outline of the course and a clear statement to indicate the way the course would be conducted and what was to be expected of each student was given to the class. In presenting the outline, the instructor was cautious not to make the course appear overwhelming.

2.5.1.2. Presentation of Practical Exercises and Practical Examinations

Fifty-seven percent of the course material was presented in the form of Practical Exercises and Practical Examinations. RRC instructors administered each exercise and assisted student interpreters who were realizing difficulties with the material. Upon completion of each exercise the students were "talked through" each mission and their answer sheets were corrected. Figures 2-3 and 2-4 depict student interpreters participating in Practical Exercise. Tables 2-7 and 2-8 provide the results of the exercises. Results of the "annotated search" on AN/AAD-5 imagery is not included. This exercise was intended as a practice exercise to familiarize the students with the material format.

Practical Exercise
AN/AAD-5 Infrared Imagery -
Two-Man Team Concept

Practical Exercise
AN/AAD-5 Infrared Imagery -
Individual Exercise

Figure 2-3

Figure 2-4

Practical Exercise - Target Detection, Identification and Reporting - AN/AAD-5 Infrared Imagery

Practical Exercise - Team Concept, Target Detection, Identification and Reporting - AN/AAD-5 Infrared Imagery

Table 2-7 Results of Practical Exercises Instruction Blocks 7, 11, 12 and 16 AN/AAD-5 Infrared Imagery

Interpreter	Total Targets	Correct Identifications	Incorrect Identifications	False Alarms	Omissions	Total Errors
1	151	131	20	21	2	43
2	151	139	12	23	0	35
3	151	116	35	17	2	54
4	151	131	20	18	1	39
5	151	143	8	4	0	12
6	151	134	17	7	2	26
7	151	127	24	4	0	28
8	151	147	6	6	0	12
9	151	125	26	7	0	33
10	151	127	24	10	0	34
11	151	130	21	14	0	35
12	151	143	8	26	6	40
$\bar{X}$	151	133	18	13	1	33

Table 2-8 Results of Practical Exercises Instruction Blocks 7, 11, 12 and 15 PAVE TACK FLIR

Interpreter	Total Targets	Correct Identifications	Incorrect Identifications	False Alarms	Omissions	Total Errors
1	217	187	30	24	11	65
2	217	209	8	2	0	10
3	217	154	63	36	22	121
4	217	201	16	11	9	36
5	217	188	29	25	10	64
6	217	172	45	32	11	88
7	217	184	33	25	12	70
8	217	193	24	4	8	36
9	217	177	40	37	12	89
10	217	174	43	19	3	65
11	217	194	23	24	9	56
12	217	195	22	25	9	63
$\bar{X}$	217	186	31	22	9	63

2.5.1.3. Course Evaluation Sheet

Upon completion of the Quick Strike Reconnaissance Orientation Course each student was asked to complete a course evaluation sheet. The results of this evaluation are shown in Figure 2-5a. Additional comments about the course or instructor(s) can be found in Figure 2-5b.

Figure 2-5a Quick Strike Reconnaissance Course Evaluation

This questionnaire gives you the opportunity to express anonymously your views of this course and the way it has been taught. The results of this questionnaire will be made available to all concerned. Indicate the response closest to your view by selecting the appropriate letter and entering in the blank before each comment.

A - Strongly Disagree. You strongly disagree with the statement as it applies to this course or instructor.

B - Disagree. You disagree more than you agree with the statement as it applies to this course or instructor.

C - Agree. You agree more than you disagree with the statement as it applies to this course or instructor.

D - Strongly Agree. You strongly agree with the statement as it applies to this course or instructor.

		Results D	C	B	A
___ 1.	The overall objectives for the course have been made clear.	5	7		
___ 2.	There is considerable agreement between the announced objectives of the course and what is being taught.	4	7		1
___ 3.	The amount of work required is suitable for the two week period.	5	7		
___ 4.	The size of the group is not too large for effective instructor performance.	8	4		
___ 5.	The practical exercises have aided the overall learning process.	6	5	1	
___ 6.	The text materials make a significant contribution to the course.	3	9		
___ 7.	The course stimulates your thinking of the reconnaissance exploitation techniques and related subjects.	5	7		
___ 8.	The theoretical discussions are helpful to understanding FLIR concepts.	4	8		
___ 9.	The theoretical discussions are helpful to improving proficiency as an interpreter of FLIR.	2	8	2	

Figure 2-5a (Continued)

___10.	Overall I would rate this course as satisfactory.	7 5
___11.	The instructors have been actively helpful when you have difficulty.	8 4
___12.	The instructors are readily available for consultation with students.	7 5
___13.	The instructors make you feel free to ask questions.	9 3
___14.	Material is presented at a reasonable pace.	6 6
___15.	The examples or illustrations clarify the material for you.	4 8

IF YOU HAVE ANY ADDITIONAL COMMENTS ABOUT THE COURSE OR INSTRUCTOR, PLEASE WRITE THEM IN THE SPACE PROVIDED ON THE COMMENTS SHEET.

Figure 2-5b Course Evaluation Student Comments

"Very helpful to be able to look at what is discussed and see examples than to try to visualize in your mind."

"About the only thing that I didn't like about the course was that after the Practical Exercises it got boring going back over the tapes to review our answers. Perhaps if you had templates for everyone to review their own film it wouldn't seem so boring."

"Great course."

"I greatly enjoyed the informality of the classes. The learning process was greatly enhanced. I felt quite free to express my opinions when I wanted. Thank you for an informative class. I don't however see the purpose in the depths of theories that we covered. The exercises helped tremendously. The two systems are a great improvement over the AAS-18."

"The course was professionally presented and succeeded in stimulating an exuberant group participation. The instructors were somewhat hampered by a lack of FLIR tapes with a variety of target signatures, but they did an excellent job despite this drawback."

"Very informative class."

Figure 2-5b (Continued)

"The Practical Exercises were a useful tool for orientating and demonstrating the many facets of QSR. However, too often they were presented in a dry manner. This led to long hours of boredom, interspersed with a few seconds of sheer panic."

"All instructors presented the material in a manner which all could understand and enjoy."

"Speaking as an individual voice, I would like to have seen more emphasis on the nuts and bolts of the sensor systems in the vein of malfunctions etc."

"Course was useful in improving techniques in identifying quickly possible enemy equipment. QSR concept is a good idea. Instruction and classes being kept on an informal level made a more relaxed atmosphere, which is much easier to learn in. I thought the AAD-5 Manual should be read toward the beginning of the course. Reading toward the end repeats too much of what was already learned before.

"Due to the limited amount of AN/AAD-5 and FLIR material (film) the last three Practicals were boring."

SECTION 3

SUMMARY

All of the tasks defined in the Statement of Work have been completed, with the results being described in Section 2 of this report. Contract hours were applied 100% to the program. Emphasis was placed on preparing and presenting an orientation/training course that would prepare the image interpreter to participate in the IOT&E of the Quick Strike Reconnaissance concept, and gain a thorough understanding of real time/near-real time infrared imagery interpretation. Rome Research Corporation personnel feel confident that the training methods employed, and the materials prepared for the course have become a valuable asset to the United States Air Force, and to the reconnaissance community in general, through the accomplishments described in this report.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS

It is the conclusion of the program staff that the objectives of the Quick Strike Reconnaissance Orientation Training Course have been accomplished. Overall, the QSR orientation and training went quite well. This is due, in part, to the high quality of the image interpreters selected for the training. In general, the attentiveness and experience of the class contributed greatly in directing the course to areas which concerned the interpreters. The interaction which resulted provided a great deal of feedback regarding the QSR concept. The information contained in all instruction blocks was well received by the students, this was especially true with the block of instruction on Infrared Principles. Many of the students had never seen the theory of infrared applied to imagery as it was being explained. It is further concluded that:

1. The RADC/IRR Reconnaissance Data Base served as a valuable source of data for procuring training materials for the course. Many manhours were saved in reviewing and selecting course materials.

2. The QSR Training Manual and the AN/AAD-5 Infrared Reconnaissance Set Exploitation Manual provided important supplemental information as well as helping the students understand some aspects of infrared hardware.

3. Presentation of some degraded imagery allowed the student interpreter exposure to the types of data that could be encountered during an actual QSR mission. This encouraged them to extract as much intelligence as possible from the degraded imagery.

4. The Practical Exercises allowed each interpreter the opportunity to view imagery in a simulated near-real time manner.

5. Through the experience gained during the Practical Exercises, automatic target detection and recognition of "time-sensitive" targets became second nature to the interpreter; and

6. Limiting instruction time to 6 hours/day and creating a relaxed and informal classroom environment greatly enhanced the learning process.

4.1.1. <u>Recommendations</u>

Through the experience gained in preparing and presenting a training course in the near-real time interpretation of infrared imagery, Rome Research personnel offer the following recommendations:

1. Training courses of this nature require a great amount of imagery. The limited amount of both AN/AAD-5 and PAVE TACK FLIR restricted the usefulness of certain Practical Exercises. The volume of information on the imagery was sufficient to familiarize the students with various target signatures, but required a great deal of

repetition which tended to bore the students. For future training, a greater amount of imagery should be made available.

2. Imagery depicting a greater variety of targets and environmental settings would increase the value of Practical Exercises.

3. With a class of 12 interpreters, additional video monitors should be made available to alleviate crowding during FLIR Practical Exercises. A minimum of one monitor for every two students is recommended.

4. A file of QSR training materials should be established and incorporated as part of the RADC/IRR Reconnaissance Data Base, where it can be retrieved for future training programs.

5. Any training materials generated during the other phases of QSR training should also be incorporated into the data base; and

6. A program should be initiated to evaluate the value and results of all QSR training.

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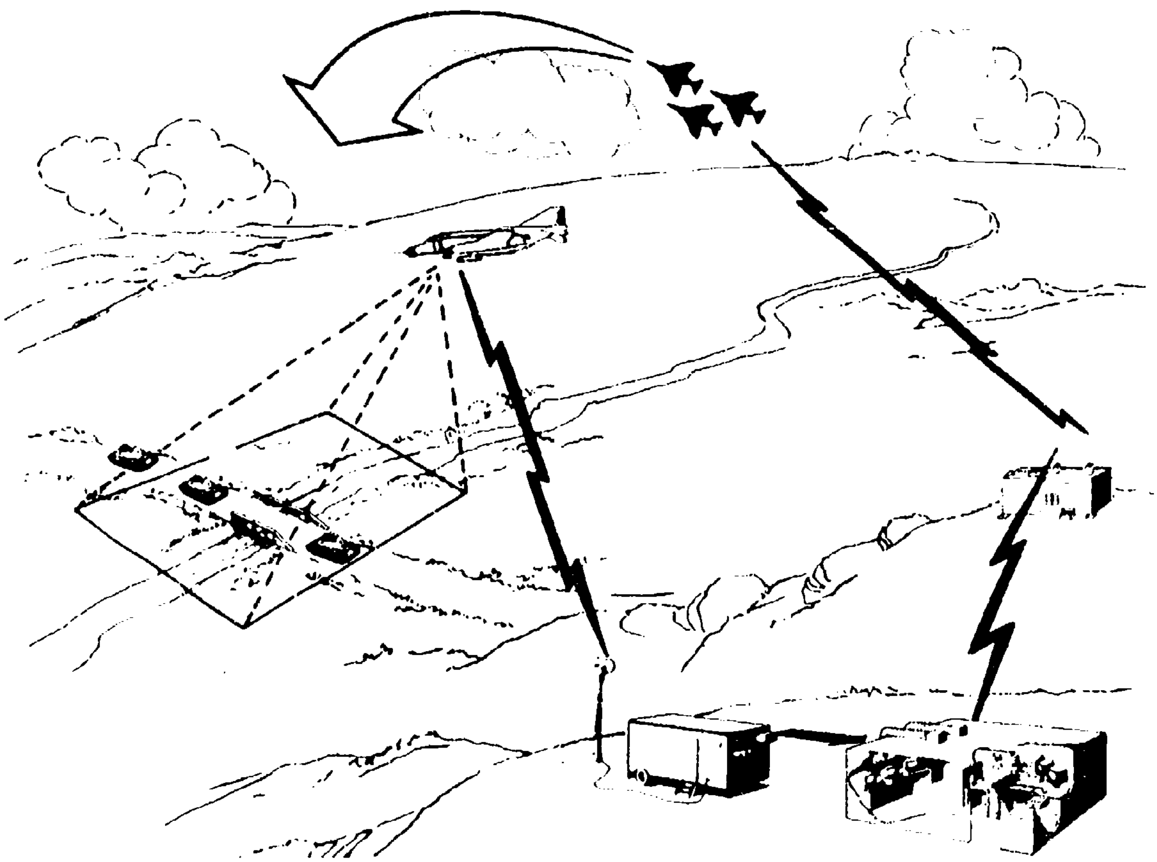
APPENDIX A

QUICK STRIKE RECONNAISSANCE TRAINING MANUAL

QUICK STRIKE RECONNAISSANCE



NEAR-REAL-TIME INFRARED IMAGERY EXPLOITATION
TRAINING COURSE

QUICK-STRIKE RECONNAISSANCE

NEAR-REAL-TIME INFRARED TRAINING

COURSE OUTLINE/SCHEDULE

Class #	Instruction Block #	Subject	Subject Duration
1	1	Introduction	2-3 Hours
	2	History of Real-Time and Near-Real-Time Interpretation	3 Hours
2	3	Infrared Principles	2 Hours
	4	Infrared Imagery Characteristics/ I.R. Signatures	4 Hours
3	5	Characteristics of the AN/AAD-5 Infrared System	3 Hours
	6	Characteristics of the PAVE TACK FLIR System	3 Hours
4	7	* Target Detection and Identification Techniques - AN/AAD-5, Near-Real-Time	6 Hours
5	7	* Target Detection & Identification Techniques - PAVE TACK FLIR, Near-Real-Time	6 Hours
	Saturday - - - No Classes		
	Sunday - - - No Classes		
6	8	* Interrelated Variables Affecting Interpreter Performance in Near-Real-Time and Quick Strike Reconnaissance	3 Hours
	9	* Data Base Preparation and Utilization	1 Hour
	10	Mission Planning Considerations	1 Hour
	11	Lab Work, Study Period	1 Hour
7	11	Lab Work, Study Period	2 Hours

	11	* Practical Examination (P.E.)	2 Hours
	12	* Practical Exercise in Near-Real-Time - AN/AAD-5 & PAVE TACK FLIR	2 Hours
8	13	* Scenario 1, Mission Planning & Preparation	1 Hour
	14	* Scenario 2A and 2B Near-Real-Time Target Detection, Identification and Reporting on AN/AAD-5 Imagery	5 Hours
9	15	* Scenario 3, Near-Real-Time Target Detection, Identification and Reporting on PAVE TACK FLIR Video	4 Hours
	16	* Scenario 4, Near-Real-Time Target Detection and Identification on PAVE TACK FLIR and AN/AAD-5 Imagery	2 Hours
10	17	* Final Exam	1 Hour
	17	Exam Correction and Review	1 Hour
	18	Closing Remarks	1 Hour

* To include practical exercises

INSTRUCTION BLOCK #1

INTRODUCTION

(2 Hours)

A need has been identified for day/night airborne sensors and a reconnaissance exploitation shelter to provide a real time ground exploitation capability for detecting and identifying time-sensitive tactical targets, and for generating target reports.

The Reconnaissance Reporting Facility (RRF) Exploitation Shelter is a ground station that has been developed for the real time exploitation of data-linked infrared imagery. Design and development of the shelter has been accomplished by the Intelligence and Reconnaissance Division of the Rome Air Development Center (RADC), Griffiss Air Force Base, New York, in support of the ASD-managed Quick Strike Reconnaissance (QSR) Program. Infrared imagery collected by the QSR RF-4C aircraft will be data-linked to the RRF for real time target detection and identification of time-sensitive targets. Additionally, the RRF capability will include a means for rapidly transmitting target information to strike decision makers within a time frame consistent with the threat imposed by the target. Due to the time-critical nature of these targets, reports should be in the hands of the strike decision makers within minutes after sensor acquisition.

In the conventional reconnaissance cycle, the time required for the aircraft to land, down-load the film, generate reports, and transmit these reports consumes several hours. This is not responsive to the needs of strike decision makers for timely information relative to tactical time-sensitive targets.

The basic mission of the Reconnaissance Reporting Facility Exploitation Shelter (Figure 1-1) is to provide immediate exploitation of reconnaissance, such that a target assignment and subsequent strike could occur as quickly as possible after sensor acquisition. To successfully accomplish this task, the RRF must provide the capabilities enumerated in Figure 1-2.

The RRF has the capability to allow immediate exploitation of video data transferred by the Quick Strike aircraft to the RRF. The interpretation team working in the RRF will be responsible for the rapid detection and identification of targets imaged by the AN/AAD-5 Infrared System, and the PAVE TACK Forward-Looking Infrared (FLIR) System. They will also be responsible for generating the reports for transmission to the appropriate command and control structure.

Within the RRF, there are two types of operator consoles. The first console format is the search or scan console. This type of console will be used primarily for target detection on the AN/AAD-5 imagery and FLIR video. The second console is the interpretation console at which the target is evaluated, and the report is composed and transmitted to the appropriate

QUICK STRIKE

GENERATE SURFACE TARGET INFORMATION FOR INTEGRATION WITH NEAR-REAL TIME STRIKE CAPABILITY

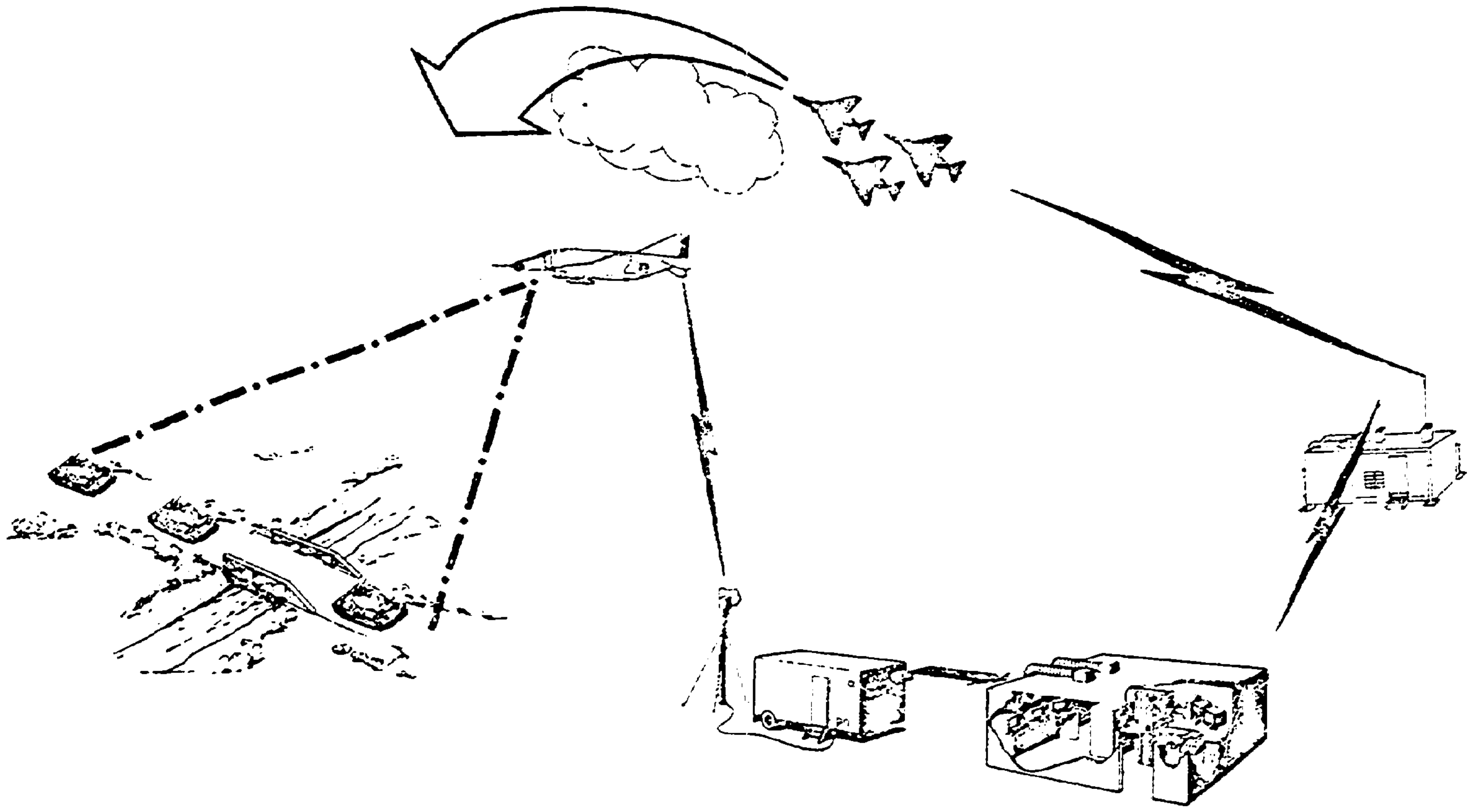


FIGURE 1-1

RECONNAISSANCE REPORTING FACILITY (RRF) CAPABILITIES

1 - Present FLIR and AAD-5 sensor imagery for interpretation

2 - Provide controls to enhance presentations of the video imagery

3 - Provide automated mechanical and computer interfaces to assist the interpreter in accurate and timely target detection and intelligence dissemination

4 - Accurately determine target coordinates

5 - Report generation and transmission capability minimizing operator interface

6 - Digital data link to command and control center

Figure 1-2

command and control elements. Figure 1-3 depicts the layout of the consoles within the RRF. Figure 1-4 is a line drawing of the Quick Strike - Target Detection and Interpretation Console. Figure 1-5 shows the Quick Strike - FLIR Detection and Interpretation Console.

The next phase of Quick Strike Reconnaissance training to be conducted by Texas Instruments, Inc. will provide each student with detailed instructions on the physical layout and activities of the Reconnaissance Reporting Facility (RRF). The intent of this first phase of instruction is to familiarize the interpreter in real time or near-real time interpretation techniques.

It is our belief that self-confidence is the key characteristic of an effective real time or near-real time interpreter. In most instances, the near-real time interpreter gets only one chance to detect and correctly identify his target(s). For this reason, he must have the confidence to report his findings to the strike decision makers quickly.

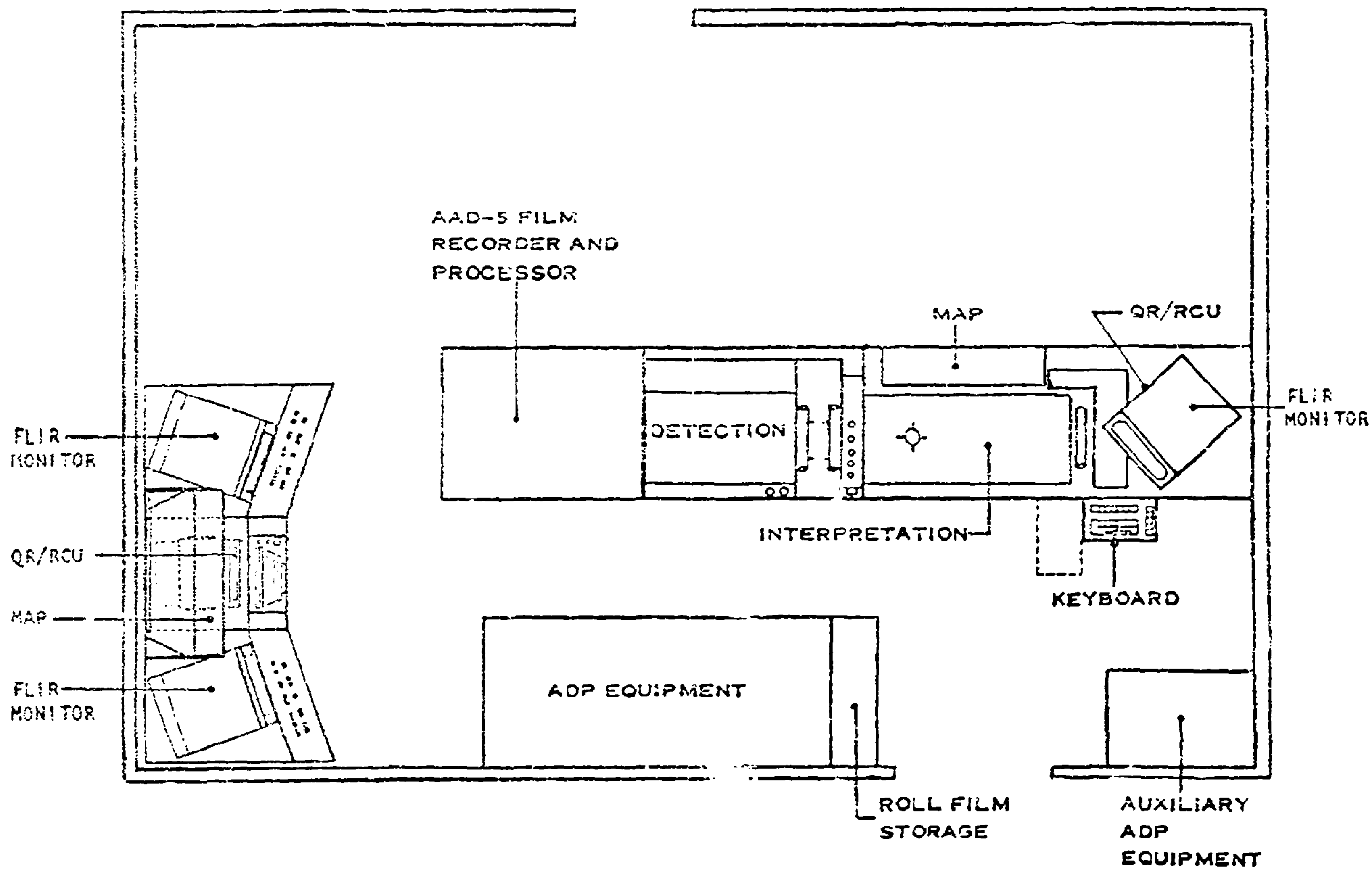

AAD-5 FILM
RECORDER AND
PROCESSOR
MAP
QR/RCU
FLIR
MONITOR
DETECTION
INTERPRETATION
KEYBOARD
FLIR
MONITOR
QR/RCU
MAP
FLIR
MONITOR
ADP EQUIPMENT
ROLL FILM
STORAGE
AUXILIARY
ADP
EQUIPMENT

FIGURE 1·3

QUICK STRIKE
TARGET DETECTION AND INTERPRETATION CONSOLE

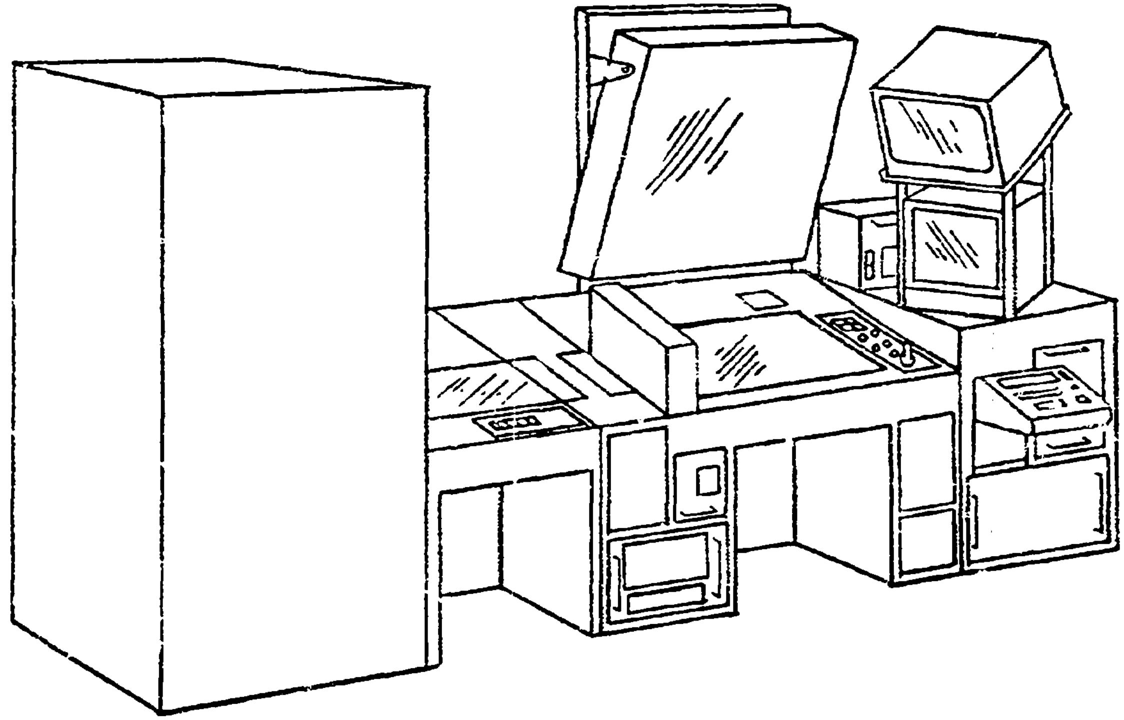
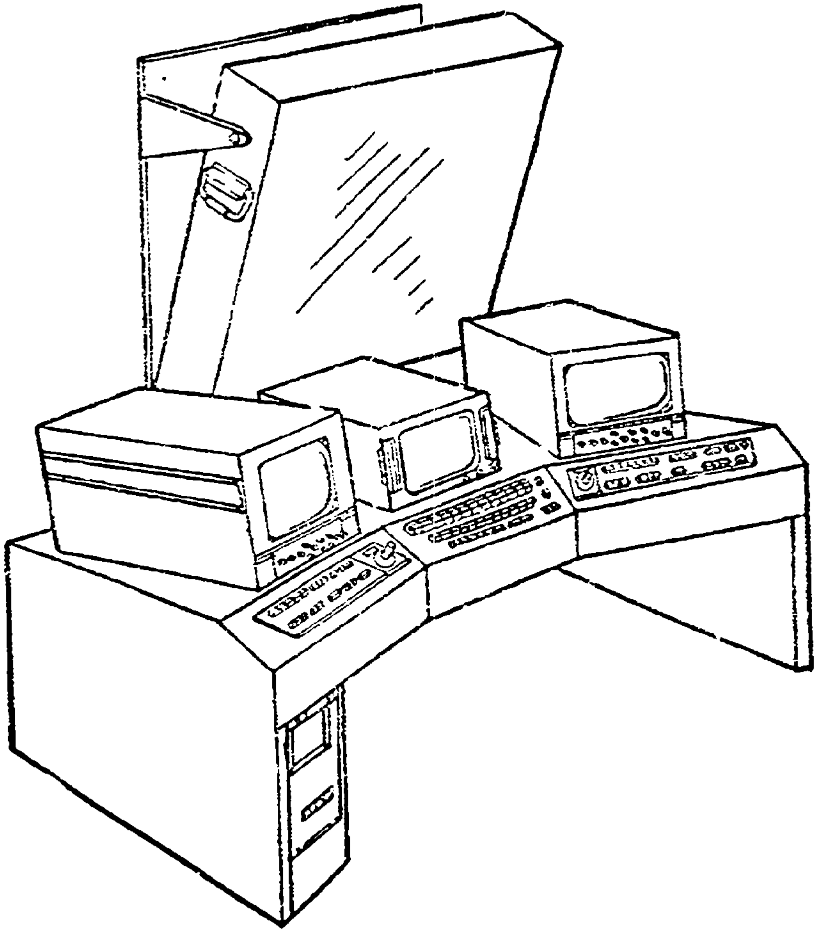


FIGURE 1·4



QUICK STRIKE

FLIR DETECTION AND INTERPRETATION CONSOLE

FIGURE 1-5

INSTRUCTION BLOCK #2

HISTORY OF REAL-TIME AND NEAR-REAL-TIME INTERPRETATION

(3 hours)

OBJECTIVE

It is felt that this three-hour block of instruction is essential as a foundation in understanding the value and effectiveness of real-time and near-real-time interpretation. A history of real-time and near-real-time interpretation studies, along with operational employment of this concept, will be presented at this time.

INTRODUCTION

In a combat situation, such as Southeast Asia, the imagery obtained from infrared linescan systems is often too late for tactical reaction. In response to this situation, specifications were set up to provide a real-time capability for aircrews. Many real-time readout linescan systems were tried; however, the imagery presented on the Cathode-Ray Tube (CRT) was still only that which the aircraft had just flown over and no immediate reaction was possible. This brought about the integration of a forward-looking infrared system with an active weapons delivery system, thus providing immediate reaction to the information obtained.

During the early part of 1965 one improved Forward-Looking Infrared System (FLIR) was developed by Texas Instruments, Inc., and installed in an A-26A aircraft to provide immediate reaction capability.

Test flights were conducted in a FC-47 aircraft over Eglin AFB, Florida from 28 July through 3 August 1965. This program was given the title of PROJECT RED SEA I.

The operational configuration within the RED SEA I aircraft consisted of one or two operator/interpreters seated before a 3 1/2" x 7" cathode-ray tube display. The IR scanner was continuously adjustable, and could view the terrain from 5° above horizon to a -80° inclination. The operator had the option to vary the inclination angle at any time during the flight. A 16 mm movie camera was mounted directly in front of the CRT at a distance of 16", and operated by a technician to provide hard copy of the display.

The function of the operator/interpreter was to detect and/or identify the targets from the display. In order to obtain data on this in-flight mission, three measures of performance were derived. They were:

1 - Check lists of targets. This form was completed by a "back-up" operator;

2 - Tape recordings consisting of flight information and time readings as well as commentary on detections of targets; and

3 - Debriefing sessions, conducted at the conclusion of each mission with each operator and covering all phases of the mission including sensor performance and target detections.

It was determined by the test team that the RED SEA I FLIR system would not display Vietnamese-type targets on the in-flight operators CRT, even with large orientation fires to aid in target location and detection. (See Figure 2-1.) In addition, the concept was ineffective against time-sensitive targets.

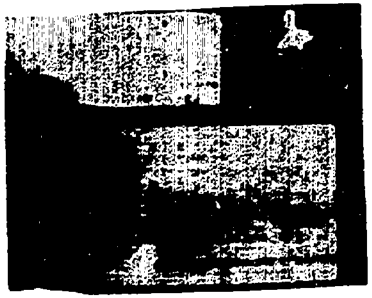
Project RED SEA I was followed by Project RED SEA II which was a tactical evaluation of the Hughes Aircraft Company's FLIR system. Test flights for this system were conducted in a B-26 test aircraft over Eglin AFB, Florida from 13 September through 21 September 1965. The installation in the B-26 consisted of an external, nose-mounted scanner/receiver, operator display CRT and controls, and associated electronic equipment (Figure 2-2). The operator display was a 5" multimode tonotron reflected to a side-mounted 16 mm scope recording camera by an offset mirror between the operator and the CRT. Only representative displays were recorded because of:

1 - The large amount of film required for a complete mission record, and

2 - The problem of handling large numbers of small magazines in flight.

FORWARD LOOKING INFRARED (FLIR) IMAGERY

PROJECT RED SEA I



MISSION NO. 9 — PASS NO. 5

AIRCRAFT: FC-47

SENSOR: TI FLIR

ALTITUDE: 500'

DATE: 02 AUG. 65

TIME: 2335 CST

LARGE HOT SPOT INDICATES FIRE DRUM MARKER, SMALLER HOT SPOTS INDICATE VEHICLES ON ROAD NEAR TARGET NO. 1

FIGURE P-1

HUGHES AIRCRAFT COMPANY'S
FORWARD LOOKING INFRARED SYSTEM INSTALLATION

FIGURE 1: B-26 TEST AIRCRAFT

FIGURE 2A: SYSTEM INSTALLATION

FIGURE 2B: OPERATOR DISPLAY AND CONTROLS

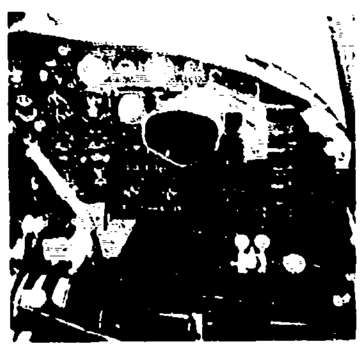


FIGURE [illegible]-[illegible]

During the mission, the operator had continuous control over inclination and aspect angles. In addition, he had the capability to "lock-on" to a target.

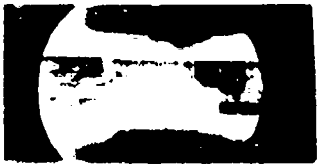
As was the result of RED SEA I, it was determined by the Project RED SEA II tests that the system would not display simulated Viet Cong targets on the in-flight operator's display. (See Figure 2-3.)

On 18 July 1966, Project RED CORSIT tests commenced to determine the capabilities and limitations of an airborne observer's ability to obtain reconnaissance intelligence from an in-flight, real-time display. Again the tests were conducted over Eglin AFB in an effort to simulate the Southeast Asia (SEA) environment. The primary sensor system used for the test was a modified UAS-5 infrared line scanner with in-flight display capabilities (Figure 2-4). The Image Processor Viewer (IPV) provided for in-flight processed 5" film recording and viewing of a CRT linetrace. The Thermoplastic Recorder (TPR) offered a real-time high resolution display with a magnification capability.

The re. lts of Project RED CORSIT revealed:

1 - That the equipment used was below standards required for operational utilization,

2 - More than one interpreter is required for effective in-flight interpretation, and



MISSION NO. 5
AIRCRAFT: B-26
SENSOR: HUGHES' FLIR
MODE: 20° X 4°
ALTITUDE: 2,000'
DATE: 15 SEPT. '65
TIME: 2200-2400 CST

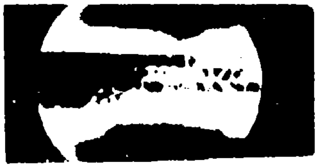
EXAMPLE SHOWING YELLOW RIVER BORDERING TARGET AREA

MISSION NO. 7
AIRCRAFT: B-26
SENSOR: HUGHES' FLIR
MODE: 10° X 4°
ALTITUDE: 1,000'
DATE: 16 SEPT. '65
TIME: 2000-2200 CST

RANGE CONTROL TOWER 1/4 MILE WEST OF TARGET NO 5

MISSION NO. 7
AIRCRAFT: B-26
SENSOR: HUGHES' FLIR
MODE: 10° X 4°
ALTITUDE: 3,000'
DATE: 16 SEPT. '65
TIME: 2000-2200 CST

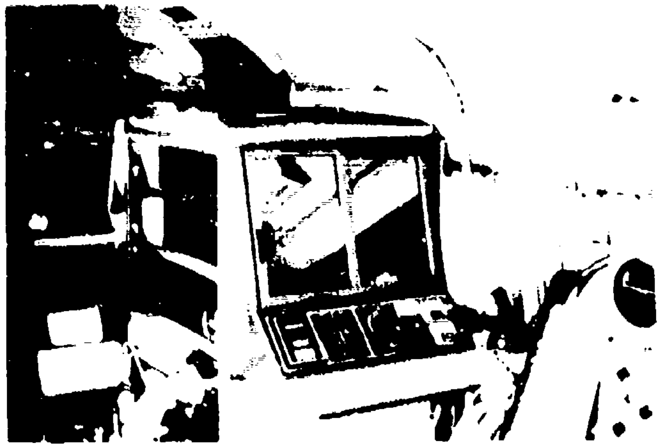
BRUSH FIRE AND RESOLUTION TARGET NEAR TARGET NO 6



MISSION NO. 9
AIRCRAFT: B-26
SENSOR: HUGHES' FLIR
MODE: 20° X 4°
ALTITUDE: 1,000'
DATE: 21 SEPT. '65
TIME: 0200-0400 CST

TARGET INDICATOR (FIRE DRUM).

FIGURE 2-3 EXAMPLES ENLARGED FIVE TIMES.



AIRBORNE THERMAL PLASTIC RECORDER/VIEWER

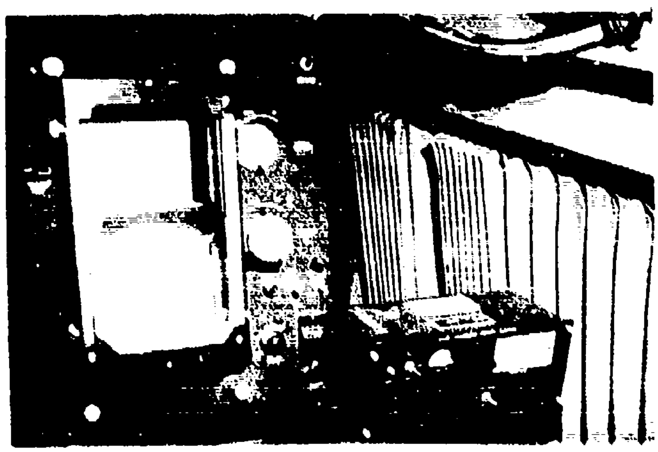


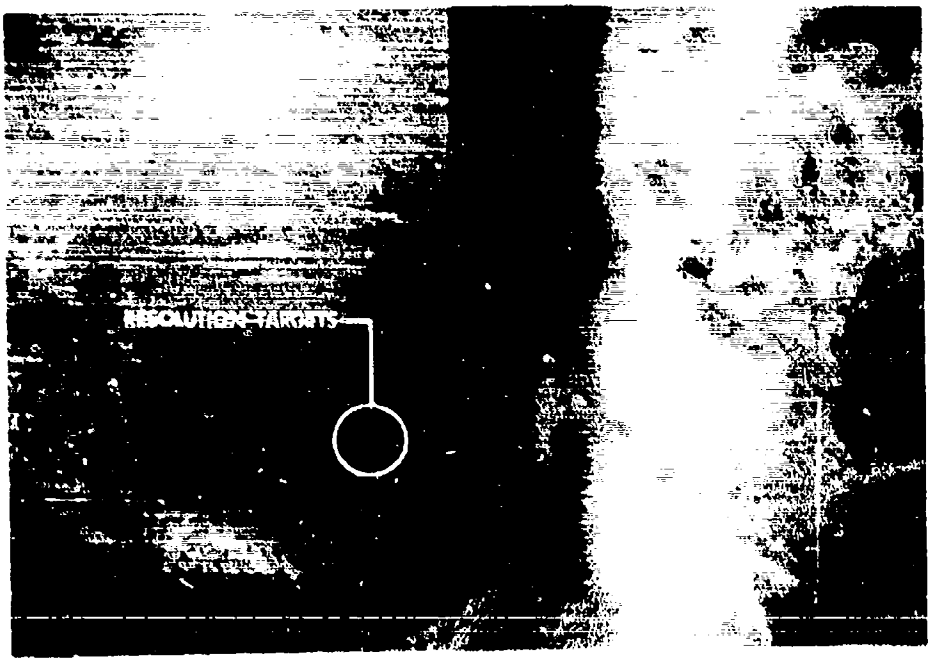
IMAGE PROCESSER-VIEWER

FIGURE 2-9

3 - That the images displayed were inadequate for accurate interpretation results. (See Figures 2-5, 2-6, and 2-7.)

Another system developed was the LONESOME Tiger Weapon System designed to provide the USAF with a real-time night reconnaissance strike capability. In this system, a forward-looking infrared scanner was coupled to a weapons release computer (WRC) to permit level bombing under blackout conditions. Figures 2-8 and 2-9 are examples of FLIR imagery collected by the Lonesome Tiger FLIR system. Testing of this system resulted in the conclusion that the field of view of the FLIR scanner was too narrow, and the FLIR range would not permit the aircraft to operate at a safe altitude in a combat situation.

Between 1 February 1967 and 15 April 1967, BLACK SPOT flight tests were accomplished over the Underbrush Test Range at Eglin AFB. RADC was tasked to analyze the interpreter's situation in terms of what might be expected to influence his ability to extract reconnaissance information for immediate strike operations. During this program, an assessment was made of the ability of an observer to detect targets from images displayed by a Forward-Looking Radar (FLR), a Forward-Looking Infrared, and a Low Light Level Television (LLLTV). This concept was further tested in the SEA operational environment, and proved worthy of future development of advanced real-time systems.



1:2,500 1:10,000

EGLIN TARGET DETECTION RANGE

FIGURE 2-5

PROJECT RED CORSIT

1:2,500 1:10,000

SITE II
ALT: 2500'
DATE: 23 JULY '66
MSN: RC-4

FIGURE 2-6

PROJECT RED CORSIT

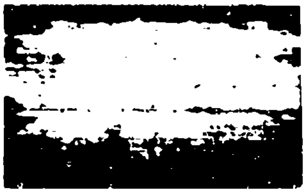
SAM SITE
ALT: 2500'
DATE: 23 JULY 66
MSN: RC-4

FIGURE 2-2

SAMPLE IMAGERY - FLIR

RANGE: 3/4 NM

RANGE: 1/4 NM



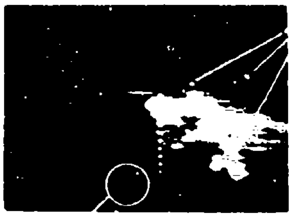
ALT: 1,200'
TIME 1918
SPEED 200K
R/H: 91%

RANGE: 1/10 NM

TRUCK CONVOY

FIGURE 2

SAMPLE IMAGERY - FLIR

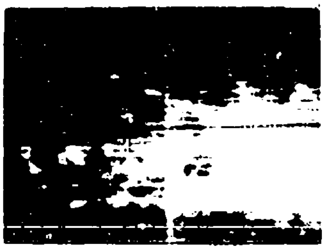


ACTIVE TRUCKS

SAM SITE

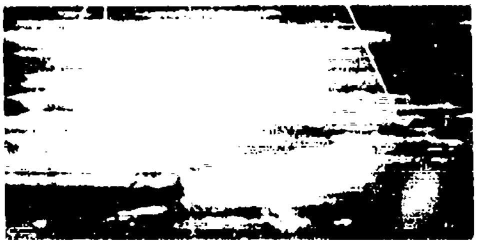
INACTIVE MISSILE

ALT: 1,000'
TIME: 2215
SPEED: 180K
R/H: 73%



ACTIVE TRUCKS

AIRCRAFT ON RAMP



HANGAR AND AIRCRAFT, EGLIN AFB

ALT: 500'
TIME: 2025
SPEED: 240K
R/H: 89%

FIGURE 2-9

INSTRUCTION BLOCK #3

INFRARED PRINCIPLES

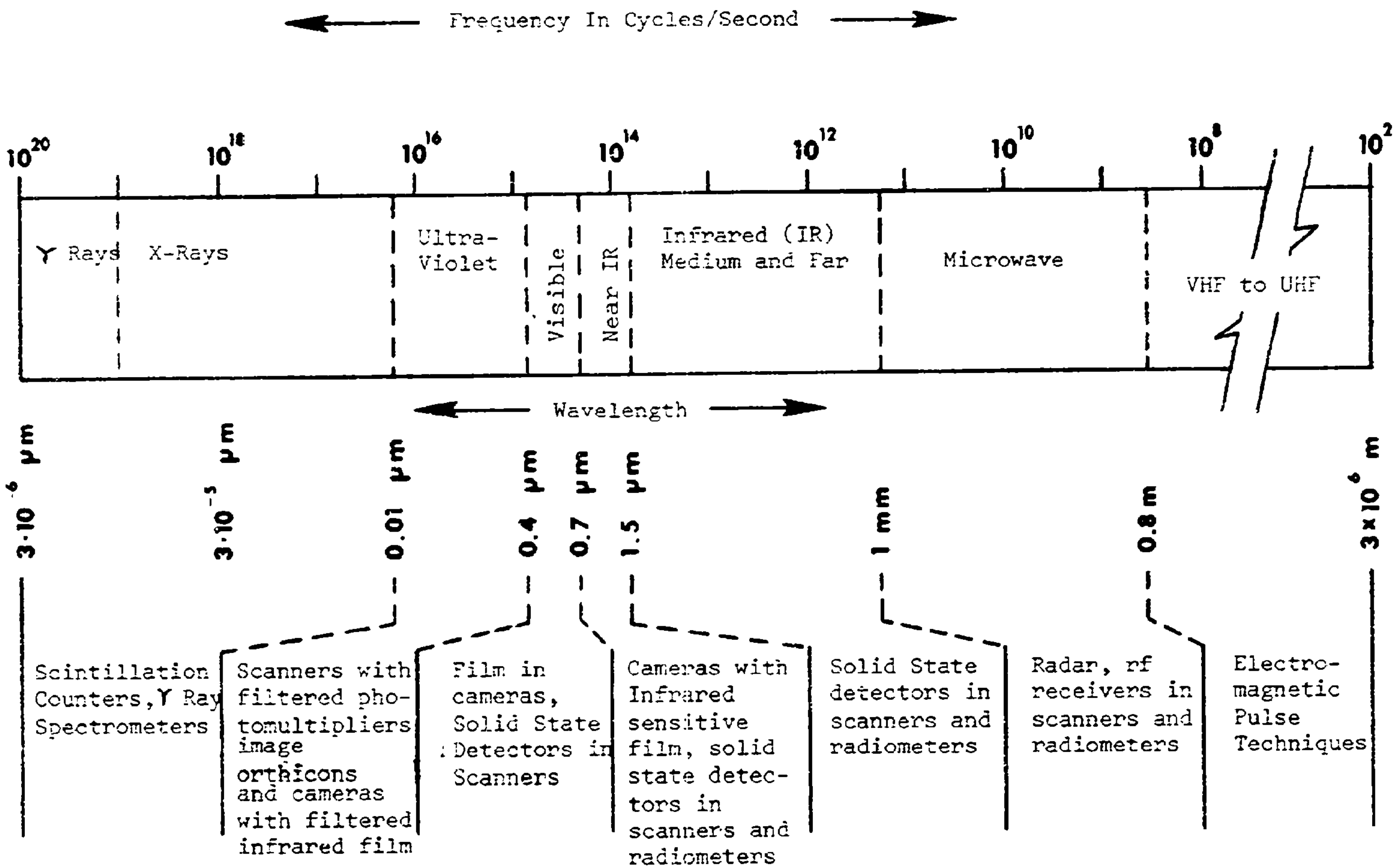
(2 hours)

This instruction block is designed to review infrared theory, including the infrared spectrum, atmospheric transmission of Infrared (IR), basic radiation laws and infrared physics.

INFRARED RADIATION

In order to understand the properties of IR radiation, an overview of the entire electromagnetic spectrum may be of value. Figure 3-1a illustrates the range of electromagnetic (EM) energy identified by its wavelength and frequency. Included is a listing of some sensors commonly used to detect energy within certain regions of the spectrum. Electromagnetic radiation is essentially a continuum of frequencies and wavelengths from very high frequency gamma waves with an extremely short wavelength to low frequency radio waves characterized by long wavelengths. Although the spectrum in Figure 3-1a is broken down into several wavelength bands such as x-rays, ultraviolet, visible light, etc., the boundaries are not absolute; in fact, there is a degree of overlap between adjacent regions.

The infrared portion of the electromagnetic spectrum is found just beyond the visible range. It is identified as having wavelengths ranging



BREAKDOWN OF THE ELECTROMAGNETIC (EM) SPECTRUM
INCLUDING A LISTING OF SENSORS EMPLOYED WITHIN VARIOUS EM REGIONS

FIGURE 3-1a

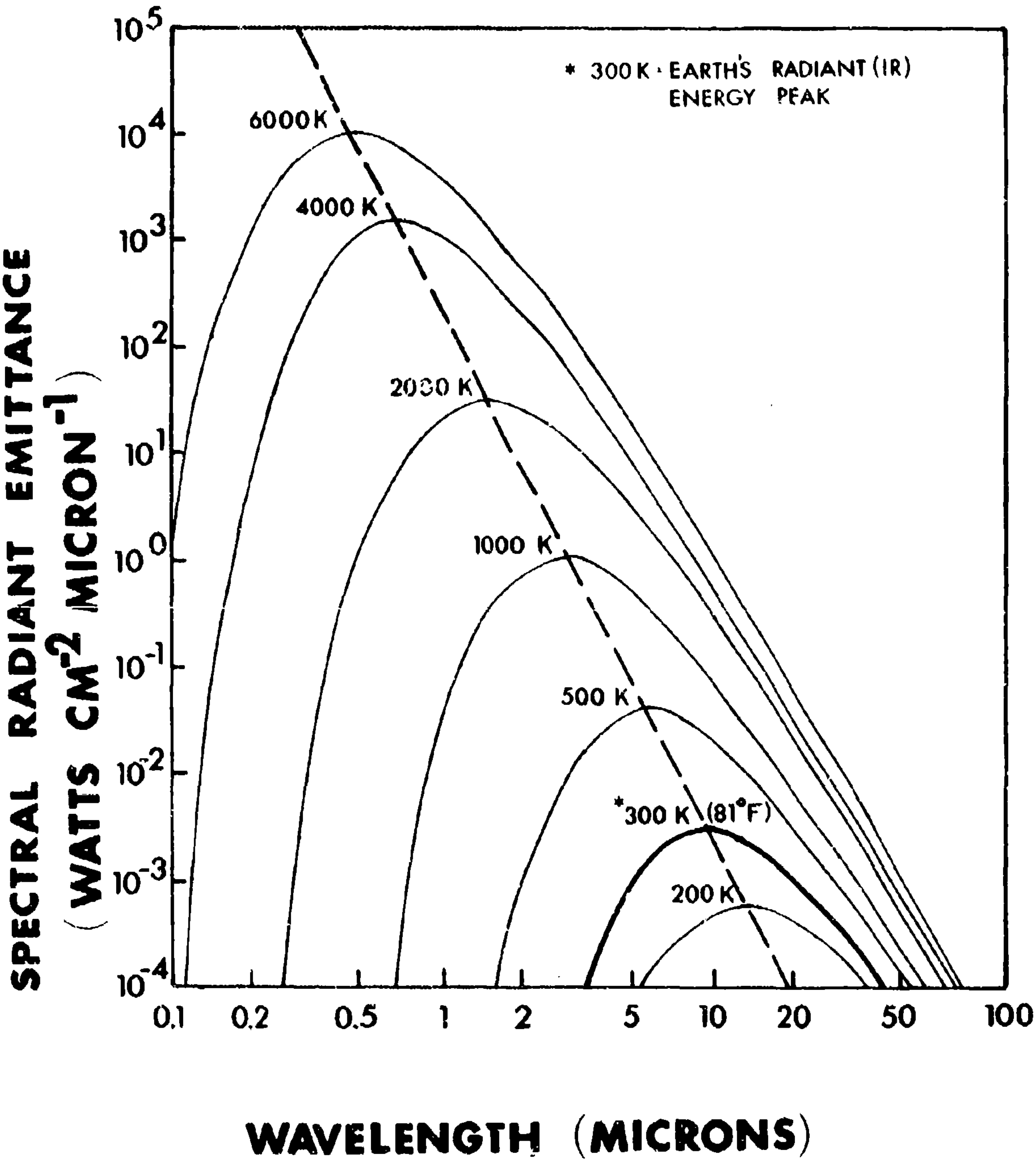
from .7 μm (micron 1/1,000,000 meter) to 1000 μm (1000 micron = 1/1,000 M). Note Figure 3-1b.

METRIC UNITS - CONVERSION FACTORS

1 μm (micron)	=	10^{-6} meters
1 mm	=	10^{-3} meters
1 cm	=	10^{-2} meters
1 meter	=	1,000,000
1 meter	=	1000 mm
1 meter	=	100 cm

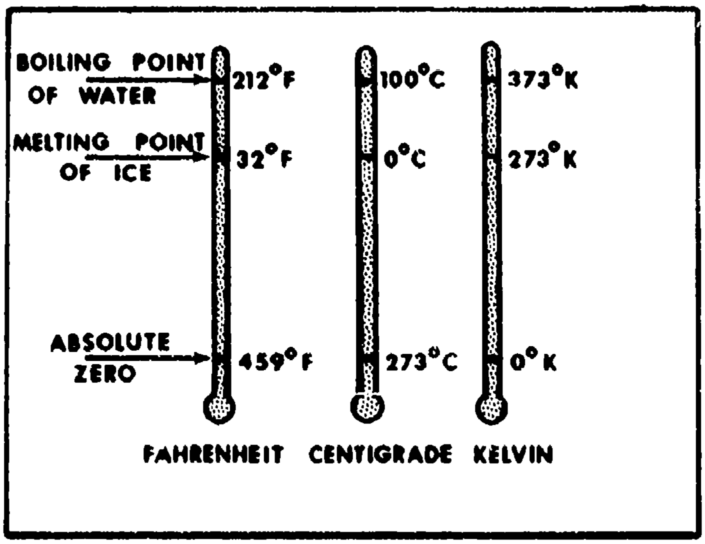
Figure 3-1b

Infrared (IR) radiation is further subdivided into 3 parts: (1) the near IR, 0.7 μm to 1.5 μm; (2) middle IR, 1.5 μm to 5.5 μm; and far IR, 5.5 μm to 1000 μm. The emphasis of this course as it applies to IR reconnaissance will be in the 5.5 μm to 100 μm range. It is within this region that the earth's radiant energy peak exists. (Note Figure 3-2) Any object with a temperature greater than 0°K (Absolute Zero) emits IR energy and therefore is detectable within the thermal (far) IR portion of the electromagnetic spectrum. Comparative temperature scales and conversion formulas are shown in Figure 3-3. But measurement of radiant energy within the thermal IR range is not entirely dependent upon the temperature of an object. According to Stefan-Boltzmann's Law, the radiant energy measured per unit area is a function of T^4 (temperature °K), Stefan Boltzmann's constant and the (ϵ) emissivity of a particular



RELATIONSHIP OF TEMPERATURE (°K) TO RADIANT EMITANCE AND WAVELENGTH

FIGURE 3-2



$$°K = C + 273$$

$$°F = 9/5\, C + 32°$$

$$°C = 5/9\, (F - 32)$$

KEY:

K = KELVIN

F = FAHRENHEIT

C = CELCIUS - CENTIGRADE

Conversion Formulas for Temperature in Kelvin, Fahrenheit and Celcius.

FIGURE 3-3

object. Emissivity is the expression of the radiant emission of a radiating body divided by the radiant emission of a blackbody at the same temperature.

A blackbody is defined as any object which completely absorbs all radiation incident upon it. Thus the blackbody emits the maximum amount of radiation possible at a given temperature. The emissivity value of an object which does not absorb all incident radiation lies somewhere between 0.0 and 1.0. Thus the term gray body is often applied to these objects. Illustrated in Figure 3-4 is a table listing the emmissivity for ten different surfaces. Included is the comparison of emmission of IR radiation for two of these surfaces.

Through this example the importance of [ε] as a factor is established. Carbon, which has an emissivity approaching that of a blackbody, radiates a far greater amount of thermal IR radiation than polished silver - which acts more like a perfect reflector. As ε approaches zero, the total radiance is diminished.

It must be remembered that there are temporary environmental influences which modify the emissivity of a gray body. Water in the form of dew, frost, or rain may alter the radiant emission of an object. In addition to this, dust or oxides on a surface can change the surficial characteristic of a target.

MATERIAL	TOTAL EMISSIVITY
ALUMINUM (POLISHED)	0.07
CARBON	0.81
COPPER (POLISHED)	0.04
IRON (OXIDIZED)	0.71
LEAD (OXIDIZED)	0.28
NICKEL (OXIDIZED)	0.39
PLATINUM (BLACK)	0.93
SILVER (POLISHED)	0.02
TUNGSTEN (UNOXIDIZED)	0.024
ZINC (OXIDIZED)	0.28

STEFAN-BOLTZMANN'S LAW

$$W = \varepsilon \cdot \sigma \cdot T^4$$

W = THERMAL RADIATION IN WATTS/cm^2

σ = STEPHAN BOLTZMANN'S CONSTANT 5.67×10^{-12}

ε = EMISSIVITY

T = TEMPERATURE °K

POLISHED SILVER

$W = 5.67 \times 10^{-12} \times .02 \times 300^{\circ 4}$

$W = 9.2 \times 10^{-4}$ watts/cm.^{2}

$W = .00092$ watts/cm.^{2}

CARBON

$W = 5.67 \times 10^{-12} \times .81 \times 300^{\circ 4}$

$W = 3.72 \times 10^{-2}$ watts/cm.^{2}

$W = .037$ watts/cm.^{2}

EMISSIVITY TABLE & APPLICATION OF STEFAN-BOLTZMANN'S LAW

FIGURE 3-4

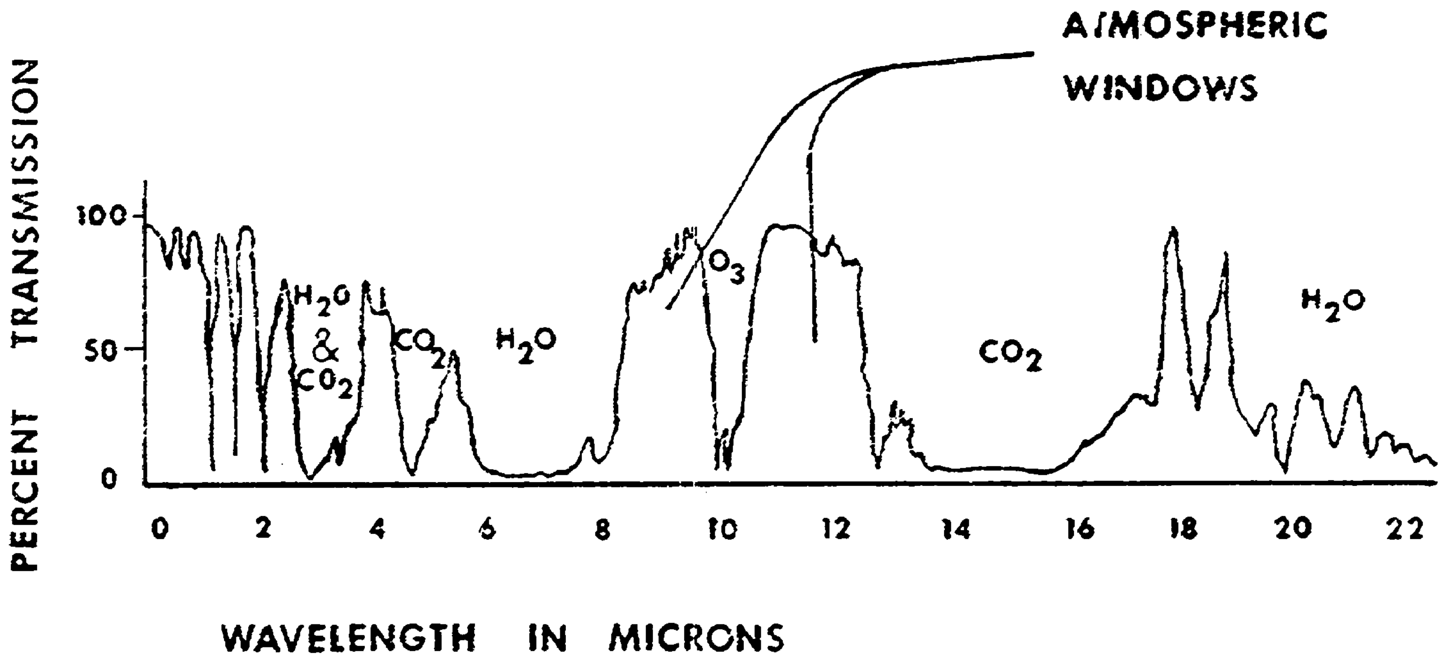
TRANSMISSION OF INFRARED ENERGY

A primary concern in the interpretation and analysis of information derived from remotely sensed imagery is the effect of the earth's atmosphere on electromagnetic radiation within the atmosphere. There are many elements which can alter the image and hinder the utility of a sensor which operates in a particular wavelength band. Changes in the signal received by a sensing device may be due to the presence of gaseous and particulate matter in the transmission medium, the atmosphere.

The process of atmospheric scattering is most pronounced in the shorter wavelengths (e.g., visible light). Scattering is the diffusion of electromagnetic radiation by gaseous and particulate matter in the atmosphere. In the IR spectrum, this process occurs in the near IR region and decreases rapidly in the longer wavelengths.

Absorption occurs in (certain regions of) the IR band from 1.0μ to 20.0μ due to the presence of gases such as H_2O, CO_2, O_2 and O_3. (Note Figure 3-5.) In this case, energy is actually absorbed by naturally occuring gases interfering with the free transmission of IR radiation.

Portions of the electromagnetic spectrum, where little or no absorption takes place, are referred to as atmospheric windows. In the IR range, the 8 to 14 μ band is relatively free of elements which absorb radiation. It is in this region of the spectrum that the highest transmission of energy takes place.



Varying Transmission of IR Energy due to the Presence of Atmospheric Gases

FIGURE 3-5

Although the presence of H_2O in fog weakens the transmission of IR radiation, sensors operating in the thermal IR range are far more useful than those operating in the visible spectrum.

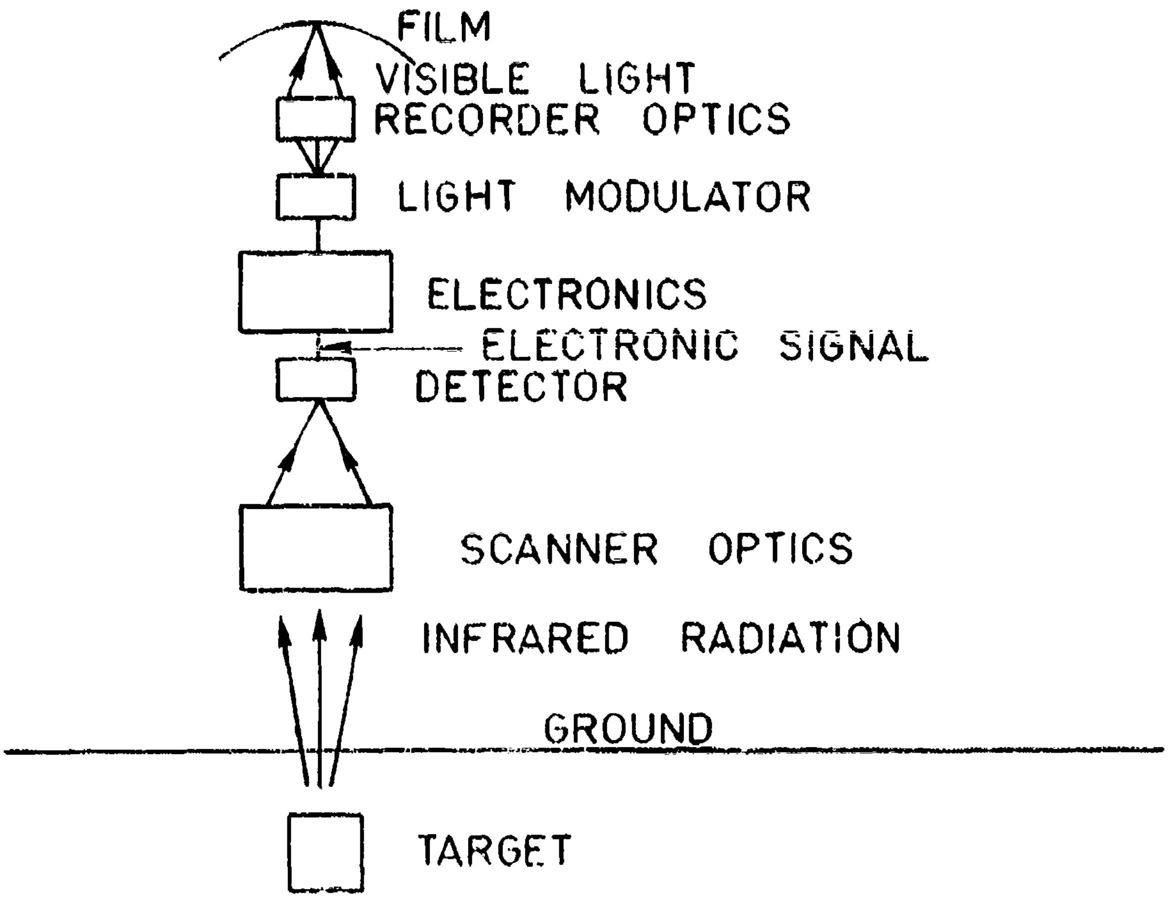
DETECTORS

So far this instruction block has centered on the principles of IR radiation as it exists in space. The purpose of this section is to outline the process in which IR energy is detected and put into a form which can be recorded and/or displayed in a real- or near-real-time situation.

Figure 3-6 illustrates the major components of an IR reconnaissance system. The most important element in such a system is the detector. It is this component of the system that is initially responsible for the detection of the electromagnetic energy and therefore plays a critical role in the acquisition of remotely sensed imagery.

IR detectors can be divided into two separate classes - thermal detectors and quantum detectors. A thermal detector absorbs photons (discrete particles which make up light) and the absorbed energy is diffused through the detector's atoms, causing the temperature to rise.

An example of a thermal detector is a thermometer. It detects changes in temperature and the change in the volume of mercury is a function of that temperature. A thermocouple is another device which possesses the characteristics of a thermal detector. It operates in such a way that the voltage



General Schematic of an Infrared Reconnaissance System

FIGURE 3-6

generated by the contact between two dissimilar metals or alloys depends on temperature.

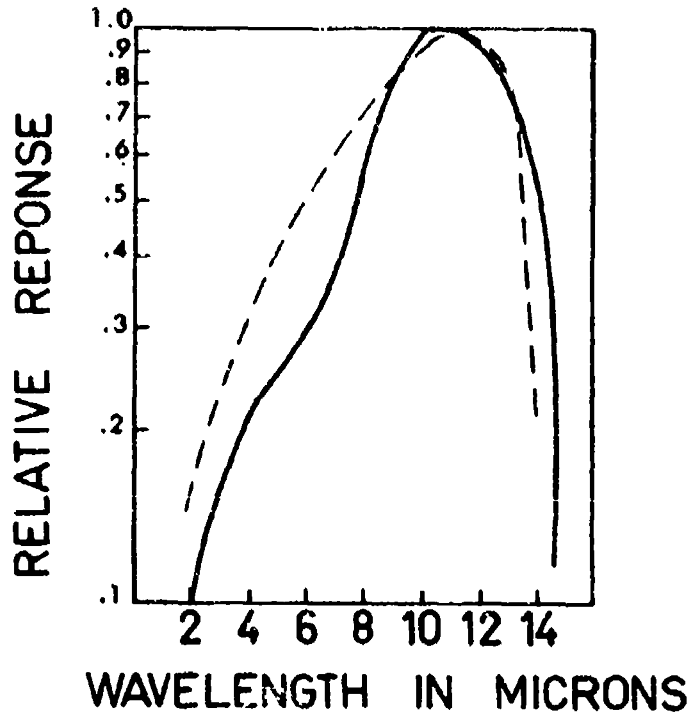
A basic limitation inherent to thermal detectors is the slowness with which they react to temperature change. Another problem is the limited sensitivity which such devices possess.

A quantum detector is quite different from a thermal detector since internal temperature fluctuations are not evident. This type of detector is far more selective since it does not react to a change in the total quantity of energy (number of photons), but rather the energy possessed within each photon. Therefore, a quantum detector is sensitive to particular regions of the IR band and can be selectively applied to certain conditions.

A drawback in the use of quantum detectors is that they must be maintained at a very cool temperature. This is to minimize the effects of thermal "noise" generated by the temperature of the detector itself.

Figure 3-7 illustrates the relative response and sensitivity of two commonly used quantum detectors. Figure 3-8 further illustrates the range of sensitivity for several other quantum detectors. The temperature in $^{\circ}K$ listed within each detector range is the temperature at which the detector's performance is greatest. A detector sensitive to longer wavelengths must be cooled far more than one sensitive to the relatively shorter IR wavelengths.

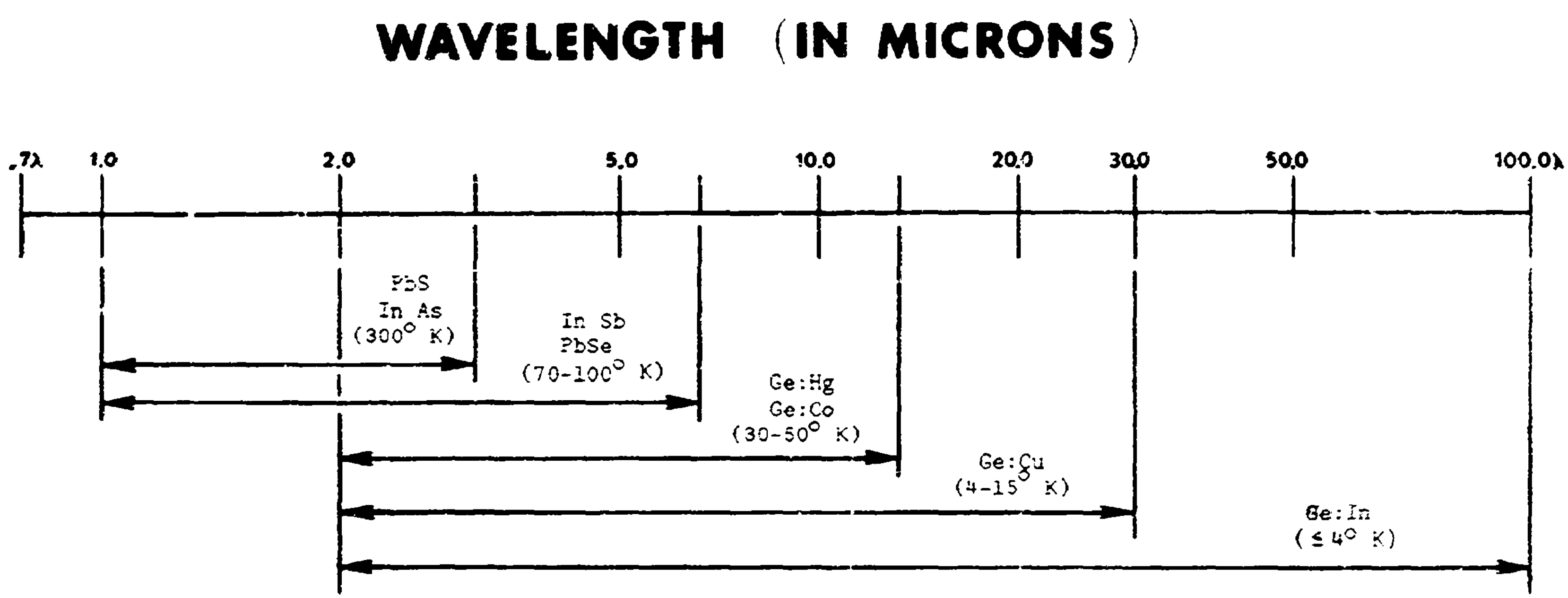
SPECTRAL RESPONSE OF TWO QUANTUM DETECTORS



- - - - - MERCURY-DOPED GERMANIUM

——— MERCURY CADMIUM TELLURIDE

FIGURE 3-7



PbS - Lead Sulfur
In As - Indium Arsenic

In Sb - Indium Antimonide
Pb Se - Lead Selenium

Ge:Hg Mercury doped Germanium
Ge:Co Cobalt doped Germanium

Ge:Cu Copper doped Germanium
Ge:In Indium doped Germanium

Range and Optimum Operating Temperature for 8 Quantum Detectors

FIGURE 3-8

There are three types of quantum detectors, they are photovoltaic, photoelectromagnetic, and photoconductive. A photovoltaic detector is made up of a metal and another material (semiconductor) which, when exposed to certain wavelengths of thermal radiation, generates a voltage.

A photoelectromagnetic detector depends on the generation of voltages due to excitation of charge carrier gradients for their transducing properties.

A photocon ictive detector reacts in such a way that when exposed to specific wavelengths of thermal radiation, its internal resistance changes.

The primary advantages of a quantum detector lie in two areas - greater responsiveness and the speed of its response. In addition, the response of these detectors may be easily amplified by standard electronic means, transduced to visible light and recorded on film. It is because of these characteristics that the quantum detector is used in IR reconnaissance.

IR SCANNING SYSTEM PRINCIPLES AS THEY APPLY TO IMAGE INTERPRETATION

In order to fully appreciate the principles discussed thus far, this final section will deal somewhat with the application of an IR reconnaissance system.

The factors affecting the success of a mission are a combination of environmental and mechanical considerations. For example, time of day, time of year, and atmospheric conditions must be taken into account when planning a mission as well as when interpreting imagery. Since the sun is the earth's primary source of energy, knowledge of its diurnal and seasonal cycles is of value.

Because an IR sensor is not totally sensitive to visible light, the importance of the sun is indirect. For the most part, radiant energy emitted by objects on earth is the net result of energy stored during daylight hours. Due to varying temperatures, emissivities and heat capacities, the radiance of each object reveals a distinct signature or IR imagery. It is the understanding of these signatures that makes correct interpretation possible. The final product of an IR reconnaissance system is an image which depicts objects of differing contrast; this contrast is the result of a target's unique physical characteristics.

INFRARED IMAGERY CHARACTERISTICS/INFRARED SIGNATURES

INSTRUCTION BLOCK #4

(6 hours)

Techniques used in the interpretation of infrared imagery will be presented during this block of instruction. The student will become aware of the relationship that exists between the apparent temperature of an object and its image tone.

Regardless of its form, infrared imagery is essentially a thermal map, imaged by an electrical infrared reconnaissance set. An electro-optical system must be used since photographic film is not sensitive to thermal infrared wavelengths, i.e., the region from five to one hundred microns. After thermal radiation is detected by the system and amplified electronically, the resultant imagery can take one of two forms. A hardcopy version of infrared information can be produced by exposing black and white photographic film in front of an intensity modulated cathode-ray tube or an image of the terrain can be displayed in real-time on a monitor similar to a T.V. tube.

In the case of the Quick Strike Reconnaissance program there are two types of the sensors employed. The first system that we will be concerned with is the AN/AAD-5 downward-looking infrared line scanning system which scans the terrain in a vertical mode.

This system produces hardcopy imagery (film) similar to the type depicted in Figure 4-1 for target detection, interpretation and mensuration. The other sensor employed is the PAVE TACK Forward-Looking Infrared (FLIR) system. Data collected by this sensor is recorded on tape and viewed by image interpreters working off video monitors. Figure 4-2 is a photograph of FLIR imagery taken off of a video monitor.

Since a given type of target will appear differently when imaged by a line-scan system scanning in a vertical mode than when imaged by a FLIR in a slant-range mode, it is imperative that the interpreter become familiar with both vertical and FLIR target presentations.

In both imagery formats the signature of thermal energy is basically the same. Variations in IR radiation detected by the sensors are displayed on the imagery by a combination of gray tones which correspond to the changes in thermal emissions. When objects are hot (i.e., radiate highly) relative to their surroundings they are recorded as <u>dark images on infrared negatives</u> which appear as light or <u>bright images on positive transparencies</u>. (Note Figure 4-3a and 4-3b). During this instruction block we will be working with both positive and negative image presentations since the interpreter will have this option when working in the RRF. However, for the purpose of discussion we will refer to images as they appear on positive transparencies. An object may produce a bright image on a day presentation as a result of either the thermal energy it emits or the solar energy it reflects. Bright images on night presentations, of course, result from the emission of thermal

FIGURE 4-1

LINE SCAN INFRARED IMAGERY EXAMPLE
(NOTE SCAN LINES)

DATE: 3 NOV 71
TIME: 2000
ALTITUDE: 2000'
AREA: UNDERBRUSH RANGE

FIGURE 4-2

PHOTOGRAPH OF PAVE TACK FLIR IMAGERY
(POSITIVE IMAGES)

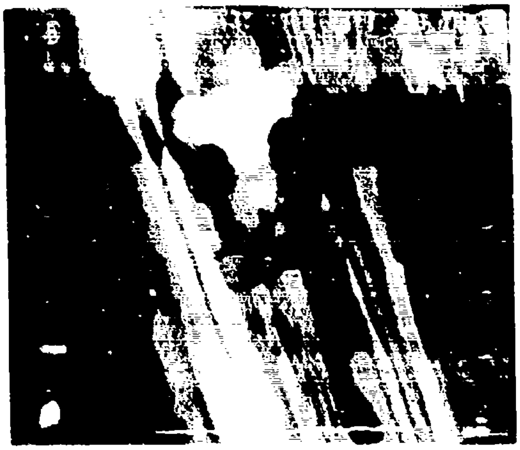
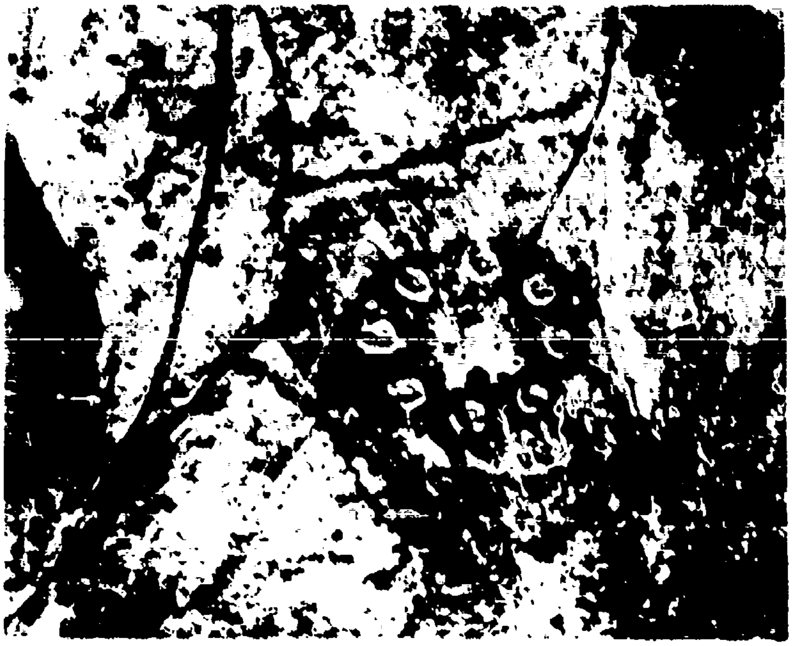


FIGURE 4-3a

INFRARED IMAGE OF AN ANTIAIRCRAFT ARTILLERY SITE
(POSITIVE PRESENTATION)



DATE: [illegible] AUG 71
TIME: [illegible]
ALTITUDE: 1000'
AREA: UNDERBRUSH RANGE

FIGURE [illegible]

INFRARED IMAGE OF AN ANTIAIRCRAFT ARTILLERY SITE
(NEGATIVE PRESENTATION)

DATE: [illegible] AUG [illegible]
TIME: 0900
ALTITUDE: 1000'
AREA: [illegible] RANGE

energy only. The presence of reflected energy tends to make objects look more natural (that is, three-dimensional) on day presentations than on night presentations. (Figure 4-4).

TARGET/BACKGROUND CONTRAST

Bright image patterns on infrared presentations can be of help in determining activity in areas of operation. Note the brightness of the target signatures shown in Figure 4-5. Brightness is not the only consideration to be used when interpreting infrared data. It should be noted that images on infrared presentations are distinguishable only because of contrast with their backgrounds. Compare Figure 4-5 with Figure 4-6. You will notice the targets that were quite obvious in Figure 4-5 are not so obvious in Figure 4-6. The fact that the targets depicted in Figure 4-6 are now cold and therefore blend more into their background accounts for this feature. In other words, an object is distinguishable on an infrared presentation only because its rate of emmission and/or *reflection is higher or lower than that of its surroundings. Therefore, emissivity and temperature of objects are important factors. Figure 4-7 depicts warm target signatures against a snow-covered background. It should be noted however, that when two objects are at the same temperature they emit the same amount of energy only if their surface characteristics are the same. Since infrared sensors record only the radiation from objects, they will record two objects which are at the same temperature differently, if the objects material emissivities are different.

---

* Daytime Imagery

FIGURE 4-4

COMPARISON OF DAY-NIGHT
INFRARED IMAGERY

DAY

DATE:26 OCT 72
TIME:1050
ALTITUDE:2000
AREA:ORISKANY FALLS,NY

NIGHT

DATE:19 OCT 72
TIME:2130
ALTITUDE:2000
AREA:ORISKANY FALLS,NY

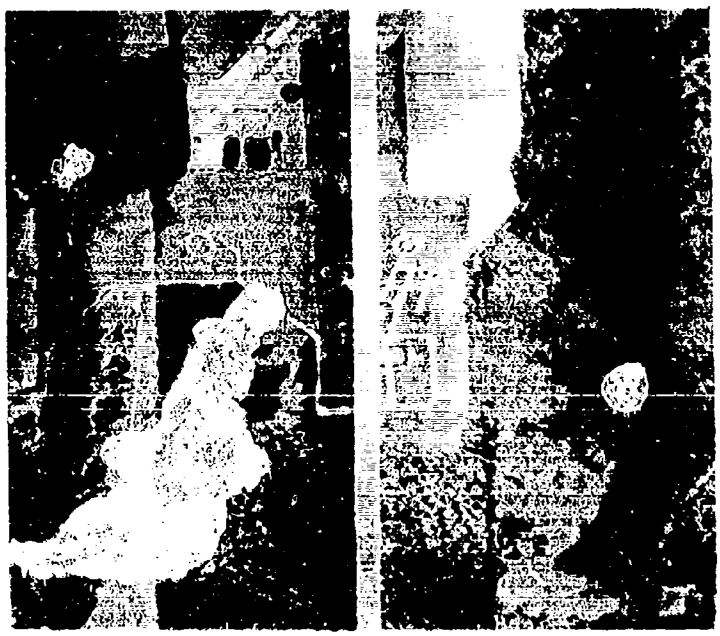
FIGURE 4-5

THERMAL SIGNATURE OF STOCKBRIDGE TEST SITE
(NOTE TANK ARRAY WITH HOT ENGINES)

DATE: 10 OCT 74
TIME: 1940
ALTITUDE: 2000'
AREA: STOCKBRIDGE, NY

FIGURE 4-6

THERMAL SIGNATURE OF STOCKBRIDGE TEST SITE
(NOTE ABSENCE OF TANK ARRAY)



DATE: 6 SEPT 73
TIME: 2020
ALTITUDE: 2000'
AREA: STOCKBRIDGE, NY

FIGURE A-[illegible]

INFRARED IMAGE OF URBAN AREA WITH
SNOW AND ICE BACKGROUND

DATE: 1[illegible] JAN [illegible]
TIME: 1[illegible]
ALTITUDE: [illegible]
AREA: WASHINGTON, NY

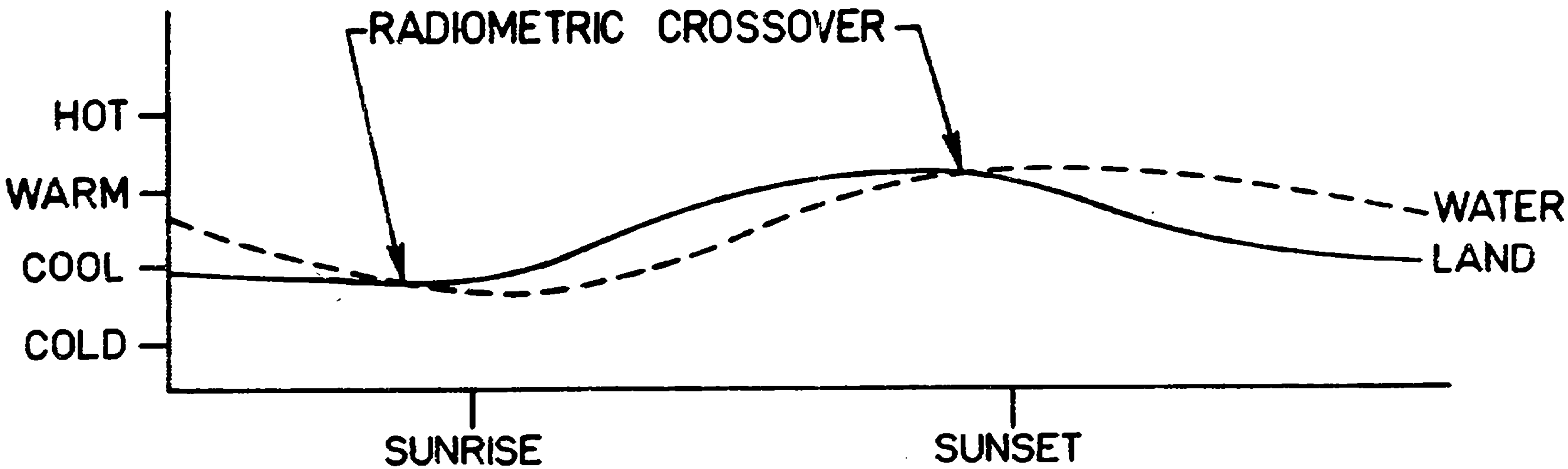
Objects vary in temperature for many reasons. Perhaps the most important reason for differences in the temperatures of objects is that their rates of warming and cooling are different. The temperatures of most objects vary continously. As a rule objects which heat quickly, cool quickly. If two objects with different heating and cooling rates are recorded on infrared imagery at different times during the day and night, the one with the high rate of temperature change will appear brighter during the hot part of the day and darker during the cold part of the night.

RADIOMETRIC CROSSOVER

One exception to this rule would be during radiometric crossover. This term generally refers to loss of contrast between two adjacent objects. Crossover effects can best be illustrated in Figures 4-8, 4-9a and 4-9b. Crossover effects occur one hour prior to sunrise and continue until one hour after sunrise. These effects also occur one hour prior to sunset and continue until one hour after sunset. In Figure 4-9a the bridge on Image A may very easily go undetected because the level of radiant emittance from the bridge is essentially equal to the radiant emittance of the water under the bridge. Recognition of this fact (radiometric crossover) could preclude erroneous interpretation.

IMAGE CHARACTERISTICS

The concept to remember is that IR imagery is a record of relative thermal radiation differences, and the factors which affect an object's tone



Typical Day/Night Radiometric Temperature Differences for Water and Land

FIGURE 4-8

FIGURE 4-9a

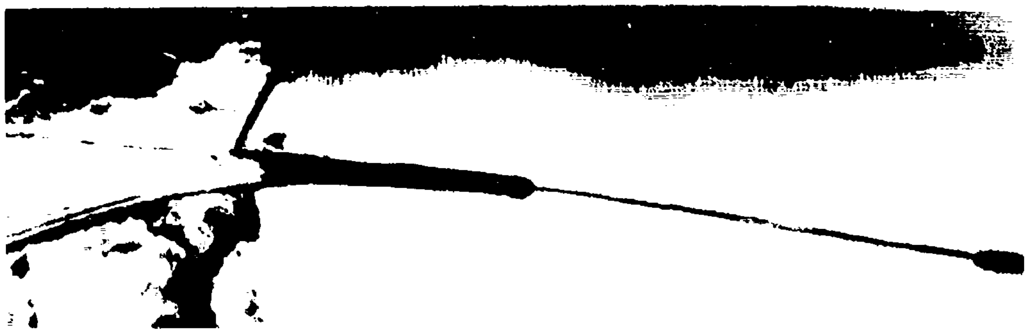
ILLUSTRATION OF RADIOMETRIC CROSSOVER
(POSITIVE IMAGE)

ALTITUDE: 2500'
TOT: 2040

ALTITUDE: 2000'
TOT: 0200

FIGURE 4-9b

INFRARED IMAGE ILLUSTRATING THE EFFECT OF RADIOMETRIC CROSSOVER



BEFORE CROSSOVER

DURING CROSSOVER

are the thermal emittance of the target and the radiation emitted by surfaces surrounding it. Taking these considerations into account it is easy to understand why knowledge concerning time of day and image presentation (positive or negative) is of critical importance in IR interpretation.

With the exception of tone, the characteristics to look for when interpreting IR imagery are similar to those found in conventional black and white aerial photography. Size, shape, texture, shadow (on daytime IR imagery), pattern and surroundings are all important elements to be considered in the interpretation of imagery. Tone is different in the sense that it bears no relation to the color characteristics of an object, it is purely a function of emissivity and temperature. The geometric relationship between a target and sensor can vary the strength of the signal received from the object of interest and therefore its signature on IR imagery.

INVERSE SQUARE LAW

A basic geometric consideration is that of distance (altitude above ground) between detector and target. A simplified version of the Inverse-Square Law states that radiation from a point source (e.g., object on the ground) as measured by a receiver will vary inversely as the square of the distance between source and receiver. Energy transmitted to the receiver equals energy at the source divided by the distance squared. Essentially this means that if a point source is radiating X watts, the energy received at 250 feet is $X/250^2$ watts. In other words, as the distance between the sensor and target scene increases, there is a vast decrease in energy received.

LAMBERT'S LAW

Another law governing the strength of the signal received from a radiating body is Lambert's Law of Cosines. The law states that radiation received from a flat surface will vary as the cosine of the angle from which the surface is viewed. Essentially this means that the signal received from a target is decreased if it is not directly beneath the aircraft.

In addition to these external considerations, there are internal mechanical factors which will also alter the portrayal of tone on IR reconnaissance. System settings, which in the case of AN/AAD-5 are automatic, vary the tone of an object in two separate scenes. This occurs because the system self-adjusts both dynamic range and video gain. As a result, the average scene temperature and target to background differences can affect image contrast and the tone of a particular object. Since the controls for these variables are automatic, there is little the interpreter can do about them; however, knowledge of their affect on IR imagery is quite important.

Generally, there is a correlation between image tone and temperature. Because of this basic association the interpreter can make careful assumptions about common building materials, normal temperature patterns and typical surfaces. Illustrated in Table 4-1 are the usual thermal signatures which depict common materials.

NIGHTTIME IMAGERY

COOL	METAL WOOD COMPOSITE ROOF	MODERATE	GRASS SOIL TREES	WARM	WATER CONCRETE ASPHALT

DAYTIME IMAGERY

COOL	METAL WATER TREES	MODERATE	GRASS SOIL WOOD	WARM	CONCRETE ASPHALT

TABLE 4-1

COMMON MATERIALS AND THEIR USUAL TONE ON IR IMAGERY

INFRARED TARGET SIGNATURES

In the interpretation of real-time and near-real-time imagery, the accuracy of detection and identification of time sensitive targets is crucial. Because the Quick Strike Reconnaissance concept will deal with targets of this nature, a basic familiarity with their signatures on infrared imagery will aid the image interpreter in carrying out his task. This instruction block includes a table which outlines the characteristic signals for various target classes. The emphasis of this interpretation signature index is on targets which are highly perishable and therefore many less mobile targets have been omitted.

For the sake of clarity, the following terms will be used in reference to IR imagery signatures: hot - denoting an area of high infrared return, warm - an area with moderate return, cool - an area with a relatively low return and cold - an area denoting an almost total absence of infrared energy. These terms will eliminate the use of words such as dark or light, thus the mode of presentation (positive-vs-negative) will not affect the way in which tonal quality is described.

TRACKED AND WHEELED VEHICLES

-Trucks-

In general trucks tend to present a cool signature because they are constructed of metal. Size affects the ability to interpret the target correctly; as size increases, correct identification becomes easier.

Infrared Signature

Trucks are generally recognizable by their rectangular shape, (length-to-width ratio normally 3:1) and show up as cool-cold returns on IR imagery.

An exception to this is the hot signature which is a result of the energy emitted by the hot engine-exhaust sections of a truck. Front end engine and single exhaust system typifies most military trucks.

-Tracked Vehicles-

Tanks, armored personnel carriers, and self-propelled guns are all highly mobile vehicles found in nearly all physical environments.

Infrared Signature

The IR signature for tracked vehicles is typically rectangular with a length-to-width ratio of 2:1. They usually give off a cool-cold signal when not in operation.

When tracked vehicles are in operation the moderate to strong warm return from the single or dual exhaust system and engine compartment is quite evident.

-Artillery-

Artillery is the term applied to canons, launchers, and misseles designed to support infantry and armor units in the field.

Due to its mobility and obvious tactical value, detection and identification of artillery can be of critical importance. Although detection of this class of targets is possible, the potential to identify particular target types varies with artillery size and the environmental setting. A key to identifying these targets lies in the pattern in which they are found. Therefore, it is important that an interpreter be familiar with the typical arrays for a variety of artillery pieces.

Infrared Signature

A canon or large field gun, when imaged in a favorable open environment, can be identified by the long hot or cold signature of its barrel in relationship to the diameter of its bore. In many instances, the weapon array may aid in identification when the artillery pieces are configured in a definite geometric pattern. The weapons may be in a straight line, in an arc, or set up in a boxlike or circular pattern. In nearly all cases, revetments will be constructed as emplacements for field artillery. Although the revetments may take on one of several shapes, all will have an open side to permit the entrance and exit of the weapon. The signal received from such emplacements varies with construction material which may be excavated earth, logs, rocks, sand bags, concrete or a combination of available material.

Due to the complexity and variety of physical properties possessed by these construction materials, there is no one signature which typifies all the possibilities. Generally speaking, the revetment will be visible on IR imagery in contrast to surrounding terrain.

Like field artillery, missiles and rockets are mobile and are more easily identified by their spatial distribution in the field than through the recognition of individual weapons. When identifiable, rockets and missiles are characterized by a cold signature which yields a silhouette of the weapon. In most cases, there is evidence of support equipment in the vicinity, such as generators, radar antennas, and radar trailers which are rectangular and have a length-to-width ratio on the order of 3:1. When in use, heat producing equipment will give off hot spots as will truck engines for truck-mounted missiles. Revetments constructed of a variety of materials will also be visible around missiles that are in a "readied" state.

Although mortars are relatively small, they may also be detected due to the cool signal received from the mortar pits in which the weapons are emplaced. Any such area, whether it is a trench or artillery emplacement, may be visible if it is in a relatively open area.

-Roads-

The signature of most roads is usually evident due to the difference in material between the roadway and the adjacent terrain; the greater the contrast in the physical characteristics of these materials, the more obvious the signature. Paved roads possess the capacity to absorb heat during the day and therefore radiate a high amount of thermal energy in the early evening hours. Unpaved roads do not have this capacity and are less evident. Most times, the difference between an unpaved road and surrounding vegetation is great enough to produce a recognizable signature. Roads can be found in nearly all stable and semi-stable terrain and in all environments.

Infrared Signature

The long linear pattern and angular intersections that characterize roads make detection quite easy. Although both asphalt and concrete roads generally render a strong warm signal, asphalt's greater thermal capacity results in a comparatively stronger signature on late-night imagery. The median strip on divided highways is usually evident as a cool signature. Vehicles along a road are normally detectable and sometimes identifiable if conditions are optimal.

-Railroads-

The appearance of railroad tracks is characterized by a long linear signature and long sweeping curves, and unlike roads have no angular intersections.

Infrared Signature

On IR imagery, the rail bed usually gives off a weak warm signal with a cool signal from the rails themselves. Ability to correctly detect the presence of railroad tracks depends on the number of tracks and the surrounding terrain. Caution should be exercised so that a roadway is not mistaken for railroad network.

-Railroad Support Facilities-

Variety of tracks, rolling stock, locomotives and support facilities makes detection and interpretation relatively easy. They are usually found in or near population centers or near major transportation facilities (harbor, major highway) where freight can be transferred to or from rail networks.

Infrared Signature

A weak warm signal from the rail yard, and shapes of objects within a railroad support area, aid in correct identification. Hot signals from engine compartments in locomotives indicate that they have recently arrived or are about to depart. Tank cars containing fluids may reveal a warmer (nighttime) or cooler (daytime) signature than typical freight cars. An exception to this is when high viscosity petroleum products are heated and pumped into tank cars; here a warm-hot signature from the tank car is accompanied by a hot linear pipeline pattern leading from storage tanks to the filling area.

-Bridges-

Bridges can be made of a variety of materials; therefore, the signature on IR imagery may vary somewhat. Since most bridges of tactical importance cross over water, their object to background contrast changes with time of day. The bridge width, the apparent number of approaches, and other associated features distinguish a road and railroad bridge.

Infrared Signature

Bridges imaged over water during mid-day hours render a warm signature; whereas at night, the signal received from most bridges produces a cold signature in contrast to the water below.

Caution should be exercised when interpreting imagery acquired around sunrise or sunset. During these hours, radiometric crossover occurs which virtually eliminates the contrast between a bridge and the water which lies below.

-Harbor Facilities-

As is the case with rail yards, there are several components of a harbor facility, which due to their size and shape make correct identification easy. The objects of interest are often less obvious since they are dependent upon differing thermal emissions.

Infrared Signature

Due to a number of heat-producing activities, there are a variety of returns from an area identified as a harbor facility. The signatures of ships with running engines are identifiable by the hot spots where stacks release exhaust.

Tankers can often be detected on imagery since they may be adjacent to a hot pipeline system leading from POL storage tanks.

Due to contrast with water, identification of ships, submarines and small vessels is possible from the silhouette produced on IR imagery.

-Airfields-

Airfields are generally identifiable by the pattern revealed by the runways and taxiways. Surrounding features such as hangars, fuel tanks and service buildings are usually apparent on the imagery as well.

Infrared Signature

Paved runways and taxiways bear the same characteristics as roadways constructed of the same material. They generally appear as warm geometric returns.

Buildings tend to return a cool-cold signal and are identifiable by shape and relative position. Fuel tanks are easily identified by their typical cylindrical shape. The tone of the tank depicted on the imagery may offer some idea of whether it is full or empty.

-Aircraft-

The detection of aircraft located at an airfield is usually rather easy. The contrast between the metal and pavement is sufficient to make identification of aircraft type possible.

Infrared Signature

The definite cold signal of most aircraft against the warm signature of the pavement reveals a detailed silhouette.

Aircraft with running engines are visible due to hot return from the engine areas.

The shaded pavement beneath an aircraft may leave a "thermal shadow" hours after the aircraft has been moved. This cool, hazy silhouette is most apparent after a cloudless day and on surfaces with a relatively high thermal capacity.

The warm fan-shaped signature is often the result of warm-up prior to an aircraft's take-off.

-Troop Activity-

The presence of troops in a previously unoccupied area may be evident through a number of changes in the landscape. Some changes are quite subtle and may just involve the clearing of a small area for a temporary camp.

Sites of a more permanent nature usually have a number of structures such as tents or support facilities and are near a good transportation network.

A common element found in areas occupied by troops is fire. The size, number and pattern of fires is sometimes a clue as to the number of troops in a region.

Track activity is another clue to an area occupied by troops.

Infrared Signature

Cleared areas show up as cool-cold areas at night, and as warm areas during the day in relation to surrounding vegetation. Some familiarity with the area is necessary to recognize this change in the landscape.

Tents and other structures render cool-cold signatures unless there is some heat-producing activity inside the shelter, then warm-hot signals are produced.

The hot spots produced by fires are easily detected on infrared imagery. A trailing effect and an exaggeration of the size of a fire often occurs due to the intense heat.

INSTRUCTION BLOCK #5

CHARACTERISTICS OF THE AN/AAD-5 DOWNWARD-LOOKING INFRARED SYSTEM

(WILL INCLUDE PRACTICAL EXERCISES)

(3 Hours)

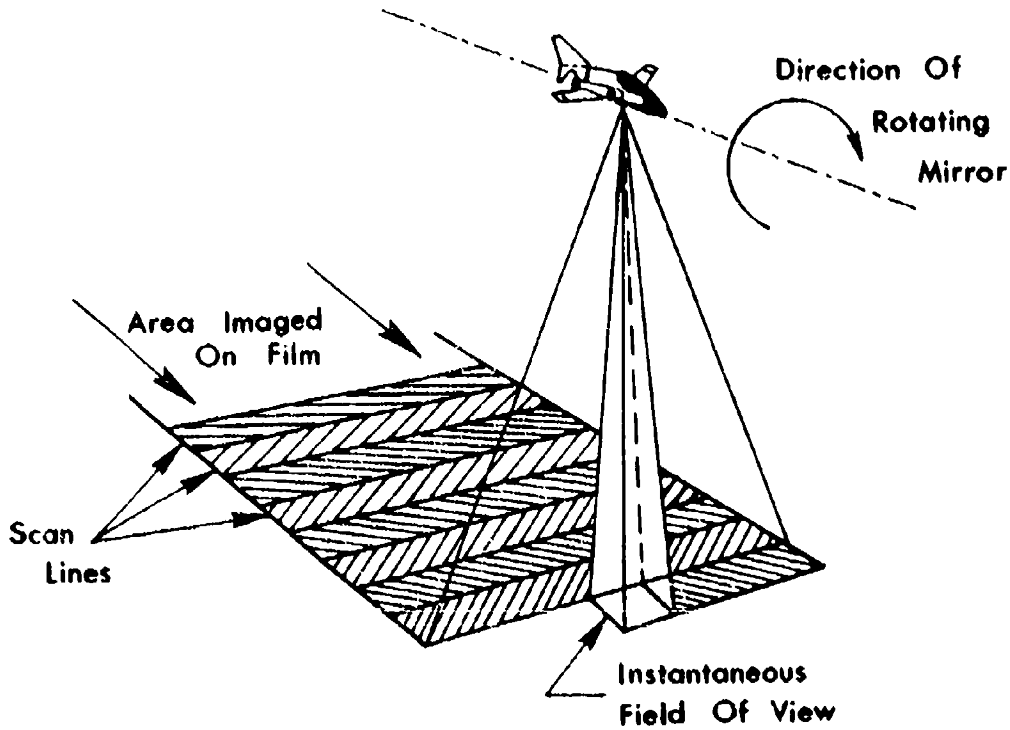
I. INTRODUCTION - SYSTEM FUNDAMENTALS

A. Line Scanning System

This instruction block is intended to familiarize student interpreters with the AN/AAD-5 downward-looking infrared system. The AN/AAD-5's components, its operation, and characteristics are outlined and described in the following sections. Included in this block of instruction are examples of imagery collected under favorable, as well as unfavorable conditions. For the purpose of this course, emphasis will be on the AN/AAD-5 characteristics peculiar to Quick Strike Reconnaissance.

The AN/AAD-5 system employs components which scan, detect and process information. Unlike a photographic system which records the terrain one frame at a time, the scanner produces a continuous image. It accomplishes this through the forward motion of the aircraft and the transverse motion of the mirror in the IR receiver. (Note Figure 5-1.)

Through a series of mirrors, thermal IR radiation is directed to an array of twelve detectors. The signal generated by each detector is amplified and



Line Scanning Of Terrain
By AN/AAD-5

FIGURE 5-1

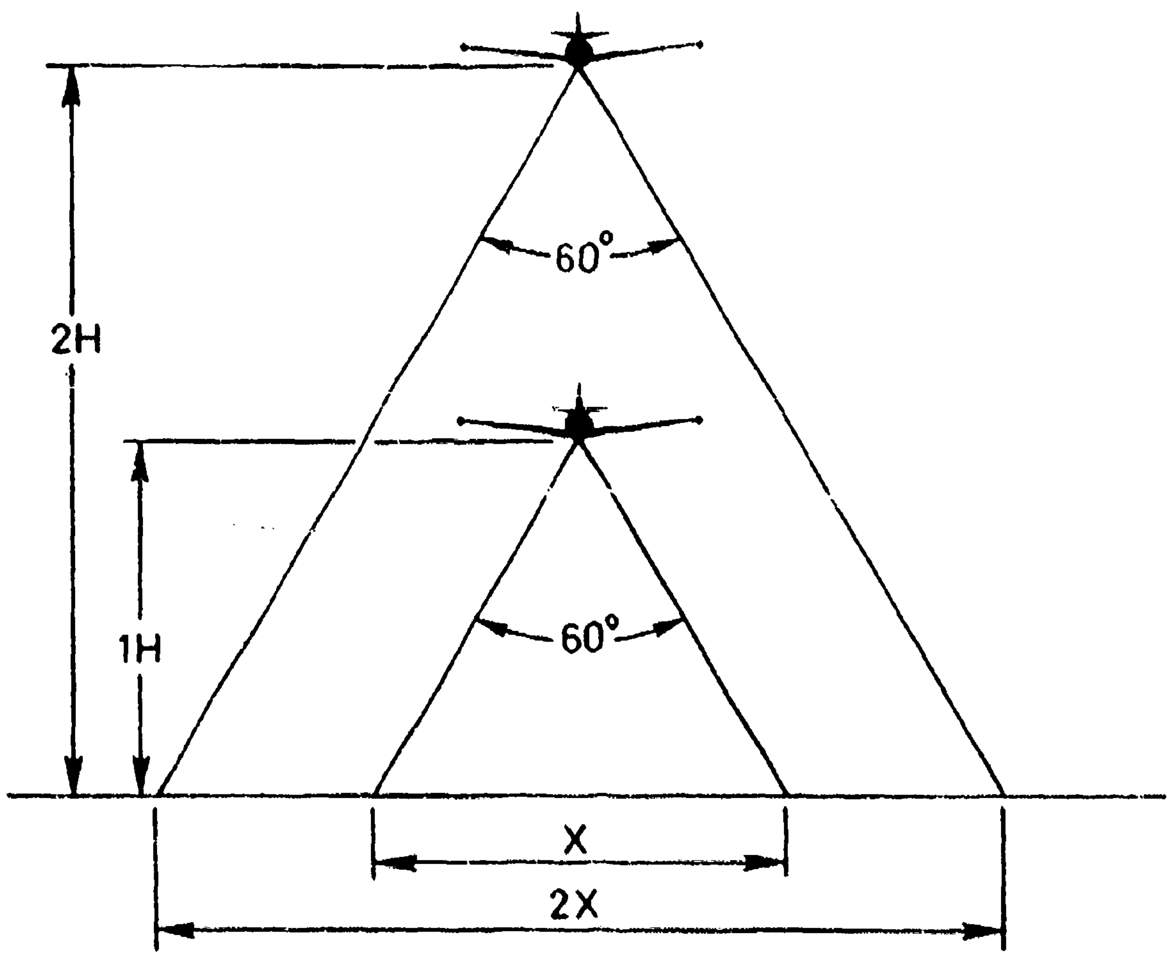
then stored on the aircraft or transmitted to a ground facility. In either case the electrical signals are used to modulate a beam of light creating an image on a cathode-ray tube (CRT). As the intensity of thermal radiation varies over space, the brightness of the light illuminated on the CRT varies accordingly. Photographic film moving simultaneously across the front of the CRT is exposed, creating a hardcopy IR record of the terrain being covered. In Quick Strike operations the laser beam recorder in the RRF exposes heat-processed dry silver film which is available to the interpreter in a matter of minutes.

B. Basic Geometry of the AN/AAD-5 IR Reconnaissance Set

The length of the scan line depicted in Figure 5-1 is a function of two variables - altitude of the aircraft above ground level and field of view (FOV). The concept of altitude is rather simple, the greater the aircraft altitude, the more terrain covered by a single sweep of the scanning mirror (assuming a constant FOV) (Note Figure 5-2a). With the AN/AAD-5 Reconnaissance System, the FOV can be changed. In turn, this will change the length of the scan line. The system can operate in a 60° narrow (NFOV) or a 120° wide (WFOV) field of view as illustrated in Figure 5-2b. The lateral coverage of the terrain in the WFOV is equal to that flown at three times the altitude in the NFOV. (Note Figure 5-2c).

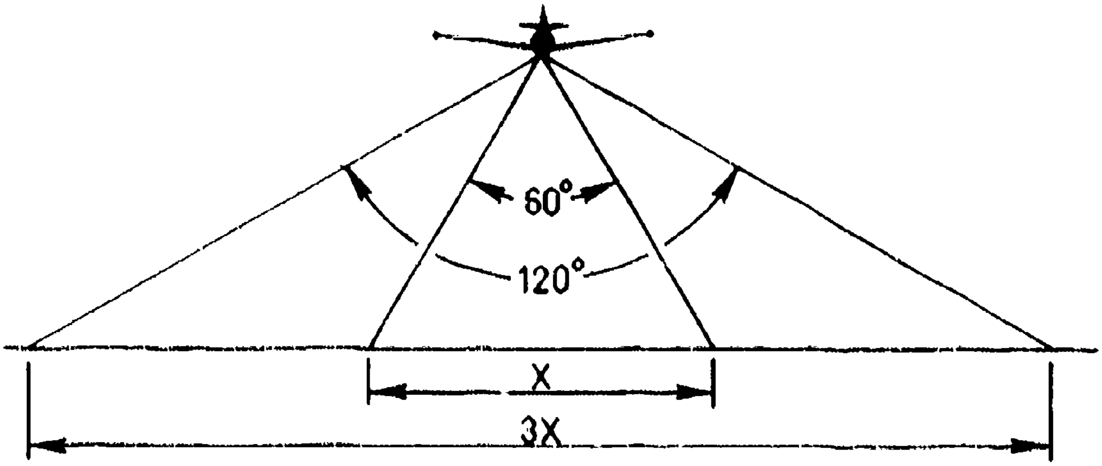
Selection of the field of view is based on the following considerations:

V/H Ratio - Air Speed (V) and Altitude (H)

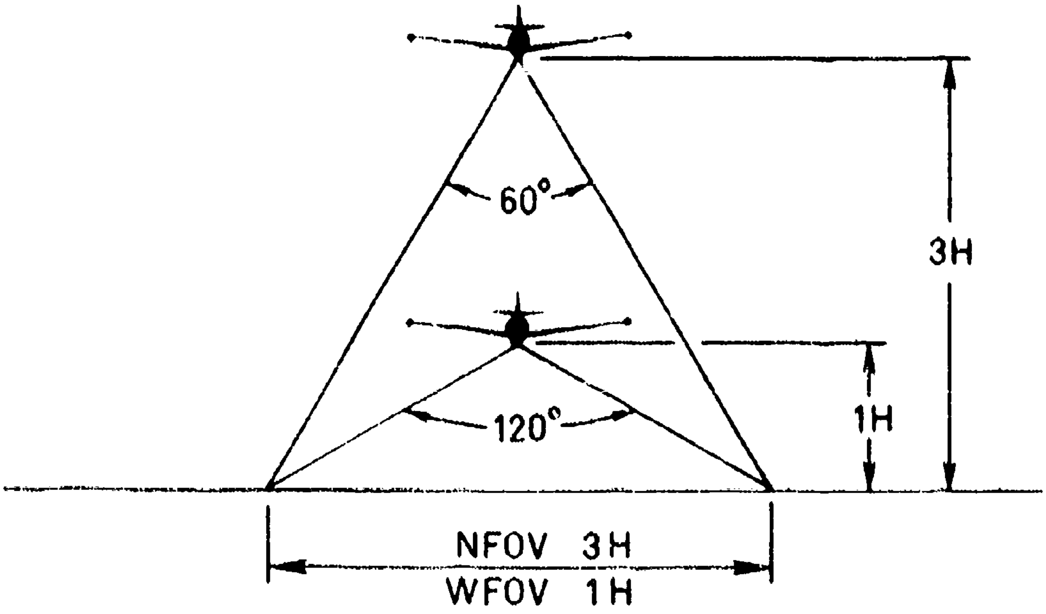


Relationship Between Altitude and Length of Scan Line

FIGURE 5-2a



Length of Scan Line in Narrow and Wide Field of View (Same Altitude)
FIGURE 5-2b



Length of Scan Line in Narrow and Wide Field of View (Different Altitude)
FIGURE 5-2c

(Spatial) Resolution with a given FOV

The V/H Ratio is the velocity of the aircraft divided by the height above the ground. Factors such as weather, enemy activity and terrain configuration can affect both altitude and air speed. Due to mechanical limitations, employment of the AAD-5 sensor is restricted to two V/H ranges: one in the NFOV and the other in the WFOV. If the V/H range within a FOV is exceeded, there is loss of ground coverage between sensor scans, resulting in degraded imagery. Basic to the Quick Strike Concept is the need to data link imagery to the Reconnaissance Reporting Facility Exploitation Shelter. Since there is also supplementary information that must accompany the imagery concerning aircraft altitude, velocity, location, etc., the full twelve-channel transmission of imagery must be reduced to six channels. Because of this modification, the potential V/H range of the AN/AAD-5 system used in Quick Strike operations is reduced by one half.

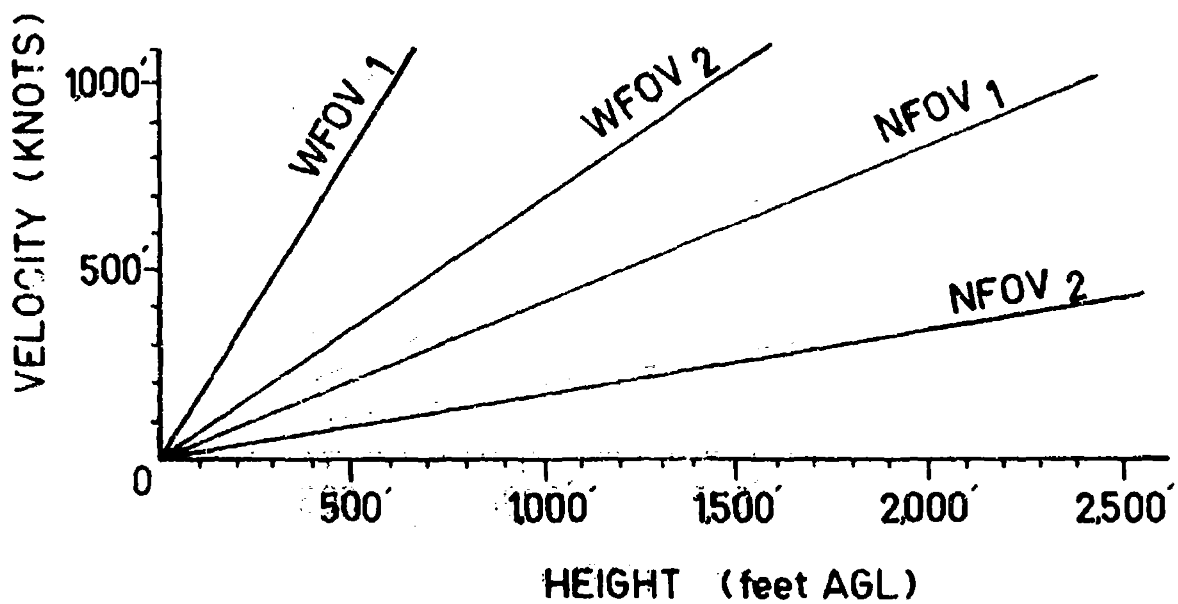
If the full twelve channels were transmitted in addition to navigational information, an excessive portion of the available communication frequency band would be used. This would diminish the number of frequencies available to command and control systems. As a result, the interpreter may view imagery that lacks portions of information. When this occurs, targets imaged on the film are compressed along the line of flight as illustrated in Figure 5-3a. There is a direct relationship between the percentage of information lost and the degree to which the V/H limit is exceeded. Although there is an absence of information on compressed imagery, it has been determined to be of tactical value since detection and interpretation can still be accomplished.

It should be remembered that there is no distortion or loss of information across the line of flight since the V/H ratio does not affect the sensor's capability to record information along a scan line.

The V/H limits in both fields of view and the V/H ratio at which 80% accurate target identification was possible in prior testing of the AAD-5 system are depicted in Figure 5-3a. There are V/H limits which in some cases dictate which FOV must be utilized. For example, if an aircraft is flying at a low altitude and high ground speed, (V/H ratio in the high range) it may be necessary to use the wide FOV in order for the reconnaissance system to image scan lines adjacent to one another. This is because the WFOV has greater spatial resolution, (note Figure 5-3b) which allows the sensor to scan a larger area of the terrain with each sweep. The system can therefore be employed at lower altitudes and higher velocities without omitting sections of terrain.

Resolution, a measure of the system's performance, is altered by altitude and FOV. With the AN/AAD-5 system, the resolution is different in the two fields of view. The resolution parameter within the system is referred to as angular resolution. This measurement is independent of altitude and is expressed in angular units known as milliradians (mrad); a milliradian equals .057°. The angular resolution in the two fields of view can be obtained from the AN/AAD-5 Exploitation Manual which will be provided later in the course. This angle determines the dimensions of the area being instantaneously viewed by the scanner (instantaneous field of view IFOV - note Figure 5-3c. Notice that the area of the IFOV varies along the scan line track. Though the

AN/AAD-5 WIDE AND NARROW FOV V/H LIMITS



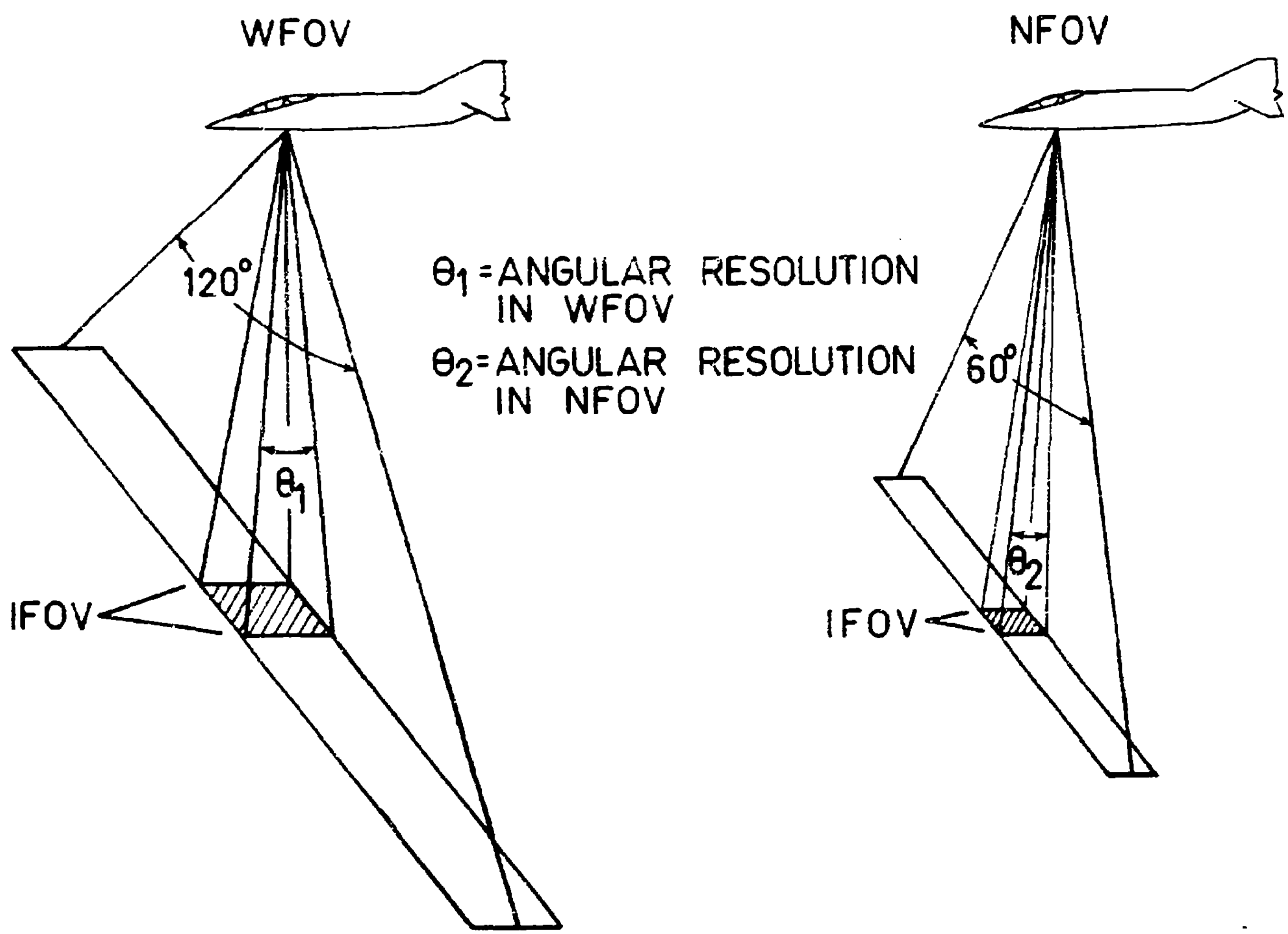
$WFOV_1$ = V/H Limit Yielding 80% Identifiable Imagery in WFOV

$WFOV_2$ = V/H Limit of Contiguous Ground Coverage in WFOV

$NFOV_1$ = V/H Limit Yielding 80% Identifiable Imagery in NFOV

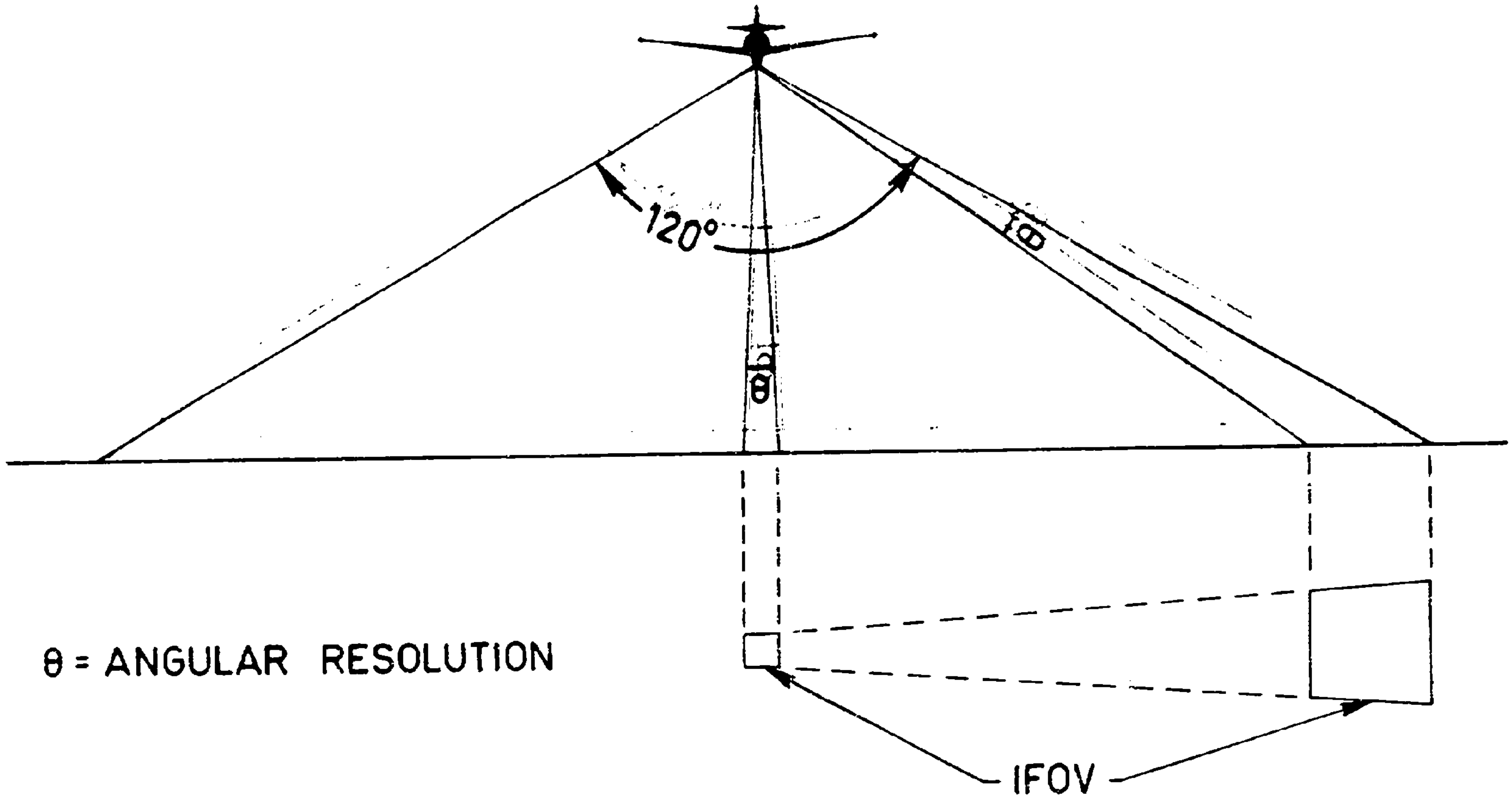
$NFOV_2$ = V/H Limit of Contiguous Ground Coverage in NFOV

FIGURE 5-3a



GENERALIZED COMPARISON OF SPATIAL RESOLUTION IN THE AN/AAD-5 SYSTEM

FIGURE 5-3b



Change in the Dimensions of the IFOV as Scanner Sweeps Terrain in the WFOV

FIGURE 5-3c

angular resolution remains constant, the instantaneous field of view (IFOV) increases in size as the sweep angle extends away from the nadir line. It is apparent that as altitude increases, the area of the IFOV increases. The dimensions of the IFOV (in feet) can be determined by multiplying angular resolution in milliradians times .001 and then multiplying this by the altitude in feet.

It is the average scene radiation within the IFOV that is sensed by the detector and imaged on the film. Therefore the smaller the angular resolution, the smaller an object is that can be detected by the sensor and the more accurate the representation of objects on the imagery. Due to this relationship between angular resolution and the resolving power of the system, it is in the NFOV that the best IR imagery is obtained with regard to ground resolution.

Another measure of the Reconnaissance system's performance is thermal resolution. Thermal resolution is a laboratory specification of the smallest temperature differential that can be discriminated by the system. This operating parameter is also listed in the AN/AAD-5 manual and is given in degrees Celsius.

An important point to remember when dealing with resolution values is that they are derived theoretically and can be affected by a number of elements. Atmospheric attenuation and aircraft vibration are just two factors which greatly affect actual performance.

II. MAJOR COMPONENTS

The AN/AAD-5 is made up of several major components. They are outlined in the following section with a brief description of their operation and function within the system. Figure 5-4 shows the generalized location of the major components within the aircraft.

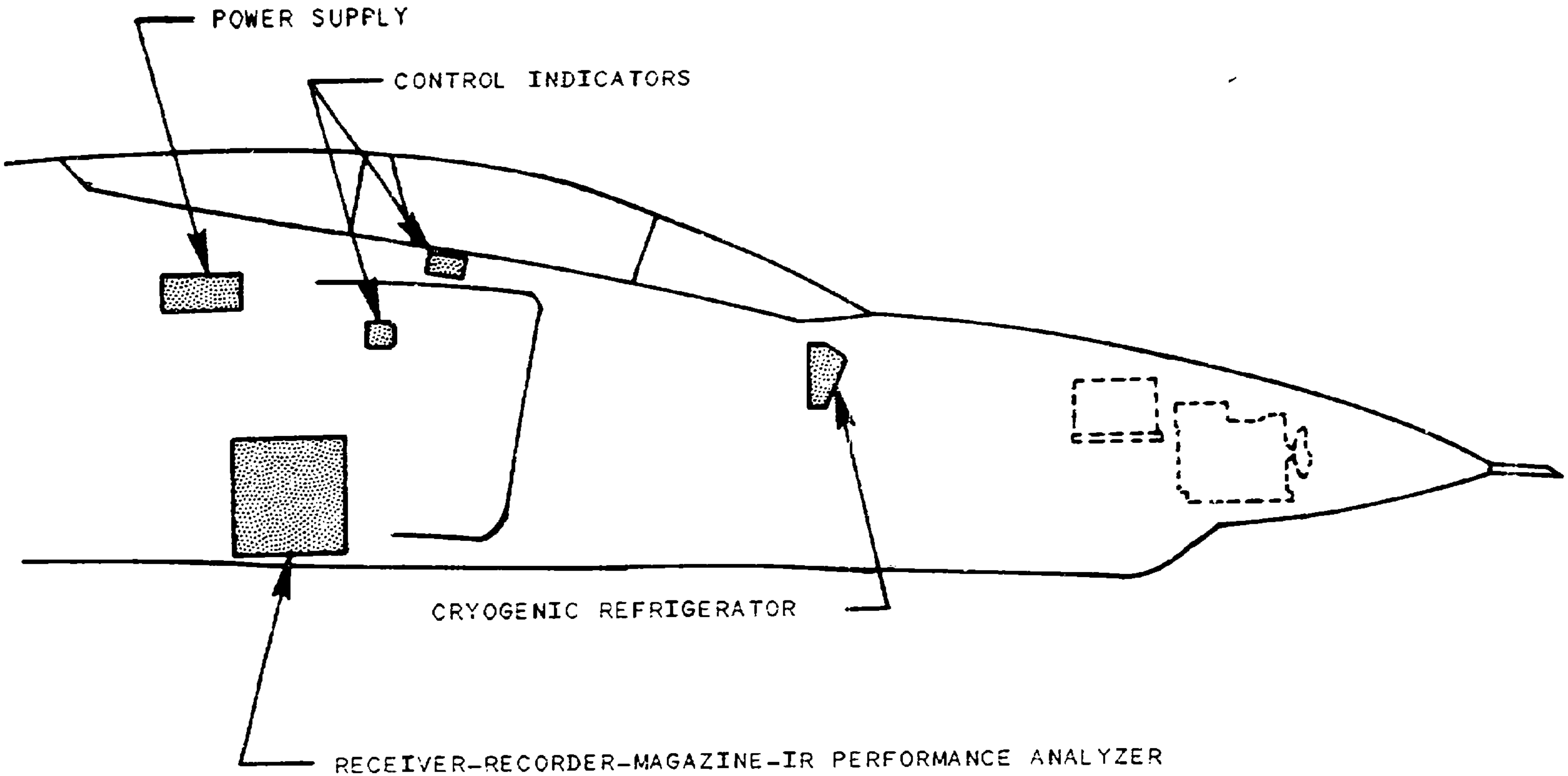
A) Power Supply - Provides regulated and unregulated voltages to all components.

B) Infrared Receiver - Contains the scanner, detector array, and cryostat responsible for maintaining detector temperature.

C) Infrared Recorder - Converts the video signals and timing pulses from the receiver and the roll correction information into the required format necessary to produce an accurate film record of the terrain.

D) Film Magazine - Contains 350' of 5" standard base film or 500' of thin base film plus associated electronics for maintaining proper film speed and film annotation circuits.

E) Control Indicator - Display and control of field-of-view mode, standby switch, ... etc.



COMPONENT LOCATIONS IN RF-4C AIRCRAFT

FIGURE 5-4

III. AN/AAD-5 IMAGE CHARACTERISTICS

A. Elements of Interpretation

The physical characteristics of AN/AAD-5 imagery are in some ways similar to photographic film. Features are identifiable by the nature of their size, tone, texture, shape, and associated features. The difference lies in the emphasis placed on each of these elements. For example, the tone on nighttime IR imagery is a result of a target's radiance and bears no relation to the tone of an object in terms of visible light. The tone depicted on AN/AAD-5 imagery depends upon the target's radiation and the average background radiation across the entire view of the system. The same target can appear differently at two different times depending on background radiation. If a warm target is placed against a cool background, it's image on positive film will appear light. Yet if the same target is placed against a background that is warmer than the target itself, the image will appear dark (Note Figure 5-5).

B. AN/AAD-5 Flight Information

Binary coded ADAS data blocks containing pertinent flight information appear every six inches along the bottom of all AN/AAD-5 imagery used in QSR operations (Note Figure 5-6a). Non-QSR film has data blocks every twelve inches but is less accurate in determining coordinates for automated target location. All information contained in the data blocks is presented in an excess-three format which is "read" automatically in the RRF and processed by the computer. These blocks can be read manually but it is generally very time-

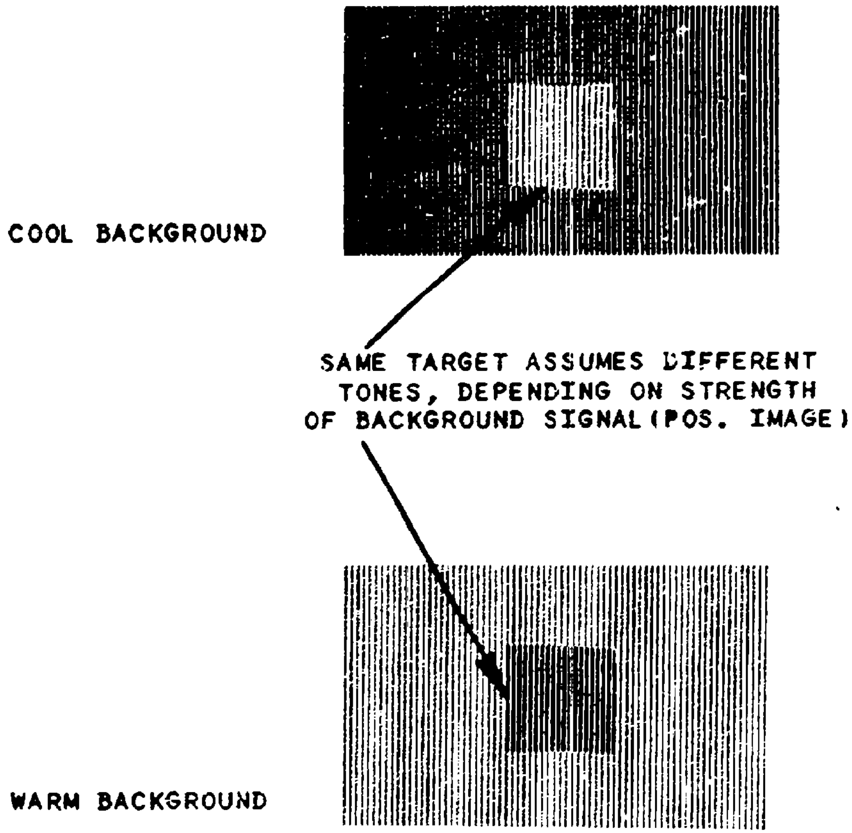


ILLUSTRATION OF TARGET TONE AS A FUNCTION OF BACKGROUND RADIATION

FIGURE 5-5

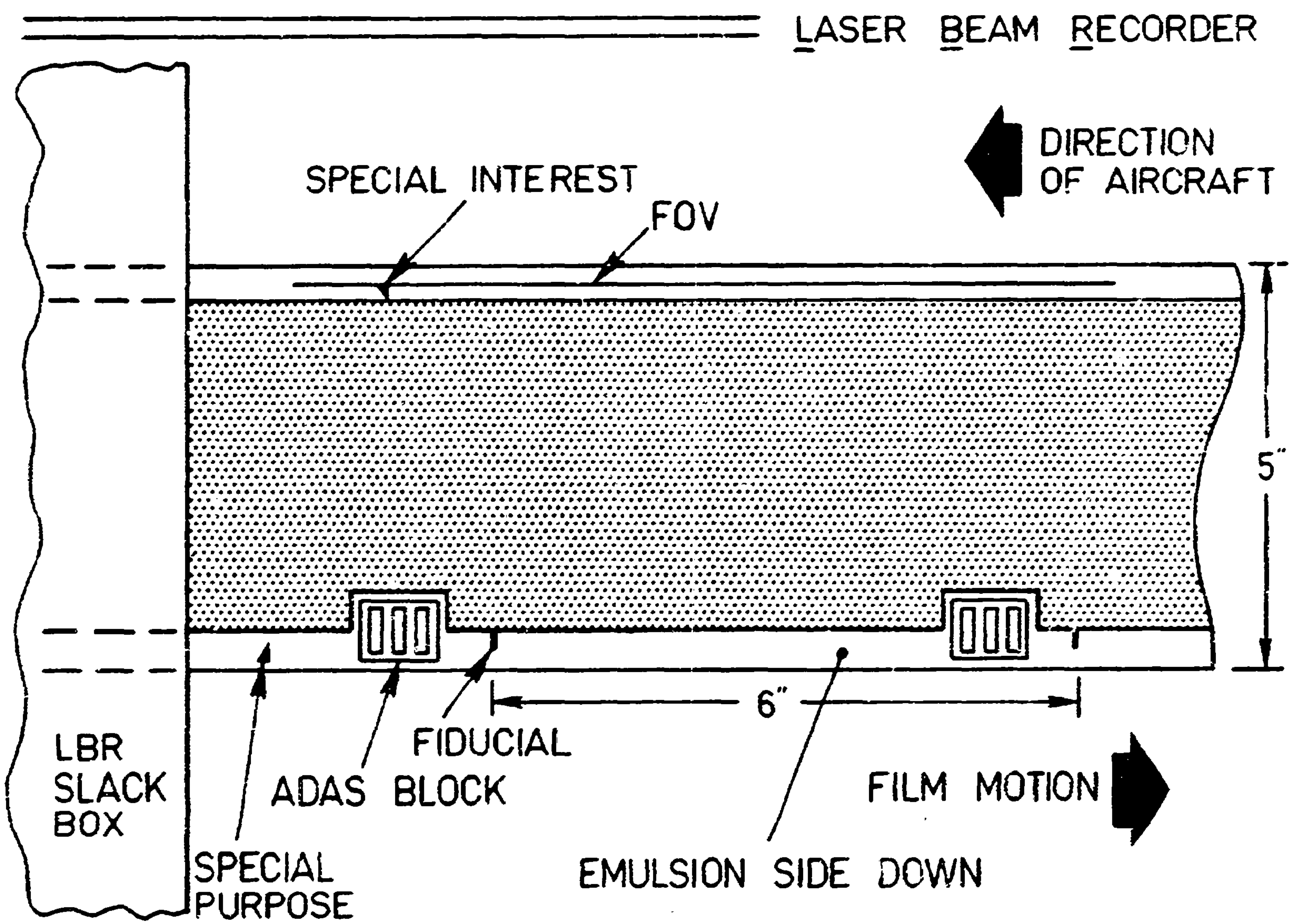

LASER BEAM RECORDER
DIRECTION OF AIRCRAFT
SPECIAL INTEREST
FOV
5"
6"
LBR SLACK BOX
FIDUCIAL
ADAS BLOCK
FILM MOTION
SPECIAL PURPOSE
EMULSION SIDE DOWN

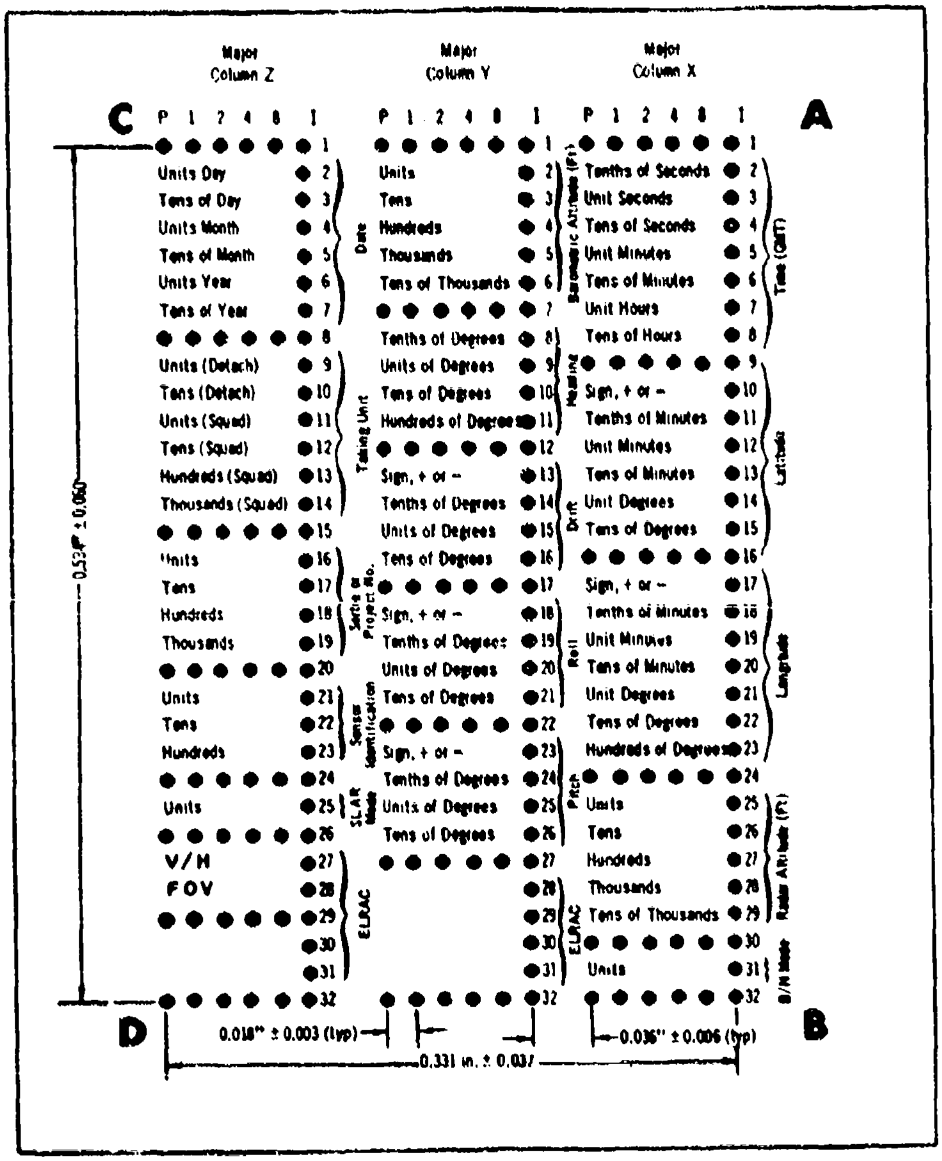
FIGURE 5-6a

consuming. Figure 5-6b is an enlarged illustration of the ADAS block. Columns within the block represent values of one, two, four, and eight, with the sum of the bits in each column read across a given row, minus three, yielding a value as shown in Figure 5-6c.

The codes for V/H and FOV are unique to AN/AAD-5 QSR operation and require a special explanation. V/H information is given in values ranging from zero to seven. This refers to the change in scale (compression) along the line of flight as the aircraft exceeds a V/H limit. As the value increases, compression of imagery becomes more evident. Only a value of zero indicates that the aircraft is operating within a given V/H limit, all other values identify increasing degrees of image compression.

Field of view is indicated by one of two codes on the data block. The wide field of view is identified by the binary code for a plus sign (+) and the narrow field of view by a minus sign (-).

In addition to the data blocks, annotations may appear on the film which will directly aid the interpreter in performing his interpretation task. An example of supplemental data which appears on the film are the flags displayed on the top and bottom of the film. The annotations along the top are special-interest markers, triggered by the air crew upon detection of possible target activity.



ADAS BINARY DATA BLOCK

FIGURE 5-66

THE DATA MATRIX IS CODED IN EXCESS THREE BINARY CODED DECIMAL. THIS SYSTEM USES DECIMAL NUMBERING BUT IT IS RECORDED IN A CODED BINARY FORM AS LISTED BELOW. IT IS READ AS A BINARY SYSTEM, I.E., LEFT TO RIGHT, MAKING A SUMMATION OF THE SIGNIFICANT BITS, THEN SUBTRACTING THREE TO OBTAIN THE DECIMAL VALUES TABULATED BELOW:

	COLUMNS						
DECIMAL VALUE (ROWS)	(BIT VALUE) PARITY BIT(P)	D1 1	D2 2	D3 4	D4 8	INDEX BIT I	NUMERIC MEANING
-3	●					●	NOT USED
-2		●				●	MINUS SIGN
-1			●			●	ERROR
0	●	●	●			●	ZERO
1				●		●	ONE
2	●	●		●		●	TWO
3	●		●	●		●	THREE
4		●	●	●		●	FOUR
5					●	●	FIVE
6	●	●			●	●	SIX
7	●		●		●	●	SEVEN
8		●	●		●	●	EIGHT
9	●			●	●	●	NINE
10		●		●	●	●	PLUS SIGN
11			●	●	●	●	SPECIAL
12	●	●	●	●	●	●	DIVIDER

NOTES:

1. THE INDEX MARK ALWAYS IS PRESENT.

2. THE PARITY BIT IS PRESENT TO CAUSE THE TOTAL COUNT OF DOTS ACROSS ONE COLUMN TO BE AN EVEN NUMBER. THIS PROVIDES THE "PARITY CHECK" TO INSURE THAT THE BIT RECORDING IS CORRECT. IF THE TOTAL DOT COUNT IS ODD, AN ERROR IS INDICATED AND THE DATA SHOULD BE REJECTED.

3. THE DIVIDER IS USED AS A VISUAL INDICATOR TO SEPARATE MAJOR GROUPS OF CHARACTERS WITHIN THE CODE MATRIX BLOCK.

4. SIGNIFICANT BITS PROGRESS FROM D1 (LEAST SIGNIFICANT) THROUGH D4 (MOST SIGNIFICANT).

5. "NOT USED" (DECIMAL VALUE -3) INDICATES THAT DATA IS NOT AVAILABLE FOR RECORDING.

6. "ERROR" (DECIMAL VALUE -1) INDICATES THE INFORMATION GENERATED FOR RECORDING IS OUTSIDE THE RANGE OF THE PARTICULAR SENSING DEVICE IN USE.

7. "SPECIAL" (DECIMAL VALUE 11) INDICATES THAT THE INFORMATION NORMALLY PRESENTED IN THIS LOCATION WILL BE RECORDED BY SOME OTHER RECORDING DEVICE.

ADAS MATRIX BLOCK CONVERSION

FIGURE 5-6c

Flags appearing along the bottom of the film are hot spot indicators. They automatically annotate targets on the ground radiating IR energy above a predetermined threshold.

Another annotation of interest to the interpreter is the line running along the top edge of the film. This line will appear when the system is flown in the Narrow Field of View (NFOV).

The fiducial mark to the right of the ADAS block indicates the point along the film to which the flight information refers. Loran coordinates identify the point of intersection between the nadir and an intersecting line from the fiducial.

C. Mensuration

Techniques used to measure objects on operational AN/AAD-5 imagery can be obtained from the Sensor Exploitation Manual. When working in the RRF/ES, measurements will be done by the computer.

INSTRUCTION BLOCK #6

CHARACTERISTICS OF THE PAVE TACK

FOWARD-LOOKING INFRARED (FLIR) SYSTEM

(3 Hours)

Instruction block 6 will deal with the unique characteristics of the PAVE TACK FLIR System. The purpose is to familiarize the interpreter with its operation so that his skills will be maximized while working in the RRF/ES. This familiarity is necessary to accomplish immediate exploitation of near-real-time FLIR video during a QSR mission.

The FLIR System is a near-real-time infrared imaging device that receives IR energy from a scene and reproduces this scene on a CRT display. A unique aspect of this system is the ability to "look" in any direction below the aircraft. Information derived from FLIR imagery supplements data gathered by the AN/AAD-5 Downward-Looking IR System. The POD containing the FLIR sensor is mounted below the RF-4C aircraft and can be manually controlled by the system operator or automatically positioned by the aircraft computer.

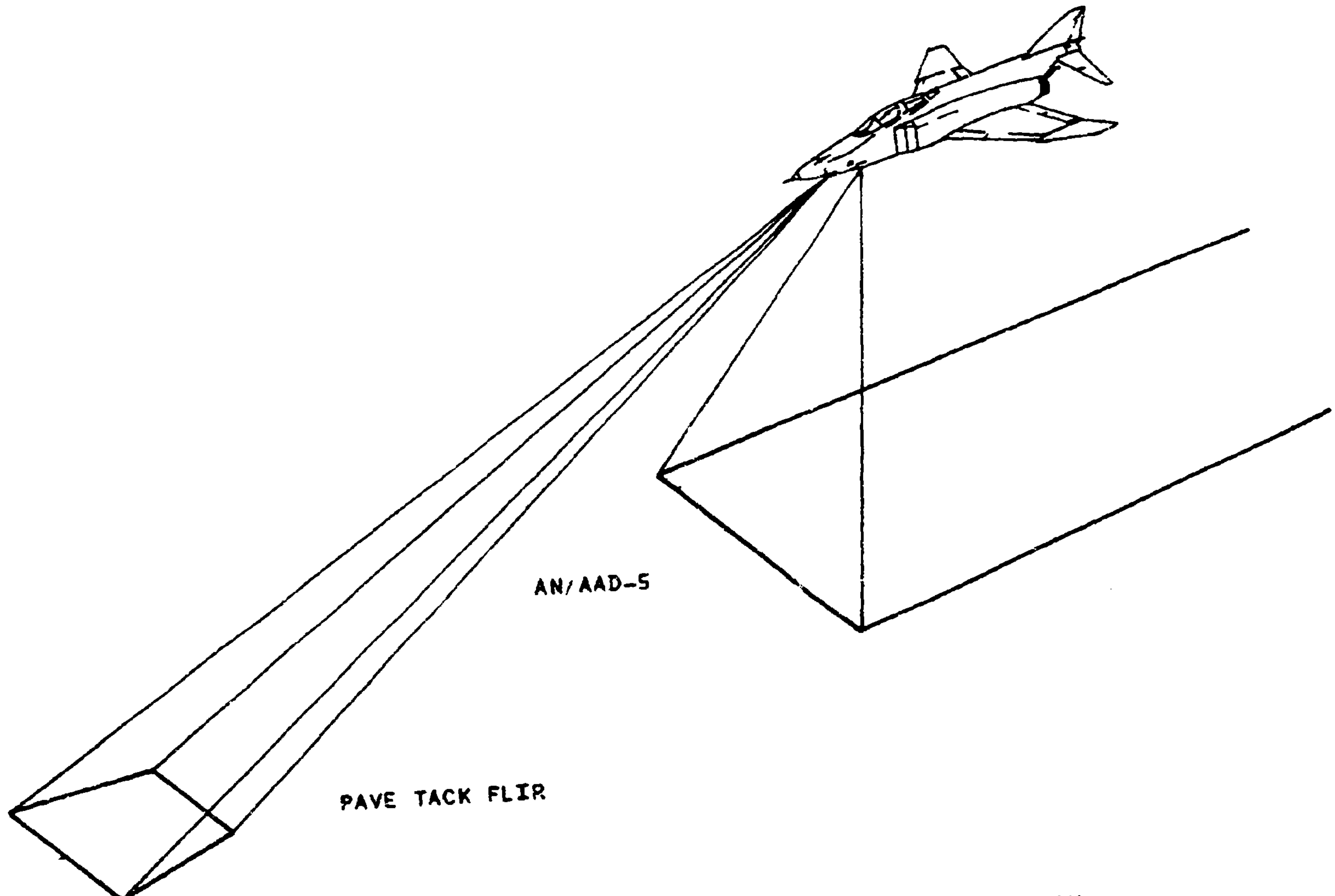
Because the system can search anywhere along the terrain, it possesses a stand-off capability unlike a downward-looking sensor. Targets of a hostile nature such as AAA sites can be viewed without directly endangering the reconnaissance aircraft. In addition, this capability gives an oblique perspective of a target area, which may yield more information than a vertical view. An example illustrating this characteristic would be the search for troop activity along the edge of a heavily wooded area. A downward view can result in omission of targets and possibly draw artillery fire from hostile ground forces, whereas the FLIR system can stand off at a safe range and acquire imagery.

SYSTEM CHARACTERISTICS

Direct control of the PAVE TACK FLIR System is maintained by the operator in the RF-4C. In addition to controlling the direction in which the system "looks", he can switch polarity from positive to negative, change fields of view, zoom in on a target, and rotate an image on the monitor.

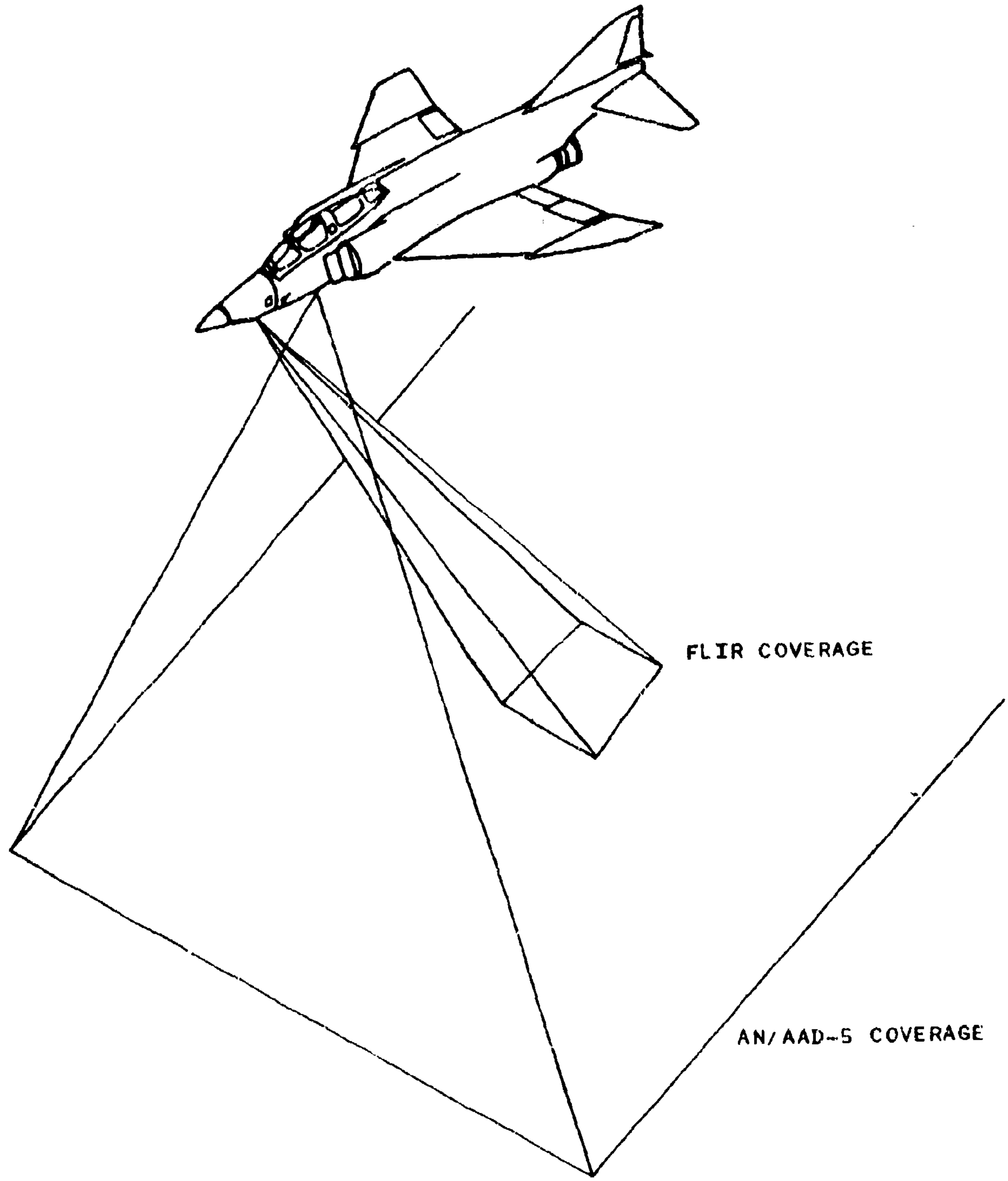
The system's ability to search the terrain in a variety of modes; forward, side, and AFT search, provides information normally unavailable with conventional reconnaissance systems. In the forward search mode, potentially dangerous areas may be detected and appropriate changes made in the flight path. Figure 6-1a illustrates the FLIR System's capability to look into hostile environments before actually flying over unsecured areas with the AN/AAD-5 system.

Due to smaller fields of view, the PAVE TACK FLIR sensor can also compliment AN/AAD-5 coverage of the same area as illustrated in Figure 6-1b. This gives interpreters a second view of a target scene which improves the probability for correct identification.



FORWARD SEARCH CAPABILITY OF THE PAVE TACK FLIR SYSTEM

FIGURE 6-1a



GENERALIZED FIELD-OF-VIEW COMPARISON
BETWEEN THE AN/AAD-5 AND PAVE TACK FLIR

FIGURE 6-1b

During a QSF mission, the system operator may switch polarity from positive to negative. If a certain presentation annoys the interpreter, he also has the option to reverse the polarity when it appears on the video monitor. Figure 6-2 is an example of positive and negative FLIR presentations.

Two fields of view are available with the FLIR System, and the choice of which FOV is employed is determined by the operator. Unlike the AN/AAD-5's FOV, FLIR FOV's are measured angularly in three directions. Horizontal, vertical and diagonal measurements are listed in Table 6-1 for both narrow and wide fields of view along with a comparison of ground coverage at various altitudes for both the PAVE TACK FLIR and the AN/AAD-5.

ANGULAR DIMENSIONS FOR PAVE TACK FLIR

	Horizontal	Vertical	Diagonal
Narrow Field of View	3.2°	2.5°	1.9°
Wide Field of View	12.6°	10.1°	7.6°

HORIZONTAL GROUND COVERAGE* AT VARIOUS ALTITUDES

FOR PAVE TACK FLIR AND THE AN/AAD-5

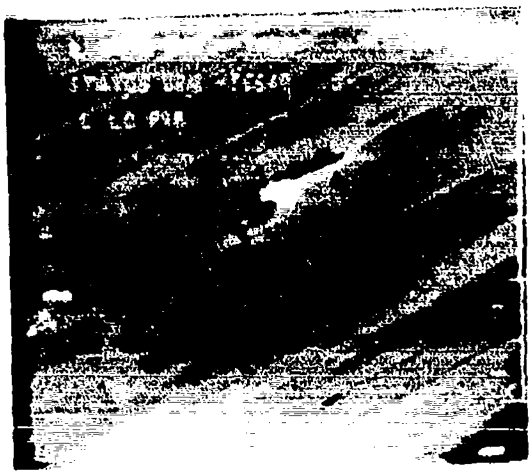
Radar	FLIR		AAD-5	
Altitude	NFOV	WFOV	NFOV	WFOV
500'	27.5	110	349.3	1048
1000'	55	220	698	2096
1500'	82.5	330	1047	3144
2000'	110	440	1396	4192

* All dimensions measured in feet.

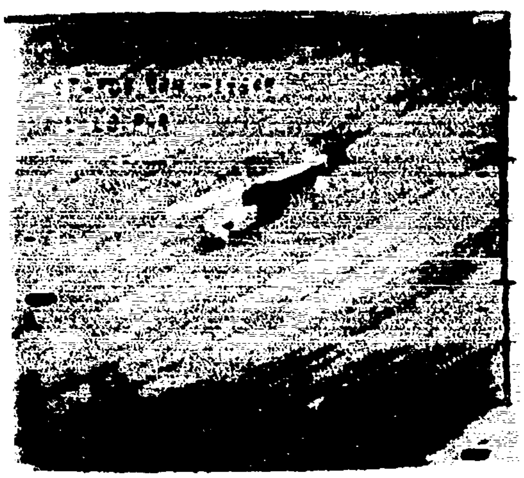
Table 6-1

FIGURE 6-2

POSITIVE AND NEGATIVE FLIR IMAGES



POS.



NEG.

The option to zoom in on a particular target is excercised on board the aircraft. This results in a 2x enlargement of any scene with no change in resolution, giving the FLIR interpreter an image of increased scale from which identification can be made.

Due to the disorientation that can result from slewing* the sensor in a variety of directions, rotation of a scene may be done within the aircraft to compensate for imagery which would appear unnatural on the monitor. For instance, if the system operator cues in on a target as the aircraft passes over it, the scene will invert and appear upside down as the sensor is directed behind the aircraft. Rotation corrects this problem so that an interpreter can work more quickly with FLIR imagery.

FLIR INTERPRETATION

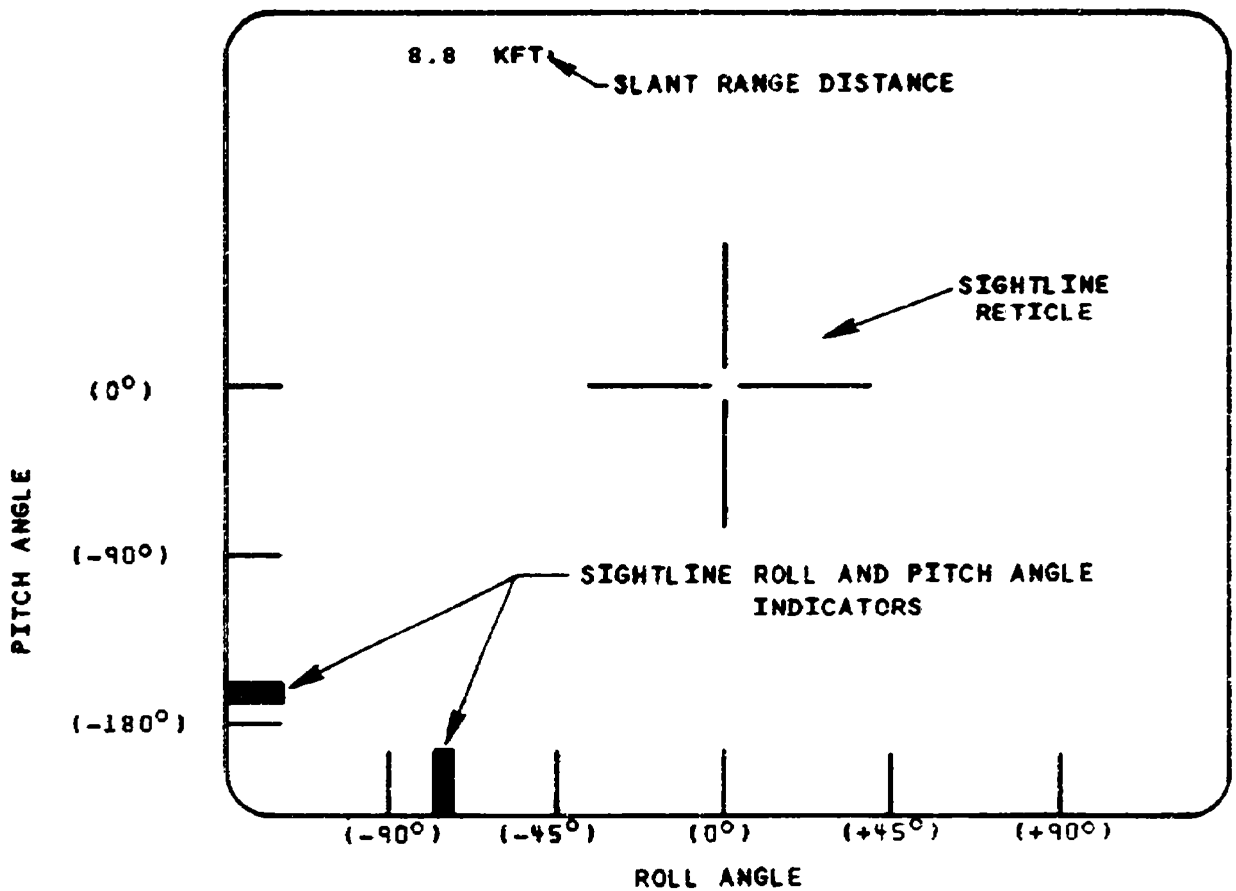
Target signatures on FLIR imagery are in many ways similar to those on hard copy AN/AAD-5 imagery. The form of presentation is the primary difference between the two systems. The FLIR sensor operates in the thermal infrared region of the electromagnetic spectrum as does the AN/AAD-5; therefore, tonal characteristics are basically the same for both systems. Targets which emit more thermal energy than their background appear light on positive imagery and dark on negative imagery.

---

* Changing of viewing angle.

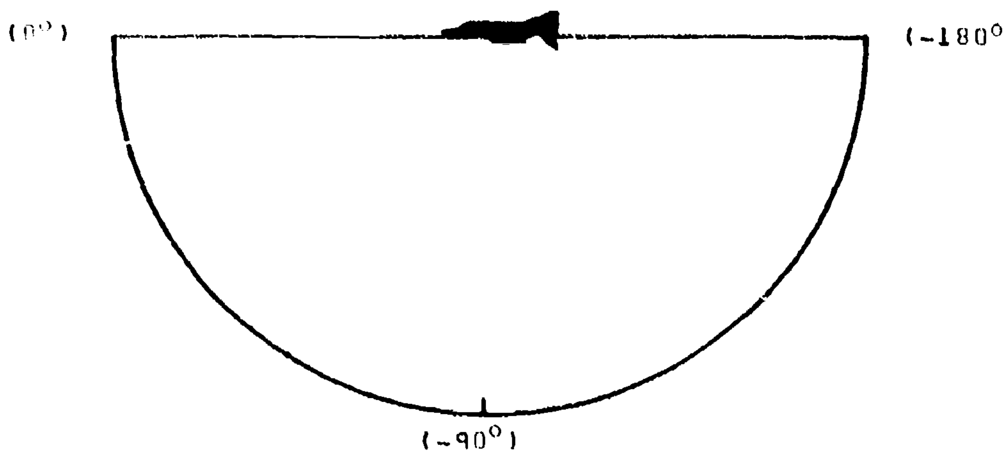
Imagery appears on the monitor within the RRF/ES at a rate of 30 frames per second. It can be played back at 1, 3, 6, 10, 15 and 20 frames per second to more closely scrutinize a target scene. The interpreter also has the option to freeze onto a scene, but this usually results in a degraded image. The FLIR display also contains additional information pertaining to the operational status of the system. Most of this data is of little importance to the interpreter with the exception of slant range distance, and sight line roll and pitch angles. The slant range distance appears along the top of the display as illustrated in Figure 6-3. It is given as 8.8 KFT, meaning that it is 8,800 feet from the aircraft to the point on the ground in the center of the sightline reticle.

Sightline pitch and roll indicators along the left side and bottom of the display indicate the direction in which the PAVE TACK FLIR System looks at the terrain. The pitch angle scale describes the orientation of the POD along the line of flight. The indicator runs from (0°), pointing to the front of the aircraft, to (-180°), directly behind the aircraft (note Figure 6-4a). The roll angle indicator shows an interpreter the downward inclination of the system across the line of flight. An angle of (-90°) indicates that the PAVE TACK FLIR POD is "looking" outward to the left of the aircraft and (+90°) means it is imaging to the right of the aircraft (note Figure 6-4b). It is important that the interpreter calculate the downward inclination of the system using both pitch and roll angles. Figure 6-5 depicts the orientation of the FLIR sensor and the appropriate pitch and roll angles as they appear on the FLIR monitor.



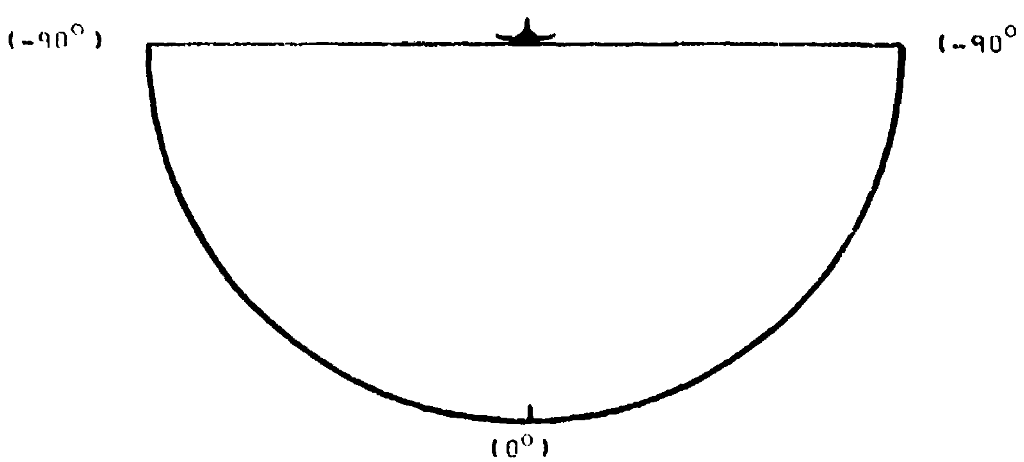
PAVE TACK FLIR MONITOR DISPLAY

FIGURE 6-3



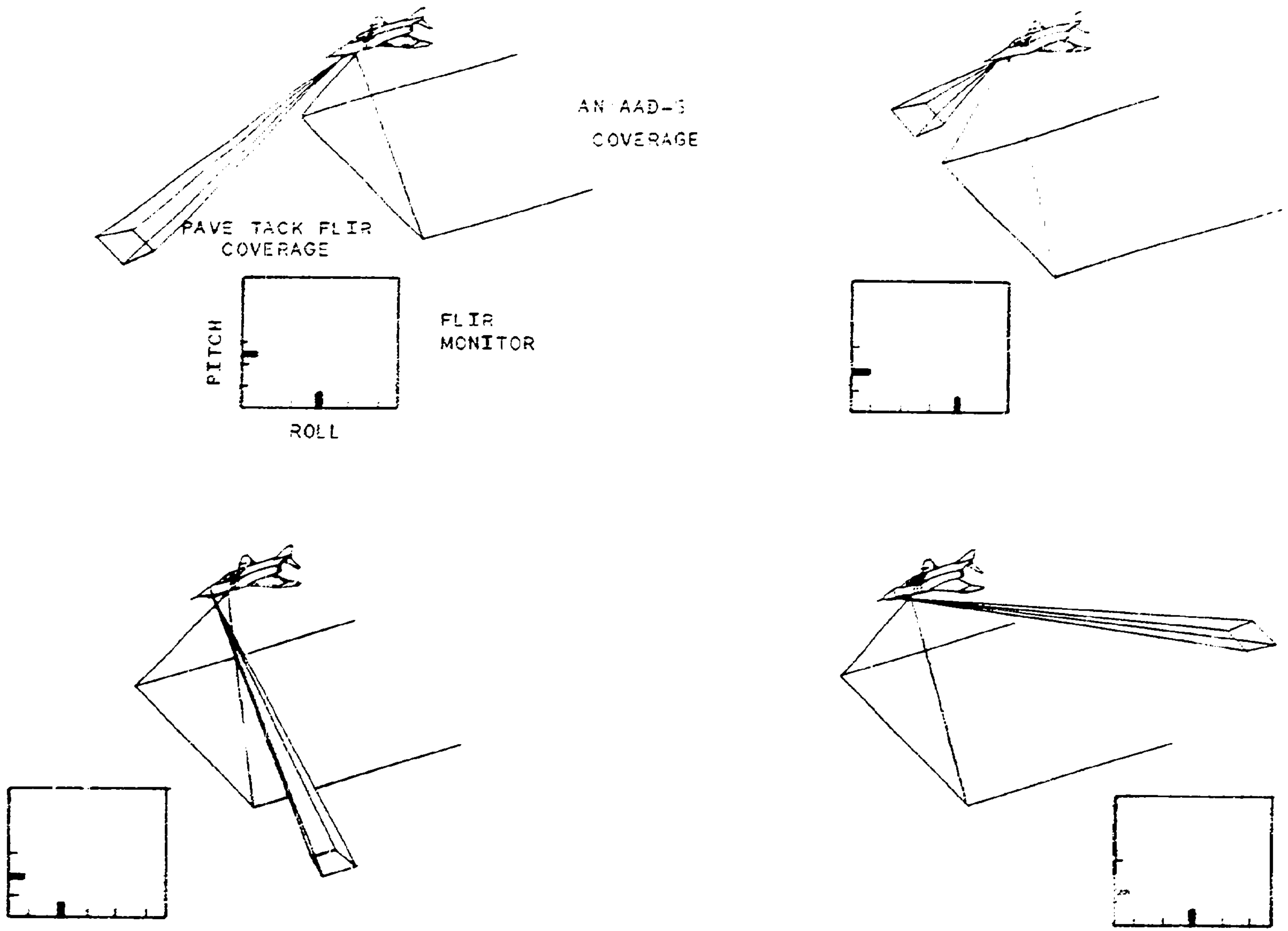
PITCH SCALE

FIGURE 6-4a



ROLL SCALE

FIGURE 6-4b



PAVE TACK FLIR ORIENTATION
FIGURE 6-5

INSTRUCTION BLOCK #7

TARGET DETECTION AND IDENTIFICATION TECHNIQUES IN NEAR-REAL TIME

(12 Hours)

The key ingredient to effective near-real-time interpretation is rapid target detection and accurate target recognition. The ability to perform in these areas is the result of training and experience. During this training course each interpreter became familiar with the sensor system's capabilities, infrared principles and infrared imagery characteristics/IR signatures. During this twelve-hour block of instruction the interpreter will be employing all techniques of imagery interpretation to rapidly detect and correctly identify "time-sensitive targets." The results of past studies conclude that as the speed of film presentation to an interpreter is increased, the probability of his making errors also increases. However, it was further concluded that if image interpreters have been selected for having extremely fast reaction-times, it might be safe to present the film at a speed of 18 inches/second.[1] These results were derived from experiments utilizing interpreters viewing conventional aerial photography. Further studies indicated that a speed of 6 inches/second is an acceptably high rate of film presentation. Interpreters received near-perfect correct response scores at this running speed.[2] Further, when the interpreters were allowed to control the running speed, some individuals would speed up the film to an average rate of 10 inches/second, without hindering their ability to detect critical targets.[3]

1. Human Aspects of Photographic Interpretation, Boston University Physical Research Laboratories, May 1957, p.31.
2. Ibid, p. 32.
3. Ibid, p. 32.

When interpreting the AN/AAD-5 infrared imagery in the RRF/ES, the interpreter will be viewing the imagery at a maximum speed of 2.6 inches/second or 13 feet/minute in the WFOV; and 1.3"/second or 6.5 feet/minute in the NFOV. He will have the capability to view the imagery at a slower rate and to "freeze onto" a target (stop the film advance). As was covered in a previous instruction block, one image interpreter will be responsible for detecting and annotating targets, while another will be responsible for the identification of those targets. For the purpose of training, each interpreter will be working individually during the Practical Exercises in this block of instruction.

When interpreting the PAVE TACK FLIR imagery the interpreter will be viewing the data on a CONRAC RQB-17 Video Monitor. As is the interpretation situation with the AN/AAD-5, he will have the capability to "freeze" or "lock onto" a target scene. Again, emphasis will be placed on rapid detection.

o SCANNING TECHNIQUES IN NEAR-REAL TIME

oo AN/AAD-5 Hardcopy Imagery

Several experiments have been conducted in the area of imagery scanning techniques when interpreting aerial frame photography. Most researchers have concluded that for accurate results, the interpreter should scan the edges of the image frame first, and work to the center of the frame.

When scanning continuous-strip imagery such as the AN/AAD-5 while it is moving across the light table, experience has proven that it is beneficial to begin scanning as soon as the start of the film reaches the illuminated surface of the table, and to scan the imagery from top to bottom and bottom to top just as the scanner scans the terrain. (See Figure 7-1.) In dense canopy-covered areas, the interpreter should limit his search to the edges of the covered areas and to any roads, trails or cleared areas that may be apparent. In the event that there are distortions in the segment of imagery being scanned, attention should be focused only on those areas that are discernible. Good scanning practices also include forming habits such as moving the eyes rather than the head, exercising caution to detect, identify and move on, rather than dwelling upon identified targets. Keep in mind that when working in the RRF/ES, one image interpreter will be responsible for detection of targets, another for identification. However, targets that are overlooked at the detection station should be detected on the identification station. It should also be kept in mind that when working at the detection station, the interpreter will have the capability of moving the film in the advance direction only.

oo PAVE TACK FLIR Data

The PAVE TACK FLIR data will be displayed on, and interpreted from, video monitors. Normally, the interpreter will be

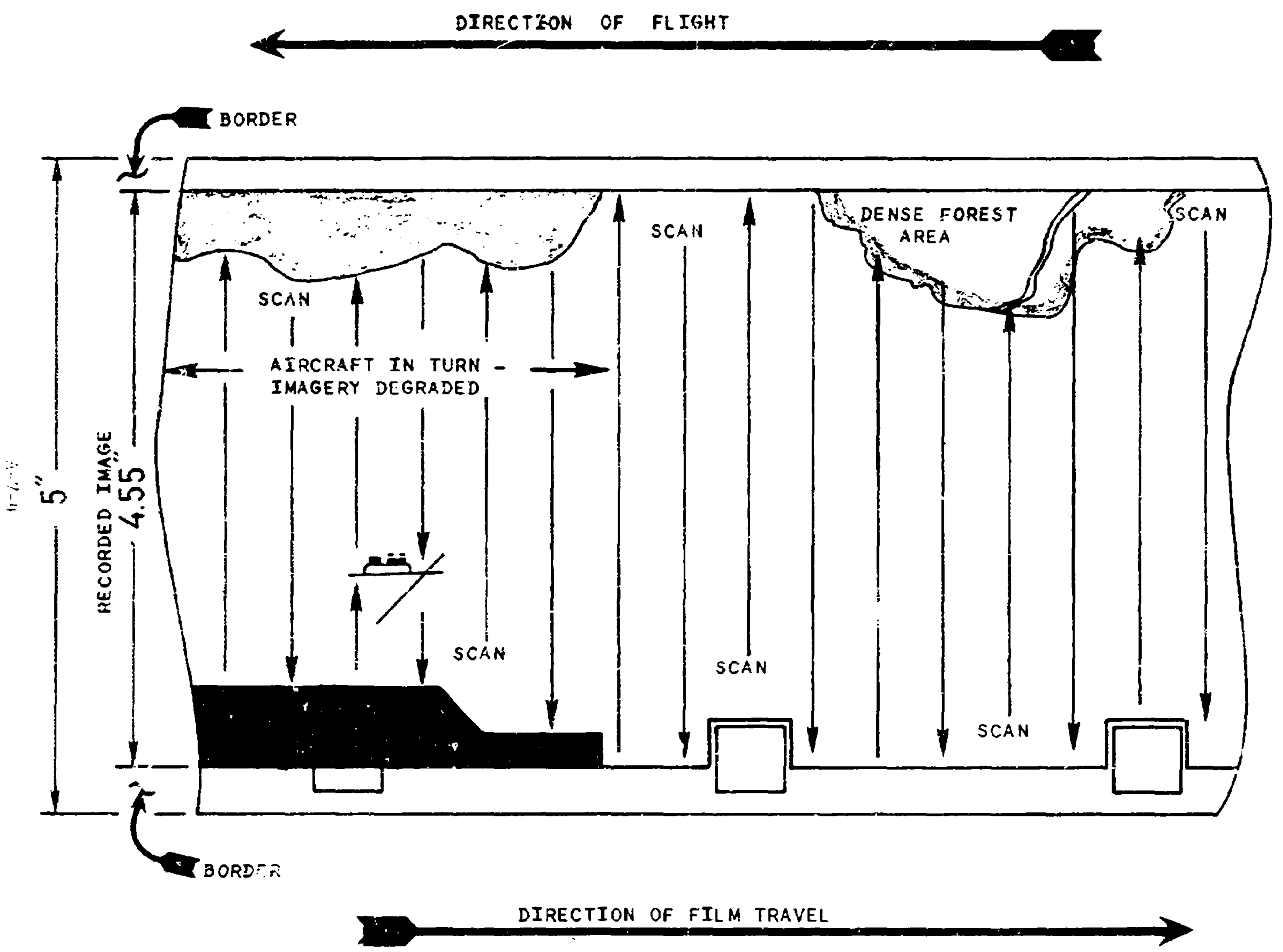

DIRECTION OF FLIGHT
BORDER
SCAN
AIRCRAFT IN TURN -
IMAGERY DEGRADED
SCAN
SCAN
SCAN
DENSE FOREST
AREA
SCAN
SCAN
RECORDED IMAGE
4.55"
5"
BORDER
DIRECTION OF FILM TRAVEL

FIGURE 7 - 1

receiving 30 frames/second; however, he will also have the capability to select recording rates of 15, 20, or 30 frames/second. In addition, he will also have a "slow-motion playback" capability of 1, 3, 6, 10, 15, 20, or 30 frames/second. The manner in which the FLIR data is displayed on the video monitor is a function of the way the data is collected. For example, if the FLIR scanner is imaging the terrain behind the aircraft, the data will be presented on the screen of the video monitor from the bottom. Should the FLIR system be slewed to the right side of the aircraft, the data will be presented from the left side of the screen on the video monitor. The method used to scan the data should be established early, and remain constant throughout the detection task.

During the remainder of this block of instruction, the interpreter will be performing various "Practical Exercises" to improve his detection and interpretation techniques in real time/near-real time. These techniques will improve through training and experience. As the interpreter's proficiency improves, so will his self-confidence.

INSTRUCTION BLOCK #7

PRACTICAL EXERCISE

ANNOTATED SEARCH AND IDENTIFICATION-AN/AAD-5

Equipment: Light table, 7x tube magnifier, 3 exercise answer sheets, lead pencil.

Objective: To identify as many targets depicted in the annotated areas during the time allocated for each exercise. There will be "false-alarm" targets. The exercise is designed to train the interpreter in rapid target detection and recognition It is intended to serve as a confidence-building tool.

Instructions: 1 - Place the roll of AN/AAD-5 infrared imagery on the light table (Emulsion down, data blocks in a readable position).

2 - Drive the entire roll of film across the table, so that you will become familiar with the type of annotations you will be working with during the exercise. Do not attempt to identify the annotated targets. Once you have scanned the entire roll, rewind the imagery to the first target scene.

3 - During the first exercise, you will have five minutes to identify the annotated targets. You will be viewing the imagery at approximately 13 feet/minute. This is the maximum speed that you will be using when working in the RRF. Write the identification of each annotated target next to the appropriate number on answer sheet #1. Begin the exercise.

4 - During exercise #2 you will be allowed 6.5 minutes to identify the annotated targets. You will be viewing the imagery at approximately 11 feet/minute. Record your identification next to the appropriate numbers on answer sheet #2. Begin the exercise.

5 - During exercise #3, you will be viewing the imagery at approximately 9 feet/minute. You have 8 minutes to complete this exercise. Use answer sheet #3 to record your answers. Begin the exercise.

Upon completion of exercise #3, the instructor will talk the students through each target scene. Each student will be required to check their answer sheet during this review. On the top of each answer sheet record the number of targets correctly identified, and the number of targets incorrectly identified, or omitted.

PRACTICAL EXERCISE

FREE SEARCH - DETECTION AND IDENTIFICATION-AN/AAD-5

Equipment: 7x tube magnifier, three (3) answer sheets, lead pencil, 1 each red, blue and black grease pencils (china markers), masking tape.

Objective: To increase the interpreter's skills in rapid detection and identification.

Instructions: 1 - Place the roll of AN/AAD-5 infrared imagery on the light table (emulsion down, scene numbers and data blocks in a readable position).

2 - During the first exercise, you will be viewing the imagery at approximately 13 feet/minute. Using a red grease pencil annotate all "time sensitive" targets that you detect on each pass. Key your annotations to the answer sheet provided. Use the following procedure and format:

Target Scene	Annotation #	Target/Target Activity
1	1	2 1/2 ton truck
1	2	Bridge, under construction
2	1	S.P. gun
2	2	Tank

2	3	1/4 ton truck
2	4	Barge, off loading

You have 13 minutes to complete this exercise.

3 - Following the same procedure as you did for exercise 1, annotate all "time sensitive" targets using a blue grease pencil. During this exercise, you will be viewing the imagery at 11 feet/minute. You have 15 minutes to complete this task. Note: should you desire to change any of the interpretations made during the previous exercise, circle the target in blue and record your findings on the answer sheet. Do not erase your first annotation.

4 - Following the same procedure as you did for exercise 1 and 2, annotate all "time sensitive" targets using a black grease pencil. During this third exercise, you will be viewing the imagery at a rate of 9 feet/minute. You have 18.5 minutes to complete this task.

Upon completion of exercise #3 you will be given an "overlay key" to check the results of each task.

INSTRUCTION BLOCK #7

PRACTICAL EXERCISE

SCANNING/TARGET DETECTION TECHNIQUES IN NEAR-REAL-TIME - PAVE TACK FLIR

Equipment: Video monitors, lead pencil, and answer sheets.

Objectives: Practice in scanning FLIR data and detecting/identifying targets from a video monitor.

Instructions:

1. This practical exercise will consist of three-40 minute exercises.

2. During each exercise you will be required to record your <u>detections</u> on the answer sheets provided.

3. After completion of each detection exercise, the video data will be presented to you a second time.

4. During this phase of the exercise you are to confirm your detections and properly identify them on your answer sheets.

5. Target scenes will be identified by the "digital time reference code" on the video monitor. An example of how your answers are to be recorded is shown in Figure 7-2.

INSTRUCTION BLOCK #7

PRACTICAL EXERCISE - DETECTION AND IDENTIFICATION PAVE TACK FLIR

ANSWER SHEET - 4

Exercise #_____

Digital Time Reference Code	Target Type(s)	Number of Targets

Figure 7-2

INSTRUCTION BLOCK #8

INTERRELATED VARIABLES AFFECTING INTERPRETER PERFORMANCE IN NEAR-REAL-TIME INTERPRETATION AND STRIKE RECONNAISSANCE

(3 Hours)

INSTRUCTION BLOCK #9

DATA BASE PREPARATION AND UTILIZATION

(1 Hour)

INSTRUCTION BLOCK #10

MISSION PLANNING CONSIDERATION

(1 Hour)

INTRODUCTION:

For the next three hours we will be dealing with conditions that can adversely affect the interpreter's performance in near-real-time interpretation. To reduce and/or eliminate these conditions there are certain techniques that the interpreter can employ. Two such techniques are: data base preparation and utilization, and mission planning and preparation. Because the material presented in blocks 9 and 10 have an effect on the variables encountered when interpreting in near-real-time, instruction blocks 8, 9 and 10 will be dealt with together. By presenting the material in this manner, the interpreter will realize the importance of thorough mission planning and preparation. He will also recognize the value of a data base when preparing for a QSR mission, and while performing his duties during an actual mission.

INSTRUCTION BLOCK #8

INTERRELATED VARIABLES AFFECTING INTERPRETER PERFORMANCE IN NEAR-REAL-TIME INTERPRETATION AND STRIKE RECONNAISSANCE

(3 Hours)

During this block of instruction, the interpreter will be introduced to two main variables which may affect his performance in near-real-time interpretation. These variables are:

1. Stimulus Variables, and
2. Response Variables

Under stimulus variables, display conditions will be considered. When viewing the AN/AAD-5 imagery, these conditions include:

Image Scale

Object (Target Component(s) Size, Shape, Microstructure, Contextual Factors)

Image Resolution (Spatial/Thermal)

Polarity (Positive/Negative Presentation)

Contrast

Display Arrangement

Light Intensity

Size of Viewing Surface

Viewing Distance

Magnification

Film Speed (Viewing Time)

Number of Targets Present

The following illustrations depict some of the previously mentioned stimulus variables (note Figures 8-1 through 8-5).

Response variables to be considered when viewing the AN/AAD-5 imagery include:

Interpreter's Acuity

Interpreter's Alertness

Interpreter's Fatigue

Interpreter's Scanning and Search Techniques

Interpreter's Morale

Apperceptive Content (target recognition and training)

Environmental Conditions (crowded, noisy work area)

When interpreting PAVE TACK FLIR data in the QSR/RRF Exploitation Shelter, the stimulus and the response variables will be the same as when working with "hard copy" AN/AAD-5 imagery; however, additional stimulus variables will be introduced. Two such variables are: jitter and ambient light. Jitter is often present on the PAVE TACK video-monitor. This is especially true when the interpreter "locks on" or "freezes" a target.

Classified pages 8-5 through 8-9 to be distributed on the day of class.

Perhaps this was noticed during previous instruction blocks. The effects of ambient light may annoy the interpreter because of reflections on the video screen. Other stimulus variables worthy of mention are aircraft motion and sensor slewing. These variables can have an adverse effect on the interpreter in that he may become disorientated or even realize a sense of vertigo. For the next thirty minutes or so, these stimulus variables will be presented. During this time, the interpreter should experiment with adjusting the light intensity and contrast on the video monitor. He should also experiment with image polarity selection and attempt to establish a comfortable viewing distance from the video monitor which will enable him to achieve optimum interpretation results.

The primary response variable when viewing PAVE TACK FLIR data is fatigue. The interpreter may realize fatigue in a shorter period of time when interpreting from a video monitor than he would when interpreting hard copy imagery over a light table.

INSTRUCTION BLOCK #9

DATA BASE PREPARATION AND UTILIZATION

(1 Hour)

The QSR/RRF Exploitation Shelter has a capability for establishing a data base which can be utilized when planning and preparing for a mission or during the actual QSR mission. The mechanics of how to prepare and use this capability will be explained during Texas Instrument's training program. The value and purpose of maintaining a data base will be explained at this time.

There are three primary purposes for establishing and maintaining a data base for QSR missions. These purposes are:

1. The interpretation team can utilize the data to familiarize themselves with the target area (environment) to be flown. This can be accomplished as a mission planning and preparation task which will be further explained during the next block of instruction. Past experience has proven that when an image interpreter is familiar with an area of operation, his interpretation time is decreased and his interpretations are more accurate.

2. The interpretation team can utilize the data to familiarize themselves with the signatures of specific targets that the QSR mission will be flown against. This can also be accomplished during the mission

planning and preparation phase of the QSR mission. Here the interpreter has an opportunity to view these targets under various conditions. For example, the data base may contain a record of a target imaged at different orientations. A record that shows a target under various conditions might also be contained in the data base. For example, the interpreter may have the opportunity to become familiar with the siganture of a certain type of tank when it appears on an open road, or when it is positioned along a tree line, or in a hull defilade position.

3. The interpretation team can utilize the data base for comparative coverage. This may be done during the actual QSR mission. Should the interpreter detect an object that looks suspicious, but does not display enough characteristics for accurate interpretation, he may refer to the data base to see if the target appeared on previous mission data. This procedure can reduce the false alarm rate.

It should be kept in mind that time is of utmost importance during a QSR mission; therefore, the data base should be utilized to a greater extent prior to the actual QSR mission.

MISSION PLANNING CONSIDERATIONS

INSTRUCTION BLOCK #10

(1 Hour)

When planning an infrared mission, the image interpreter should be familiar with mission planning considerations and factors that will affect the appearance of the imagery. Planning infrared scanner and FLIR missions for general reconnaissance of a specific activity requires a knowledge of:

- The effects of time
- Weather conditions
- Sensor system capability
- Target type/thermal characteristics, and
- Position of the target with respect to nadir (mission profiles, in order to obtain the most usable intelligence data)

Occasionally, the mission planner will have some control over such variables as the flight profile and the time of day. The situation often will not permit waiting for optimal weather conditions.

o Effects of Time

When planning an infrared mission the following time-of-day factors should be considered:

a. Heat from vehicles, generators, pipelines, etc., can be obscured by solar heating in the daytime. Should it be necessary to fly a daytime mission, this tendency can often be reduced by the use of proper filters.

b. The periods one hour before sunrise and one hour after sunrise, and the periods one hour prior to and one hour after sunset are the poorest for infrared missions since these are times of minimum temperature contrast. (Refer to Instruction Block #4, "Radiometric Crossover.")

c. Maximal heating occurs two to three hours after local noon on a clear day.

d. Target materials that heat quickly, cool quickly.

e. During periods of extended heavy overcast, daytime records do not have the thermal detail of imagery obtained on a clear day because shadows are absent. Overcast conditions are usually more favorable for detecting indications of activity (especially vehicle exhausts and aircraft engine run-up) than are clear-day conditions.

f. The nature of the target activity should be considered. For example, after heavy firing, weapon tubes can remain hot for varying lengths of time.

o Effects of Weather

Infrared systems can be operated with limited success in marginal weather conditions that would be unacceptable for conventional aerial photographic missions. When planning an infrared mission, the following weather conditions should be considered:

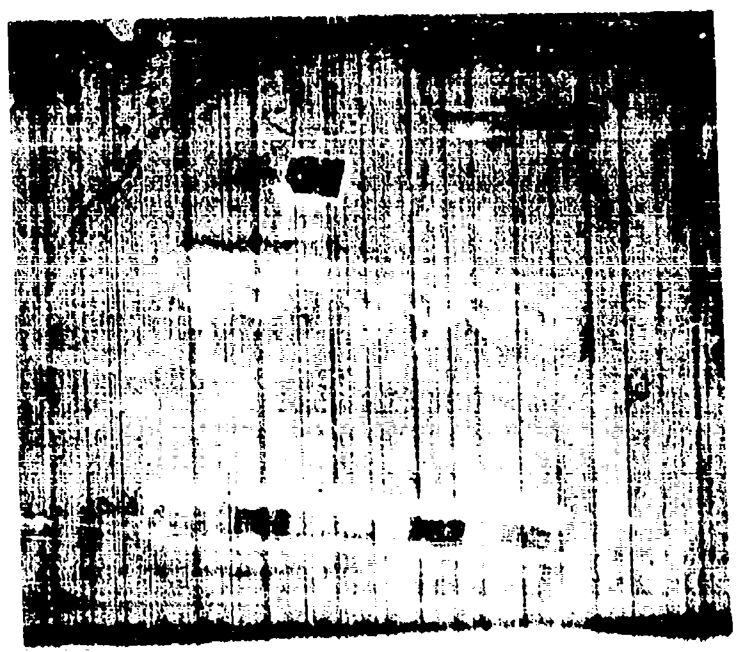
a. Extended periods of overcast reduce thermal contrast and may eliminate details of the terrain. (Figure 10-1)

b. Extended periods of low, heavy overcast produces a condition in which: 1 - all ground surfaces, 2 - the base of the clouds, and 3 - the atmospheric paths between, approach the same temperature, decreasing thermal details. (Washout of thermal contrasts usually is most severe during nighttime). (Figure 10-2)

c. An extended period duration of winds reduces differential radiant cooling effects, bringing all exposed surfaces to nearly the same level of radiation. High humidity in addition to wind creates a wind shadow effect on line scan imagery as depicted in Figure 10-3.

FIGURE 10-1

INFRARED IMAGE AFTER EXTENDED PERIOD
OF OVERCAST HAS REDUCED THERMAL CONTRAST



DATE: 24 OCT 72
TIME: 0930
ALTITUDE: 1000'
AREA: GRIFFISS AFB

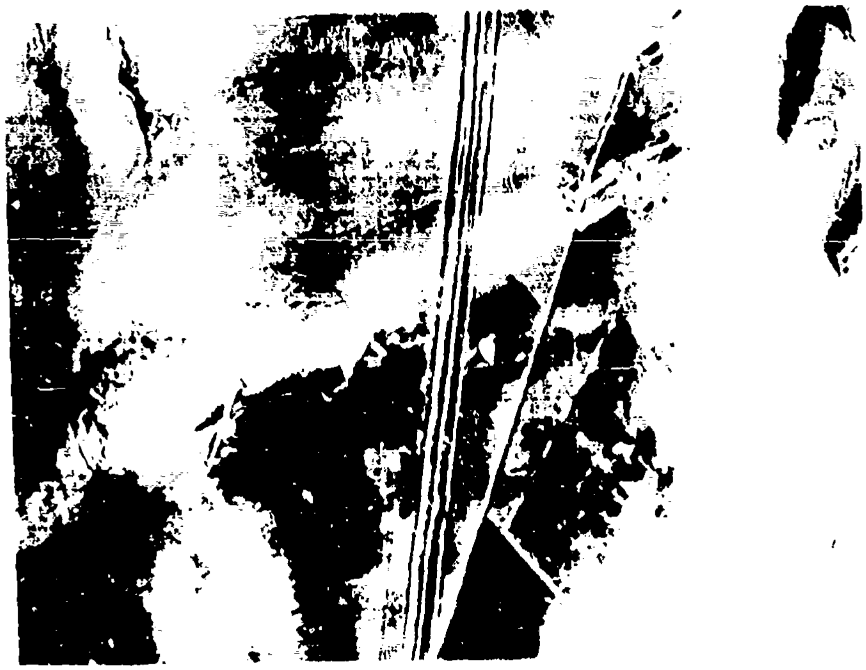
FIGURE 10-2

INFRARED IMAGE OF TERRAIN WITH LOW
HEAVY OVERCAST

DATE: 4 MAR 75
TIME: 2000
ALTITUDE: 5000'
AREA: FLOYD, NY

FIGURE 10-3

EFFECT OF HIGH WINDS AND HUMIDITY
ON I.R. IMAGERY



DATE: 12-1-61
TIME: 2030
AREA: NEAR FORT WORTH, TEXAS

d. When all surfaces are saturated with water, they radiate with high emissivity. If all surfaces are saturated immediately after a rain, they may appear low in contrast. (Figure 10-4)

e. Heavy fog will prevent the detection of targets located in depressions of the terrain and in low-lying areas. (Figure 10-5.) Ground fog generally forms in the late evening hours and may be expected to continue well into the night.

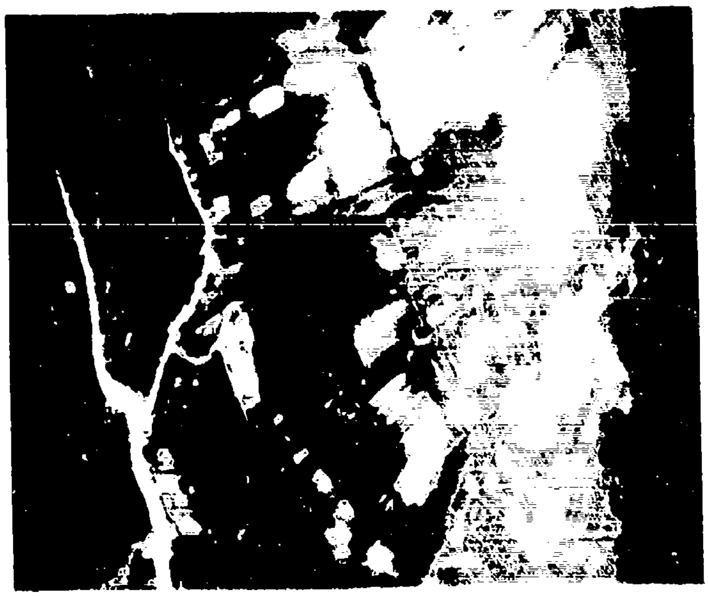
f. Unlike fog, smoke cover over a target area will not affect the quality of the infrared image of that area. Because of the ability of infrared wavelength energy to penetrate most smoke covers, infrared reconnaissance systems provide an excellent method for troop movement detection under smoke concealment, and for post-strike damage assessments.

g. High humidity, rain, clouds, and dust have an adverse effect on the PAVE TACK FLIR system, as will be demonstrated on the following tape.

Table 10-1 offers the interpreter a limited "Target Selection Guide" for detecting targets and target activity under various weather conditions.

FIGURE 10-4

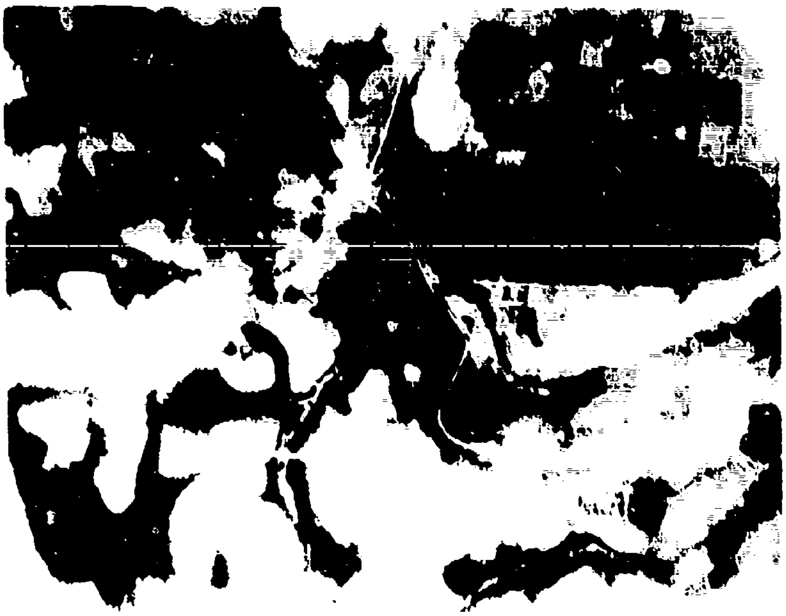
ELIMINATION OF THERMAL CONTRAST DUE
TO SATURATION OF SURFACE WITH RAINWATER



DATE: 24 APRIL 68
TIME: 0100
ALTITUDE: 2500'
AREA: VIETNAM

FIGURE 10-5

THERMAL IMAGE DEPICTING INFORMATION LOSS
DUE TO GROUND FOG IN LOW LYING AREAS



DATE: 29 OCT 66
TIME: 0225
ALTITUDE: N/A
AREA: VIETNAM

Classified Page A-10-10 to be distributed on the day of class.

Table 10-1 Target Selection Guide

	Clear	Haze	Clouds		Overcast	Rain		Fog		Smoke	Radiometric Crossover Period
			Above A/C	Below A/C		Heavy	Light	Heavy	Light		
Nighttime											
Fires	E	E	E	U	E	U	E	U/V	E	E	E/S
Gun Tubes:											
Hot	E	E	E	U	E	U	E	U/V	S	E	E/S
Cold	E	E	S	U	S	U	P	U	U/P	E	P/U
Trenchworks	E	S	S	U	S	U	P	U	P	E	P/U
Emplacements	E	S	S	U	S	U	P	U	P	E	P/U
Trucks/Track Vehicles:											
Hot	E	E	E	U	E	U	E	U/V	E	E	E/S
Cold	E	S	S	U	E	U	P	U	P	E	E/S
Bridges	E	E	S	U	E	U	P	U	P	E	P/U
Ferry Crossing Sites	E	S	S	U	S	U	P/V	U	P/V	E	U
Daytime (Unfiltered)											
Fires	S	S	S	U	E	U	S	U/V	E	S	E/S
Gun Tubes:											
Hot	S	S	S	U	S	U	S	U/V	E	S	E/S
Cold	S	P	P	U	S	U	P/U	U/V	P	S	S/P
Trenchworks	P	P	P	U	S	U	P/U	U	P	P	P/U
Emplacements	P	P	P	U	S	U	P/U	U	P	P	P/U
Trucks/Track Vehicles:											
Hot	S	S	S	U	S	U	S	U/V	E	E	E/S
Cold	P	P	P	U	S	U	P	U	P	P	P/U
Bridges	S	S	S	U	E	U	P	U/V	P/V	S	P/U
Ferry Crossing Sites	P	P	P	U	S	U	U	U	U	P	U

Anticipated Results:
- E - Excellent
- S - Satisfactory
- P - Marginal Effectiveness
- V - Variable Effectiveness (dependent upon density)
- U - Unusable

o Mission Profile

The flight profile assigned by the mission planner/image interpreter and flown by the pilot should be an optimization of factors concerning the basic capabilities of the AN/AAD-5 Line Scan System and the PAVE TACK FLIR system, those concerning the safety of the Quick-Strike aircraft and the military significance of the targets being sought.

o Mission Preparation

When working in the QSR/RRF Exploitation Shelter, the interpreter may be called upon for advice as to how specific target areas should be flown to achieve optimum results; however, his primary duties will be "mission preparation." Prior to flying a QSR mission, the interpretation team working in the RRF will be alerted. At this time, the team will be given the coordinates of the geographic area to be flown and the types of targets that the mission will be flown against. Procedures must then be established to plan and prepare for the mission. These procedures should include the following tasks:

1. Determination and selection of the appropriate maps/charts that will depict the target area(s).

2. Familiarization with and annotation of the target area(s) on the charts.

3. Research of existing data base to determine if IR coverage of the target area is available; if so, the team should familiarize themselves with the area.

4. Familiarization with the target signatures that the mission will be flown against.

5. Determination of the best or preferred polarity for optimum interpretation results.

Completion of these tasks will maximize the efficiency of the QSR concept.

INSTRUCTION BLOCK #11

PRACTICAL EXAM PART I

TARGET DETECTION AND IDENTIFICATION ON AN/AAD-5 IMAGERY

(2 Hours)

This instruction block will be comprised of a two-part practical exam. The first section will deal with target detection and identification on AN/AAD-5 hard copy imagery. Targets appear on both day and night IR imagery.

Equipment: Light table, 7 x tube magnifier, exam answer sheets, and lead pencils.

Objective: To correctly identify as many targets on the film as possible, within the allotted time.

Instructions:

1. Place the roll of AN/AAD-5 infrared imagery on the light table with the emulsion side down and the data blocks in a readable position.

2. You will be viewing the film at an average speed of 11 feet per minute. During this viewing time, all targets must be listed according to frame number on answer sheet #1.

3. If you feel that there is no significant target activity within a frame, note it on your answer sheet.

PRACTICAL EXAM PART II

TARGET DETECTION AND IDENTIFICATION ON PAVE TACK FLIR IMAGERY

This portion of the practical exam will involve detection and identification of targets as they appear on FLIR imagery. As in Part I, both day and night imagery will be viewed by the interpreter. You will only have one chance to view each scene.

Equipment: CONRAC monitor, exam answer sheet, lead pencils.

Objectives: To correctly identify any target which appears on the FLIR monitor.

Instructions:

1. Turn on the CONRAC monitor and set brightness, contrast, video, and size controls to your liking.

2. There will be no slow motion or stop action of video; therefore, you must work quickly to correctly identify the number and type of target.

3. Targets must be recorded along with the corresponding time which appears directly above the sightline reticle on the video

monitor. The first four digits of this computer read-out are sufficient for correct identification. In certain scenes it will be difficult to see the numerals on the clock because the background tends to blend in with the digital information. In the event that a target is spotted and you cannot read the time, wait until the background changes and record the time as soon as it is readable.

INSTRUCTION BLOCK #12

PRACTICAL EXERCISE

NEAR-REAL-TIME TARGET DETECTION AND IDENTIFICATION

AN/AAD-5 IMAGERY AND PAVE TACK FLIR VIDEO

(2 Hours)

Introduction: This Practical Exercise will be accomplished in two phases. During one phase, the interpreter will be viewing hard copy AN/AAD-5 imagery over a light table. During the other phase, he will be interpreting FLIR data presented on a video monitor.

Equipment: Light table, CONRAC (or equivalent) video monitor, tube magnifier, grease pencil, lead pencil, and answer sheets.

Phase I

Instructions:

1. Place the AN/AAD-5 film on the light table so that it is oriented properly.

2. You will have a total of 10 minutes to complete the exercise, which means that

average viewing speed will be approximately [illegible] feet per minute.

3. List all targets and target activity on answer sheet #1 by frame number. If there is no significant target activity within a frame, make note of this on your answer sheet.

Phase II

Instructions:

1. Adjust all controls on the CONRAC monitor for optimum viewing conditions.

2. As was the case with the practical exam, the video will only be played one time. There will be no option to freeze a scene or play it back in slow motion.

3. Record all target/target activity on answer sheet 2 along with the proper digital time reference that appears on the monitor.

INSTRUCTION SHEET #13

SCENARIO #1

MISSION PLANNING AND PREPARATION

(1 Hour)

Introduction

This scenario is intended to serve as a practical exercise, and to compliment the material covered in Instruction Block #10. After completing this first scenario, the interpreter should be familiar with his responsibility in QSR mission planning and preparation.

Equipment - AMS 1:250,000 Chart, Sheet NH 16-5, Lead Pencil, Imagery Examples of Target Signatures, Magic Marker, and Report Forms.

Scenario

The interpretation team working in the RRF Exploitation Shelter has just been notified that a QSR mission has been fragged to fly a designated area in search of targets peculiar to a Mechanized Armored Unit. Ground Intelligence sources reported sighting two Soviet GAZ-63 vehicles (similar to the U.S. 2 1/2 ton truck), and one Soviet T-54/55 medium tank on a trail in the vicinity of geographic coordinates 30° 37' 00" N, 86° 15' 00" W. It is suspected that the 75th Mechanized Armored Division is preparing to "link-up" with the 5th

Airborne Brigade near a drop zone located at geographic coordinates 30° 31' 00" N, 86° 20' 00" W and together advance an attack on Eglin Air Force Field #2 (Pierce).

The QSR aircraft has been tasked to fly all primary, secondary and tertiary roads and trails in the suspected target area to verify this reported enemy activity.

Procedures

Upon notification that a QSR mission has been fragged, the interpretation team should begin preparing for the mission. Preparation should include the following procedures:

1. Determination and procurement of the appropriate maps/charts that will adequately depict the target area(s) that are to be flown.

2. Familiarization with, and annotation of, the target area(s) on the chart(s).

3. Research of existing data base to determine if coverage of the target area is available.

4. Familiarization with the target area on all existing coverage. (Static targets that could be mistaken for QSR targets should be

noted and recorded on the charts in an effort to reduce the "false alarm" rate during the actual mission.)

5. Determination of the types of equipment that comprise a mechanized armored unit. This task may require researching order-of-battle information and/or imagery interpretation keys.

6. Familiarization with all target signatures peculiar to the unit's equipment.

7. Determination of the best or preferred polarity for optimum interpretability of each target type.

8. Familiarization with the QSR/RRF report format, and all abbreviations used in the Quick Strike report. (This material will be covered during Scenarios 2A and 3A.)

INSTRUCTION BLOCK #14

PRACTICAL EXERCISE

NEAR-REAL-TIME TARGET DETECTION, IDENTIFICATION, AND REPORTING - AN/AAD-5 IMAGERY

Equipment: Light table, tube magnifier, grease pencil, lead pencil, and "Quick Report" forms.

Instructions: During this exercise you will be working in two-man teams. One interpreter will be responsible for detecting and annotating targets on the AN/AAD-5 imagery and the second interpreter will be responsible for target identification and verbal reporting. Keep in mind that when working at the detection station, the film can only be transported in one direction; therefore, the interpreter will get one look at each target scene before it is advanced onto the take-up spool.

The interpreter responsible for target identification and verbal reporting has the capability to move the film in either direction; however, keep in mind that the objective of the QSR mission is to report activity to the strike decision-makers in minimal time. This is particularly important for transitory (TNS) and mobile (MOB) type targets.

Procedures:

1. Place roll #1 of the AN/AAD-5 infrared imagery on the light table (data blocks in a readable position).

2. Interpreter #1 - annotate all targets that are specified in the previously read, attached scenario.

3. During this exercise you will be allowed 13 minutes to detect and annotate the appropriate type targets. You will be viewing the imagery at approximately 11 feet/minute.

4. Upon completion of the detection exercise, rewind the imagery to the supply spool.

5. Interpreter #2 - identify all annotated targets. Verbally inform Interpreter #1 of your identifications.

6. Interpreter #1 - record the identifications on the Quick Report forms provided. The mission number for this exercise is SØ1. Each target

or group of like-targets detected in the same location must be included on separate forms, i.e., you have detected and identified seven 2 1/2 ton trucks in a convoy; your report should read:

Mission Number:	S Ø 1
Target Report Number:	Ø Ø Ø 1
Identification:	T R K _ _ _ _ _ _ _
Number of Targets:	Ø 7
Operational Status:	O P R
Perishability:	T N S
Relationship:	H

The next target or group of targets detected and identified should be recorded on "TARGET REPORT NUMBER" Ø Ø Ø 2; etc., until all targets identified have been reported.

7. Upon completion of the exercise, the instructor will talk the students through each target scene. Each student will be required to check their "Quick Reports" during this review. On the top of each report, record the number of targets correctly identified and the number of

targets incorrectly identified or omitted. Once this has been accomplished, clean all annotations off the film.

8. During the next phase of the exercise, Interpreter #2 will perform the detection and reporting tasks, and Interpreter #1 will be responsible for identifying all detected targets.

9. Place roll #2 of the AN/AAD-5 infrared imagery on the light table in the appropriate manner.

10. Follow the same procedures outlined in items 1 through 7.

11. During this exercise you will be allowed 3 minutes to detect and annotate the type of targets specified in the scenario. You will be viewing the imagery at approximately 11 feet/minute.

INSTRUCTION BLOCK #14

SCENARIO 2A AND 2B, NEAR-REAL-TIME TARGET DETECTION, IDENTIFICATION AND REPORTING ON AN/AAD-5 IMAGERY

(5 Hours)

There are three primary functions to be accomplished in the near-real-time, ground exploitation of imagery. These functions are:

1. Target detection,
2. Target identification, and
3. Target report generation.

Target detection can be defined as determination of the existence or non-existence of targets by viewing the imagery. There are two methods used to detect targets. These methods are:

1. The direct approach (actually seeing the target), and

2. The associative method (the target is determined by its surroundings).

Target identification is the extraction of sufficient information from imagery, relative to the target, to determine its military significance. The types of information might include target type, number of targets, target location, operational status and perishability. Target report generation is the consolidation of target identification information into a concise report for transmission to the strike decision-makers.

In the conventional imagery exploitation environment where time is not a critical factor, the design of equipment and operating procedures does not need to specifically isolate the three primary functions. Basically, a single interpreter, working with a single piece of equipment, performs all three functions. However, in the near-real-time environment, in order to meet the critical time criteria, it is necessary to isolate each of the above functions, and initiate operational procedures to allow several interpreters to work in a "production line" fashion.

In the RRF Exploitation shelter, the implementation of the "production line" approach to exploitation completely separates the target detection and target identification functions. In this implementation, target detection is accomplished by one interpreter scanning the incoming imagery in near-real-time. His sole responsibility is to detect targets and to cue a second interpreter to those segments of imagery containing targets. The second interpreter, cued to the smaller segments or areas of imagery, performs the target identification function and inputs the identifying information into a pre-formatted target report (see Figure 14-1). Optional operating procedures will allow a third interpreter to actually generate the target reports using verbal inputs from the second interpreter as he accomplishes the identification function.

Figure 14-1 Quick Strike Reconnaissance "Quick Report"

MISSION NUMBER------:	XXXX
TARGET REPORT NUMBER:	XXXX
IDENTIFICATION------:	XXXXXXXXXX
NUMBER OF TARGETS---:	XX
OPERATIONAL STATUS--:	XXX
PERISHABILITY-------:	XXX
RELATIONSHIP--------:	X
ELEVATION OF TARGET-:	XXXX
LORAN TDA-----------:	XXXXXXX
TDB-----------:	XXXXXXX
GEO COORDS----------:	XXXXXX.XX XXXXXX.XX
UTM OR UPS----------:	XXXXXXXXXXXXX
COMMENTS------------:	X_____ 40 __________X

The detection station or first station provides film motion and light intensity controls necessary for accomplishing the target detection function. The detection station operator scans the film as it moves across his station and designates targets by circling with a grease pencil. The film moves through a drop box to the identification station or second station where the target identification and report generation functions are accomplished. The identification station, through the interface with the automated data processing (ADP) subsystem, provides automated assistance for determining target coordinates and generating target reports. The identification operator, cued to the circled areas on the film, identifies the target to the extent necessary to complete the target report. Coded data blocks on the film are read automatically by the code matrix reader. Using this positional data as a reference, target locations are determined by placing the film light-station cursor on the target. A mapboard with cursor allows automatic correlation between film positions and locations on the reference map.

Reporting

Because the report used in the QSR/RRF is unlike other interpretation reports that the interpreter is familiar with, it is necessary to become acquainted with its format, the types of information to be reported, and the abbreviations to be used in the report.

The report shown in Figure 14-1 will be the type used in the QSR/RRF. The "Mission Number", and "Target Report Number" will be automatically initialized at the beginning of each QSR mission. The only information that the interpreter generating the report will be responsible for is:

IDENTIFICATION - XXXXXXXXXX

NUMBER OF TARGETS - XX

OPERATIONAL STATUS - XXX

PERISHABILITY - XXX, and

RELATIONSHIP - X

All information included below "Relationship" will be automatically recorded for the interpreter.

Figure 14-2 lists the abbreviations used in the "Identification" field of the Quick Report. The interpreter is allowed up to ten letters under this field.

"Number of Targets" is self-explanatory. After the target identification is recorded, the number of targets must be included. For example, if two camouflaged anti-aircraft artillery (AAA) sites are identified, the report should read:

IDENTIFICATION---AAACAM

NUMBER OF TARGETS---02

Figure 14-2 Abbreviations

The following abbreviations may be used in the identification field of the Quick Report.

ABN	Airborne
ACT	Aircraft
AFL	Airfield
AMO	Ammunition
ANT	Antenna
AAA	Anti-aircraft artillery
AMG	Anti-aircraft machine gun
ARM	Armor
ART	Artillery
ATW	Automatic weapons
APC	Armored personnel carrier
BKS	Barracks
BBL	Barrels
BN	Battalion
BTY	Battery
BIV	Bivouac
BRG	Bridge
BLD	Building
CAM	Camouflage
CML	Commercial
COM	Communications

DEP	Depot
DIV	Division
DZ	Drop zone
ELC	Electronics
EQP	Equipment
FRY	Ferry
HAR	Harbor
HQ	Headquarters
HEL	Helicopter
HOS	Hospital
IND	Industry
INF	Infantry
JCT	Junction
LOC	Lines of communication
MIS	Missile
MSL	Mean sea level
NAS	Naval Air Station
NVB	Naval base
PER	Personnel
PET	Petroleum
PWP	Power plant
QTR	Quarters
RR	Railroad
RFY	Refinery
RVT	Revetment
RVR	River
RWY	Runway

SAM	Surface-air missile
SSM	Surface-surface missile
TRP	Troops
TRK	Trucks
TNL	Tunnel
VEH	Vehicle

The next category on the report that the interpreter should be concerned with is "Operational Status". Figure 14-3 lists the abbreviations used in this field. Again, let us assume that two camouflaged anti-aircraft artillery sites are identified. In addition, the interpreter determines that both are dummy sites. His report should then read:

IDENTIFICATION---AAACAM

NUMBER OF TARGETS---02

OPERATIONAL STATUS---DEC

In the third category the interpreter is responsible for is "Perishability". The codes shown in Figure 14-4 describe the degree to which a target is transitory in nature. Again using the AAA site example, the QSR Quick Report should read:

IDENTIFICATION---AAACAM

NUMBER OF TARGETS---02

OPERATIONAL STATUS---DEC

PERISHABILITY---FIX

RELATIONSHIP---H

"Relationship" is the last category of concern to the interpreter. Figure 14-5 lists the codes pertaining to "Relationship". The code that should be reflected on the Quick Report is shown in the example above. In addition, a "Comments" section which can accomodate up to forty letters is

Figure 14-3 Operational Status

The following are computer-acceptable entries of operational status for the Quick Report and their definitions.

OPR	Operational. All essential elements of the target are observed to be operational or other operational indicators are observed.
NOP	Not Operational. Essential elements of the target are observed to be nonoperational or operational indicators for the target type are observed to be absent.
OCC	Occupied. The target appears to be inhabited and/or does not contain the equipment necessary to accomplish its designated task.
UNP	Unoccupied. The target does not appear inhabited and/or does not contain the equipment necessary to accomplish its designated task.
UCO	Under Construction. The target is being constructed, repaired or modified in such a way as to restrict the operational capability of the installation.
COM	Complete. The target appears to be externally complete and capable of operation, but without activity indications to

show that the installation is actually operational (to be used only when reporting targets formerly UCO).

DMG	Damaged. The target has been damaged to an extent that it is no longer capable of performing its mission but could be restored to a usable condition.
DST	Destroyed. The target has been damaged to an extent that it can no longer function, nor can it be restored to usable condition.
DEC	Deception. The sole purpose of the target is to deceive, e.g., dummy SAM sites.
ABN	Abandoned. Target/Installation is observed not in condition to be of immediate use.
RMV	Removed. Target/Installation has been razed, dismantled or removed.

Figure 14-4 Perishability

The following codes describe the degree to which a target is transitory in nature.

FIX	Fixed target. One which has a high degree of probability that it will still be at the reported coordinates when re-acquired for strike; such as a building or bridge.
MOB	Mobile target. One which is capable of being moved within a short period of time; such as an SA-6 site or bivouac area.
TNS	Transitory target. One which is in motion or capable of immediate movement; such as a tank column or truck park.

Figure 14-5 Relationship

The following codes describe the target's relationship to friendly forces:

F	Friendly
H	Hostile
N	Neutral
U	Unknown

available for any other pertinent information that the interpreter considers essential to the Strike decision makers. Keep in mind that a separate report must be generated for each target, or group of targets detected at particular geographic locations.

The remainder of this block of instruction will be a Practical Exercise. The exercise will be presented in scenario form.

INSTRUCTION BLOCK #14

SCENARIO 2A AND 2B

Situation:

The "Friendly" (BLUE) Forces have successfully overtaken Eglintac Main Air Force Base that had been previously held by the RED Forces. At the time of engagement, the RED Force Units were not up to combat strength; however, armor convoys were detected in logistical holding areas outside the reservation of Eglintac Main. It was determined by intelligence sources that the vehicles were awaiting P.O.L. and ammunition re-supply.

It should be assumed that the RED Forces are aware of the present combat situation and are preparing to launch a counter-attack on Eglintac Main. There are two airfields located in the vicinity of the enemy-occupied areas. Both airfields are capable of accommodating cargo and fighter aircraft. At the present time, these airfields have not been secured by friendly forces.

In addition, a standard-guage rail line also services the area occupied by RED Forces. Re-supply could be accomplished through any available means of transportation.

Allied ground-recce forces report that many of the tertiary roads in the area are in need of repair before any heavy vehicles can travel on them.

QSR Mission Fragged:

The interpretation team has just been briefed on the current operational situation. They received notification that a QSR mission has been fragged by higher command. The mission will be flown against the following types of targets and target activity:

Wheeled Vehicles

Tracked Vehicles

Aircraft

AAA Sites

SAM Sites

Supply Areas

Troop Movement

Airfield Activity

Rail Activity

Road Improvement

Airfield Improvement

Temporary Bridges, and

Road By-Passes

The interpretation team has completed mission preparation, and is ready to receive mission data (imagery).

The weather has been overcast with light rain showers for the past 24 hours; therefore, it may be necessary to fly both day and night missions to satisfy the QSR objectives. It should be assumed that any activity detected on the imagery is hostile.

INSTRUCTION BLOCK #15

SCENARIO 3, NEAR-REAL-TIME TARGET DETECTION, AND IDENTIFICATION ON PAVE TACK FLIR VIDEO

(4 Hours)

FLIR imagery is input as composite video and is exploited using the video exploitation subsystem. This subsystem is composed of three video viewing stations, a video switching network and video controller, and a FLIR digital data interface unit. One of the video viewing stations is mounted in the film interpretation console. The remaining two stations are in the FLIR Imagery Interpretation Console. Each video viewing station consists of a Conrac RQB-17C video monitor, Echo Science VDR-300 video disk recorder/reproducer, video cursor generator, and operator control panel. Using the control panel, an operator can select to view incoming real-time FLIR video, video previously recorded on his disk, or to transfer video frames recorded on his disk to any other operator's disk.

The video disk at each station provides the capability to store 600 frames of video. Routine of the video (incoming, disk-to-disk transfers, and disk-to-monitor playback) is accomplished by the video switching network and video controller in response to commands from the operator control panel and ADP subsystem. The FLIR Digital Data Interface Unit inputs the positional data associated with the video frames. This incoming data is maintained by the ADP subsystem for correlation with the frames recorded on the disks.

On a premission basis, operators at two of the video stations are designated to perform the detection function. These two operators view the incoming real-time FLIR imagery to detect targets. When a target is detected by an operator, he may freeze (stop action display) and/or replay the frames containing the target at any one of several selectable replay rates. Once the existence of a target has been confirmed, the operator transfers the video frames containing the target to the video disk at the third station. Meanwhile, the second detection operator has continued to scan the incoming FLIR video to detect the next target. The operators continue to function in this "ping-pong" fashion throughout the mission.

The third viewing station operator is designated to perform the identification and report-generation functions. The short segments of video transferred to his disk may be replayed in forward or reverse at any of several replay rates and in stop action. The operator identifies the target, determines the target location with the assistance of the video cursor and ADP subsystem, and generates the target report in the same manner as previously outlined.

During the next phase of your QSR training (provided by Texas Instruments) you will be working in the QSR/RRF Exploitation Shelter. At that time, you will be instructed on how to use the video exploitation subsystem. The remainder of this block of instruction will be a Practical Exercise presented in scenario form. You will be tasked to detect and identify targets without the benefit of a freeze option. To the extent that your video monitors have brightness, contrast, and polarity-reversal controls, you have the freedom in the operation of these controls in order to gain experience of how they affect the video data.

INSTRUCTION BLOCK #15

SCENARIO 3

SITUATION:

The "Friendly" (BLUE) Forces are still occupying Eglintac Main Air Force Base; however, previously fragged strike missions were unsuccessful in preventing the RED Forces troop buildup, due to the lack of ground support.

Allied ground-recce forces report sighting several enemy helicopters, and fixed-wing transport aircraft outside the containment area of Eglintac Main.

In addition, large convoys of armored vehicles were reported moving closer to logistical holding areas.

Intelligence sources suspect that the anticipated counterattack on Eglintac Main is about to be launched.

QSR MISSION FRAGGED:

The interpretation team has just been briefed on the current operational situation. They received notification that a QSR mission has been fragged by higher command; however, it was determined that it would be extremely hazardous to fly the AN/AAD-5 directly over the enemy-occupied areas. The PAVE TACK FLIR system will be flown against the following targets and target activity:

Wheeled Vehicles

Tracked Vehicles

Fixed-Wing Aircraft

Rotorcraft (Helicopters)

AAA Sites

SAM Sites

Supply Areas

Troop Movement

Airfield Activity

Rail Activity

Road Improvement

Airfield Improvement

Temporary Bridges

Road Bypasses

Ferry-Crossing Activity

The interpretation team has completed mission preparation, and is ready to receive mission data (FLIR video). It should be assumed that any activity detected is of hostile nature.

Record all identifications on the "Quick Report" forms provided. The FLIR target scene number should be noted in the "mission number" space on the report.

INSTRUCTION BLOCK #16

SCENARIO 4, NEAR-REAL-TIME TARGET DETECTION AND IDENTIFICATION ON PAVE TACK FLIR AND AN/AAD-5 IMAGERY

(2 Hours)

This entire two hour block of instruction is a Practical Exercise presented in scenario form. During the exercise you will be working in two-man teams.

SCENARIO 4

SITUATION:

As a result of successful strike missions, the RED Forces have terminated their counterattack on Eglintac Main and have begun to regroup in logistical holding areas.

It has been determined by intelligence sources that the enemy has established defenses around several auxiliary airfields outside of Eglintac Main. In addition, Blue Forces' aircraft reported receiving SAM fire during previously flown missions.

Prior to attempting another counterattack, it is essential that the RED Forces be resupplied with munitions and P.O.L. To prevent this resupply and counterattack, higher command has issued a "seek and destroy" order.

QSR MISSION FRAGGED:

The interpretation team has been briefed on the current operational situation. They received notification that a QSR mission has been fragged by higher command. The mission will be flown against all time-sensitive targets to include civilian truck and tractor-trailer activity. It should be assumed that any activity detected is of hostile nature. Record all identification on the "Quick Report" forms provided. The FLIR target scene number should be noted in the "mission number" space on the report.

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