CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

TEST AND EVALUATION OF AN INFRARED JAMMER

A graduate project submitted in partial satisfaction of the requirements for the degree of Master of Science in

Engineering

by

Michael Edward Laub

May, 1975

The graduate project of Michael Edward Laub is approved:

____
Committee Chairman

California State University, Northridge

May, 1975

TABLE OF CONTENTS

		Page
PREFACE		iv
ABSTRACT		vi
INTRODUCTION		1
GROUND TESTS		4
AIRBORNE TESTS		12
EVALUATION CRITERIA		20
CONCLUSIONS		27
BIBLIOGRAPHY		28
TABLES		
I	CAIR III Evaluation Criteria	21
II	Maintenance Action Form	26
FIGURES		
1	Test configuration used to make radiometric measurements	9
2	Functional diagram of a PACMISTESTCEN designed radiometer	10
3	Rate table test equipment	11
4	Flight maneuvers performed during ATIMS (Airborne Turret Infrared Measurement System) tests	16
5	Airborne Turret Infrared Measurement System (ATIMS)	17
6	Functional diagram of Special Instrumentation Pod (SIP)	18
7	Typical infrared seeker and the PACMISTESTCEN designed tracking rate simulator block diagram	19

PREFACE

This project report is an account of the author's on-the-job experience obtained at the PACMISTESTCEN (Pacific Missile Test Center) while participating in the TP (Technical Professional) program which was conducted by CSUN (California State University at Northridge). The TP program is a one-year program designed to allow qualified civil service employees to obtain a Masters Degree in Science while working and going to school at the PACMISTESTCEN. The TP is a student and worker taking part in an extension program where he spends 20 hours in class and an equivalent 20 hours a week in a CSUN approved job assignment. The job assignment is chosen so that when it has been completed and properly documented, it fulfills the graduate project requirements for a Masters Degree in Science.

My job assignment was to assist in the test and evaluation of the CAIR III (Countermeasures Airborne Infrared III). CAIR III represents the most recent advance in Naval IR (infrared) countermeasures development and for this reason the data obtained from the tests and any conclusions pertaining to the effectiveness of the jammer cannot be presented since this information is confidential in nature. It is also important to note that due to the complexity and importance of the project, the author could not assume full responsibility for all phases of the test and evaluation. For this reason, the project received the full attention of a senior project engineer and the author assisted and assumed full responsibility whenever possible.

The author is particularly indebted to Mr. L. S. Marquardt because he was the one who brought my attention to the TP program. I would like to thank the Missile Targets Branch of the Threat Simulation

Department for allowing me to leave my responsibilities and commitments there on extremely short notice in order to further my education. More specifically, I would like to express my appreciation to Mr. L. J. Szot, the Missile Targets Branch Head, and Mr. W. M. Horton, the Missile Targets Engineering Branch Head, for making my transition to the TP program so easy. I would like to thank Mr. D. E. Papcke, my supervisor and the head of the Infrared Systems Branch of the Laboratory Department, for proposing the CAIR III job assignment I worked on. I want to give my general thanks to the employees of the Infrared Systems Branch for their help, with special recognition to Mr. J. L. Rothgeb who was the CAIR III project engineer and my technical advisor. Next, I want to express by appreciation to Dr. E. S. Gillespe who was my CSUN advisor and who helped me organize and publish my project report. Finally, I cannot forget to express my gratitude to my wife and two children, not so much for their help but for their patience and understanding during the entire TP program.

ABSTRACT

TEST AND EVALUATION OF AN INFRARED JAMMER

by

Michael Edward Laub

Master of Science in Engineering

May 1975

CAIR III (Countermeasures Airborne Infrared III) is an IR (infrared) countermeasures system which is designed to protect the F-4 Phantom jet from attack by IR seeking missiles. This project report documents the test and evaluation of the CAIR III countermeasures system conducted at PACMISTESTCEN (Pacific Missile Test Center), Point Mugu, California. A brief history and description of the CAIR systems is included. Emphasis is placed on the ground and airborne tests. The discussion of these tests covers an operational description of the equipment employed, a description of how the test was conducted, and an indication of the type of data obtained from the tests.[1] Also presented is a proposed CAIR III evaluation criteria.

[1]The data obtained from these tests are confidential and therefore are not presented.

INTRODUCTION

The development of IR (infrared) missiles has increased the susceptibility of aircraft to attack by heat sensitive missiles. As a result, IR jammers have been developed to protect aircraft against attack by air-to-air and surface-to-air missiles employing seekers homing on IR radiation. More specifically, CAIR (Countermeasures Airborne Infrared) systems have evolved from efforts by the U.S. Navy to protect aircraft from attack by IR missiles. The CAIR systems are designed to be able to operate continuously throughout the entire flight and also to be able to function with little if any maintenance between successive flights.

The CAIR I is the first jammer developed by the Navy and is the only Naval jammer in production. This jammer is contained in a pod which is seven feet eight inches in length, 10 inches in diameter and weighs 305 pounds. During operation, the CAIR I jammer is normally mounted on the wing station of the aircraft to be protected. The necessary system operating power is supplied via a ram air turbine which is mounted on the forward section and jamming is produced by electrically pulsing a cesium lamp located in the aft section of each pod. A three-position switch on a control box mounted in the aircraft cockpit determines whether CAIR I is in the off, standby, or transmit mode and indicator lights verify what operating mode the jammer is in.

CAIR II is a second generation IR jammer developed by the Navy. Like CAIR I, the CAIR II jammer is normally mounted on the designated aircraft wing station. The CAIR II is contained in a cylindrical-shaped pod which is four feet in length, 14 inches in diameter and has an initial operating weight of 174 pounds. The forward section of the pod is a nose cone fuel tank which has the capacity to carry seven gallons of JP-4 or JP-5 fuel. The IR source consists of a ceramic cavity which is heated by combustion of nose cone fuel with ambient air. The necessary air for combustion and cooling is provided by an air intake inlet mounted on the side of the pod. Jamming is produced by mechanically modulating the heated ceramic source. CAIR II is controlled and monitored from the cockpit in a manner similar to the CAIR I jammer.

CAIR III is the most recent countermeasure system developed by the Navy. This jammer is designed to protect the F-4 Phantom jet from attack by IR seeking missiles. For this program, the Navy funded two contractors to separately develop CAIR III jammers which would fulfill certain jamming requirements. Each contractor also had the responsibility to design and fabricate a modified F-4 drag chute door to house their proposed jammer. A structual analysis indicated that a maximum combined jammer and modified paradoor weight of 50 pounds could not be exceeded if the drag chute system was to perform its normal function without any aircraft modifications. Size limitations were automatically imposed on the CAIR III jammer by specifying its design be such that it interface with the existing F-4 aircraft on a non-interference basis. To satisfy the weight and size constraints, the CAIR III had to be smaller in size and lighter in weight than any of the previous CAIR systems. The F-4 aircraft supplies the electrical power required for system operation. Jamming is produced by mechanically modulating an electrically heated IR source. The jammer is controlled and monitored from the cockpit of the F-4 CAIR III enhanced aircraft. Prior to its delivery to PACMISTESTCEN (Pacific Missile Test Center) for test and evaluation, jammers from each contractor would be subjected to environmental tests to determine if they were capable of surviving in the F-4 flight envelope.

Ground and airborne tests were conducted at the PACMISTESTCEN. Ground tests were composed of radiometric and rate table tests. Radiometric tests were conducted in order to determine the IR characteristics of the CAIR III countermeasures system. The jammer's effects on actual IR missiles seekers were determined from rate table tests. Airborne tests consisted of ATIMS (Airborne Turret Infrared Measurement System) and SIP (Special Instrumentation Pod) tests. ATIMS tests were conducted to collect data on the IR outputs of the F-4 aircraft and CAIR III jammer. SIP tests were employed to determine the effects of the jammer on missile seekers in a realistic operational environment. A discussion of these tests is presented as well as a proposed CAIR III evaluation criteria.

GROUND TESTS

Ground tests were the first tests conducted on the CAIR III system. These tests consisted of radiometric and rate table measurements. Radiometric tests were conducted in order to determine the IR output characteristics of the jammer as a function of aspect angle and also as a function of elevation angle. Rate table tests were used to establish the effects of the CAIR III jammer on the tracking rates of various missile seekers. The data obtained from these tests are used in assessing the effectiveness of the jammer. These tests also give the evaluator a meaningful reference which can be used in comparing the characteristics of various IR jammers.

Radiometric measurements involved the determination of the peak ac (peak modulated IR output), dc (constant IR output) and IR waveform characteristics of the countermeasures system. The ac measurements were made to find out what the maximum modulated IR output of the jammer was as a function of aspect angle. These peak IR intensity measurements were used to make plots of the radiant intensity of the jammer measured in watts/steradian versus aspect angle measured in degrees. Another measurement of importance was the dc output of the jammer. This measurement indicated the constant IR output of the jammer as a function of aspect angle. The dc output measurements are important because a constant IR output adds to the strength of the signal that can be tracked by a threat missile. A record of the IR output waveform of the jammer as a function of aspect angle was also made. Such a record is an important factor in determining the jamming characteristics of a countermeasures system. The waveform shape, depth of modulation and frequency are important and, therefore, should be monitored. These data were obtained by photographing the jamming waveform recreated on the face of an oscilloscope.

To make the peak ac, dc and waveform measurements, the radiometer and CAIR III jammer were arranged as shown in Figure 1. Data were taken with a fixed zero-degree elevation angle for ten-degree increments of aspect angle. The data were also recorded in both the clockwise and counterclockwise directions (see Figure 1). Due to its design, the jammer was expected to have the same IR output in both the vertical and horizontal planes. This expectation was verified for a fixed zero-degree aspect angle. Spectral filters can be added to the radiometer so that the IR characteristics of the jammer can be determined in certain wavelength bands. All radiometric measurements discussed were taken in two specific spectral bands. The CAIR III jammer was supplied to the Navy with both clear quartz and covert transmission windows. Therefore, all radiometric measurements were duplicated for each transmission window. The jammer also has the capability for varying the jamming waveform frequency. For this reason, frequency measurements of the IR waveform were recorded to insure that the desired operating frequencies were obtained and maintained. During the radiometric tests, the input power required to operate the jammer was also measured and recorded.

The radiometer used to make the measurements was designed at the PACMISTESTCEN. Figure 2 shows a functional diagram of this radiometer. Since this radiometer design is unique to the PACMISTESTCEN, it is felt that some discussion of how the system operates would be worthwhile. The initial step in conducting the radiometric tests was to insure that the calibration curves of irradiance versus the IR reference source input voltage were correct. A 1,000°C blackbody was used to check the calibration curves. Once the calibration curves had been updated, the measurements could commence. An oscilloscope was attached to the radiometer's output so that the output from the IR source could be monitored. The radiometer was designed so that a voltage signal proportional to the IR energy which strikes the lead selenide detector could be monitored via the radiometer's coaxial output connector. To make the peak and constant output IR measurements of the CAIR III system, the chopper blade, shown in Figure 2, was activated. When activated, the chopper blade alternately allows the IR radiation from the source to be measured and the calibrated IR reference source to reach the IR detector located inside the radiometer. The chopped waveform appeared on the oscilloscope. The IR output of the calibrated reference source was adjusted until its output equaled the peak output of the jammer. The voltage level of the reference source was recorded and the corresponding irradiance was determined from the calibration curves of irradiance versus the IR reference source input voltage. The constant output was determined by an adjustment of the reference source input voltage until its IR output was equal to the CAIR III output at its maximum depth of modulation. The reference source lamp voltage was then recorded and the irradiance was found from the same calibration curves used to determine the peak IR values. The chopper blade was then deactivated and positioned so that the output from the jammer could reach the IR detector. A photographic record was then made of the waveform which was displayed on the oscilloscope.

The next tests conducted on the CAIR III countermeasures system were the rate table measurements. The rate table was designed and fabricated by the PACMISTESTCEN. This apparatus was used to study the effects of IR jamming on various IR missile seekers. The tracking rate limitations of missile seekers can be investigated with or without jamming. To perform the tests, an IR missile seeker was secured to a moveable platform on the rate table test stand. This platform is rotated by a motor driven system with angular rate feedback information so that accurate rates can be obtained and maintained. The rate table has a two-mirror optical system which when adjusted properly centers the location of the remotely located infrared source at the axis of rotation of the rate table platform (see Figure 3). This optical arrangement makes it possible for a missile seeker to continually track an IR source as the seeker rotates. In this way, the mechanical tracking rate produces the same effect on the missile seeker as would be produced if the missile seeker was actually tracking a target moving at constant angular rate. The missile seeker was electrically activated and its output was monitored using an electrical harness which was connected to the missile seeker by way of a specially designed slip ring. This slip ring is a high-quality low-noise assembly designed so as not to alter the signals originating from or going to the missile seeker. The angular rate of the system can be adjusted from 1/1,000 to 1,000 degrees per second with an accuracy of 1/10 percent of the selected rate. The missile seeker secured to the moveable table top platform monitored the combined output of the jammer and a variable intensity IR source. The angular rotation of the rate table was increased until the missile seeker could no longer track the combined IR signal. Maximum missile seeker tracking rates were found for the jammer without an IR source and for an IR source without any jamming. The J/S (Jamming/Signal) ratio and rate were recorded when missile break track occurred. The output of the variable IR source was adjusted to some new level and the maximum tracking rate of the missile seeker was again determined and recorded. The variable source was readjusted. New readings were taken for several different IR source levels. The data obtained from these tests were used to make plots of J/S ratio versus maximum missile tracking rate measured in degrees per second.

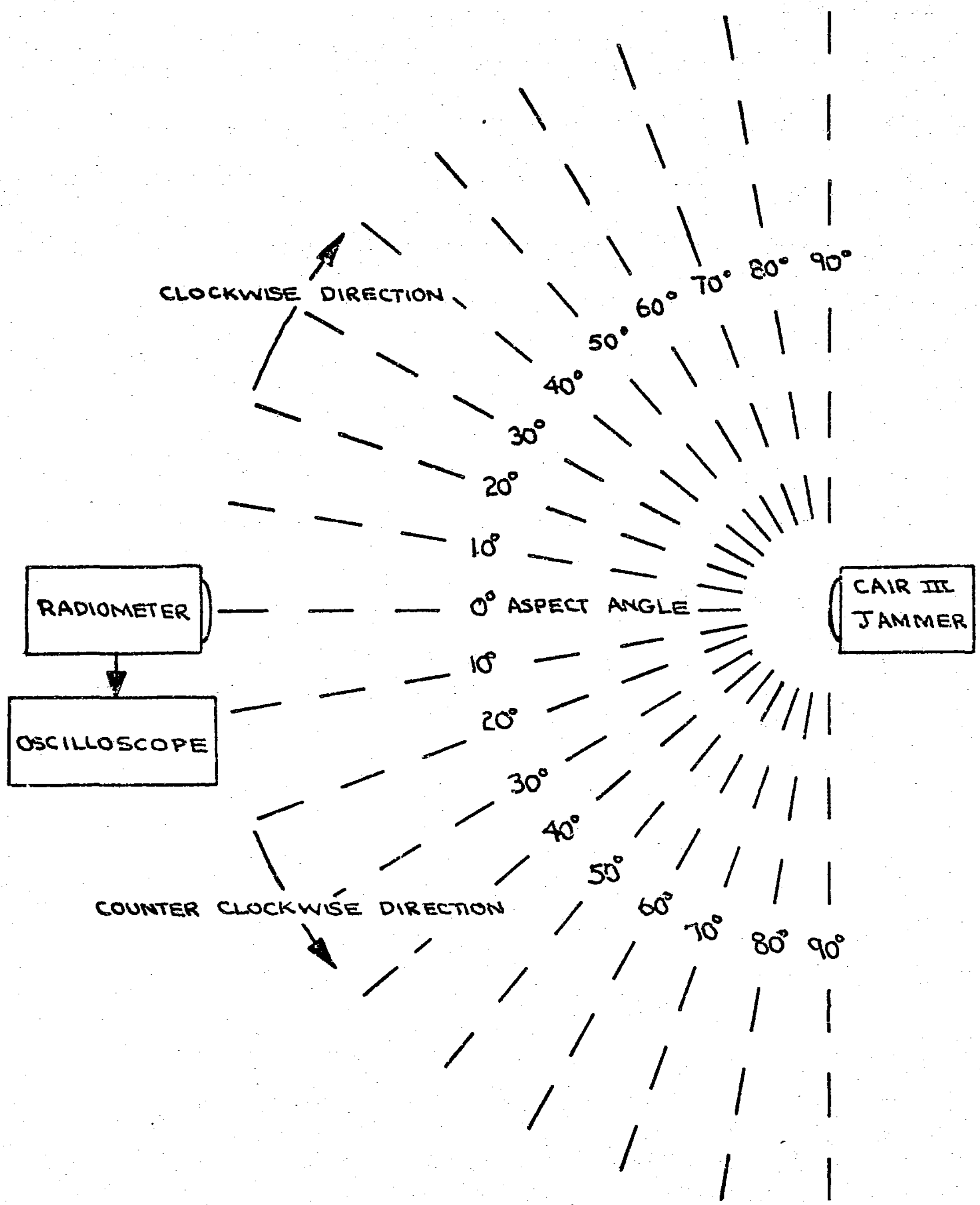

Figure 1. Test configuration used to make the radiometric measurements.

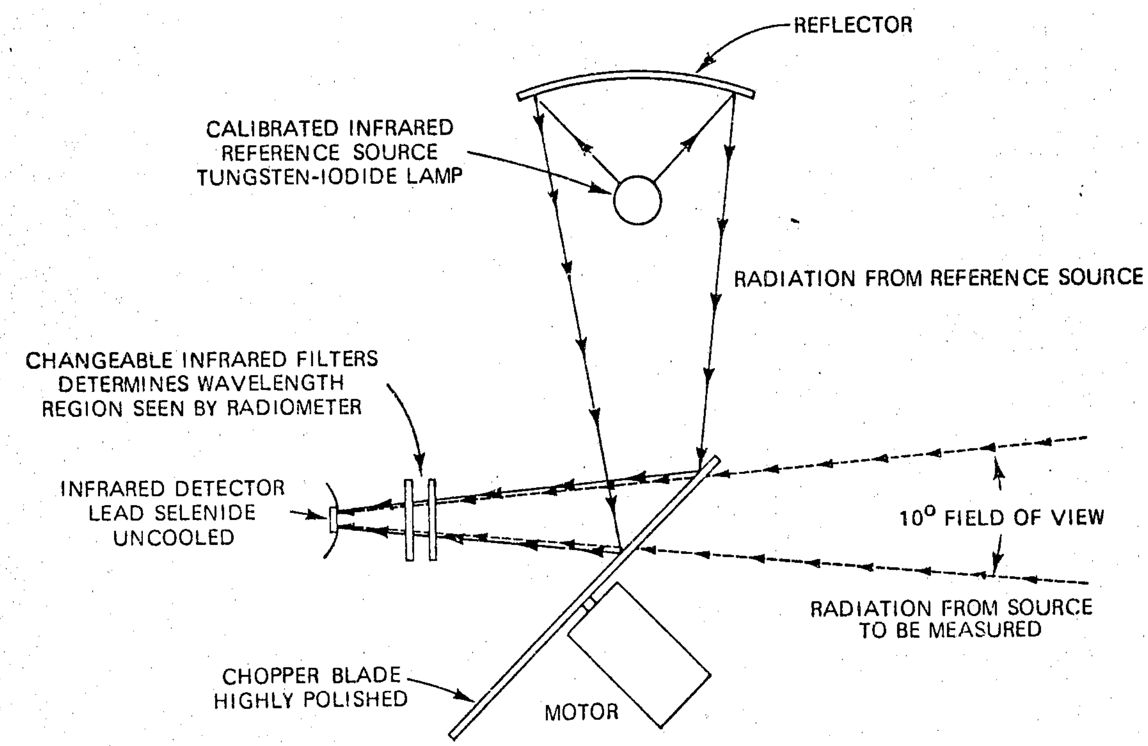

Figure 2. Functional diagram of a PACMISTESTCEN designed radiometer.

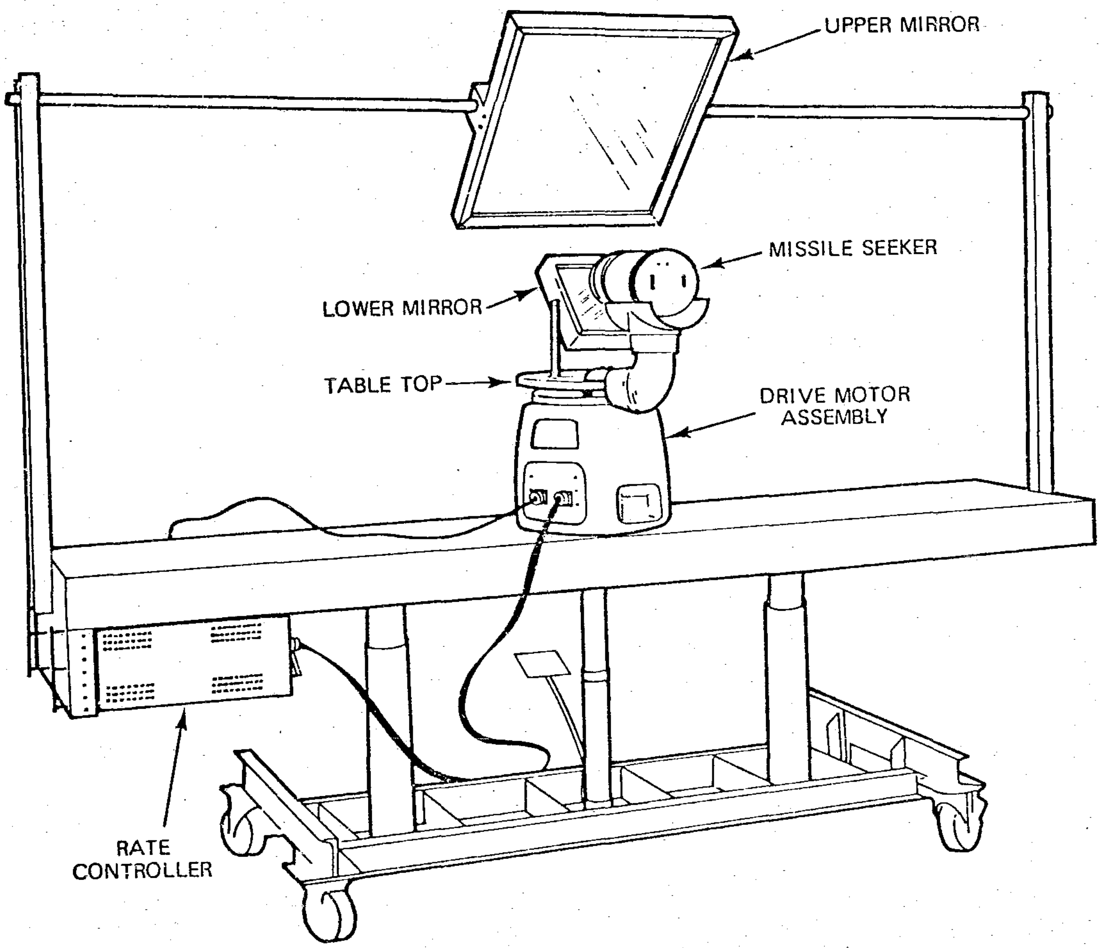

Figure 3. Rate table test equipment.

AIRBORNE TESTS

Airborne tests were conducted in order to assess the CAIR III countermeasure's performance under actual environmental conditions. There were two types of airborne tests. First ATIMS tests were performed. ATIMS tests were used to obtain airborne radiometric measurements of the CAIR III configured F-4 aircraft. Second SIP tests were conducted. SIP measurements were made in order to determine the effects of the CAIR III jammer on missile seekers operating in an airborne environment. These two airborne tests supply the evaluator with the same kind of information that was obtained in the ground tests. An added benefit of the airborne tests was the collection of data on how the CAIR III system performs during actual flight conditions.

The ATIMS system was used to record the IR output of the F-4 aircraft and CAIR III jammer. For these tests, the CAIR III configured aircraft performed two basic flight maneuvers. Figure 4 is a pictorial representation of these two maneuvers. In Flight Profile I the ATIMS configured A-3 aircraft flies a straight and level profile. In the same horizontal plane, the CAIR III configured F-4 aircraft approaches from behind and overtakes the ATIMS aircraft. The CAIR III configured F-4 aircraft begins a 90° flat, zero bank angle, starboard turn just as it overtakes the ATIMS aircraft. The ATIMS aircraft records IR data on the CAIR III aircraft just previous to the point of overtake until the completion of the 90° flat turn. Flight Profile I ideally produces IR recordings of the F-4 aircraft and CAIR III jammer as a function of aspect angle with a zero degree elevation angle. Data were taken for 90° port and starboard flat turns. In Flight Profile II, the ATIMS configured A-3 aircraft flies a straight and level profile. Once again the CAIR III configured F-4 aircraft approaches from behind and overtakes the ATIMS configured aircraft. At the point of overtake the F-4 configured CAIR III does a starboard 90° snap roll and at the same time begins a 90° starboard turn. Throughout the maneuver the pilot of the F-4 tries to keep his aircraft in the same horizontal plane as the ATIMS aircraft. As before the ATIMS aircraft begins recording data of the CAIR III configured F-4 aircraft just before the point of overtake and continues to record data until the 90° starboard turn has been completed. Ideally the ATIMS record of Flight Profile II will produce IR measurements of the F-4 aircraft and CAIR III jammer as a function of elevation angle for zero degree aspect angle. Data were taken for 90° snap roll maneuvers for both port and starboard turns.

The ATIMS system requires two operators (see Figure 5). Initially the acquisition operator locates the target. In this case the target was the CAIR III configured aircraft. The acquisition operator follows the target until the tracking operators takes over. The tracking operator follows the target with much more precision than the acquisition operator. This precision is required in order to make the IR measurements. The acquisition and tracking operators both view the IR target from their own video monitor. When the tracking mirror is aligned properly, the image of the target is reflected onto a beam splitter. A visible signal is directed to a TV camera and the output from this camera supplies the video required by the acquisition and tracking operators. Visible information is also directed to the lens of a film camera. The IR signal is directed to a radiometer spectrometer. To collect data, the IR target is acquired and tracked by the two operators. When IR recordings are desired, the film camera and 14-track recorder are simultaneously activated. Timing information is fed to and recorded by the film camera and 14-track recorder. This is so that the visible IR records can be correlated during data reduction.

To reduce the data it was necessary to get information from the film and 14-track recordings. First the film was reviewed and individual film frames were chosen as data points. The film was then sent to the PDAS (Photo Data Analysis System) group. The PDAS system was used to obtain range, aspects, and elevation information from the selected ATIMS film frames. The corresponding IR measurements for these film frames were then located on the 14-track recording. The 14-track recording was then used to determine the IR outputs of the CAIR III jammer and F-4 aircraft in watts per steradian. The J/S ratio was also determined from the 14-track recordings. The reduced ATIMS data provided information on the IR output of the CAIR III countermeasures system, the F-4 aircraft and the J/S ratio of the CAIR III configured F-4 for specific aspect and elevation angles.

The SIP was used to determine what effect the CAIR III jammer had on actual missile seekers. Figure 6 is a functional diagram of the SIP. To make the measurements, the SIP configured aircraft followed the CAIR III configured F-4 aircraft. Ideally, both aircraft remained in the same horizontal plane. The pilot of the SIP configured aircraft positioned the CAIR III configured aircraft in the center of his TV monitor and attempted to maintain this position during the data recording segments of flight. The TV monitor and seeker were boresighted to have the same field of view when the seeker was in the caged position. Crosshairs, indicating the seeker head position, were electronically superimposed on the TV monitor (see Figure 6). At selected times throughout the flight the seeker was uncaged and a tracking rate signal was injected into the precession amplifiers of the seeker. Figure 7 is a block diagram of the PACMISTESTCEN designed tracking rate simulator and a typical IR seeker. The inject tracking rate produced the same effect as would be produced if the seeker was actually tracking a target moving at a constantly changing angular rate. The injected tracking rate was automatically increased in discrete steps to some predetermined value. The value of the maximum injected tracking rate was determined based on the information obtained from the rate table tests. Two recorders were activated when the seeker was uncaged and the injected tracking rate initiated. One recorder was used to collect information describing the seeker head characteristics versus time. The second recorder was used to record the video displayed by the SIP's video monitor (see Figure 6). The information from the two recorders was used to determine the effects of the CAIR III system on selected missile seekers. Data runs were also made without the jammer operating. Thus, a comparison of the missile seekers tracking performance with and without jamming was possible.

During all airborne tests, various environmental and system parameters were monitored. Accelerometers were used to determine what accelerations were encountered during flight. Two temperature sensors were used to monitor the temperatures of the CAIR III jammer. Two temperature sensors were used to monitor temperatures inside the F-4 aircraft's drag chute compartment. The frequency and mode of operation of the jammer were also monitored. This information revealed the environmental conditions the system encountered as well as how the system operated under these conditions.

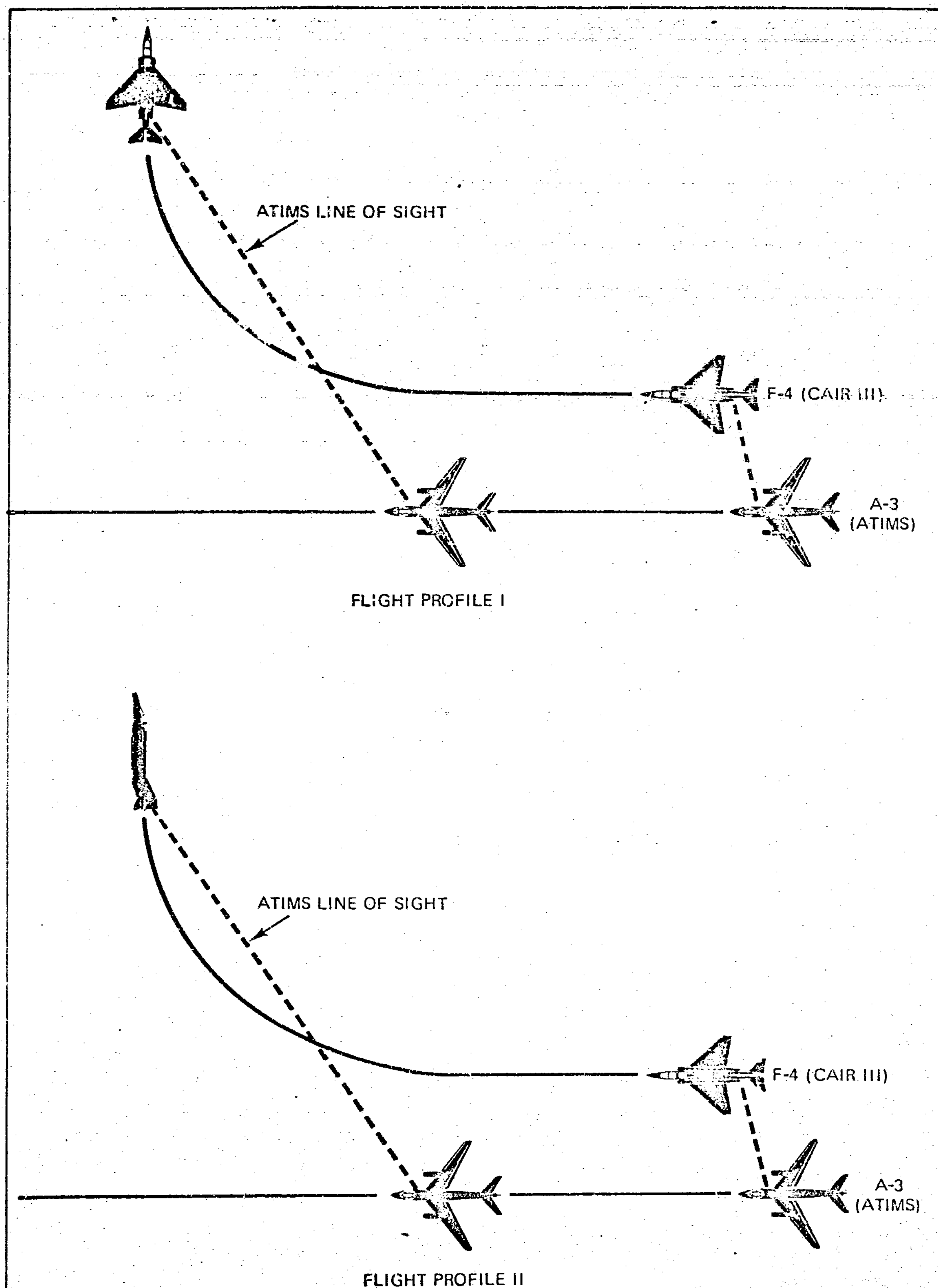

Figure 4. Flight maneuvers performed during ATIMS (Airborne Turret Infrared Measurement System) tests.

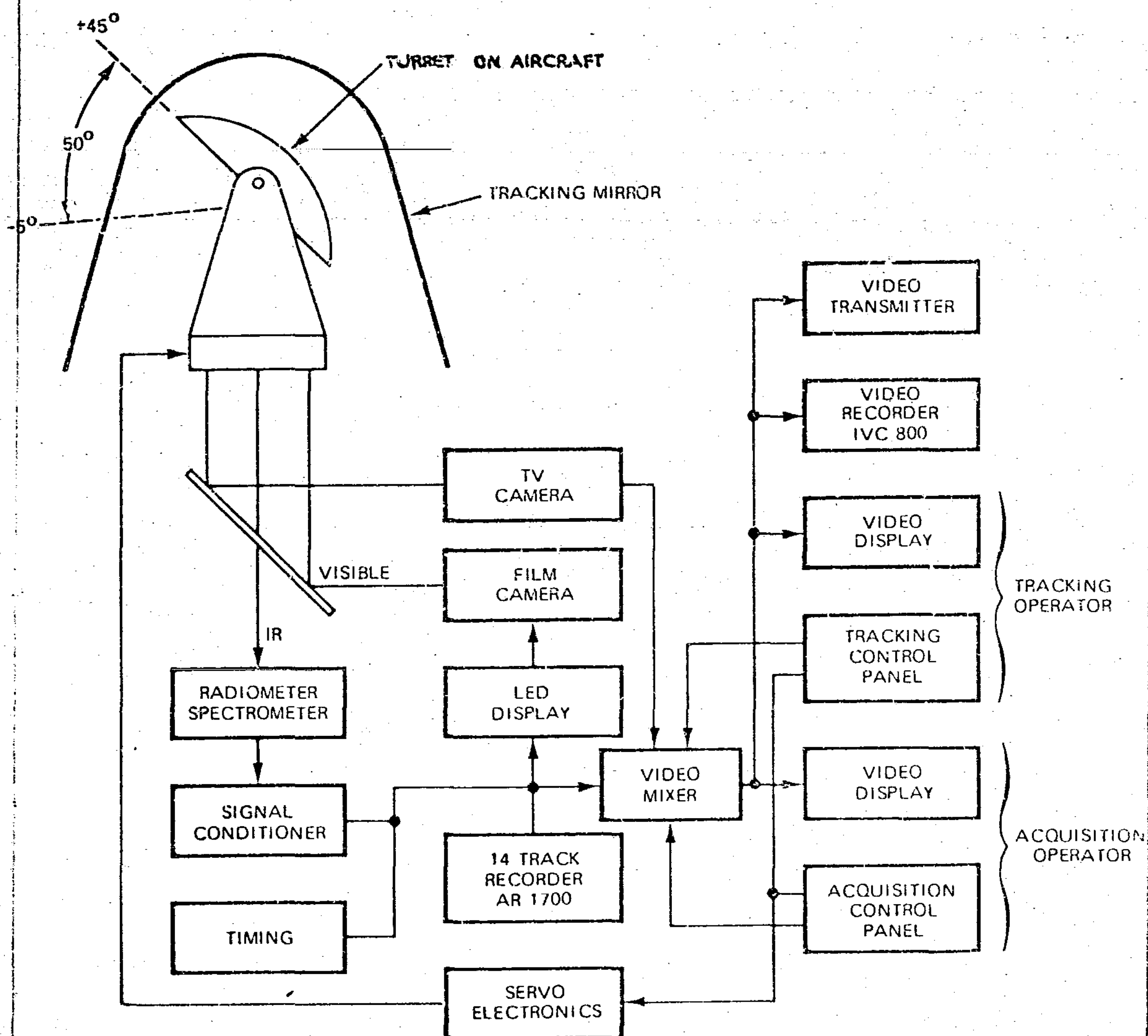

Figure 5. Airborne Turret Infrared Measurement System (ATIMS).

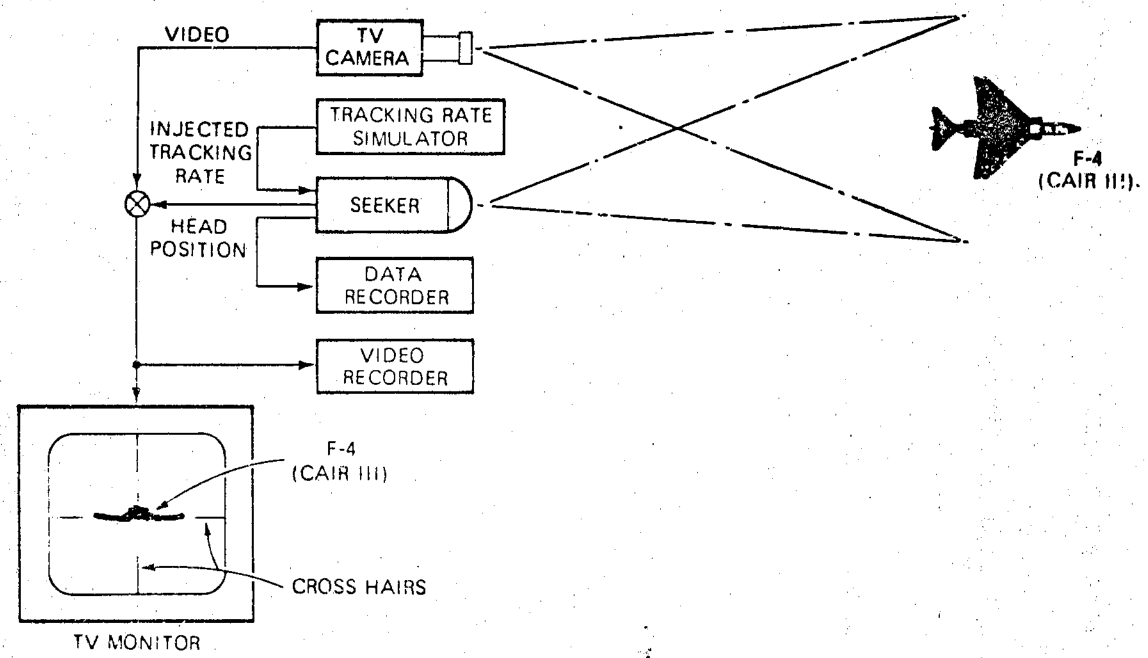

Figure 6. Functional diagram of Special Instrumentation Pod (SIP).

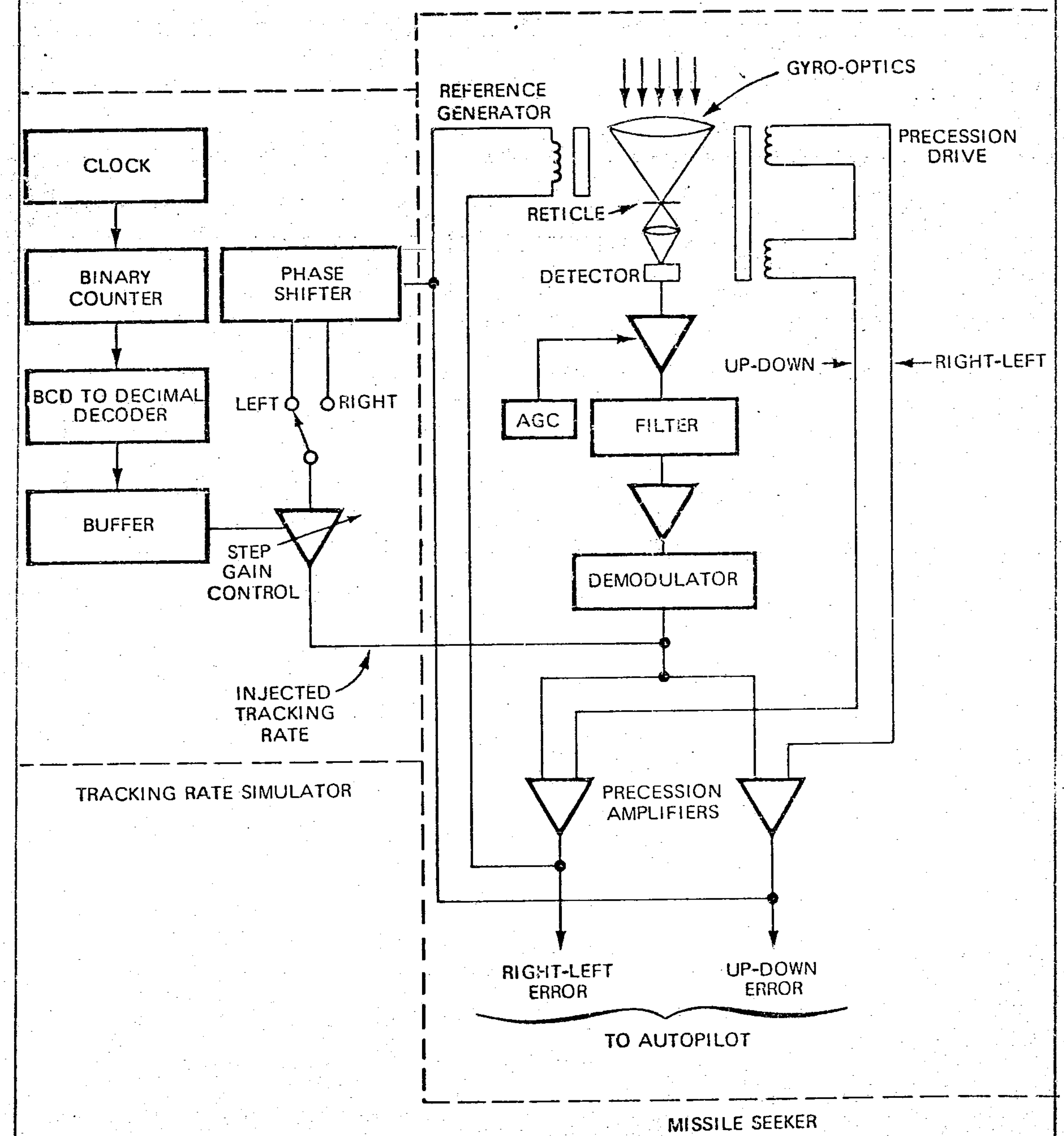

Figure 7. Typical infrared seeker and the PACMISTESTCEN designed tracking rate simulator block diagram.

TABLE I

CAIR III Evaluation Criteria

		Fractional Weighting Factor (Subgroup)	Fractional Weighting Factor (Group)
1.0	Contractor Performance		0.10
1.1	Reports	0.0250	
1.2	Delivery Schedule	0.0250	
1.3	Environmental Tests	0.0250	
1.4	Overall Effort	0.0250	
2.0	Performance Characteritics		0.40
2.1	Radiant Output Pattern (J/S)	0.1800	
2.2	Reduction of Missile Tracking Rate	0.1200	
2.3	Countermeasures Versatility	0.0600	
2.4	Depth of Modulation	0.0400	
3.0	Physical Characteristics		0.25
3.1	Aircraft Modifications Necessary for Installation	0.1000	
3.2	Weight	0.0500	
3.3	Size	0.0500	
3.4	Power Requirements	0.0500	
4.0	Reliability and Maintainability		0.25
4.1	Time to Repair	0.0625	
4.2	Time between Failures	0.0625	
4.3	Routine Maintenance	0.0625	
4.4	Supportability and Systems Handling	0.0625	
	TOTAL	1.0000	1.00

CAIR III Evaluation Criteria

1.0 Contractor Performance (Fractional Weighting Factor 0.10)

1.1 Reports (Fractional Weighting Factor 0.0250) This subgroup refers to the quality of communication between the contractor and the testing agency. The category refers to both verbal and written reports.

1.2 Delivery Schedule (Fractional Weighting Factor 0.0250) Normally when a contract is awarded to a company, the contract specifies an expected delivery date or dates. This category evaluates how well the contractor meets his commitments.

1.3 Environmental Tests (Fractional Weighting Factor 0.0250) The contractor has to fulfill certain environmental design considerations. This category is concerned with how well the equipment meets the environmental requirements, which really reflects the quality and quantity of the test. The ability of the equipment to operate in the actual airborne environment will be displayed in the ratings awarded to group 2.0 (Performance Characteristics) and 4.0 (Reliability and Maintainability).

1.4 Overall Effort (Fractional Weighting Factor 0.0250) This is a general performance category. Items that should be considered in this subgroup could be the quality of the contractor's field service, contractor interest in his equipment and its performance, attitude in meeting contractual requirements, etc.

2.0 Performance Characteristics (Fractional Weighting Factor 0.40)

2.1 Radiant Output Pattern (J/S) (Fractional Weighting Factor 0.1800) This subgroup has the largest possible weighting factor in the entire evaluation criteria. The category reflects the theoretical effectiveness of the infrared jammer. Data obtained from ground and airborne radiometric measurements will be used to determine whether or not acceptable radiant output patterns have been established. Acceptable radiant output patterns have been defined by computer simulations, previous countermeasures evaluations and theoretical expectations.

2.2 Reduction of Missile Tracking Rate (Fractional Weighting Factor 0.1200) This subgroup indicates how the IR jammer effects the performance of different missile seekers. Assignment of this weighting factor is based on ground and airborne IR jamming tests that are conducted against various missile seekers.

2.3 Countermeasures Versatility (Fractional Weighting Factor 0.0600) This category is concerned with assessing how easily the jammer can be adapted to meet new and different design objectives.

2.4 Depth of Modulation (Fractional Weighting Factor 0.0400) The jammer consists of a modulated IR source. If the jammer by itself has a constant IR output, this output adds to the radiant output of the aircraft to be protected. The larger the depth of modulation, the smaller the IR target appears. The effects of the depth of modulation on the jammer will also be reflected in subgroup 2.1 (Radiant Output Pattern (J/S)) and 2.2 (Reduction of Missile Tracking Rate).

3.0 Physical Characteristics (Fractional Weighting Factor 0.25)

3.1 Aircraft Modification Necessary for Installation (Fractional Weighting Factor 0.1000) This category has the third largest possible weighting factor. This subgroup has a high weighting factor because modifications are time consuming and documentation and labor cost required to modify aircraft are extremely high. The closer the assignment is to 0.1000 the fewer modifications required to the aircraft.

3.2 Weight (Fractional Weighting Factor 0.0500) Weight is an important consideration because added weight reduces the aerodynamic capabilities and payload capacity of the aircraft. The maximum weight of the CAIR III has already been limited since the jammer location has been restricted to the paradoor of an F-4. Also, after installation of the jammer, the paradoor must be capable of normal operation.

3.3 Size (Fractional Weighting Factor 0.0500) Size has been extremely confined since the jammer must fit in a modified F-4 paradoor. The modified paradoor is also required to fulfill the original operational requirements of a standard F-4 paradoor.

3.4 Power Requirements (Fractional Weighting Factor 0.0500) There are limitations on the amount of power that can be supplied by the F-4 aircraft and since the jammer depends totally on the aircraft power for its operation, it has to comply to these limitations.

4.0 Reliability and Maintainability (Fractional Weighting Factor 0.25)

4.1 Time to Repair (Fractional Weighting Factor 0.0625) During the test and evaluation of the jammer, records will be kept of the time to make any repairs (see Maintenance Action Form, Table II). This information will be used to determine what fraction of the possible 0.0625 weighting factor will be awarded to each contractor.

4.2 Time Between Failures (Fractional Weighting Factor 0.0625) The information recorded on the Maintenance Action Forms, Table II, will also be used to determine the time between failures. These data will then be used to make weighting factor assignments.

4.3 Routine Maintenance (Fractional Weighting Factor 0.0625) This category refers to the work that is required to be done on the jammer on a regular schedule, such as before or after each operation.

4.4 Supportability and Systems Handling (Fractional Weighting Factor 0.0625) This subgroup refers to any problems that are due to special supply considerations, jammer installation and removal difficulties and/or the need for any special equipment required to handle or maintain the system or systems.

TABLE II

Maintenance Action Form

Date____________________

System Name/No.

Contractor

Unit No./Serial No.________________

Time (Lapse Time Meter Reading________

Fault:

How Detected:

Unit Removal Time:

Unit Installation Time:

Fault Isolation Time:

Repair Time (Excluding Administration Time, Parts Chasing, etc.):

Parts Replaced:

Support Equipment Required:

Comments:

Name____________________

CONCLUSIONS

The tests described herein have been implemented and the results show good correlation between the data obtained from the ground tests and the airborne tests. Sufficient data have been acquired to identify hardware deficiencies and to determine the countermeasures effectivity. Of course, there is a continual process of improving and updating the present tests, as well as designing and/or employing new tests. The main objective is to utilize tests which are easily accomplished, accurate, require as little time as possible to conduct and lend themselves to accurate and rapid data reduction.

BIBLIOGRAPHY

Hudson, Richard D. Infrared System Engineering. New York: John Wiley and Sons, 1969.