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Soviet (AA-2 msl)

FTD-MX-09-05-74
PHASE III, VOLUME IV

# FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

# HAVE CARGO CAPTIVE FLIGHT TESTS (U)

## PHASE III, VOLUME IV

AUGUST 1974

FOREIGN TECHNOLOGY DIVISION

CLASSIFIED BY COMMANDER, FTD
EXEMPT FROM GENERAL DECLASSIFICATION
SCHEDULE OF EXECUTIVE ORDER 11652
EXEMPTION CATEGORY 3
DECLASSIFY ON 31 DECEMBER 1990

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# HAVE CARGO CAPTIVE FLIGHT TESTS (U)

PHASE III, VOLUME IV

FTD-MX-09-05-74

DIA TASK NO. T65-20-2-1

August 1974

NATIONAL SECURITY INFORMATION
UNAUTHORIZED DISCLOSURE SUBJECT
TO CRIMINAL SANCTIONS

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# PREFACE

~~(S)~~ This report is divided into four parts with each part representing a separate evaluation performed by ADTC, Eglin AFB, Florida with Soviet ATOLL (AA-2) air-to-air missiles under FTD Project HAVE CARGO.

~~(S)~~ Part I presents the results of airborne testing of standard ALA-17 flares as countermeasures to infrared guided missiles. The effectiveness of the flares against U.S. Falcon missiles and ATOLLs is discussed relative to the conditions under which the test was conducted.

~~(S)~~ Part II presents ground-to-air IR measurements and comparative missile performance data of a C-130E aircraft on low level mission profiles. ADTC's Mobile IR Measurement Laboratory (MIRML) was configured with a radiometer, a 35 mm camera, and two guidance and control units (GCU). One GCU was a standard AIM-9B Sidewinder unit and the other a HAVE CARGO GCU.

~~(S)~~ Part III presents the results of airborne IRCM effectiveness testing of the QRC-399 against the AIM-9B and ATOLL throughout the F-4C vulnerability cone. The data is presented as tables and figures of the decoy or missile track times for both missiles employed.

~~(S)~~ Part IV reports the results of airborne IRCM effectiveness tests and infrared radiometric measurements of the AAQ-4 against the AIM-9B and the ATOLL throughout the vulnerability cone of the EB-66. The measurement data are summarized as rear aspect polar plots and matrix plots of Apparent Effective Radiant Intensity in the nominal 1.8-2.7 micron region.

(U) Comments, constructive criticism, or suggested changes are solicited and should be forwarded to the Foreign Technology Division, Attn: FAMF, Wright-Patterson AFB, Ohio 45433.

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## SUMMARY

~~(S/NFD)~~ Part I of this report indicates results when standard ALA-17 flares were tested as decoys against Falcon and Russian ATOLL (AA-2) infrared guided missiles. One, two, or three flares were launched from a B-52 at ranges of one and five miles from the missiles. The guidance units were successfully decoyed in all test attempts except one. In that single exception the flare was fired alone and failed to burn as brightly as the normal ALA-17.

~~(S/NFD)~~ In Part II, a C-130 was flown in various low-level flight profiles against a ground-tracking Sidewinder and an ATOLL to test the feasibility of using an IR ground-launched missile system against C-130 aircraft. Lock-on and automatic tracking were possible with both missiles as long as the flight profiles had a zero or near-zero offset from the launch position. For offsets greater than 1/2 mile, lock-on difficulties and tracking problems occurred.

~~(S/NFD)~~ For Part III, QRC-399 equipment was evaluated on infrared countermeasure against a Sidewinder and a Russian ATOLL throughout the F-4C vulnerability cone. It was determined that a J/S of greater than 2:1 was required for reliable decoy and that even with a large J/S ratio, it is difficult to decoy either missile under a zero track rate condition. However, because of its higher tracking rate, the ATOLL was decoyed more quickly than the Sidewinder.

~~(S/NFD)~~ In Part IV, airborne infrared countermeasures effectiveness tests and radiometric measurements of the AAQ-4 and an EB-66 were conducted against an ATOLL and a Sidewinder throughout the vulnerability cone of the target aircraft. The measurements were used to determine the probability of decoy for various intercept angles. Additionally, the J/S ratio was measured to determine the Apparent Radiant Intensity versus aspect angle for the EB-66 test-bed aircraft.

# PART I

# ALA-17 FLARE TESTS

# SECTION I

# TEST OBJECTIVE

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~~(S)~~ The objective of this program was to determine the effectiveness of deploying one, two, or three standard ALA-17 flares as decoys for Falcon and ATOLL type infrared guided missiles at launch ranges of one mile and five miles.

## SECTION II

## F-4C/AIDES POD TEST PROCEDURES

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~~(S)~~ The AIDES aircraft was directed by FPS-16 or MPS-19 ground-based tracking radars to intercept a B-52G or a B-52H model aircraft in the test area. As directed by the project officer, the F-4C aircraft positioned itself one mile or five miles aft of the B-52 and about 500 feet lower in altitude. Prior to deploying the flare or flares, both aircraft were flying at 0.75 Mach speed at a nominal 30,000-foot altitude. Falcon acquisition was accomplished with the F-4C radar and the ATOLL acquisition occurred whenever the target appeared within the F-4C gunsight. Both missiles were then switched into a tracking mode of operation. A ten-second countdown was given and one, two or three flares were dispensed. The B-52 then executed a 40-degree change in heading and a 500-foot climb; the AIDES aircraft continued straight and level flight at 0.75 Mach speed. Display panels and control systems located in the rear cockpit of the F-4C enabled the co-pilot to observe the missile's reaction to each flare test. At flare burnout or if the flares were overrun, both missiles were caged for reacquisition of the B-52 and the next flare test.

## SECTION III

## TEST RESULTS AND DISCUSSION

1. ~~(S)~~ Flight testing for Project GIANT BLAZE began on 7 December 1970 with a B-52G model aircraft. Thirty-six flare tests were recorded before the AIDES ran out of tape. A summary of the missions scheduled and their results is presented in Table I. Table II shows the Decoy Effectiveness of one, two, or three flares dropped at launch ranges of one mile and five miles. The denominator represents the number of flare tests under the conditions listed and the numerator represents the number of decoys achieved. More flares were dropped than are accounted for in Table II because it was determined that for some drops, either the Falcon was inoperative due to detector-cooling difficulties or that the ATOLL was not tracking the B-52 at the time of flare drop. Therefore a particular flare drop was not considered a valid test for one or both missiles.

2. ~~(S)~~ In discussing the results of this program, it is important that the reader consider the conditions under which this test was conducted. The Exhaust Gas Temperature (EGT) of the B-52H aircraft was nominally 325°C during the test and the EGT of the B-52G model was approximately 420°C. At these temperatures, the Apparent Effective Radiant Intensity ($J'_e$) of a single standard ALA-17 flare was about 10 times greater than the $J'_e$ of either B-52 aircraft in the ATOLL spectral region and approximately four times greater than the $J'_e$ of the B-52 in the Falcon AIM-4D-8 spectral region. The flares therefore had a much greater $J'_e$ in both missile spectral regions than the B-52. As a result, positive decoy was obtained on both missiles for every valid flare test with one exception, that being a single ALA-17 flare dropped at a 5-mile range which failed to decoy the Falcon missile. Examination of the Falcon missile's recorded parameters indicate that this flare did not appear to burn as well as the other flares dropped.

3. ~~(S)~~ Reference is made here to ADTC Infrared Measurement Report Number APS-120. This report consists of graphs of the $J'_e$ versus time for standard ALA-17 flares, ALA-34 Double Length flares, and ALA-34 Grooved flares. Each flare plot has three levels of $J'_e$ for a B-52G model aircraft corresponding to three EGT's: 400°C, 500°C, 630°C. The value at 500°C is an actual measured value and represents the total infrared energy emitted by all eight engines of the aircraft in each spectral region shown. The other values are "theoretical" and are extrapolated assuming a standard black-body distribution. The graphs enable the reader to compare the $J'_e$ of the flare to the $J'_e$ of the B-52G aircraft.

4. ~~(S)~~ The number of valid flare tests for the ATOLL missile at the 5-mile range is considerably less than the number for the Falcon missile. This is particularly true for the B-52H aircraft. At five miles, the

Table I. Mission Summary (U)

| Date | Aircraft | Results |
|---|---|---|
| 7 Dec 1970 | G | 36 flare tests - AIDES ran out of tape. |
| 8 Dec 1970 | H | 46 flare tests. |
| 14 Dec 1970 | G | Falcon cooling problems. F-4C hydraulic failure after 31 flare tests. |
| 15 Dec 1970 | H | Cancelled for aircraft maintenance on F-4C. |
| 18 Jan 1971 | G | Falcon cooling problems. 16 flare tests for Project 1822Y001. |
| 19 Jan 1971 | H | No data - AIDES tape recorder failure. |
| 25 Jan 1971 | G | Falcon cooling problems. 45 flare tests. |
| 1 Feb 1971 | H | New Falcon system installed. 48 flare tests. |
| 2 Feb 1971 | G | 12 flare tests - AIDES tape recorder difficulties. |
| 23 Feb 1971 | H | 55 flare tests. |
| 1 Mar 1971 | H | Cancelled for weather. |
| 2 Mar 1971 | G | Cancelled for weather. |

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Table II. Decoy Effectiveness (U)

| | One Mile | | | Five Miles | | |
|---|---|---|---|---|---|---|
| | 1 Flare | 2 Flares | 3 Flares | 1 Flare | 2 Flares | 3 Flares |
| B-52G | | | | | | |
| Falcon | 16/16 | 17/17 | 11/11 | 27/28 | 29/29 | 15/15 |
| ATOLL | 18/18 | 18/18 | 17/17 | 9/9 | 15/15 | 11/11 |
| B-52H | | | | | | |
| Falcon | 14/14 | 14/14 | 14/14 | 18/18 | 17/17 | 16/16 |
| ATOLL | 8/8 | 6/6 | 8/8 | 4/4 | 4/4 | 7/7 |

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AIDES operator had considerable difficulty in establishing lock-on and track with the ATOLL missile. At 500°C EGT, the total infrared energy measured by the ATR-1 radiometer system for a B-52G aircraft was 400 watts/steradian in the 1.88-2.7 micron region (ATOLL band) and 1200 watts/steradian in the 3.95-4.97 micron region (Falcon band). If a normal blackbody distribution is assumed, "theoretical" values for the G and H models at 420°C and 325°C respectively can be extrapolated. For the G aircraft at 420°C, the $J'_e$ would be approximately 140-160 watts/steradian in the ATOLL region and for the H model at 325°C, the $J'_e$ would be about 40-60 watts/steradian. The very low EGT's combined with an average cloud background condition made it very difficult to acquire the target at five miles with the ATOLL. Frequently the AIDES aircraft had to close to within 3.5-4 miles to lock-on and track with this missile. Falcon acquisition at five miles was easier because of the slaving to the F-4C radar system and the greater $J'_e$'s in the Falcon spectral region (estimated 750 watts/steradian for the G at 420°C and approximately 200-225 watts/steradian for the H at 325°C).

## SECTION IV

## AIDES INSTRUMENTATION AND CALIBRATION

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1. (U) The ADTC resource utilized in support of this test program was the Airborne Infrared Decoy Evaluation System (AIDES). The AIDES consists of radiometric and data recording instrumentation mounted in a pod and qualified for Mach 2 flight on an F-4C type aircraft.

2. (U) The forward section of the pod contains a two-color radiometer system. Infrared energy is separated into two spectral bands by a dichroic element in the optical system. A thermoelectrically cooled Lead Sulphide detector is used in the 1.88-2.7 micron region and a thermoelectrically cooled Lead Selenide detector is used in the 3.97-4.95 micron region. An optical filter is inserted into each channel to control the spectral response. Optical parameters of the radiometer system are presented in Table I.

3. (U) Target acquisition is accomplished by the APQ-100 Fire Control Tracking Radar System of the F-4C aircraft. Aircraft radar signals drive the servo-controlled front mirror which directs the target energy into the radiometer optical system. Radar gimbal positions and mirror gimbal positions are compared electrically with the resultant being used to drive the mirror onto the target. Measurements can be made in any direction out to 45 degrees from the pod centerline.

4. (U) A 16mm movie camera with a 100-foot film magazine providing 20 minutes of data at four frames per second provides time-correlated photographs of the radiometer's field-of-view with a reticle indicating the radiometer field-of-view. A remote time display is projected onto one side of the film allowing it to be precisely correlated with the pod's recorded data and ground-base tracking radar data.

5. (U) Brackets are provided on the bottom of the pod for any two of a variety of missile guidance and control units (GCU's). A Falcon AIM-4D-8 GCU and a Sidewinder AIM-9B GCU are normally flown. Prior to take-off, the Sidewinder is aligned with the aircraft gunsight and the Falcon is boresighted to the F-4C radar system. Two modes of operation are used: the cage mode for target acquisition and the track mode for missile self-tracking. The Falcon AGC, Track Error, Yaw and Pitch Attitude, Sidewinder Caging Coil, Gyro Speed and Pilot's Intercom are recorded in the AIDES Pod. Also recorded are the missile mode switch, radar range, radar azimuth and elevation position and crew voice. Display panels and control instrumentation located in the rear cockpit enable the co-pilot to observe and to control the two missiles' performance.

6. (U) All support equipment for the AIDES Pod is packaged within the pod shell. A data recording system consists of a 14-track magnetic tape recorder, subcarrier oscillator blocks and a calibration timing unit. A time code generator is synchronized with IRIG range time prior to each mission and provides correlation between the recorded data in the pod, the 16mm film, and ground-base tracking radar data. A 640-cubic inch gas bottle can be pressurized to 4000 psi and provides extended cooling capability to the Falcon missile seeker.

7. (U) The laboratory calibration procedure consists of irradiating the AIDES radiometer with collimated blackbody radiation and generating an irradiance input versus signal output curve for various blackbody irradiances. Repeating this technique for different blackbody temperatures, a series of system response curves are obtained. An inflight calibration standard permits accurate determination of radiometer responsibities during the measurement period by relating the response of the airborne standard to pre-mission laboratory irradiance calibrations.

Table III. Optical Parameters (U)

| | |
|---|---|
| Dome: | Material - sapphire - concentric<br>Outside Radius - 3.70 inches<br>Inside Radius - 3.50 inches<br>Diameter - 6.00 inches |
| Tracking Mirror: | Material - front surface, flat mirror, aluminized Kanigen overcoated aluminum substrate |
| Camera: | Traid KB-3A - 75mm EFL |
| Objective Lens: | Material - silicon<br>Diameter - 2.00 inch clear aperture<br>Focal Length - nominal 7.00 inches<br>Spectral Band - 1.8 to 5.0 microns<br>Field-of-View and Resolution - 3 degrees nominal 1 milliradian resolution |
| Nutation Mirror: | Material - front surface, flat mirror, aluminized Kanigen overcoated aluminum substrate<br>Nutation Angle (optical) - ½ degree diameter<br>Nutation Rate - 200 revolutions per second |
| Dichroic Mirror: | Transmission Band - PbSe<br>Reflection Band - PbS |
| Scan Reticle: | Field-of-View (each channel)<br>Angular - 3 degrees x 3½ degrees<br>Shape - canted pie-section<br>Format - single bar/frame<br>Bar Height (elevation) - 3 degrees<br>Bar Width (azimuth) - ½ degree<br>Scan Rate - 1 frame per 180 msec |
| Condenser Lens: | Material - silicon<br>Effective Geometric Speed - f/1.0<br>Detector Size - .160 in x .160 in |
| Sensitivity: | SWL - $1.0 \times 10^{-10}$ w/cm$^2$ effective<br>LWL - $1.0 \times 10^{-9}$ w/cm$^2$ effective |

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# PART II

## SUSCEPTIBILITY OF A C-130 AIRCRAFT TO A GROUND LAUNCHED IR MISSILE ATTACK

# SECTION I

# INTRODUCTION

---

1. ~~(S)~~ During times of conflict, C-130 aircraft are used to deliver supplies and equipment to outlying sites and remote places in the battlefield where it is a target for attack. Because the enemy has a potential capability with IR seeking missiles that can be ground launched, there is interest in the Air Force to know how vulnerable the C-130 is to a ground-to-air missile attack.

2. ~~(S)~~ It was the purpose of this test to determine if a ground launch of Sidewinder and ATOLL missiles with a "lock-on before launch" capability might be possible against C-130 aircraft.

# SECTION II

# MEASUREMENT OBJECTIVES

~~(S)~~ This series of ground-to-air tests was made to gather missile performance data on a Sidewinder and an ATOLL GCU unit operating simultaneously side-by-side and, to demonstrate the feasibility of using an IR ground-launched missile system against C-130 aircraft.

# SECTION III

# METHOD OF TEST

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1. ~~(S)~~ In order to satisfy the objectives, this test was designed to determine the position and range parameters at which the GCU units could lock-on to a C-130 aircraft, automatically track it, and experience break-lock while flying a variety of low-level flight profiles. A random-selected Sidewinder AIM-9B GCU unit was used for gathering data to establish a norm for determining both the comparative performance and ground launch feasibility tests. Also, infrared measurements were made in the 1.95 to 2.6 um bandpass region to provide an energy level basis for evaluating the behavior of the two GCU units.

2. (U) The technical support was provided by TAC, Vitro Services and ADTC. Missions were flown on the 5th, 16th and 17th of February 1971 on Santa Rosa Island at Site A-2. A C-130E aircraft, provided by TAC from Pope AFB, South Carolina, was used for the target on all three days. A Vitro Services MPS-19 Radar at Site A-3 was used to provide target time correlated position and tracking information. ADTC's Mobile IR Lab (MIRML) was used to provide the tracking platform and facilities for the GCU units, radiometer, electronic recording, and support instrumentation.

3. (U) The flight profiles were designed for the aircraft to fly east to west in order to minimize radiant energy received from the sun. For head-on tests, the aircraft was flown from west to east. Using MIRML as a reference and communication point, the flight path off-set, aircraft speed, altitude, maneuver, and radar coverage were controlled by the project officer. The TAC aircrew and radar operators were briefed prior to each mission. With radio contact between aircrew, radar operators, and MIRML personnel the tests proceeded.

4. (U) The two GCU units were mounted on the right instrumentation platform of the IFLOT (Intermediate Focal Length Optical Tracker). The radiometer was mounted on the left platform. A Mod IV 35 mm camera using a 40-inch focal length lens was mounted to the left of center of the IFLOT and above the tracking binoculars, Figure 1. The GCU units, radiometer, and camera were boresighted straight ahead with no compensation for parallax. The missile heads were set 11 inches apart from center axis to center axis in order to obtain better comparative results.

5. ~~(S)~~ The standard missile head used throughout the test series was an AIM-9B GCU Unit, Serial Number AP34889. A Russian-made ATOLL, HAVE CARGO GCU Unit, Number 13, was the second unit utilized. Both units were obtained from the Missile Depot, Robins AFB, Georgia.

[redacted]

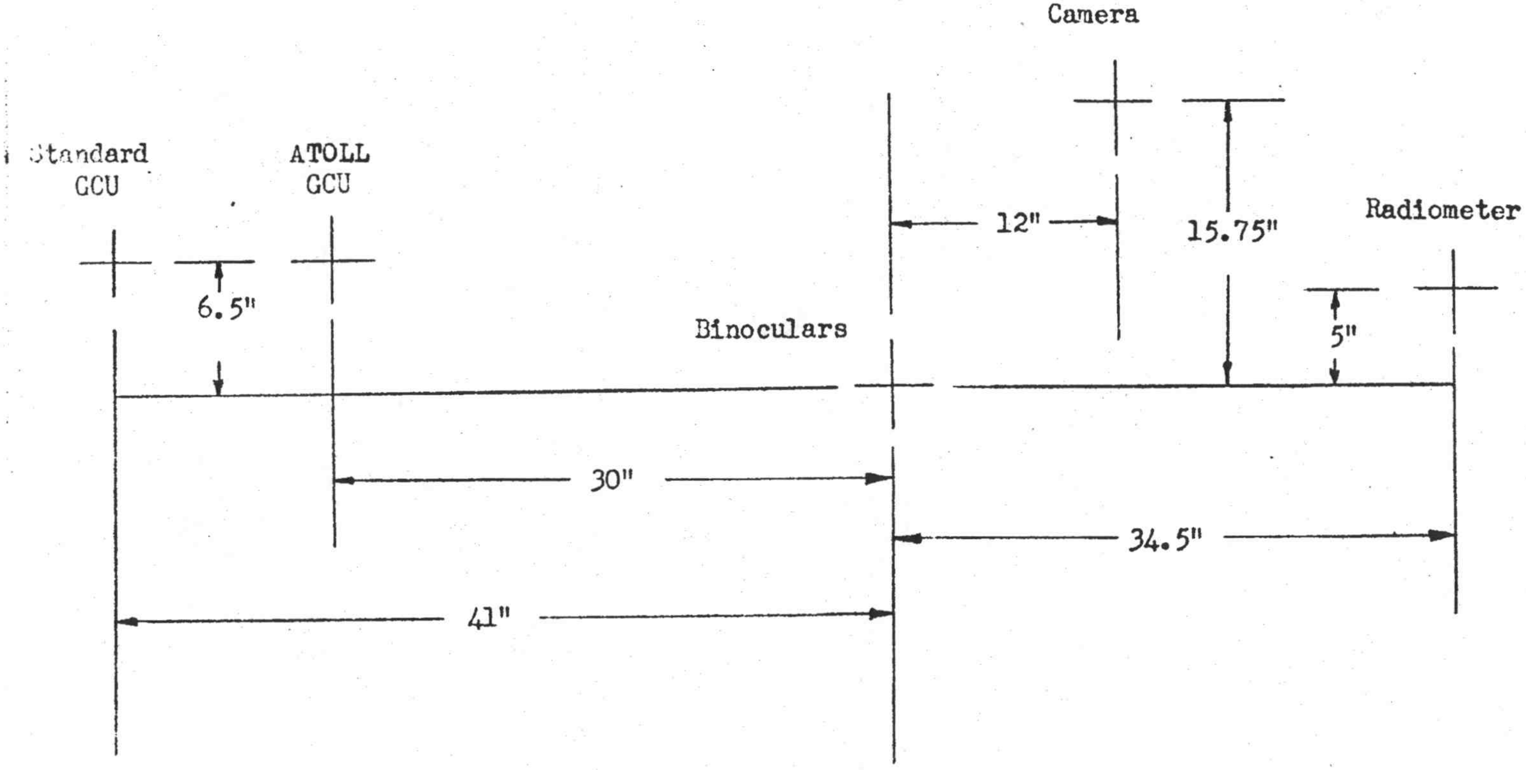

Figure 1. Instrumentation: Illustration Showing Relative Position of Instrument Mounting on IFLOT (U)

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[redacted]

6. (U) The radiometer used for making the IR measurements was a dual channel Exotech Model 8R2. This radiometer used two detectors to make simultaneous measurements in two different spectral regions. Channel "A" uses a lead selenide (PbSe) detector and Channel "B" uses a lead sulfide (PbS) detector. Both detectors are thermoelectrically cooled and both are protected by sapphire windows. The nominal range of Channel "A" is from 2.0 to 5.3 micrometers. Channel "B" is from 1.3 to 3.2 micrometers. Channel "A" uses three bandpass filters and Channel "B" uses two. These Ranges are listed as follows:

| Filter Designation | Nominal Spectral Range | |
|---|---|---|
| | Channel "A" | Channel "B" |
| A. | | 1.7 to 2.8 micrometers |
| B. | | 1.9 to 2.6 micrometers |
| C. | 3.1 to 4.95 micrometers | |
| D. | 3.6 to 5.2 micrometers | |
| E. | 3.7 to 5.1 micrometers | |

7. ~~(S)~~ Because the Sidewinder IR bandpass response is nominally 1.88 to 2.7 micrometers, filter B was used with Channel "B" for all the IR data in these tests. Filter C was used with Channel "A" but due to low sensitivity, there was no data available from this channel of the radiometer.

8. (U) A total of 53 passes was flown to establish and complete the flight test program. Flight paths were offset from zero to one nautical mile. Speeds were controlled between 130 and 300 knots and altitudes ranged from 500 to 5,000 feet.

9. (U) The Mod IV 35mm camera used for this test program is a standard camera used for making documentary films. The camera was equipped with a 40 inch focal length lens and 18° shutter. Ektachrome ER type 5257 film was used and a picture taken every 200 milliseconds.

## SECTION IV

## TEST RESULTS

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1. ~~(S)~~ Comparative electronics guidance data from two GCU units and data from an Exotech radiometer have been reduced from a series of 30 low level flight tests. Specific events of the behavior of the two GCU units are time correlated with tracking data from the radar and presented in graphic and tabular form. A presentation is made for each flight profile. The primary data, the slant range at lock-on and break-lock are presented graphically. There are several places on these plots where the standard slant range vector is terminated by an arrow. This is to indicate those occasions when the test run was ended before the GCU broke lock. The support data, aspect angles, azimuth and elevation, and when available, the radiometric data are presented in tabular form. (See Tables IV through VIII)

2. ~~(S)~~ Several photographs of the C-130 aircraft have been included to show various positions in the flight profiles that were exposed to the guidance units and instrumentation (See Figures 2 through 6)

Table IV. Flight Profile: Straight and Level: Tail View (U)

| TARGET AT LOCK-ON | | | | TARGET AT BREAK LOCK | | | |
|---|---|---|---|---|---|---|---|
| S/R (ft) | Aspect ± deg | Elev deg | Je w/str | S/R (ft) | Aspect ± deg | Elev deg | Je w/str |
| (.)1120 | +31 | -27 | - | 7012 | 0 | -5 | |
| + 2772 | +7 | -8 | - | 9524 | -1 | -3 | B/G |
| (.) 1176 | +20 | -25 | - | 6789 | -3 | -5 | |
| + 2876 | +4 | -9 | - | 10993 | -2 | -3 | B/G |
| (.)1218 | +13 | -25 | | 6799 | -2 | -7 | |
| + 2998 | +3 | -10 | - | 10639 | -1 | -3 | 17 |
| (.)2111 | +7 | -13 | | 10952 | -3 | 0 | |
| + 2111 | +7 | -13 | SAT | 31891 | -2 | 0 | 45 |
| (.)5410 | +4 | -13 | | 12838 | -2 | -2 | |
| + 5071 | +2 | -12 | SAT | 33796 | 0 | 0 | 69 |
| (.) 896 | +17 | -39 | | 13027 | -3 | -2 | |
| + 2805 | 0 | -12 | SAT | 13822 | -3 | -2 | B/G |
| (.)2932 | 0 | -11 | | 10842 | -2 | -3 | |
| + 2932 | 0 | -11 | SAT | 14234 | -4 | -2 | 47 |
| (.)1729 | +17 | -33 | | 6784 | 0 | -11 | |
| + 3706 | +6 | -14 | - | 10479 | -1 | -5 | B/G |
| (.)1124 | +9 | -27 | | 8663 | 0 | -6 | |
| + 1124 | +9 | -27 | - | 10144 | -1 | -4 | B/G |

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LEGEND:
SAT = System Saturated
B/G = Background

Table V. Flight Profile: Straight and Level: Head On 500 ft Alt. (U)

| TARGET AT LOCK ON | | | | TARGET AT BREAK LOCK | | | |
|---|---|---|---|---|---|---|---|
| S/R (ft) | Aspect ± deg | Elev deg | Je' w/str | S/R (ft) | Aspect ± deg | Elev deg | Je' w/str |
| (.)2173 | +5° | -12° | | 1295 | +12° | -23° | |
| + 2360 | +5° | -11° | SAT | 923 | +46° | -34° | - |
| (.)1469 | +24° | -20° | | 635 | +24° | -20° | |
| + 1281 | +24° | -23° | SAT | 520 | ++1° | -75° | - |
| + 1420 | +16° | -20° | SAT | 748 | +1° | -50° | - |

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LEGEND:
SAT = System Saturated
B/G = Background

Table VI. Flight Profile: Climb with Full Power: 500 ft Initial Alt. (U)

| TARGET AT LOCK-ON | | | | TARGET AT BREAK LOCK | | | |
|---|---|---|---|---|---|---|---|
| S/R (ft) | Aspect ± deg | Elev deg | Je' w/str | S/R (ft) | Aspect ± deg | Elev deg | Je' w/str |
| (.)4952 | -10 | -14 | | 18197 | +2 | -5 | |
| - 4952 | -10 | -14 | SAT | 26246 | 0 | -3 | B/G |
| (.)1304 | +5 | -36 | | 2217 | +10 | -36 | |
| + 1304 | +5 | -36 | SAT | 32341 | +2 | -4 | B/G |
| (.)954 | +23 | -45 | | 1853 | +5 | -22 | |
| + 954 | +23 | -45 | SAT | 27019 | 2 | -3 | B/G |
| (.)962 | +47 | -39 | | 11755 | 14 | -14 | |
| + 2481 | -8 | -12 | SAT | 15825 | -41 | -7 | B/G |
| (.)846 | +11 | -32 | | 16444 | -4 | -6 | |
| + 1110 | +10 | -31 | SAT | 22432 | -35 | -4 | B/G |

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LEGEND:
SAT = System Saturated
B/G = Background

Table VII. Flight Profile: Climb & Turn with Full Power, 500 ft Initial Altitude (U)

| TARGET AT LOCK-ON | | | | TARGET AT BREAK LOCK | | | |
|---|---|---|---|---|---|---|---|
| S/R (ft) | Aspect ± deg | Elev deg | Je' w/str | S/R (ft) | Aspect ± deg | Elev deg | Je' w/str |
| (.)1193 | +12 | -35 | | 11717 | -16 | -14 | |
| + 3909 | -2 | -8 | SAT | 13800 | -21 | -5 | B/G |
| (.)4942 | +3 | -30 | | 10485 | -21 | -14 | |
| + 4942 | +3 | -30 | - | 11892 | -35 | -9 | B/G |
| (.)4590 | +4 | -2 | | 7996 | -10 | -35 | |
| + 4590 | +4 | -2 | - | 8069 | -13 | -38 | B/G |
| (.)4266 | -14 | -6 | | 8077 | +6 | -35 | |
| + 4266 | -14 | -6 | SAT | 12973 | 30 | -12 | B/G |
| (.)911 | +24 | -39 | | 7775 | -22 | -13 | |
| + 3541 | +2 | -5 | SAT | 10115 | -39 | -8 | B/G |

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LEGEND:
SAT = System Saturated
B/G = Background

### Table VIII. Flight Profile: Climb and Descend (U)

| TARGET AT LOCK-ON | | | | TARGET AT BREAK LOCK | | | |
|---|---|---|---|---|---|---|---|
| S/R (ft) | Aspect ± deg | Elev deg | Je' w/str | S/R (ft) | Aspect ± deg | Elev deg | Je' w/str |
| (.)1493 | -5 | -18 | | 6793 | -17 | 0 | |
| + 2508 | -5 | -7 | - | 10398 | -30 | 0 | B/G |
| (.)6022 | +1 | -5 | | 14914 | +2 | -2 | |
| + 6022 | +1 | -5 | SAT | 19774 | +1 | -3 | 63 |
| (.)7390 | -3 | -9 | | 14011 | 0 | -7 | |
| + 6958 | -1 | -12 | SAT | 22171 | +1 | -5 | 60 |
| (.)9197 | +7 | -26 | | 17240 | +20 | -9 | |
| + 9197 | +7 | -26 | | 27349 | +2 | -12 | 104 |
| (.)7247 | -6 | -40 | | 11577 | +8 | -17 | |
| + 7247 | -6 | -40 | SAT | 36970 | +1 | -7 | 57 |

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LEGEND:
SAT = System Saturated
B/G = Background

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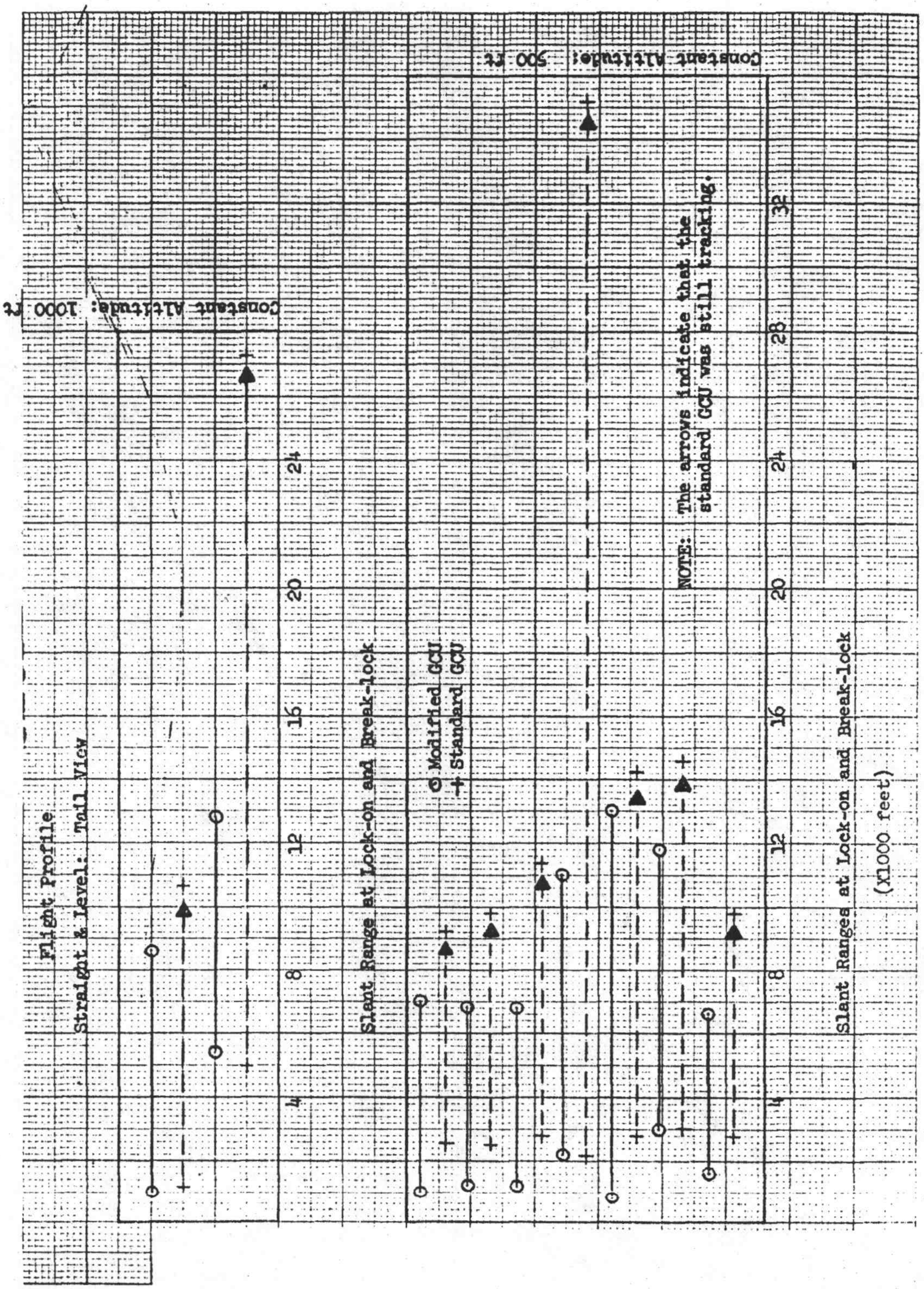

NOTE: The arrows indicate that the standard GCU was still tracking.

Figure 2. Slant Ranges at Lock-On and Break-Lock (X1000 feet)

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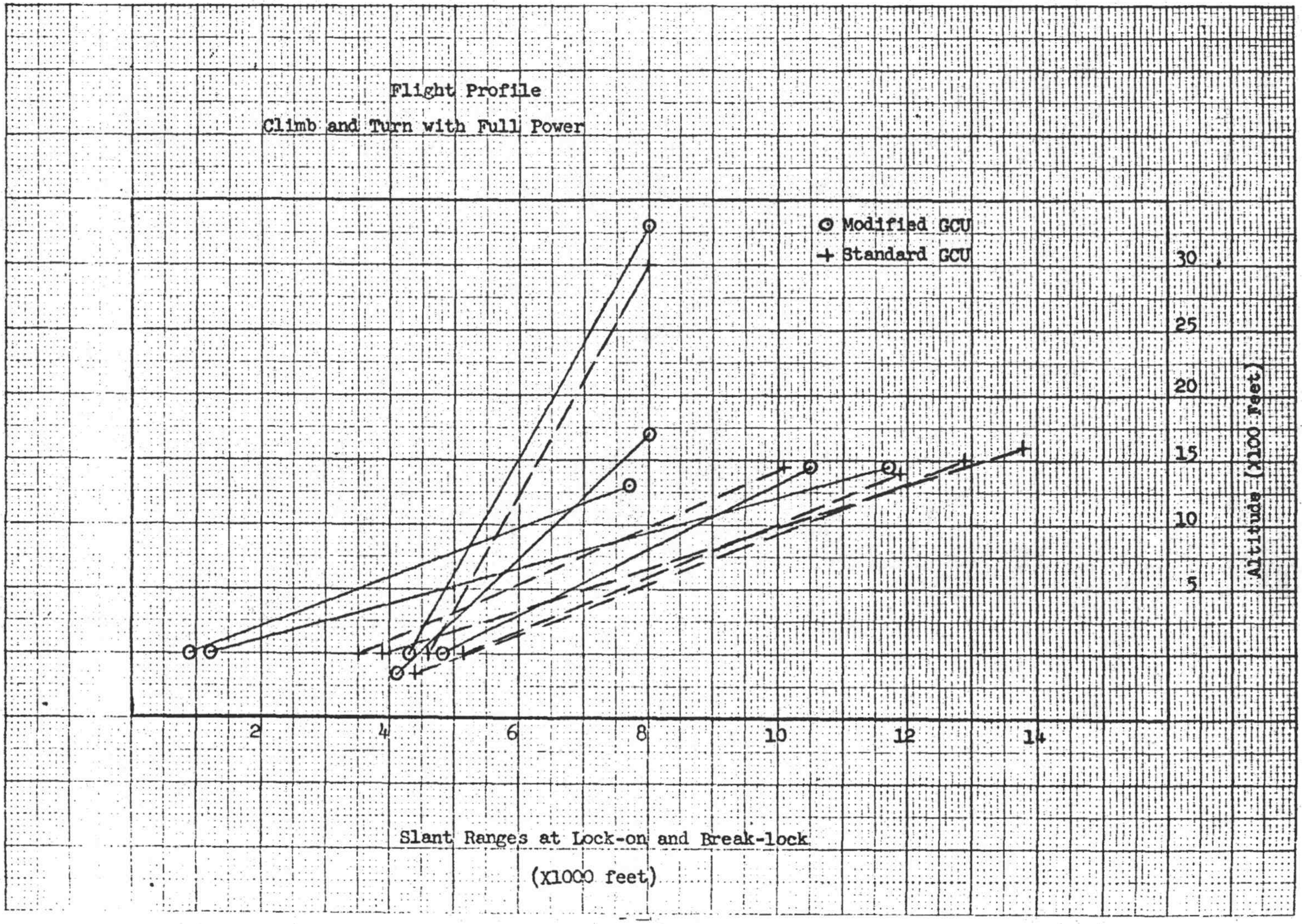

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Figure 3. Slant Ranges at Lock-On and Break-Lock (X1000 feet) (U)

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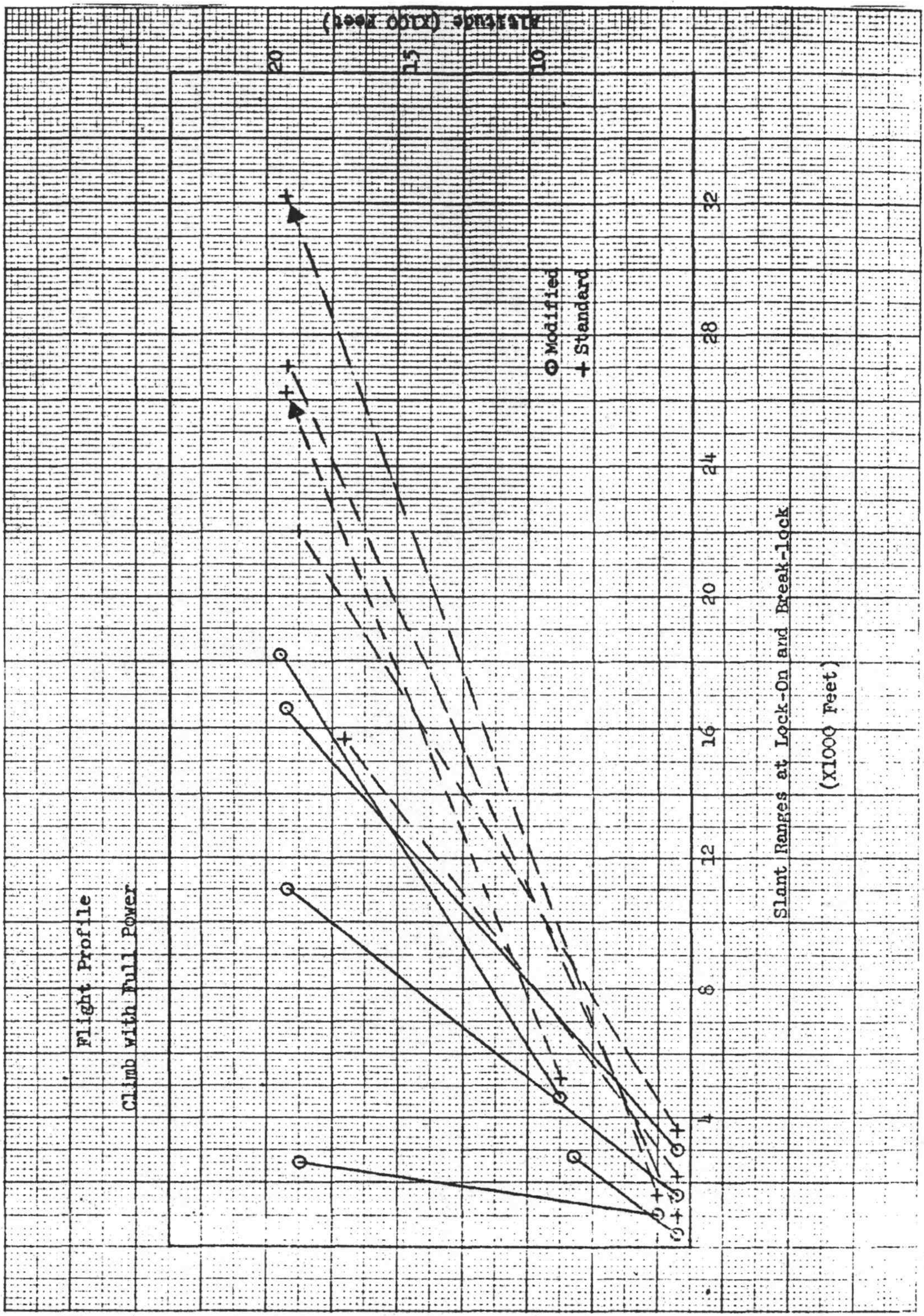

Figure 4. Slant Ranges at Lock-On and Break-Lock (X1000 feet)

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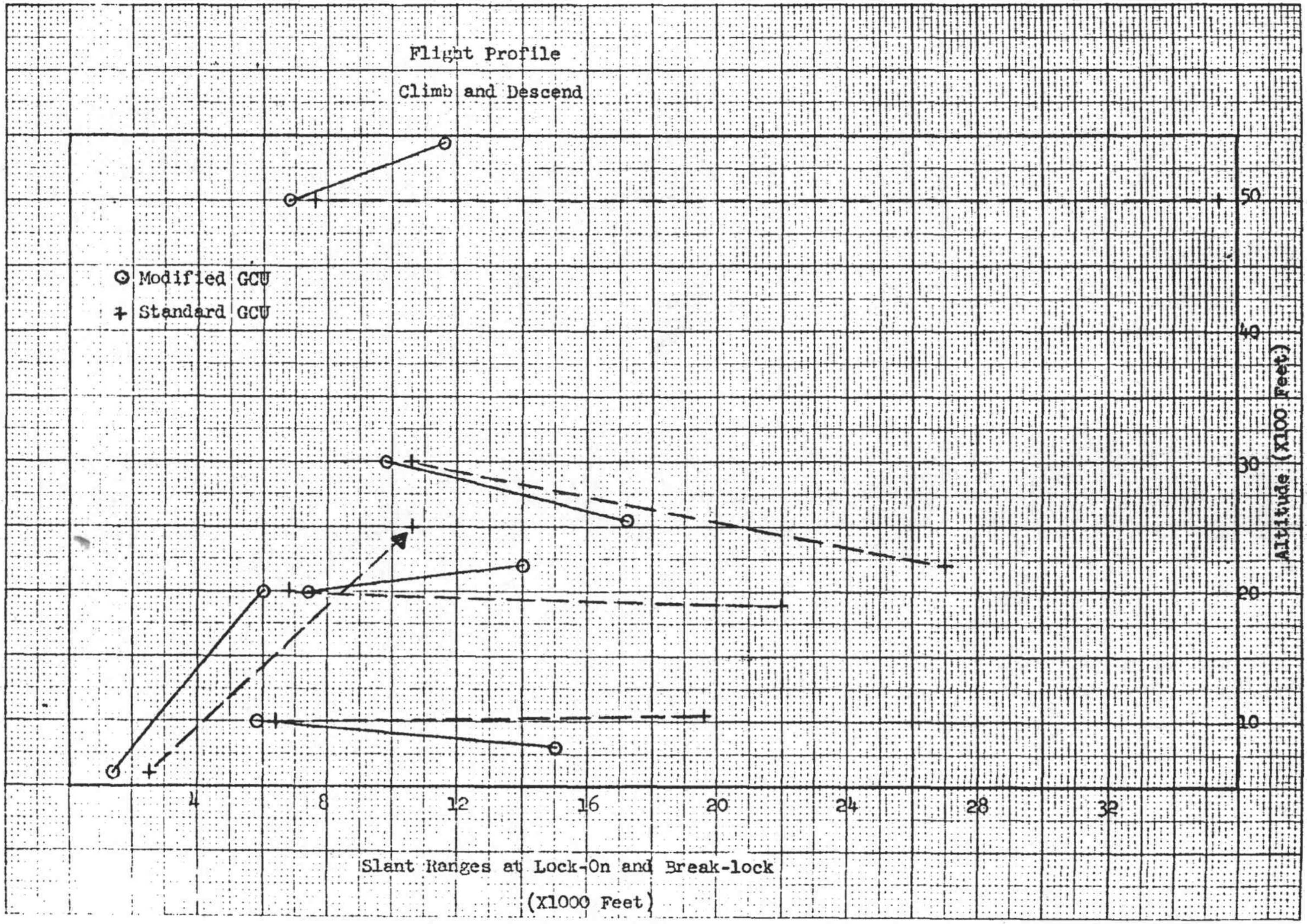

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Figure 5. Slant Ranges at Lock-On and Break-Lock (X1000 feet) (U)

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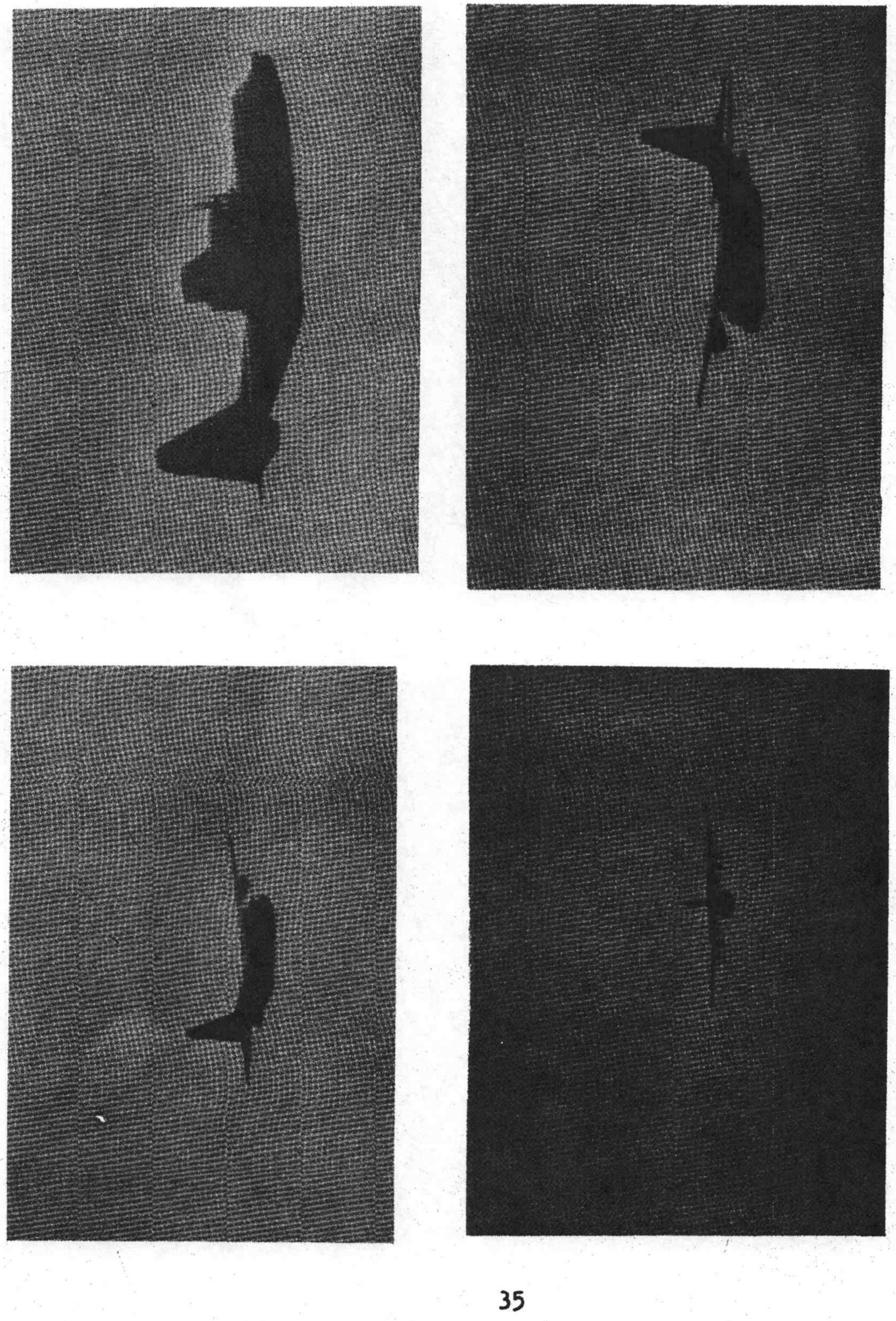

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Figure 6. Target Aircraft Flight - Profile (U)

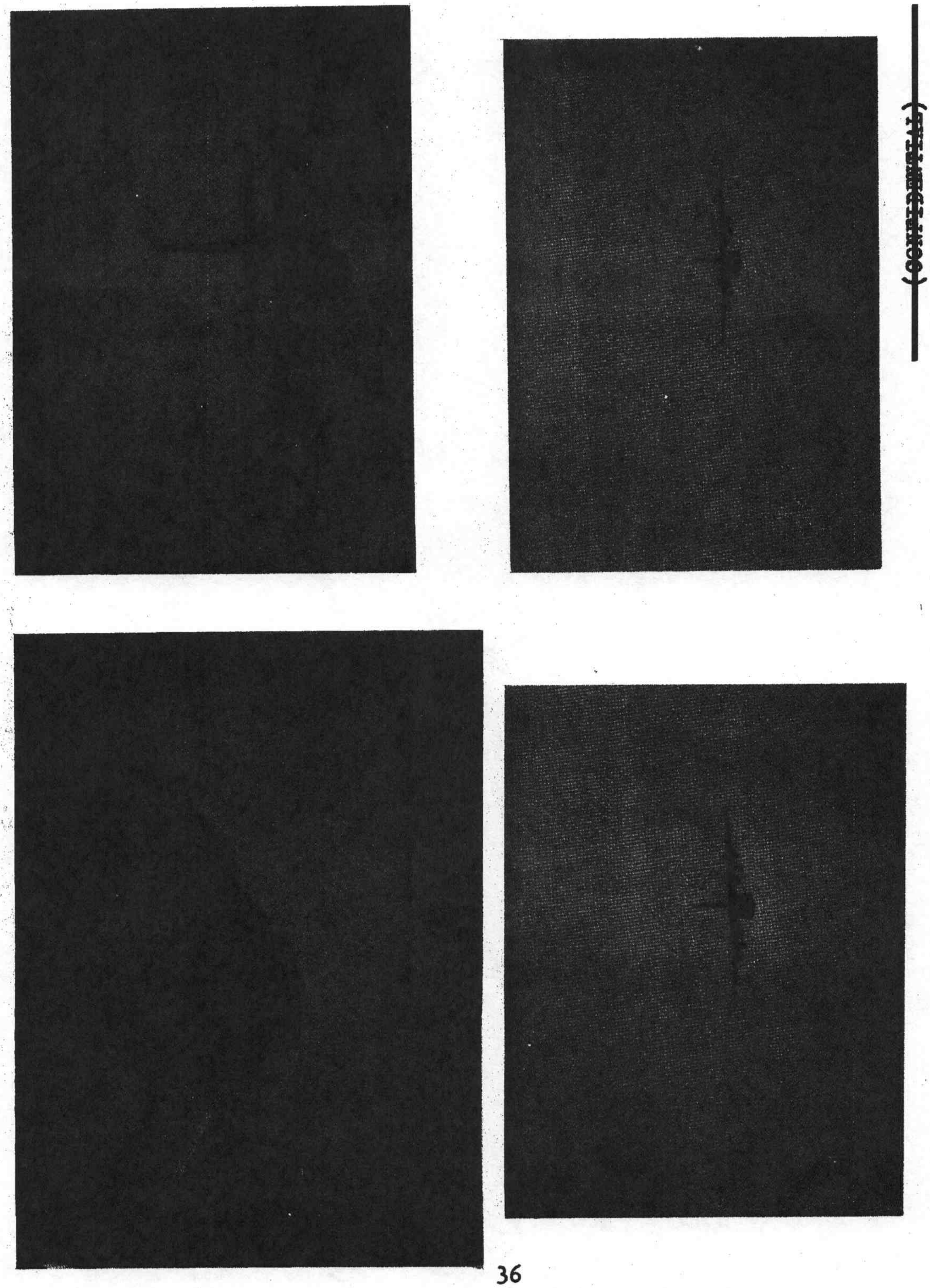

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Figure 6. Target Aircraft Flight - Profile (U) (Cont)

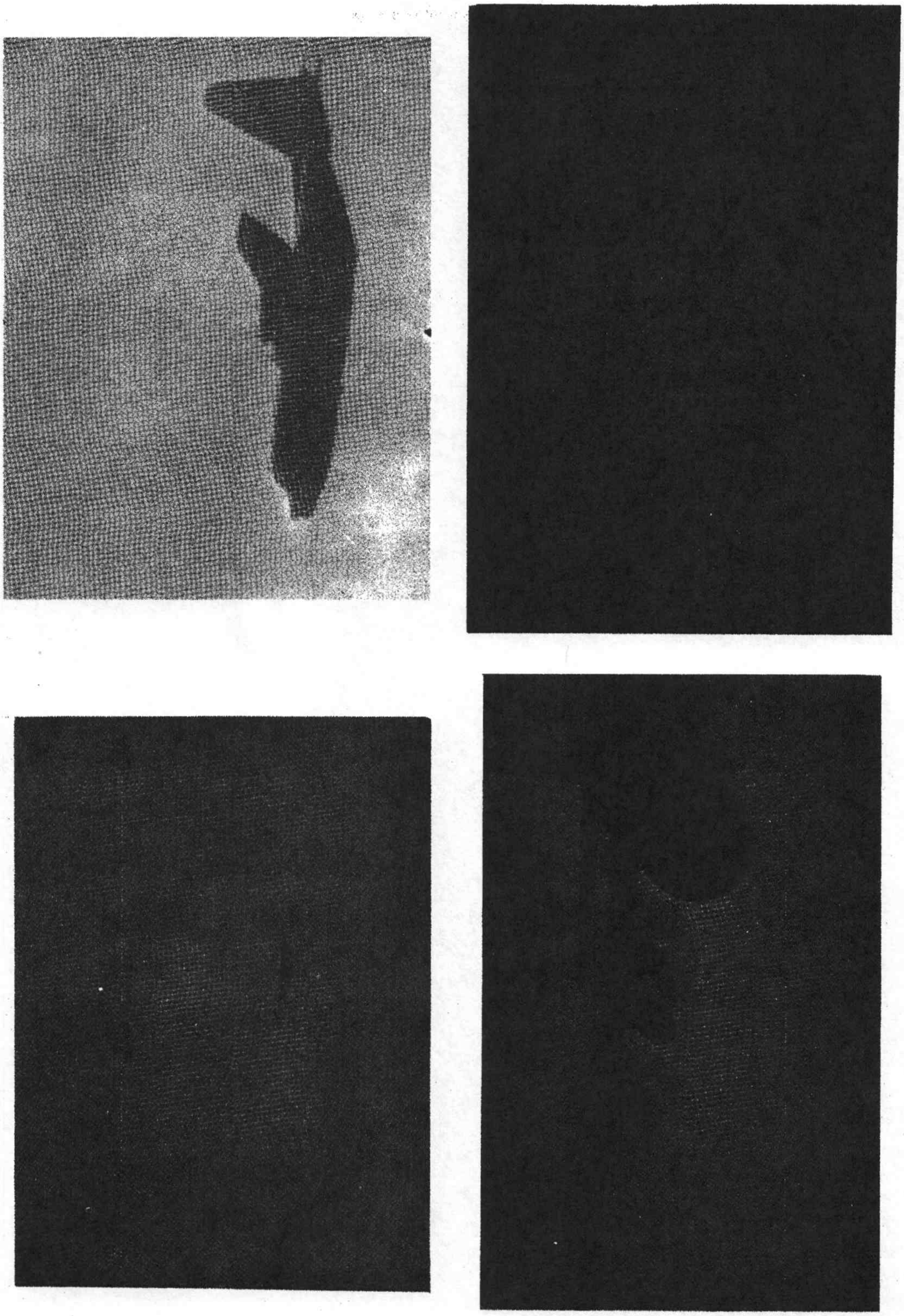

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Figure 6. Target Aircraft Flight - Profile (U) (Cont)

## SECTION V

## CONCLUSIONS

1. ~~(S)~~ Data for this report were taken from tests that were flown the 5th, 16th and 17th of February. Tests that were conducted on 5 February demonstrated that neither of the GCU units could lock on to the target aircraft when the flight profiles were offset a half mile or greater from the missile launch position. Each time the tracker could locate the target in the binoculars, point the missiles and uncage the gyros, the gyros would veer off axis. The critical offset distance was not determined.

2. ~~(S)~~ The tests conducted on February 16th and 17th were flown with flight profiles that had zero or near-zero offset from the launch position. There were no lock-on problems during these tests. Using the performance data of the AIM-9B, these tests indicate that it is feasible for an IR seeking ground-to-air missile to be used effectively against C-130 aircraft during certain low-level flight profiles.

3. ~~(S)~~ There was not a lot of radiometric data available for this report and any conclusions about the data should be made in context with both the purposes of the test, and the test parameters. First, the test program was designed to be a feasibility test. The radiometer was to be used to determine if there was enough signal strength so the GCU units could lock on and track. It was determined that there was ample signal strength and to keep the test program within the design, no tests were made for the sole purpose of gathering radiometric data. Secondly, there were physical problems to prevent the full use of the radiometer. To begin with, the radiometer and GCU units were mounted on a common platform. Therefore, for those tests when the tracking ability of the GCU units was being determined, the IFLOT was held steady and the radiometer was held steady with it. Also, differences in the field-of-view of the instruments tended to make the problem more acute. The radiometer had a 1° by 1° field-of-view while both GCU units had a nominal 6° field of view. Because of these things, the radiometer could not always be pointed at the target.

# PART III

# QRC-399 MEASUREMENT AND EVALUATION

# SECTION I

# TEST OBJECTIVE

~~(S)~~ The objective of this test program was to evaluate the effectiveness of the QRC-399 equipment as an Infrared Countermeasure (IRCM) against a Sidewinder 1A missile (AIM-9B) and a Russian ATOLL missile throughout the F-4C vulnerability cone.

## SECTION II

## METHOD OF TEST

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1. (U) The flight profile used for missions flown on this program is shown in Figure 7. While the test aircraft (F-4 #408) maintained straight and level flight, the AIDES aircraft (F-4 #876 or #716) executed three basic maneuvers.

2. (U) The first maneuver was closing on the target from direct tail aspect from a range of two miles until flyby. During this maneuver the AIDES pilot held the target within his gunsight while the AIDES operator switched the missiles from cage to track after ascertaining that a proper acquisition signal was present. If the missile video level dropped to noise, the operator switched the missile back to cage to reacquire the target. If the video level did not drop to noise level, the operator left the missile in track mode for approximately ten seconds and then switched back to cage to begin over.

3. (U) An initial position of approximately 20 degrees off tail aspect was assumed for the second type maneuver. The pilot then turned the AIDES aircraft to hold the target within his gunsight and the AIDES equipment operator repeated the procedure used in the first type of maneuver until the aspect was again direct tail or flyby occurred.

4. (U) The third type of maneuver began with the AIDES acquiring the target from direct tail aspect at a constant range of approximately one mile. After the missiles were in the track mode, the AIDES pilot maneuvered in a slow "S" behind the target out to maximum angles of 20 degrees and at a rate that would cause the missiles to track at about one degree per second. If breaklock occurred the maneuver was stopped until the AIDES operator reacquired the target. If breaklock did not occur the missiles were placed back in cage after one or two complete "S" turns and the sequence was repeated.

5. (U) Power settings of cruise, military, and afterburner were used in all of the above maneuvers. All missions were flown during daylight hours except one and various background conditions were encountered.

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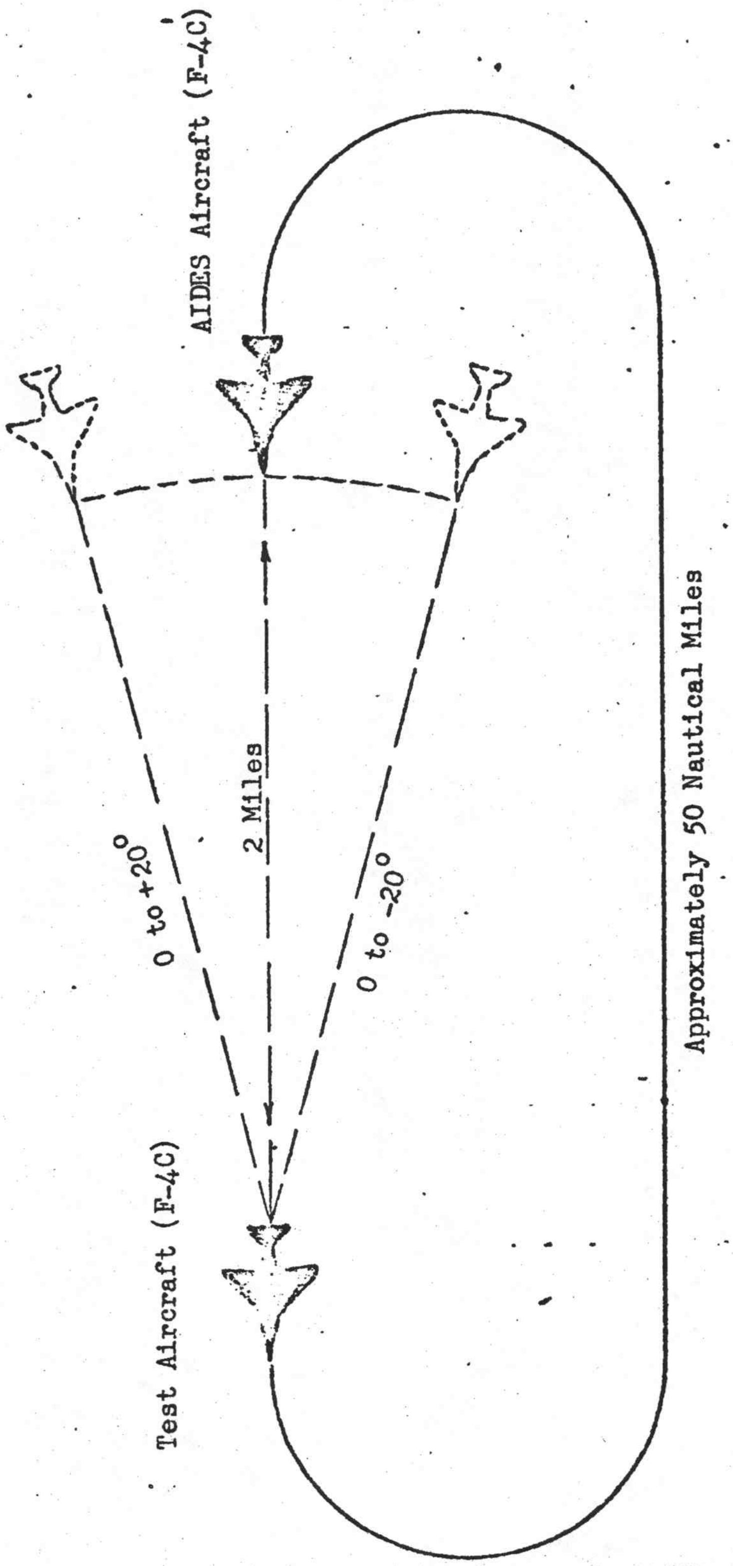

Figure 7. Measurement Geometry (U)

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# SECTION III

# INSTRUMENTATION

1. (U) The Airborne Infrared Decoy Evaluation System (AIDES) consists of various radiometric and data recording instrumentation mounted in a pod and qualified for supersonic flight on an F-4 type aircraft. Capability is provided on the pod to carry and record performance data from two infrared missile guidance-and-control units. An outline drawing of the system is shown in Figure 8. The equipment is normally carried on the left outboard wing station of specially wired F-4C's, #407 and 410, and operated from the rear seat by an instrumentation operator. A detailed description of the AIDES pod characteristics is presented in Technical Report ADTC-TR-69-100.

2. (U) Optical radiation from the target is directed into the two-color radiometer and camera by a servo-controlled optical system. The infrared energy is separated into two spectral bands by a dichroic element in its optical system. An uncooled PbS detector and a thermoelectrically cooled PbSe detector are used in the short and long wavelength channels respectively. Optical bandpass filters result in system spectral response characteristics as shown in Figures 9 and 10. Optical parameters of the system are summarized in Table IX.

3. (U) A 16mm color movie camera makes time-correlated photographs of the radiometric field-of-view (FOV) through the radiometer optics. A reticle to indicate the radiometer FOV is projected onto the 5-degree camera FOV. A nixie-tube time display is projected onto the side of the film allowing visual assessment of radiometric events.

4. (U) The on-board recording system consists of an Ampex AR-200 seven-track tape recorder, subcarrier oscillator block, and calibration timing unit. Data are recorded either direct or wideband FM on six of the tracks with the remaining track being used for multiplexing 14 subcarrier oscillator auxiliary data channels. A complete data recording format is given in Table X.

5. (U) Additional support equipment which makes up the AIDES pod includes an argon gas container, electrical power supplies, and a time code generator.

6. (U) Due to the non-availability of either of the specially wired aircrafts (#407 and 410), the AIDES pod mounted center-line on F-4 aircrafts #876 and 716 was utilized in support of this test program. In this configuration the pod was operated at reduced capability due to the limited wiring available at the center-line station.

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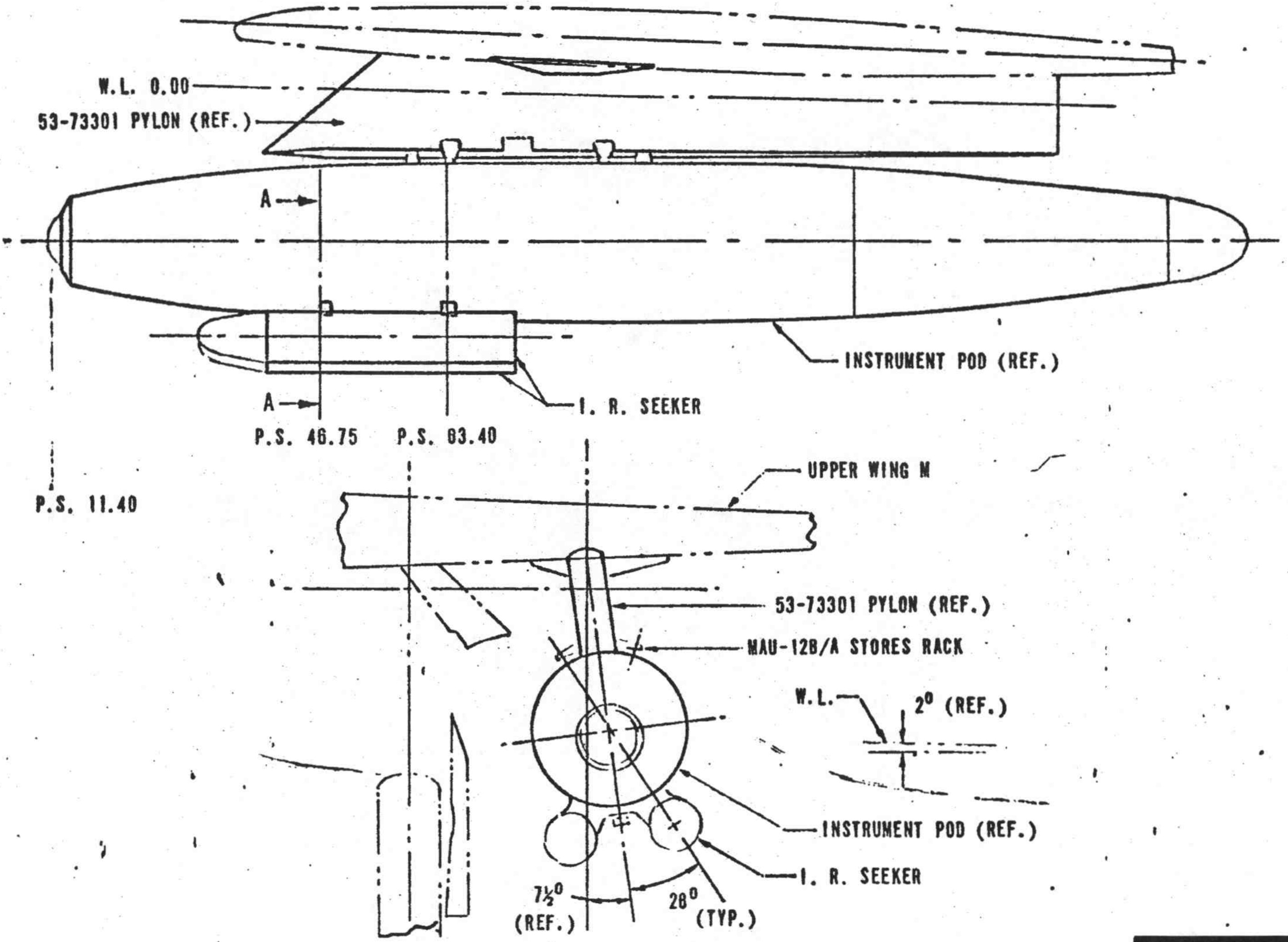

Figure 8. Outline Drawing (U)

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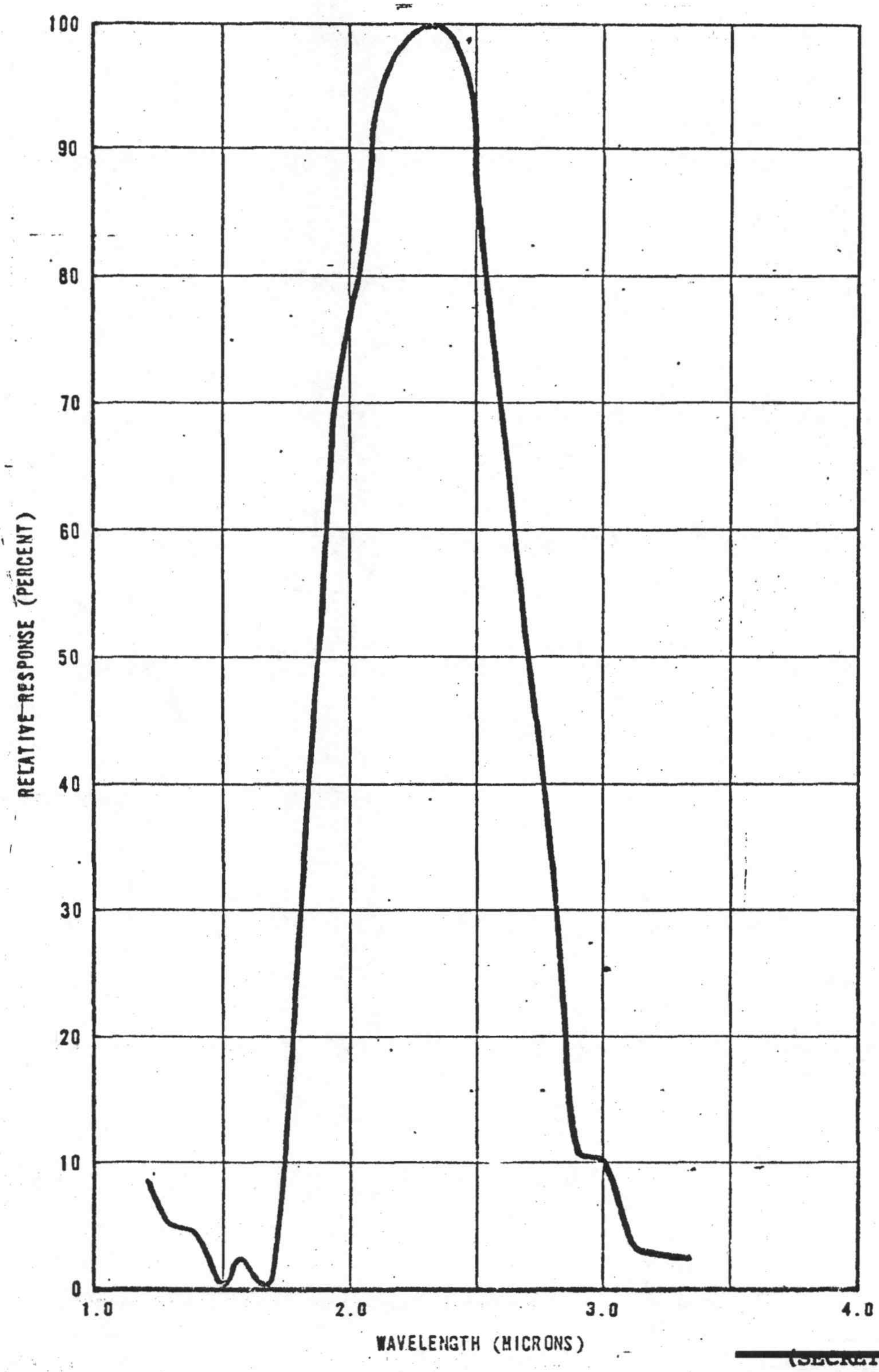

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Figure 9. Short Wavelength Spectral Response (U)

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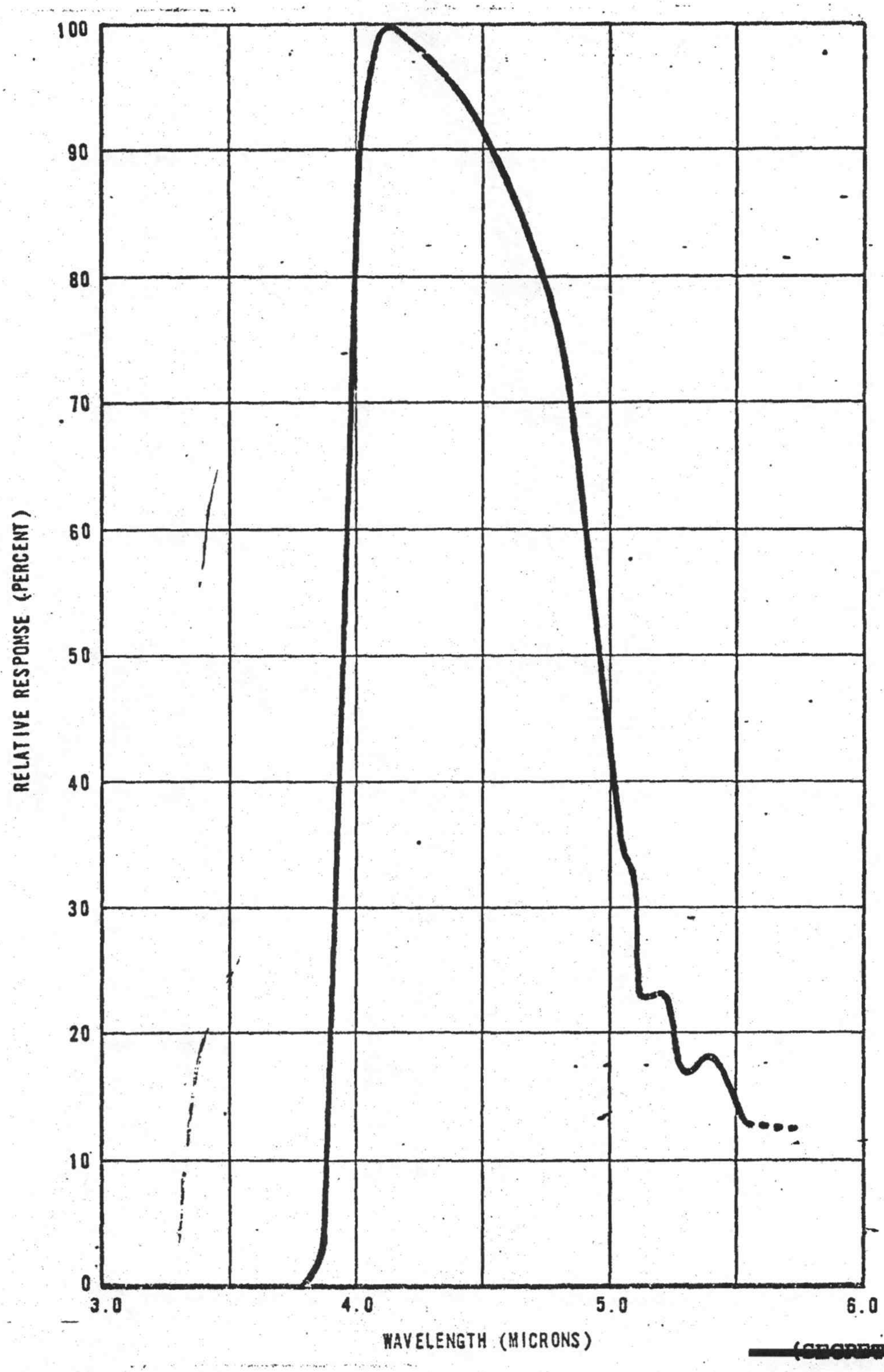

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Figure 10. Long Wavelength Spectral Response (U)

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Table IX. Optical Parameters (U)

| | |
|---|---|
| Dome: | Material - sapphire - concentric<br>Outside radius - 3.700 inches<br>Inside radius - 3.500 inches<br>Diameter - 6.00 inches |
| Tracking Mirror: | Material - front surface, flat mirror, aluminized Kanigen overcoated aluminum substrate |
| Camera: | Traid KB-3A - 75mm EFL |
| Objective Lens: | Material - silicon<br>Diameter - 2.000 inch clear aperture<br>Focal length - nominal 7.000 inches<br>Spectral band - 1.8 to 5.0 microns<br>Field-of-view and resolution - 3 degrees nominal, 1 milliradian resolution |
| Nutation Mirror: | Material - front surface, flat mirror, aluminized Kanigen overcoated aluminum substrate<br>Nutation angle (optical) - $\frac{1}{2}$ degree diameter<br>Nutation rate - 200 revolutions per second |
| Dichroic Mirror: | Transmission band - PbSe<br>Reflection band - PbS |
| Scan Reticle: | Field-of-view (each channel)<br>Angular - 3 degrees x $3\frac{1}{2}$ degrees<br>Shape - canted pie-section<br>Format - single bar/frame<br>Bar height (elevation) - 3 degrees<br>Bar width (azimuth) - $\frac{1}{2}$ degree<br>Scan rate - 1 frame per 180 msec |
| Condenser Lens: | Material - silicon<br>Effective geometric speed - f/1.0<br>Detector size - .160 in. x .160 in. |
| Sensitivity: | LWL - $1.0 \times 10^{-9}$ w/cm$^2$ effective<br>SWL - $2.0 \times 10^{-10}$ w/cm$^2$ effective |

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Table X. Recording Format and Subcarrier Oscillator Composite (U)

| Track No. | Item |
|---|---|
| 1 | Voice and camera shutter pulse |
| 2 | Long wavelength radiometer X10 |
| 3 | Short wavelength radiometer X10 |
| 4 | Long wavelength radiometer |
| 5 | Short wavelength radiometer |
| 6 | Subcarrier oscillator composite (listed below) |
| 7 | |

| Channel No. | Item |
|---|---|
| 3 | Operation mode (off, standby, calibrate, command, auto track) |
| 4 | Missile calibrate lamp voltage |
| 5 | Sidewinder caging coil |
| 6 | Sidewinder 70-cycle reference |
| 7 | Falcon elevation angle |
| 8 | Radar range voltage |
| 9 | Falcon azimuth angle |
| 10 | Radiometer calibrate lamp voltage |
| 11 | Radiometer elevation position |
| 12 | Radiometer azimuth position |
| 13 | Falcon video |
| A | Sidewinder video |
| C | Short wavelength radiometer signal |
| E | Long wavelength radiometer signal |

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7. (U) The center-line installation imposed several limitations on the system. Radar range and radar slaving of the servo-controlled radiometer and movie camera optics were not available. The servo-controlled optics were clamped in the boresight position and radiometric data was only obtained when the target was held within 1.5 degrees of the measuring aircraft gunsight. Most of the other pod functions were available with limited control and monitoring.

8. ~~(S)~~ For this test program the pod carried two Sidewinder type missiles. The port missile (No. 1) was a Russian ATOLL, HAVE CARGO Serial #1, while the starboard missile (No. 2) was a standard AIM-9B. The video and caging coil voltage of each missile was recorded for evaluation of the decoy effectiveness of the test item on each missile.

## SECTION IV

## CALIBRATION

1. (U) The two guidance-and-control units were tested before and after this test program by WRAMA at Robins AFB, Georgia, to ascertain that they were operating within specification. The more pertinent functions tested were sensitivity, track rate and gyro spin rate. Comparative engineering data supplied by WRAMA is given in Table XI.

2. ~~(S)~~ In order to measure the modulated signal generated by the test item, the AIDES radiometer was subjected to an extensive pulse response calibration. A chopper wheel was designed to simulate the pulse width and repetition rate of the QRC-399 program. The radiometer response to a modulated source (J) in the presence of a CW source (S) was calibrated over the full dynamic range of each. Figure 11 illustrates the manner in which CW and modulated signals are processed by the nutation/reticle system of the radiometer. During the time that the nutation circle is passing over the open portion of the reticle, the system is capable of operating as a modulation radiometer. That portion of the signal train where the $\frac{1}{2}^{\circ}$ nutation circle is completely within the $\frac{1}{2}^{\circ}$ reticle is used to obtain the "J" measurement. The "S" measurement is the peak-peak measurement of the sinusoidal waveform produced by the 200 Hz nutation.

3. ~~(S)~~ The output was taken directly from the detector preamplifiers for recording on wideband FM channels of the tape recorder. This provided good reproduction of the actual detector response to the modulated signal. For data reduction, the radiometer signals were stripped out on a Model 650 direct write Sanborn recorder equipped with linearized 5 KHz galvanometers.

4. (U) An in-flight system is used for calibration during missions. An internal radiation source in the radiometer is directed into the system with a flip-up mirror during the calibration mode. The calibration sequence unit in the tape recorder compartment allows the system calibration to be completely automatic. A two-point voltage calibration is applied to the tape recorder during the first 10-second period, 5 seconds for each voltage level. Infrared signals from the internal calibration source are recorded during the last 10-second period of the automatic calibration sequence.

Table XI. Missile Characteristics (U)

| TEST | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Filament Current (Amps) | 1.25 | | | | 1.3 | | | |
| PA $B^+$ (m.a.) | 98 | | | | 110 | | | |
| Gyro Speed (cps) | 70.06 | | | | 69.8 | | | |
| MAX. TRACK RATES: | R | L | U | D | R | L | U | D |
| PLA (deg/sec) | 12.5 | 12.2 | 12.2 | 11.2 | 6.2 | 6.6 | 6.5 | 6.5 |
| PL1 (deg/sec) | 12.4 | 12.0 | 12.4 | 11.8 | 9.2 | 9.0 | 9.0 | 9.5 |
| PL3 (deg/sec) | 12.8 | 12.4 | 12.6 | 12.3 | 10.4 | 10.0 | 10.3 | 0.4 |
| | PLA | PL1 | PL3 | | PLA | PL1 | PL3 | |
| DCN (Volts) | .93 | .93 | .93 | | 1.15 | 1.15 | 1.15 | |
| PI Max (Volts) | 2.65 | 3.0 | 4.3 | | 4.2 | 5.0 | 6.0 | |
| S/N | 2.85 | 3.23 | 4.62 | | 3.65 | 4.35 | 5.22 | |
| | R | L | U | D | R | L | U | D |
| 15° Off Axis/Track Rates for PL1 (Deg/sec) | 5.2 | 5.7 | - | - | 3.8 | 3.5 | 4.2 | 3.6 |

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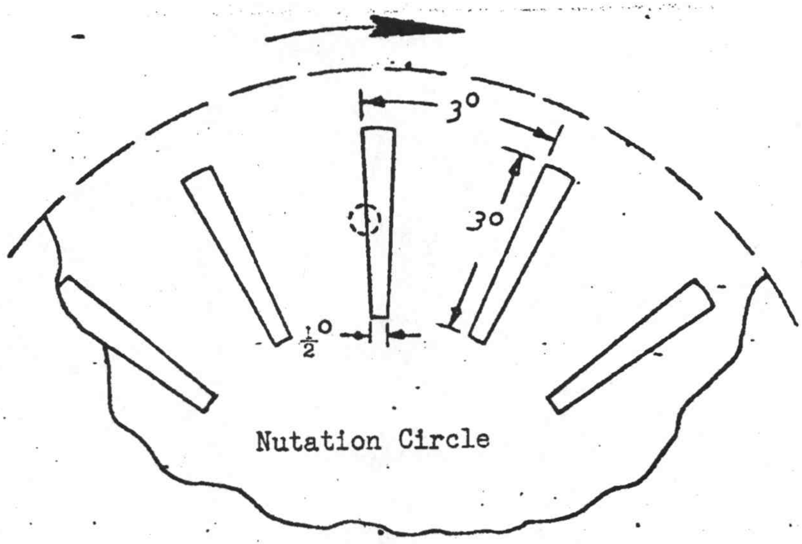
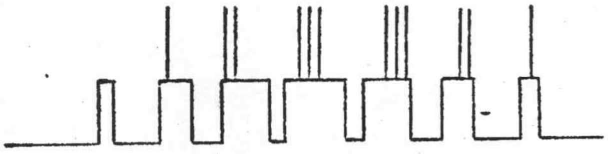
NOTE: PLA = System Gain Power Level "A"
PL1 = System Gain Power Level 1
PL3 = System Gain Power Level 3
DCN = Dark Cell Noise
PI Max = Pilot's Intercom Maximum
S/N = Signal to Noise Ratio

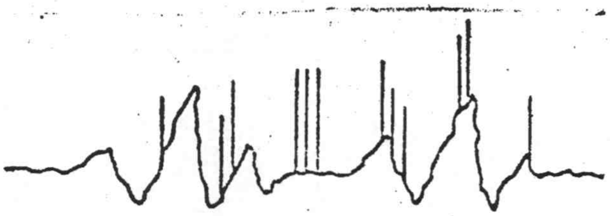


Nutation/reticle geometry

Jammer pulse train



Signal produced by jammer pulses in the presence of an ideal point source target.



Actual radiometer output signal produced by jammer and target of finite size.

**Figure 11. Radiometer CW and Modulated Signal Response (U)**
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Table XXII. Mission No. 3006, Project 4700Y086, 21 January 1970 (U) (Cont)

| | | | | MISSILE NO. 1 Td (Sec) | | | | MISSILE NO. 2 Td (Sec) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 8-2 | 20,000 | .6 | 14.0 | 3.4 | 3.4 | - | - | NL | NL | MIL |
| 8-3 | 18,400 | 2.3 | 13.1 | 1.5 | 1.5 | - | - | NL | NL | MIL |
| 8-4 | 17,300 | 2.2 | 11.2 | 2.5 | 2.5 | - | - | NL | NL | MIL |
| 8-5 | 15,500 | 2.3 | 9.0 | 2.9 | 2.9 | - | - | NL | NL | MIL |
| 8-6 | 11,100 | 1.8 | 5.0 | 4.8 | 4.8 | 1.0 | 3.9 | 14.2 | 14.2 | MIL |
| 9-1 | 23,200 | 3.2 | 24.2 | 1.5 | 1.5 | - | - | 9.9 | 9.9 | MIL |
| 9-2 | - | - | - | .5 | .5 | - | - | 5.1 | 5.1 | MIL |
| 9-3 | - | - | - | 3.7 | 6.2 | - | - | 4.1 | 4.1 | MIL |
| 10-0 | No Data | | | | | | | | | |
| 11-0 | No Data | | | | | | | | | |

NL - No Lock-on

Table XXIII. Mission No. 2008, Project 4700Y086, 3 February 1970 (U)

| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | MISSILE NO. 1 $T_d$ (Sec) Min. | MISSILE NO. 1 $T_d$ (Sec) Max. | AZ (Deg) | EL (Deg) | MISSILE NO. 2 $T_d$ (Sec) Min. | MISSILE NO. 2 $T_d$ (Sec) Max. | B-66 Power |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 13,000 | -16.0 | 20.0 | 1.3 | 1.3 | -16.0 | 20.0 | .3 | .3 | CRU |
| 1-2 | 12,200 | -16.7 | 11.0 | .3 | .3 | -16.7 | 11.0 | .5 | .5 | CRU |
| 2-1 | 11,750 | 14.7 | 13.9 | 1.4 | 1.4 | 14.7 | 13.9 | H.G. | H.G. | MIL |
| 2-2 | 11,900 | 15.7 | 10.5 | 1.1 | 2.1 | 15.7 | 10.5 | *1.6 | *1.6 | MIL |
| 2-3 | 12,600 | 17.0 | 6.5 | 1.1 | 1.1 | 17.0 | 6.5 | .3 | .3 | MIL |
| 2-4 | 12,700 | 17.5 | 5.5 | 1.7 | *4.9 | 17.5 | 5.5 | 1.0 | *4.9 | MIL |
| 2-5 | 12,900 | 17.6 | 5.1 | 1.1 | 1.1 | 17.6 | 5.1 | .3 | 5.3 | MIL |
| 2-6 | 13,000 | 18.0 | 5.0 | 1.2 | 1.2 | 18.0 | 5.0 | 1.6 | *5.4 | MIL |
| 2-7 | 12,900 | 18.3 | 4.9 | 1.7 | 1.7 | 18.3 | 4.9 | .9 | .9 | MIL |
| 2-8 | 12,700 | 18.0 | 4.1 | .8 | .8 | 18.0 | 4.1 | 5.2 | 7.2 | MIL |
| 2-9 | 12,400 | 17.3 | 4.3 | 1.5 | 1.5 | 17.3 | 4.3 | .8 | 7.8 | MIL |
| 3-1 | 17,000 | -57.4 | 30.6 | H.G. | H.G. | -57.4 | 30.6 | H.G. | H.G. | CRU |
| 3-2 | 7,100 | -26.8 | 25.0 | .5 | .5 | -26.8 | 25.0 | 1.7 | 1.7 | CRU |
| 3-3 | 11,500 | -24.3 | 10.9 | 1.9 | *2.8 | -24.3 | 10.9 | .2 | 1.5 | CRU |
| 3-4 | 11,500 | -20.9 | 9.2 | 1.0 | 1.0 | -20.9 | 9.2 | .3 | *2.4 | CRU |
| 3-5 | 11,600 | -16.7 | 7.5 | 1.6 | 1.6 | -16.7 | 7.5 | 1.0 | 3.9 | CRU |
| 3-6 | 11,600 | -13.8 | 6.6 | 1.5 | 1.5 | -13.8 | 6.6 | .5 | *6.6 | CRU |
| 3-7 | - | NT | NT | *3.2 | *3.2 | NT | NT | .3 | H.G. | CRU |
| 3-8 | - | NT | NT | .7 | .7 | NT | NT | .3 | H.G. | CRU |
| 3-9 | - | NT | NT | 1.0 | 1.0 | NT | NT | .3 | H.G. | CRU |
| 3-10 | - | NT | NT | .35 | .35 | NT | NT | .5 | H.G. | CRU |
| 3-11 | 10,500 | -18.0 | 5 | .8 | .8 | -18.0 | 5.0 | .8 | 2.9 | CRU |
| 3-12 | 10,500 | -18.0 | 5 | .6 | .6 | -18.0 | 5.0 | .5 | *3.7 | CRU |
| 3-13 | 10,500 | 17.0 | 5 | 1.4 | 1.4 | 17.0 | 5.0 | .7 | 1.7 | CRU |

NT - No Test

Table XXIII. Mission No. 2008, Project 4700Y086, 3 February 1970 (U) (Cont)

| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | MISSILE NO. 1 $T_d$ (Sec) Min. | Max. | AZ (Deg) | EL (Deg) | MISSILE No. 2 $T_d$ (Sec) Min. | Max. | B-66 Power |
|---|---|---|---|---|---|---|---|---|---|---|
| 3-14 | 10,000 | 17.7 | 4.9 | 1.0 | 1.0 | 17.7 | 4.9 | .2 | .2 | CRU |
| 3-15 | 9,600 | -18.4 | 4.8 | .7 | .7 | 18.4 | 4.8 | 1.0 | 1.0 | CRU |
| 4-1 | 10,100 | -42.2 | 26.9 | .4 | .4 | -42.5 | 26.9 | 1.7 | 2.5 | MIL |
| 4-2 | 10,500 | -29.5 | 17.9 | .4 | .4 | -29.5 | 17.9 | .6 | .6 | MIL |
| 4-3 | 11,500 | -23.6 | 13.5 | 1.8 | 1.8 | -23.6 | 13.5 | *13.3 | *13.3 | MIL |
| 4-4 | 14,400 | -19.3 | 10.0 | 1.6 | 1.6 | -19.3 | 10.0 | * 4.6 | * 4.6 | MIL |
| 4-5 | 15,700 | -18.3 | 9.4 | *3.8 | *3.8 | -18.3 | 9.4 | * 3.8 | * 3.8 | MIL |
| 4-6 | 16,800 | -18.0 | 8.9 | 1.0 | 1.0 | -18.0 | 8.9 | 10.6 | 11.5 | MIL |
| 4-7 | 16,800 | -18.0 | 8.9 | .3 | .3 | -18.0 | 8.9 | 4.1 | 4.1 | MIL |
| 4-8 | 16,800 | -18.0 | 8.9 | *4.0 | *4.0 | -18.0 | 8.9 | * 4.0 | * 4.0 | MIL |
| 4-9 | 16,800 | -18.0 | 8.9 | *4.6 | *4.6 | -18.0 | 8.9 | * 4.6 | * 4.6 | MIL |
| 4-10 | 23,800 | -17.0 | 7.4 | *4.3 | *4.3 | -17.0 | 7.4 | * 4.3 | * 4.3 | MIL |
| 5-1 | 12,700 | -59.0 | 19.3 | 1.1 | 1.1 | -59.0 | 19.3 | H.G. | .3 | CRU |
| 5-2 | 11,000 | -38.0 | 13.6 | 1.2 | 1.2 | -38.0 | 13.6 | H.G. | .3 | CRU |
| 5-3 | 10.700 | -33.6 | 11.5 | 1.0 | 1.0 | -33.6 | 11.5 | 1.4 | 1.4 | CRU |
| 5-4 | 10,600 | -27.5 | 8.9 | 1.1 | 1.1 | -27.6 | 8.9 | 1.4 | * 2.8 | CRU |
| 5-5 | 10,500 | -24.0 | 7.0 | 1.0 | 1.0 | -24.0 | 7.0 | .9 | 1.9 | CRU |
| 5-6 | 10,600 | -22.3 | 5.9 | .3 | .3 | -22.3 | 5.9 | .5 | 4.4 | CRU |
| 5-7 | 10,500 | -20.0 | 5.1 | .3 | .3 | -20.0 | 5.1 | .6 | * 3.4 | CRU |
| 5-8 | 10,500 | -19.0 | 4.9 | 1.2 | 1.2 | -19.0 | 4.9 | .5 | 1.3 | CRU |
| 5-9 | 10,100 | -19.2 | 4.8 | 1.1 | 1.1 | -19.2 | 4.8 | .2 | 2.9 | CRU |
| 5-10 | - | - | - | 1.0 | 1.0 | - | - | 1.2 | 3.2 | CRU |
| 6-1 | 10,400 | 55.6 | 21.2 | H.G. | .7 | 55.6 | 21.2 | H.G. | H.G. | MIL |
| 6-2 | 9,700 | 32.2 | 13.0 | *2.1 | *2.1 | 32.2 | 13.0 | H.G. | H.G. | MIL |

Table XXIII. Mission No. 2008, Project 4700Y086, 3 February 1970 (U) (Cont)

|  |  | MISSILE NO. 1 |  |  |  | MISSILE NO. 2 |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | $T_d$ (Sec) |  |  |  | $T_d$ (Sec) |  |  |
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 6-3 | 10,000 | 26.0 | 9.6 | 1.4 | 1.4 | 26.0 | 9.6 | 6.7 | 6.7 | MIL |
| 6-4 | 10,600 | 21.7 | 7.1 | 1.2 | 1.2 | 21.7 | 7.1 | 2.7 | 3.7 | MIL |
| 6-5 | 11,300 | 19.6 | 6.2 | 1.5 | 1.5 | 19.6 | 6.2 | 1.8 | 8.0 | MIL |
| 6-6 | 12,300 | 18.0 | 5.3 | 2.7 | 5.7 | 18.0 | 5.3 | 5.1 | *6.5 | MIL |
| 6-7 | 12,700 | 18.0 | 4.9 | *2.8 | *2.8 | 18.0 | 4.9 | 1.4 | 1.4 | MIL |
| 6-8 | 12,800 | 17.9 | 4.8 | 1.3 | 2.3 | 17.9 | 4.8 | .7 | *3.6 | MIL |
| 6-9 | 13,000 | 18.2 | 4.5 | 2.7 | 2.7 | 18.2 | 4.5 | .4 | .4 | MIL |
| 6-10 | 13,000 | 18.2 | 4.2 | 1.9 | *2.2 | 18.2 | 4.2 | .3 | .3 | MIL |
| 6-11 | 13,000 | 18.0 | 4.0 | .9 | .9 | 18.0 | 4.0 | .1 | *5.0 | MIL |
| 6-12 | 12,800 | 17.3 | 4.3 | .4 | .4 | 17.3 | 4.3 | .5 | .5 | MIL |
| 6-13 | 12,600 | 17.6 | 1.4 | 1.4 | 1.4 | 17.6 | 4.1 | 3.4 | 6.4 | MIL |
| 6-14 | 12,300 | 17.4 | 4.0 | .7 | 1.6 | 17.4 | 4.0 | 1.0 | *3.8 | MIL |
| 6-15 | 11,600 | 17.4 | 3.7 | .7 | 2.7 | 17.4 | 3.7 | *3.9 | *3.9 | MIL |
| 7-1 | 14,500 | -38.4 | 17.2 | H.G. | .7 | -38.4 | 17.2 | .2 | .2 | MIL |
| 7-2 | 13,800 | -34.7 | 14.8 | H.G. | .2 | -34.7 | 14.8 | 4.2 | 5.2 | MIL |
| 7-3 | 12,500 | -26.4 | 8.5 | 1.9 | 6.0 | -26.4 | 8.5 | *11.6 | *11.6 | MIL |
| 7-4 | 11,800 | -22.8 | 5.3 | 1.6 | 1.6 | -22.8 | 5.3 | 3.0 | *8.0 | MIL |
| 7-5 | 11,500 | -20.6 | 3.9 | 1.6 | 2.6 | -20.6 | 3.9 | .4 | 10.0 | MIL |
| 7-6 | 11,200 | -19.9 | 3.6 | 1.1 | 1.1 | -19.9 | 3.6 | .3 | 7.5 | MIL |
| 7-7 | 10,800 | -20.4 | 3.6 | .7 | 2.7 | -20.4 | 3.6 | 1.1 | 10.2 | MIL |
| 7-8 | 10,100 | -20.2 | 3.6 | H.G. | .5 | -20.2 | 3.6 | .6 | .6 | MIL |
| 7-9 | 9,800 | -19.5 | 3.4 | 1.0 | 1.0 | -19.5 | 3.4 | .3 | 6.3 | MIL |
| 7-10 | 9,300 | -19.4 | 3.2 | .6 | *4.9 | -19.4 | 3.2 | .9 | *4.9 | MIL |
| 7-11 | 8,900 | -19.4 | 3.0 | .8 | .8 | -19.4 | 3.0 | 1.0 | *4.8 | MIL |

Table XXIII. Mission No. 2008, Project 4700Y086, 3 February 1970 (U) (Cont)

| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | MISSILE NO. 1 $T_d$ (Sec) Min. | Max. | AZ (Deg) | EL (Deg) | MISSILE NO. 2 $T_d$ (Sec) Min. | Max. | B-66 Power |
|---|---|---|---|---|---|---|---|---|---|---|
| 8-1 | 8,500 | -32.7 | 14.3 | 1.3 | 1.3 | -32.7 | 14.3 | .7 | .7 | MIL |
| 8-2 | 8,300 | -27.0 | 9.6 | 3.6 | *6.0 | -27.0 | 9.6 | *6.0 | *6.0 | MIL |
| 8-3 | 8,400 | -23.4 | 6.3 | 1.8 | *6.0 | -23.4 | 6.3 | 3.2 | *6.0 | MIL |
| 8-4 | 8,600 | -21.1 | 4.8 | 1.8 | 1.8 | -21.1 | 4.8 | 1.2 | 2.2 | MIL |
| 8-5 | 8,800 | -19.8 | 4.7 | 1.2 | 1.2 | -19.8 | 4.7 | 3.6 | 5.6 | MIL |
| 8-6 | 8,900 | -19.3 | 4.4 | 1.9 | 1.9 | -19.3 | 4.4 | .2 | .2 | MIL |
| 8-7 | 9,200 | -19.6 | 4.6 | *8.7 | *8.7 | -19.6 | 4-6 | - | - | MIL |
| 8-8 | 9,300 | -19.2 | 4.3 | 1.2 | 1.2 | -19.2 | 4.3 | - | - | MIL |
| 8-9 | 9,600 | -18.6 | 3.8 | 1.8 | 4.8 | -18.6 | 3.8 | - | - | MIL |
| 9-1 | - | - | - | 2.0 | 2.0 | - | - | *7.0 | *7.0 | MIL |
| 9-2 | - | - | - | 3.5 | 3.5 | - | - | .8 | *6.6 | MIL |

~~(SECRET)~~

Table XXIV. Mission No. 5008, Project 4700Y086, 20 February 1970 (U)

| | | | | MISSILE NO. 1<br>$T_d$ (Sec) | | | | MISSILE NO. 2<br>$T_d$ (Sec) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 1-1 | 16,800 | - 2.6 | 4.0 | 3.7 | 3.7 | - 2.7 | 3.9 | *6.9 | *6.9 | CRU |
| 1-2 | 15,700 | - 2.5 | 2.9 | .3 | 4.4 | - 2.6 | 3.2 | .7 | .7 | CRU |
| 1-3 | 11,600 | - 2.4 | 2.1 | 2.2 | 2.2 | - 2.5 | 2.0 | 5.8 | 5.8 | CRU |
| 1-4 | 9,100 | - 2.3 | 1.2 | .8 | 1.9 | - 2.3 | 1.4 | .7 | .7 | CRU |
| 1-5 | 6,300 | - 2.6 | 1.1 | .5 | .5 | - 2.6 | 1.4 | *5.8 | *5.8 | CRU |
| 4-1 | 13,400 | 4.7 | - 2.7 | 2.8 | 2.8 | 4.7 | - 2.7 | 2.1 | 2.1 | MIL |
| 4-2 | 14,600 | 7.5 | - 3.5 | 1.7 | 1.7 | 7.5 | - 3.5 | *3.0 | *3.0 | MIL |
| 6-1 | 17,600 | 39.9 | 13.9 | .6 | .6 | - | - | H.G. | H.G. | CRU |
| 6-2 | - | - | - | H.G. | H.G. | - | - | H.G. | H.G. | CRU |
| 6-3 | - | - | - | H.G. | H.G. | - | - | H.G. | H.G. | CRU |
| 6-4 | 13,300 | 26.8 | 3.9 | .3 | .3 | - | - | H.G. | H.G. | CRU |
| 7-1 | 16,600 | - 6.5 | 2.0 | *1.6 | *1.6 | - 6.5 | 2.0 | *1.6 | *1.6 | CRU |
| 7-2 | 16,300 | - 1.5 | .66 | 1.0 | 1.0 | - .33 | - .36 | 2.2 | 2.2 | CRU |
| 7-3 | 15,800 | 5.5 | - 1.1 | *2.0 | *2.0 | 3.7 | - .64 | .3 | .3 | CRU |
| 7-4 | 15,200 | 10.1 | - 2.2 | *1.5 | *1.5 | 9.4 | - 2.0 | .7 | .7 | CRU |
| 7-5 | 14,900 | 11.6 | - 2.6 | .3 | - | - | - | NT | NT | CRU |
| 8-1 | 21,600 | -28.8 | - 8.8 | *1.7 | *1.7 | -28.8 | - 8.8 | .7 | *1.7 | CRU |
| 8-2 | 19,900 | -29.2 | - 8.2 | *2.4 | *2.4 | -29.5 | - 8.4 | .2 | 1.2 | CRU |
| 8-3 | 18,400 | -28.4 | - 7.9 | 1.6 | 1.6 | -28.2 | - 7.8 | .7 | 2.7 | CRU |
| 8-4 | 16,400 | -26.3 | - 7.3 | .3 | .3 | -26.0 | - 7.3 | .8 | .8 | CRU |
| 8-5 | 14,600 | -23.7 | - 6.4 | .8 | .8 | -23.3 | - 6.3 | 1.0 | 1.0 | CRU |
| 8-6 | 12,000 | -18.7 | - 5.1 | 1.0 | 1.0 | -18.7 | - 5.1 | 1.2 | 1.2 | CRU |
| 8-7 | 10,200 | -15.8 | - 4.2 | 1.0 | 1.0 | -15.8 | - 4.2 | 0.2 | 1.5 | CRU |
| 8-8 | 7,800 | -10.8 | - 2.8 | 1.0 | 1.0 | -10.4 | - 2.6 | 1.1 | *2.5 | CRU |
| 10-1 | 10,400 | .13 | .25 | 1.0 | 1.0 | - | - | H.G. | H.G. | MIL |

NT - No Test

Table XXIV. Mission No. 5008, Project 4700Y086, 20 February 1970 (U) (Cont)

| | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $T_d$ (Sec) | | | | $T_d$ (Sec) | | |
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 10-2 | 10,000 | - 4.5 | - 1.0 | .3 | .3 | - 7.7 | - .60 | 3.6 | *6.2 | MIL |
| 12-1 | 16,900 | -28.8 | -10.9 | .5 | .5 | -28.8 | -10.9 | .7 | .7 | CRU |
| 12-2 | 16,100 | -26.8 | - 9.9 | .1 | 1.1 | -25.8 | - 9.3 | 2.2 | 2.2 | CRU |
| 12-3 | 15,200 | -23.5 | - 7.9 | .1 | 1.1 | -23.9 | - 8.2 | .3 | .3 | CRU |
| 12-4 | 14,500 | -21.7 | - 7.3 | .5 | .5 | -20.6 | - 6.9 | .8 | 3.8 | CRU |
| 12-5 | 13,000 | -18.6 | - 6.0 | 1.5 | 1.5 | -18.9 | - 6.2 | .6 | .6 | CRU |
| 12-6 | 12,000 | -16.4 | - 5.2 | 2.2 | 2.2 | -16.4 | - 5.2 | .3 | 2.8 | CRU |
| 14-1 | - | - | - | - | - | - | - | - | - | MIL |
| 14-2 | - | - | - | - | - | - | - | - | - | MIL |
| 14-3 | - | - | - | - | - | - | - | - | - | MIL |
| 14-4 | - | - | - | .5 | .5 | - | - | - | - | MIL |
| 14-5 | - | - | - | .8 | .8 | - | - | .8 | *3.1 | MIL |
| 14-6 | - | - | - | *1.4 | *1.4 | - | - | .2 | *1.4 | MIL |
| 14-7 | - | - | - | 1.2 | 1.2 | - | - | *2.3 | *2.3 | MIL |
| 14-8 | - | - | - | .7 | .7 | - | - | .1 | .1 | MIL |
| 14-9 | - | - | - | .6 | .6 | - | - | .3 | .3 | MIL |
| 14-10 | - | - | - | .5 | .5 | - | - | NT | NT | MIL |
| 14-11 | - | - | - | *1.4 | *1.4 | - | - | .1 | .1 | MIL |
| 14-12 | - | - | - | 3.4 | 3.4 | - | - | 2.7 | 2.7 | MIL |
| 14-13 | - | - | - | *2.5 | *2.5 | - | - | 1.0 | 1.7 | MIL |
| 14-14 | - | - | - | 3.6 | 3.6 | - | - | 1.8 | 2.5 | MIL |
| 14-15 | - | - | - | .6 | .6 | - | - | 1.8 | 2.5 | MIL |
| 14-16 | - | - | - | *3.6 | *3.6 | - | - | .5 | .5 | MIL |
| 14-17 | - | - | - | 2.0 | 2.0 | - | - | 2.1 | 3.1 | MIL |
| 14-18 | - | - | - | 1.5 | 1.5 | - | - | .2 | 3.6 | MIL |

NT - No Test

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Table XXV. Mission No. 2008, Project 4700Y086, 3 March 1970 (U)

| | | | | MISSILE NO. 1 $T_d$ (Sec) | | | | MISSILE NO. 2 $T_d$ (Sec) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 1-1 | 9,280 | - .80 | 2.9 | .3 | .3 | - .80 | 2.9 | .2 | .2 | MIL |
| 1-2 | 6,820 | - .92 | 3.5 | 1.9 | 1.9 | - 1.2 | 3.9 | 1.1 | *6.5 | MIL |
| 1-3 | 5,215 | 1.3 | 4.4 | 1.7 | 1.7 | - 1.3 | 4.5 | .1 | 3.0 | MIL |
| 2-1 | 13,785 | -37.0 | -16.2 | .8 | .8 | -37.0 | -16.2 | .8 | .8 | MIL |
| 2-2 | 11,060 | -28.2 | -13.1 | .9 | .9 | -29.4 | -13.5 | .6 | .6 | MIL |
| 2-3 | 10.620 | -26.5 | -12.5 | .3 | .3 | -26.5 | -12.5 | .2 | .2 | MIL |
| 2-4 | 9,210 | -20.6 | -10.3 | .3 | 1.3 | -20.6 | -10.3 | .3 | .3 | MIL |
| 2-5 | 7,680 | -17.4 | - 7.3 | 1.5 | 1.5 | -15.2 | - 7.5 | .3 | 1.3 | MIL |
| 3-1 | - | - | - | - | - | - | - | - | - | CRU |
| 3-2 | - | - | - | - | - | - | - | - | - | CRU |
| 3-3 | 12,350 | -27.6 | -14.8 | .2 | .2 | -26.8 | -14.4 | 1.3 | 1.3 | CRU |
| 3-4 | 10,475 | -21.9 | -11.0 | .5 | .5 | -21.9 | -11.0 | .6 | .6 | CRU |
| 3-5 | 9,150 | -17.8 | -10.2 | 3.1 | 1.1 | -18.5 | -10.6 | .3 | .3 | CRU |
| 4-1 | 8.780 | -22.9 | 12.1 | .3 | 2.3 | -25.7 | 12.4 | .5 | .5 | CRU |
| 5-1 | 6,020 | .23 | 7.3 | .8 | *1.2 | .23 | 7.3 | *1.2 | *1.2 | CRU |
| 8-1 | - | - | - | NT | NT | - | - | NT | NT | MIL |
| 8-2 | - | - | - | NT | NT | - | - | NT | NT | MIL |
| 8-3 | 17,980 | - | - | NT | NT | 1.3 | .69 | 2.0 | 2.0 | MIL |
| 8-4 | 16,945 | - | - | NT | NT | .94 | - .02 | 1.3 | 1.3 | MIL |
| 8-5 | 14,950 | .48 | - .15 | 2.3 | 2.3 | .45 | - .05 | 3.0 | 3.0 | MIL |
| 8-6 | 12,545 | .44 | .06 | .7 | .7 | .44 | - .06 | 1.1 | 1.1 | MIL |

NT - No Test

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UNCLASSIFIED

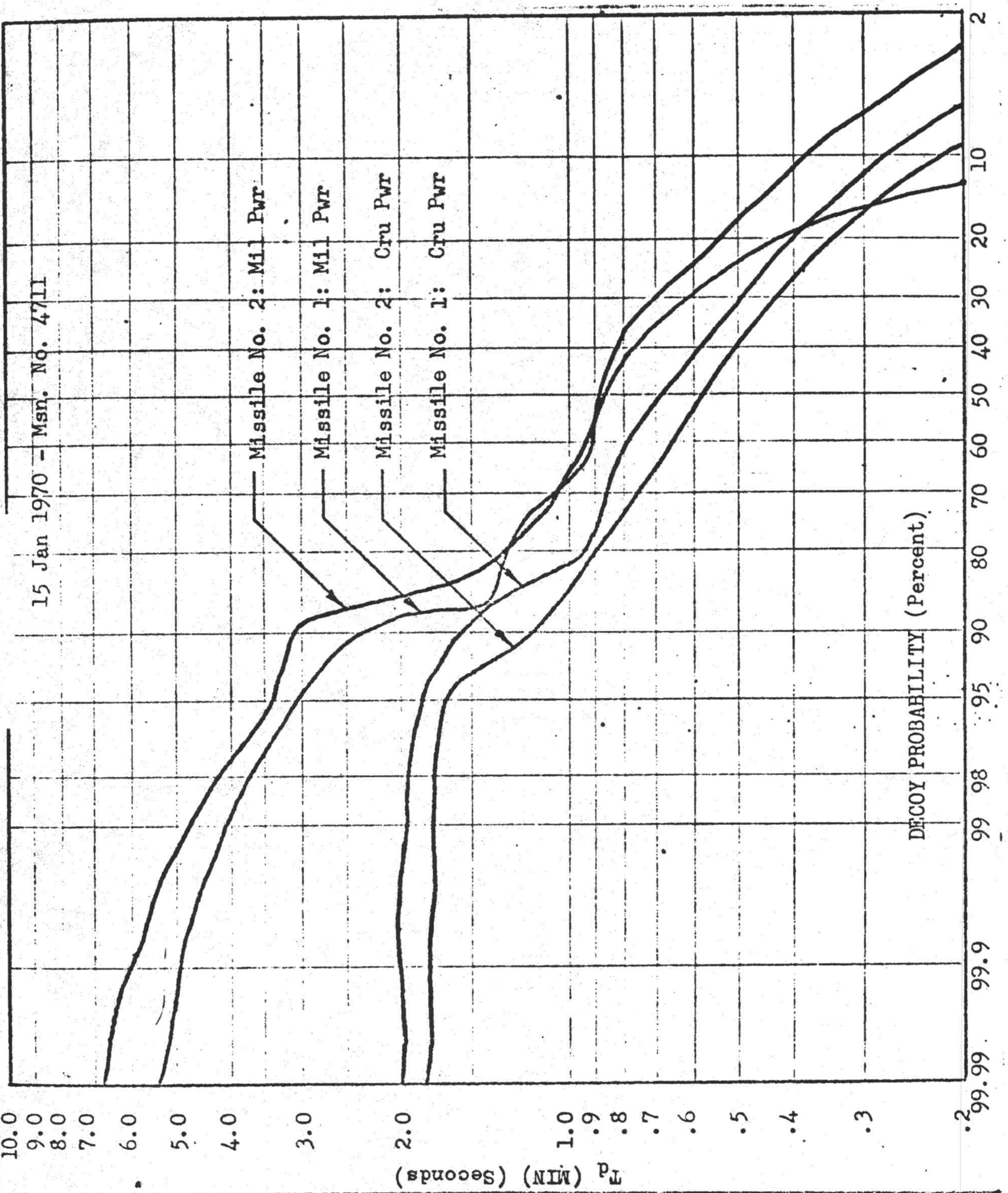

Figure 47. Decoy Probability as a Function of $T_d$(MIN) for Straight Tail Chase (U) ~~(SECRET)~~

~~SECRET~~

UNCLASSIFIED

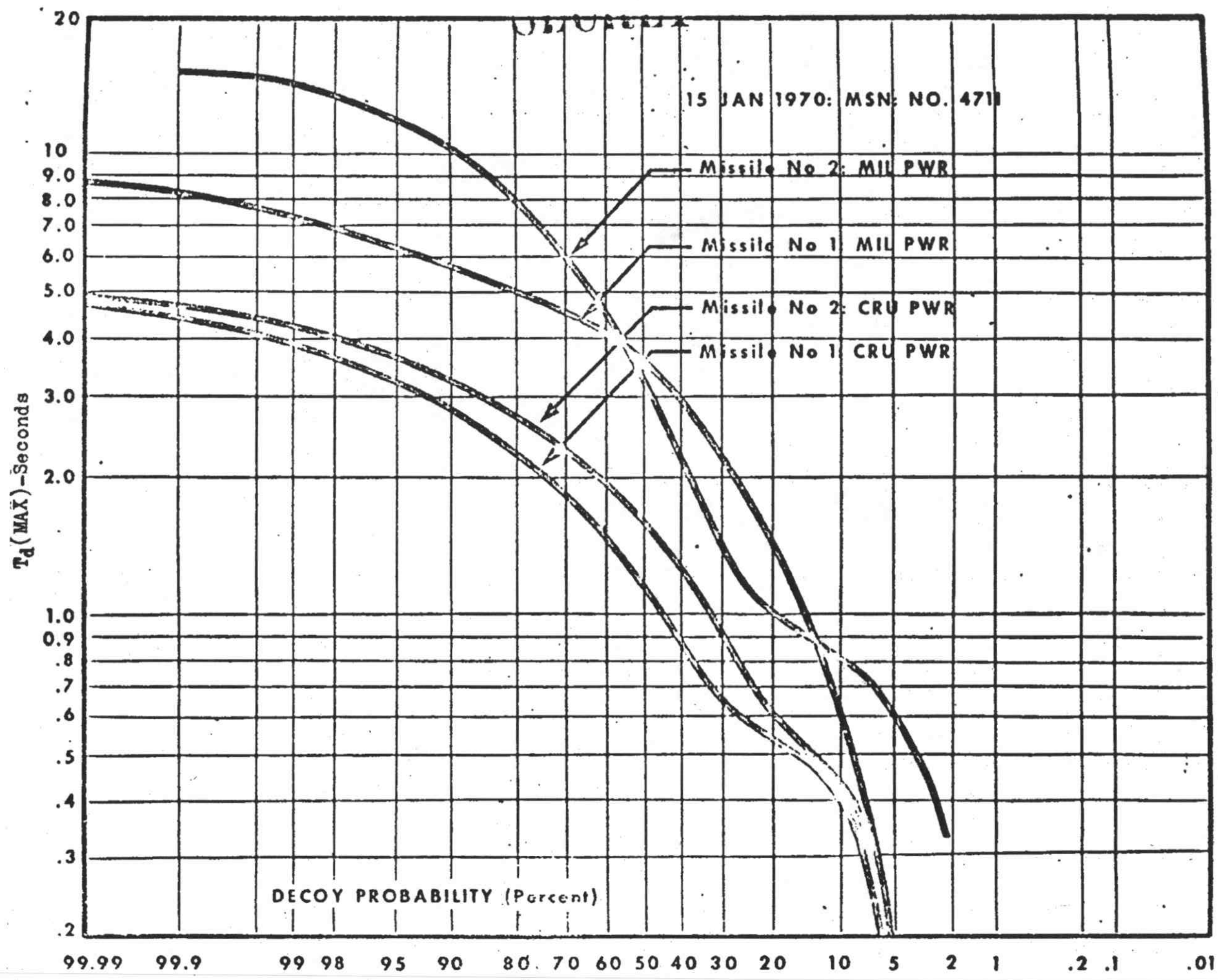

Figure 48. Decoy Probability as a Function of $T_d$(MAX) for Straight Tail Chase (U)

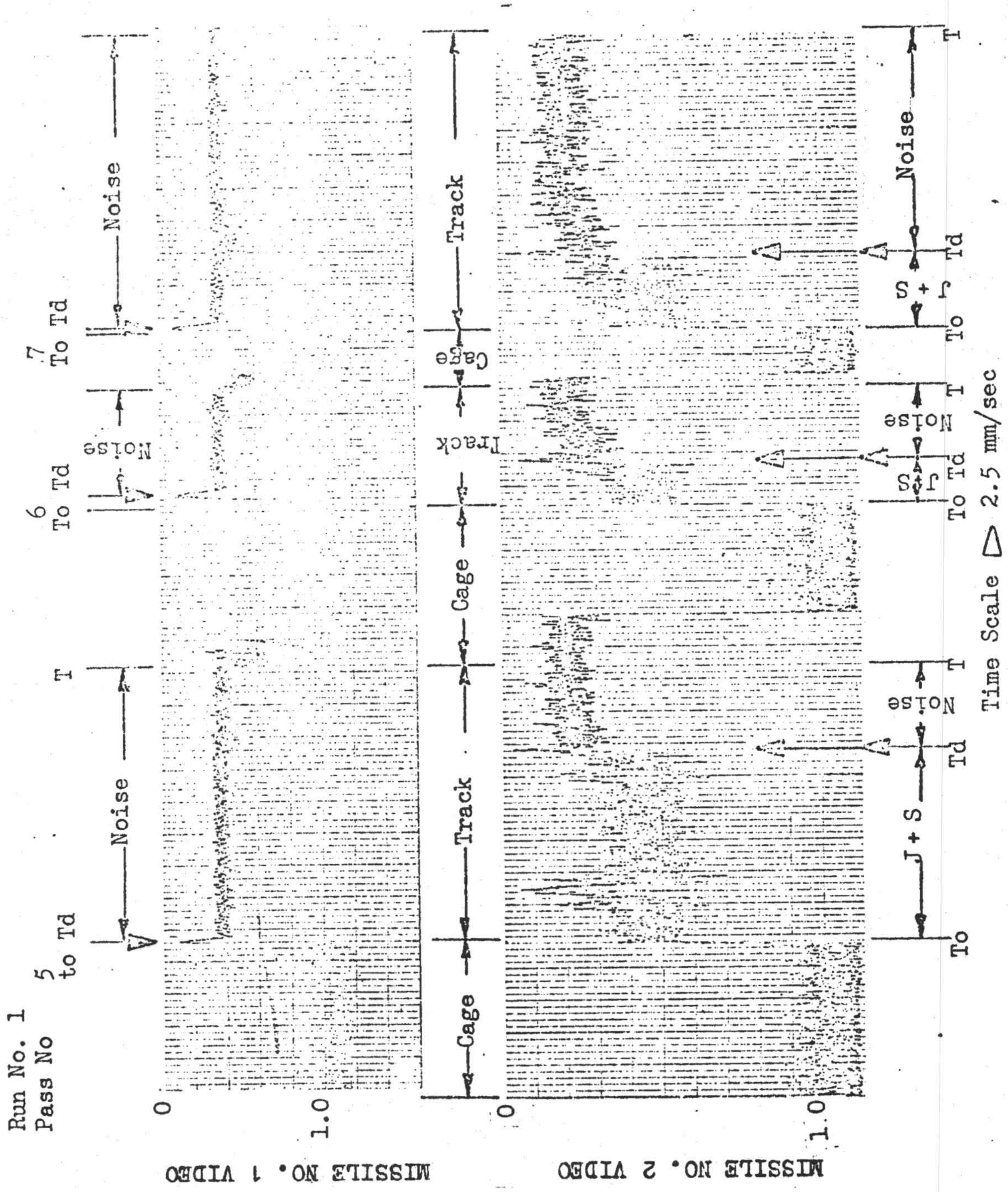

Figure 32. Mission No. 3011-B, Run 1, Pass 5, 6 & 7; Cruise Power (U)
~~(SECRET)~~

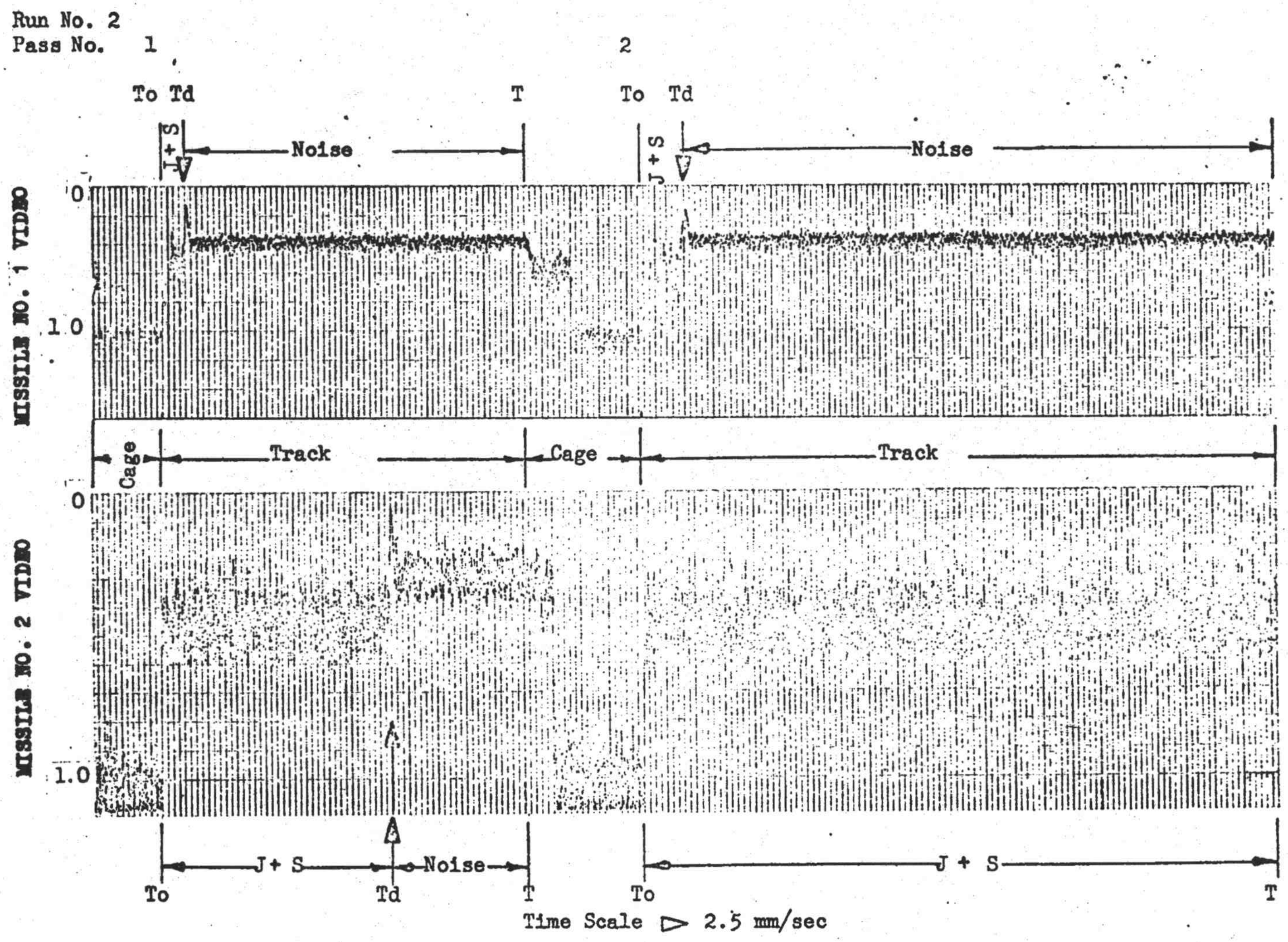

Figure 33. Mission No. 3011-B; Run 2, Pass 1 & 2; Military Power (U)
[redacted]

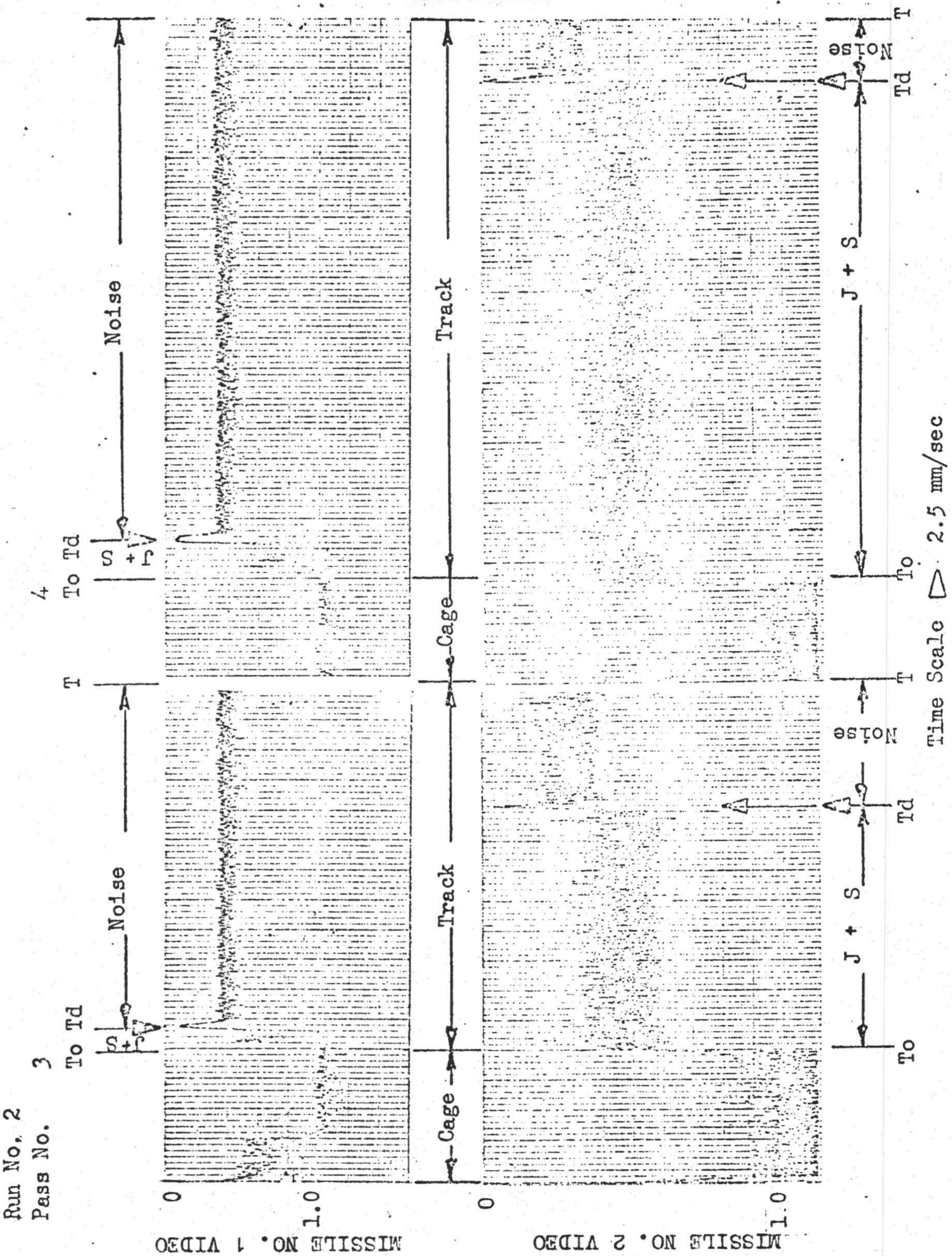

Figure 34. Mission No. 3011-B; Run 2, Pass 3 & 4; Military Power (U) ~~(SECRET)~~

~~SECRET~~

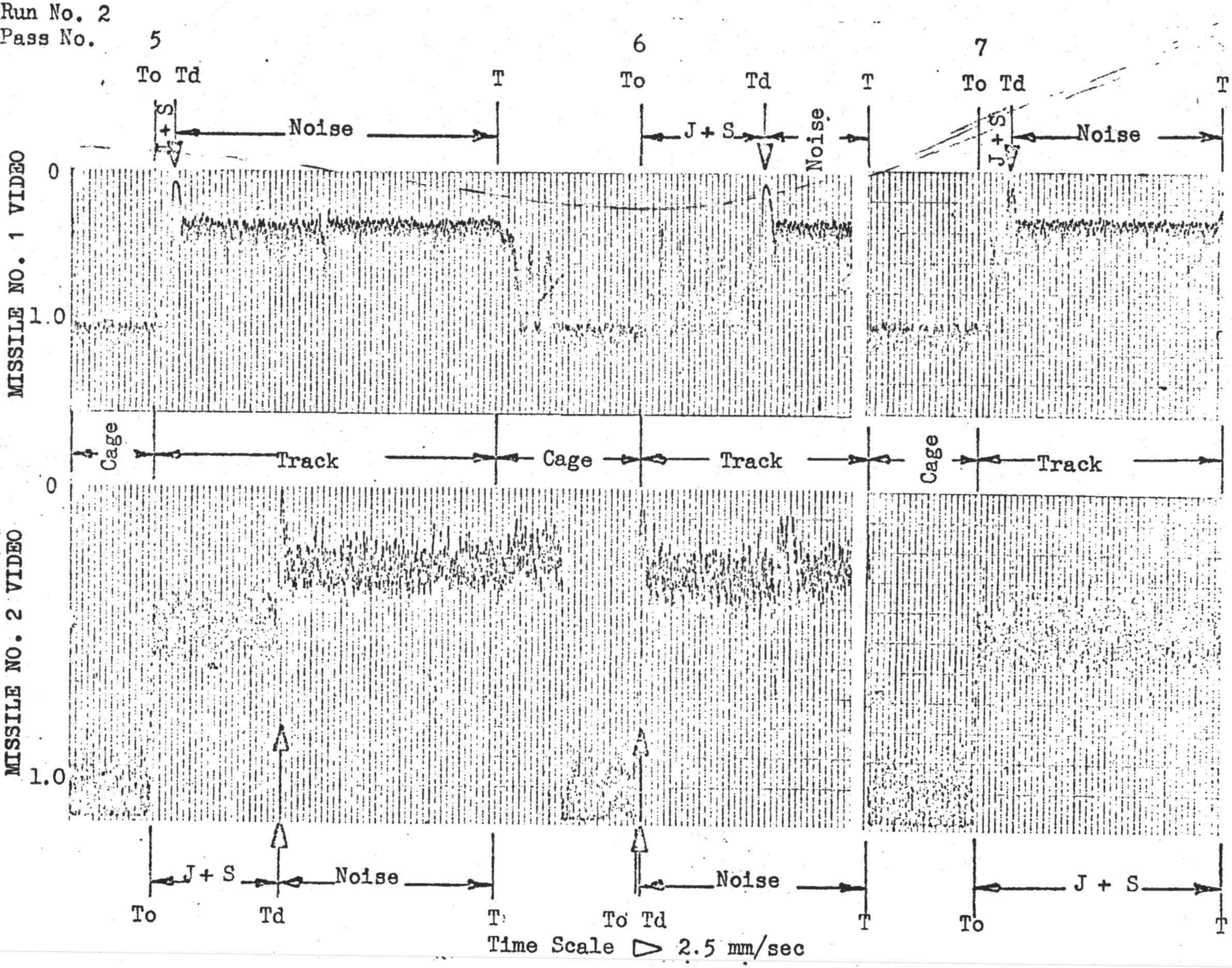

Figure 35. Mission 3011-B; Run 2, Pass 5, 6 & 7; Military Power (U) ~~(SECRET)~~

~~SECRET~~

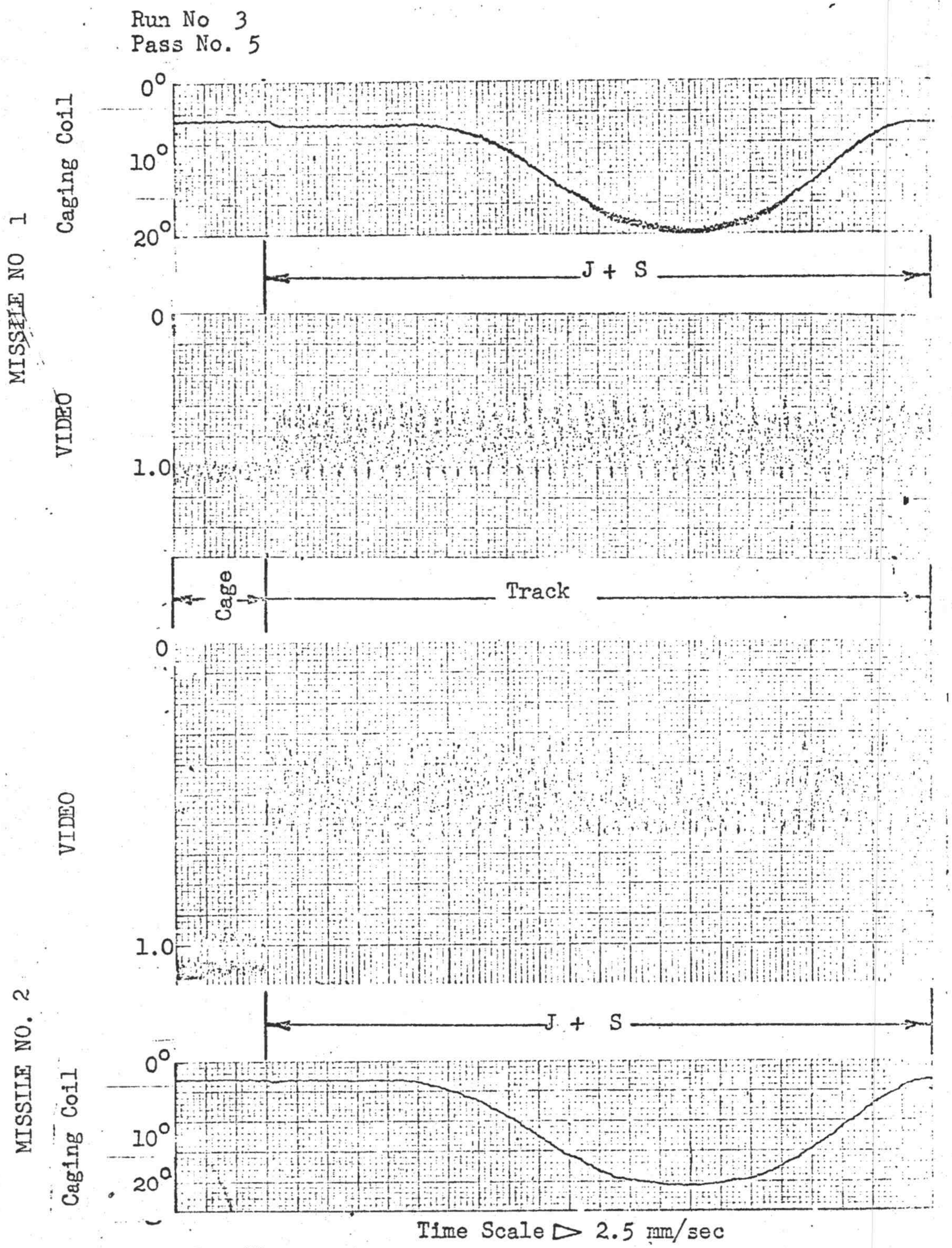

Figure 36. Mission 3011-B; Run 3, Pass 5; After-Burner (U) ~~(SECRET)~~

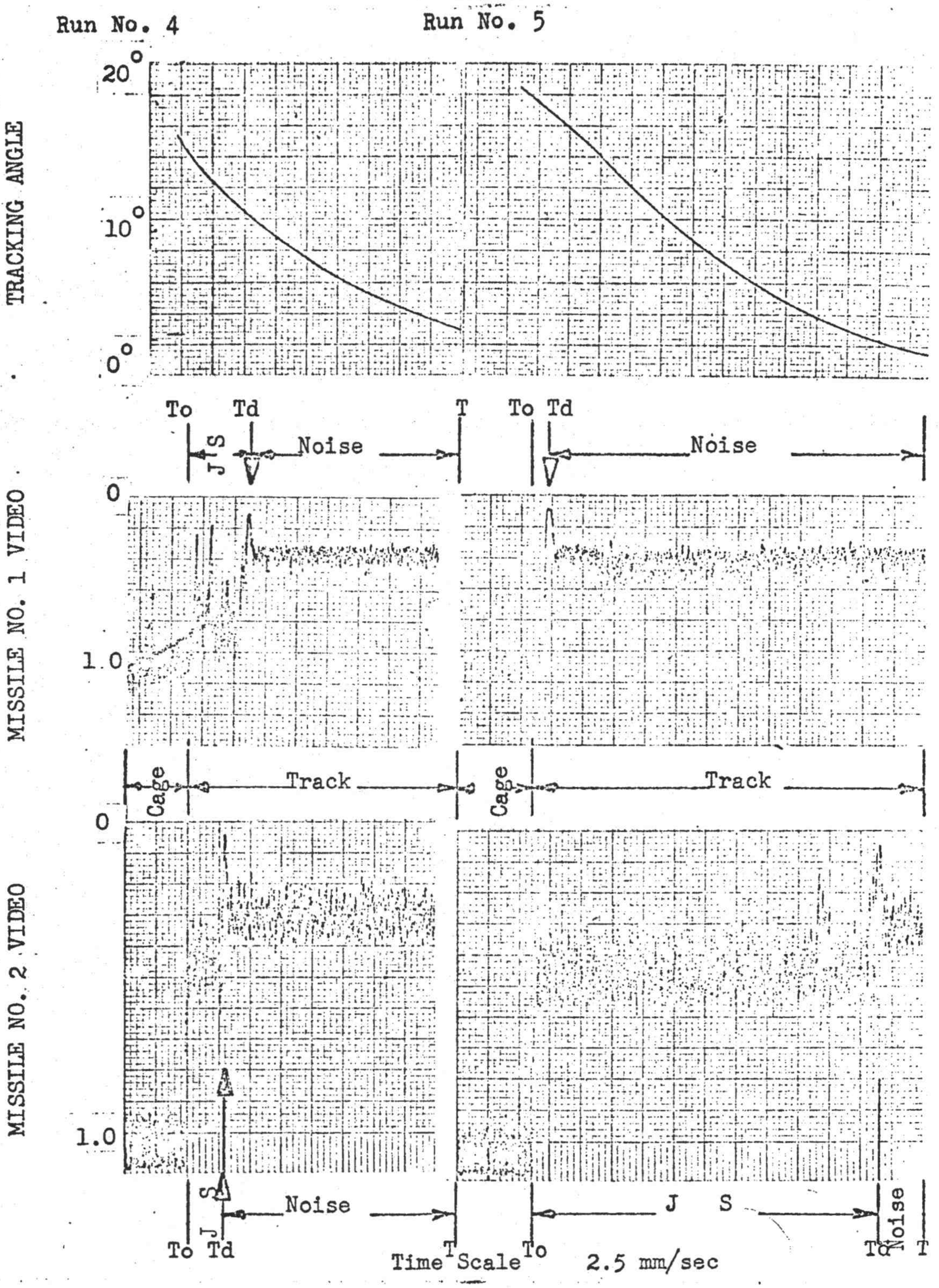

Figure 37. Mission 3011-B; Run 4 & Run 5; Cruise Power (U)
~~(SECRET)~~

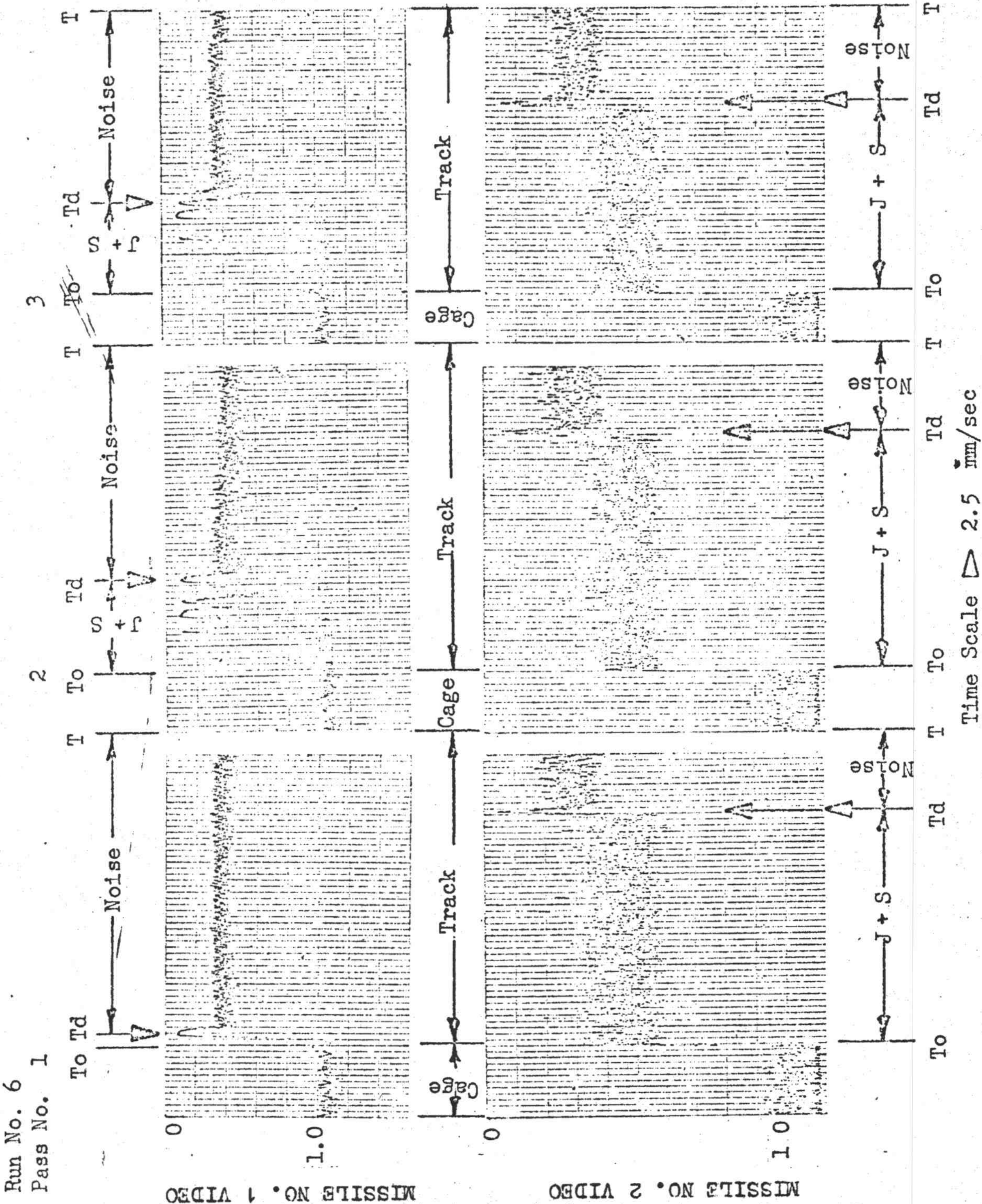

Figure 38. Mission No. 3011-B; Run 6, Pass 1, 2 & 3; Military Power (U) ~~(SECRET)~~

~~SECRET~~

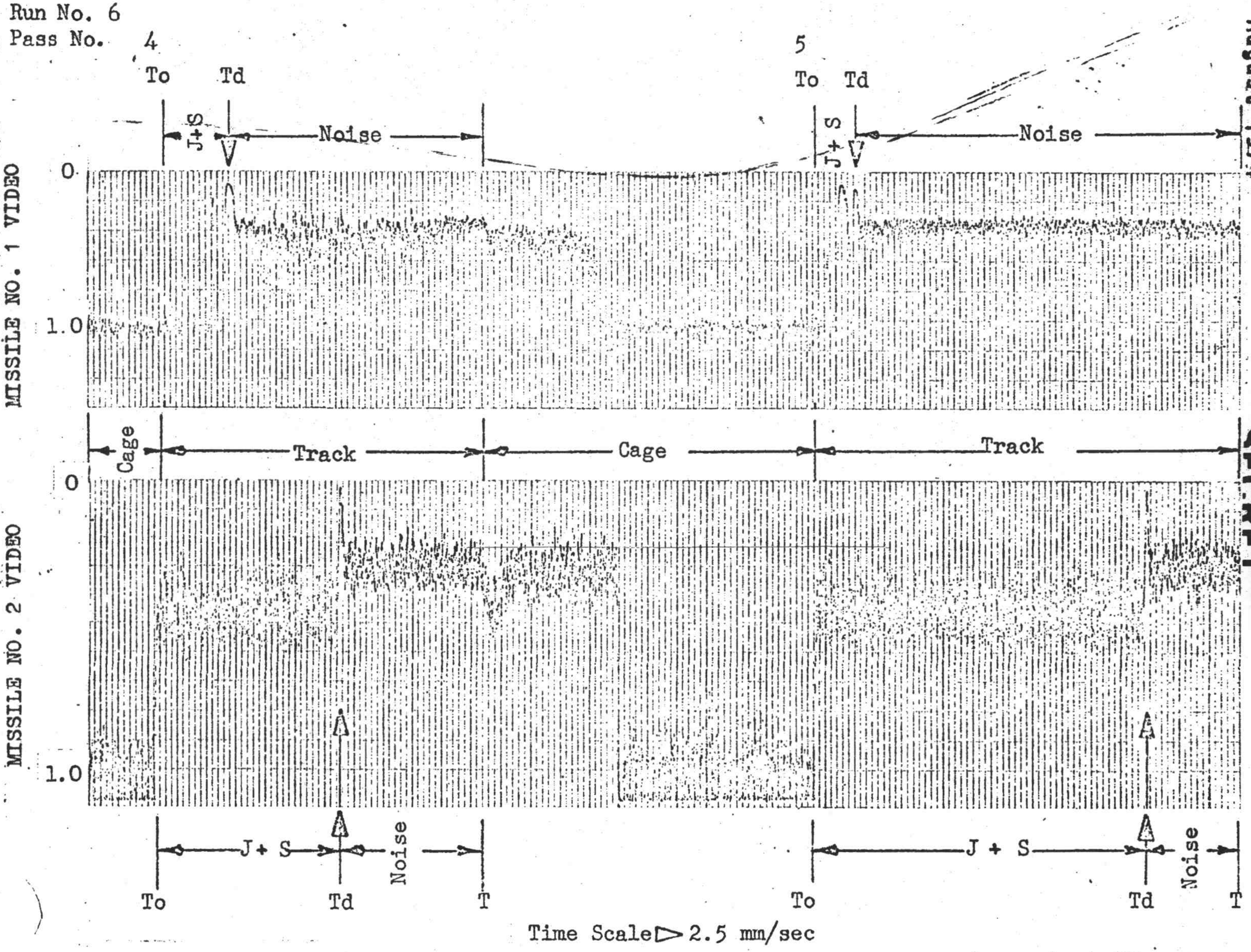

Figure 39. Mission No. 3011-B; Run 6, Pass 4 & 5; Military Power (U)

[redacted]

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# PART IV

# AAQ-4 MEASUREMENT AND EVALUATION

# SECTION I

## TEST OBJECTIVES

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~~(S)~~ The objectives of this flight test program were to:

a. ~~(S)~~ Evaluate the effectiveness of the AAQ-4 system as an Infrared Countermeasure (IRCM) against a standard Sidewinder 1A missile (AIM-9B) and a Russian ATOLL missile throughout the EB-66 vulnerability cone.

b. ~~(S)~~ Perform infrared radiometric measurements in the 1.8-2.7 micron region of both the jammer (J) and the test-bed aircraft ~~(S)~~ to reveal the Apparent Effective Radiant Intensity vs. Aspect Angle.

c. ~~(S)~~ Determine the J/S ratio as a function of aspect angle of the AAQ-4 IRCM equipment when installed on an EB-66 test-bed aircraft throughout the attack envelope of ±45° in azimuth and +20° to -50° in elevation.

## SECTION II

## METHOD OF TEST

---

1. ~~(S)~~ The AAQ-4 IRCM system was installed in an EB-66B test-bed aircraft, #53-482, which staged from Shaw AFB, SC. ATR-1/T-39 and AIDES/F-4 aircraft/instrumentation facilities were utilized for this program. The test-bed and measurement aircraft were radar directed onto a racetrack pattern similar to that shown in Figure 40. The measurement aircraft positioned itself at various slant ranges and aspect angles aft of the test-bed aircraft. Actual mission profiles were determined by background conditions present over the test area during each mission and according to mission objectives. Data were obtained at altitudes between 27,000 and 32,000 feet. Measurements and effectiveness of the jammer with the B-66 in cruise and rated military power were obtained.

2. ~~(S)~~ Decoy Effectiveness

a. (U) Decoy effectiveness testing was accomplished utilizing the Airborne Infrared Decoy Evaluation System (AIDES) mounted on an F-4 aircraft. Break-lock information was obtained throughout the vulnerability cone of the B-66 utilizing three basic maneuvers.

b. (U) In the first maneuver, with the B-66 in straight and level flight, the F-4 closed on the target from direct tail aspect from a range of two miles until flyby. During this maneuver, the AIDES pilot held the target within his gunsight while the AIDES operator switched the missiles from cage to track after ascertaining that a proper acquisition signal was present. If the missile video level dropped to noise, the operator switched the missile back to cage to reacquire the target. If the video level did not drop to noise level, the operator left the missile in track mode for approximately ten seconds and then switched back to cage to reacquire.

c. ~~(S)~~ An initial position of 20-50 degrees off tail aspect was assumed for the second type maneuver. The pilot then turned the AIDES aircraft and flew a missile intercept course holding the target within his gunsight. The AIDES equipment operator repeated the missile lock-on/off procedure until the aspect was again direct tail or flyby occurred. It was found that this type maneuver produced excessive gravitational and inertial forces on the missile gyro when the intercept was made at angles greater than approximately 30° off tail.

d. (U) In order to obtain data at aspect angles greater than 30° and at upward angles, a third maneuver was developed. In this case, as the F-4 began his intercept run, the B-66 went into a turn with a fixed bank angle of 10°, 20°, 30° or 40°. This allowed the F-4 to make low-G

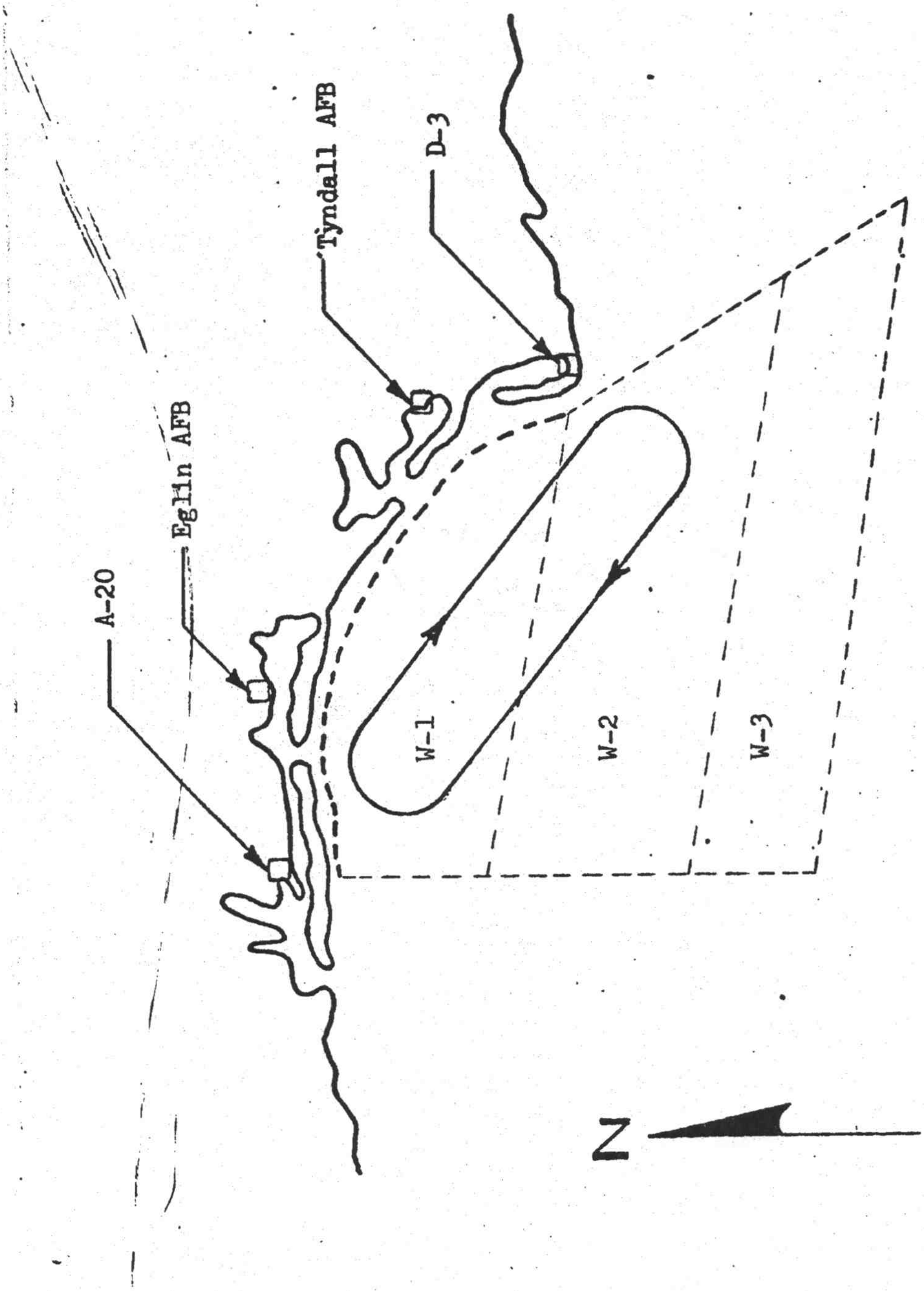

Figure 40. Typical Mission Profile for Project 4700Y086 (U)

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turns during the intercept. As before, the AIDES operator repeated the missile lock-on/off procedure.

e. ~~(S)~~ The decoy criteria applied to the missile track data defined a maximum and minimum condition. The time of maximum decoy, $T_d$(MAX), was defined to be that time at which the jammer was able to force the seeker head completely off the target, resulting in a drop in the video signal to noise level and remaining at that level for a period of at least one second. Minimum decoy, $T_d$(MIN), was defined to be that time at which a strong effect of the jammer is first manifested simultaneously in the video signal and in the movement of the seeker head.

f. ~~(S)~~ The maximum decoy criteria demand very stringent conditions which are probably not realistic under an actual missile launch situation. In a launched mode, the missile normally must track its target with a changing line-of-sight (LOS), i.e., with some tracking rate. This is somewhat unlike the captive intercept mode under which these tests were performed. It is for this reason the minimum decoy criteria were introduced. It is felt that these criteria more nearly simulate the decoy effects that the jammer will have under a real world situation. Since this point is subject to criticism, both criteria were applied to the data and presented in this report.

3. ~~(S)~~ Radiometric Measurements

a. ~~(S)~~ Infrared radiometric measurements of both the AAQ-4 and the test-bed aircraft were made with the T-39/ATR-1 facility utilizing the same basic racetrack profile as the F-4/AIDES. While maintaining a given elevation angle, the T-39 aircraft moved slowly off to each side of the B-66 to a maximum "look angle" of the measuring equipment (± 60°). Repeating this maneuver, measurements were performed throughout most of the attack envelope of ± 45° in azimuth and +20 to -50° in elevation.

b. (U) Time Space Position Information (TSPI) from two FPS-16 tracking radars was used to compute azimuth, elevation, and slant range of the F-4C or T-39 measurement aircraft relative to the B-66 test-bed aircraft. In the case of the B-66 performing a turn maneuver, the roll (bank) and pitch angles of the B-66 were included in the computations.

## SECTION III

## INSTRUMENTATION

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1. (U) The Airborne Infrared Decoy Evaluation System

a. (U) The Airborne Infrared Decoy Evaluation System (AIDES) consists of various radiometric and data recording instrumentation mounted in a pod and qualified for supersonic flight on an F-4 type aircraft. Capability is provided on the pod to carry and record performance data from two infrared missile guidance-and-control units. The system installed on an F-4C aircraft is shown in Figure 41. The equipment is normally carried on the left outboard wing station of specially wired F-4C's #407 and 410, and operated from the rear seat by an instrumentation operator. A detailed description of the AIDES pod characteristics is presented in Technical Report ADTC-TR-69-100.

b. (U) Optical radiation from the target is directed into the two-color radiometer and camera by a servo-controlled optical system. The infrared energy is separated into two spectral bands by a dichroic element in its optical system. An uncooled PbS detector and a thermoelectrically cooled PbSe detector are used in the short and long wavelength channels respectively. Optical band-pass filters result in system spectral response characteristics matching those of the AIM-9B and AIM-4G missiles.

c. (U) A 16mm color movie camera makes time-correlated photographs of the radiometric field-of-view (FOV) through the radiometer optics. A reticle to indicate the radiometer FOV is projected onto the 5-degree camera FOV. A nixie-tube time display is projected onto the side of the film allowing visual assessment of radiometric events.

d. (U) The on-board recording system consists of an Ampex AR-200 seven-track tape recorder, subcarrier oscillator block and calibration timing unit. Data are recorded either direct or wideband FM on six of the tracks with the remaining track being used for multiplexing 14 subcarrier oscillator auxiliary data channels. A complete data recording format is given in Table XVI.

e. ~~(S)~~ For this test program, the pod carried two Sidewinder type missiles. The port missile (No. 1) was an ATOLL, while the starboard missile (No. 2) was a standard AIM-9B. The video and caging coil voltage of each missile was recorded for evaluation of the decoy effectiveness of the test item on each missile.

f. (U) The two missile guidance-and-control units were tested before and after this test program by WRAMA at Robins AFB, Georgia, to ascertain

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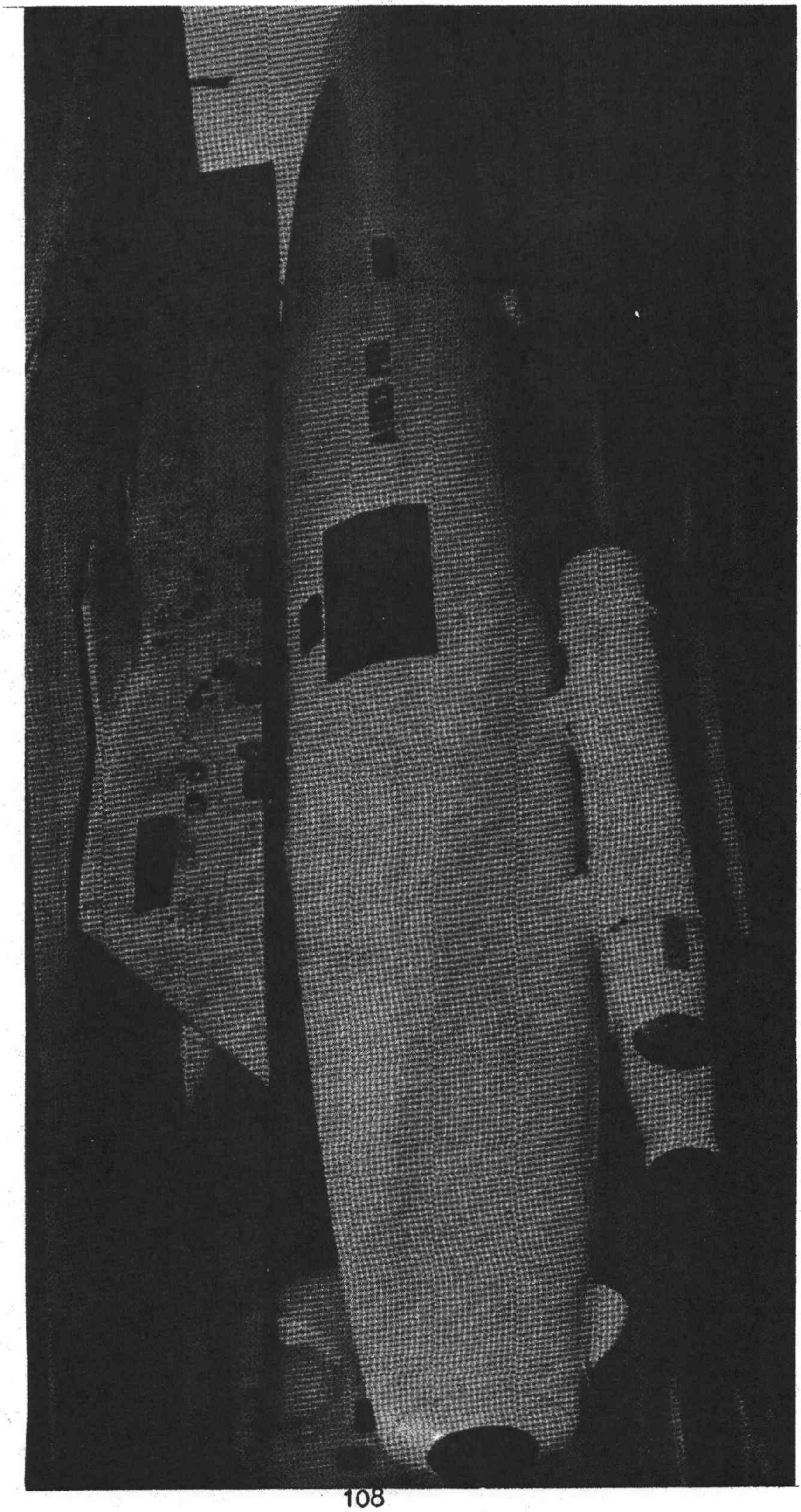

Figure 41. Airborne Infrared Decoy Evaluation System (U)

Table XVI. AIDES Recording Format (U)

| Track No. | Item |
|---|---|
| 1 | Voice and camera shutter pulse |
| 2 | Long wavelength radiometer (X10) |
| 3 | Short wavelength radiometer (X10) |
| 4 | Long wavelength radiometer (X110) |
| 5 | Short wavelength radiometer (X100) |
| 6 | Subcarrier oscillator composite (listed below) |
| 7 | Time (IRIG B) |
| **Channel No.** | **Item** |
| 3 | Operation mode (off, standby, calibrate, command, auto track) |
| 4 | Missile calibrate lamp voltage |
| 5 | No. 2 Sidewinder caging coil (X1) |
| 6 | Sidewinder 70-cycle reference |
| 7 | No. 1 ATOLL caging coil (X1) |
| 8 | Radar range voltage |
| 9 | No. 1 ATOLL caging coil (X5) |
| 10 | No. 2 Sidewinder (X5) |
| 11 | Radiometer elevation position |
| 12 | Radiometer azimuth position |
| 13 | No. 1 ATOLL video |
| A | No. 2 Sidewinder video |
| C | Long wavelength radiometer (X1) |
| E | Short wavelength radiometer (X1) |

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that they were operating within specification. The more pertinent functions tested were sensitivity, track rate and gyro spin rate. Comparative engineering data supplied by WRAMA is given in Table XVII.

g. (U) Additional support equipment which makes up the AIDES pod includes an argon gas container, electrical power supplies and a time code generator.

h. (U) Due to the non-availability at the beginning of the flight test program of either of the specially wired aircrafts (#407 and 410), the AIDES pod was mounted center-line on F-4 aircrafts #876 and 716. In this configuration, the pod was operated at reduced capability due to the limited wiring available at the center-line station. Radar range and radar slaving of the servo-controlled radiometer and movie camera optics were not available. Most of the other pod functions were available with limited control and monitoring.

i. ~~(S)~~ The missile test data were stripped out on three six-channel Sanborn pen recorders. The data primarily used for analysis of missile track behavior was the video signal, caging coil voltage and track mode indicator of each missile. An example of these is shown in Figure 42. The level and character of the video reflects the type of target which the seeker is tracking. A normal target produces a steady voltage level slightly above the background noise level. The presence of a pulsed source such as a jammer is reflected in a higher, modulated level. Complete decoy is recognized when the video level drops to the background noise level.

j. ~~(S)~~ The amplitude of the caging coil voltage is a measure of the angle between the center-line of the missile body and the tracker line-of-sight (LOS). However, this is not necessarily the angle which the tracker has been forced off of the target by the jammer. This would only be true for the idealized case of the missile being pointed continuously at the target and is not the case under a typical missile intercept maneuver. The target remains on center-line only as accurately as the pilot can hold the gunsight "pipper". Therefore, this voltage cannot be used to determine precisely when the target moves to the edge of the missile FOV. It can be, and is, used to correlate movement of the seeker head with variations in the tracker video signal level. These parameters together give a positive indication of when the target moves out of the seeker FOV.

## 2. (U) The ATR-1 Radiometric System

a. (U) Another of the ADTC resources utilized in support of this program was an instrumented T-39 aircraft and support crews, shown in Figure 43. The primary instrument used for the collection of infrared radiometric data aboard the T-39 aircraft was the ATR-1 tracking radiometer with slant range data provided by ground-based ranging radars (FPS-16).

Table XVII. Missile Characteristics (U)

| TEST | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Filament Current Amps | 1.2 | | | | 1.35 | | | |
| PA B+ (m.a.) | 106 | | | | 125 | | | |
| Gyro Speed (cps) | 72.6 | | | | 70.6 | | | |
| MAX. TRACK RATES | R | L | U | D | R | L | U | D |
| PLA (deg/sec) | 9.2 | 9.6 | 9.0 | 9.5 | 10.8 | 10.6 | 10.3 | 10.6 |
| PL1 (deg/sec) | 9.6 | 10.4 | 9.8 | 10.2 | 11.0 | 10.9 | 10.8 | 11.2 |
| PL3 (deg/sec) | 10.8 | 11.4 | 10.9 | 11.3 | 11.5 | 11.3 | 11.0 | 11.5 |
| | PLA | | PL1 | PL3 | PLA | | PL1 | PL3 |
| DCN (Volts) | 1.3 | | 1.3 | 1.3 | .34 | | .34 | .34 |
| PI Max (Volts) | 3.5 | | 3.9 | 6.5 | 3.0 | | 3.8 | 4.5 |
| S/N | 2.7 | | 3.0 | 5.0 | 8.8 | | 11.2 | 13.2 |
| | R | L | U | D | R | L | U | D |
| 15° Off Axis/Track Rates for PL1 (deg/sec) | - | - | - | - | 3.0 | 3.0 | 3.0 | 3.0 |

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NOTE: PLA = System Gain Power Level "A"
PL1 = System Gain Power Level 1
PL3 = System Gain Power Level 3
DCN = Dark Cell Noise
PI Max = Pilot's Intercom Maximum
S/N = Signal to Noise Ratio

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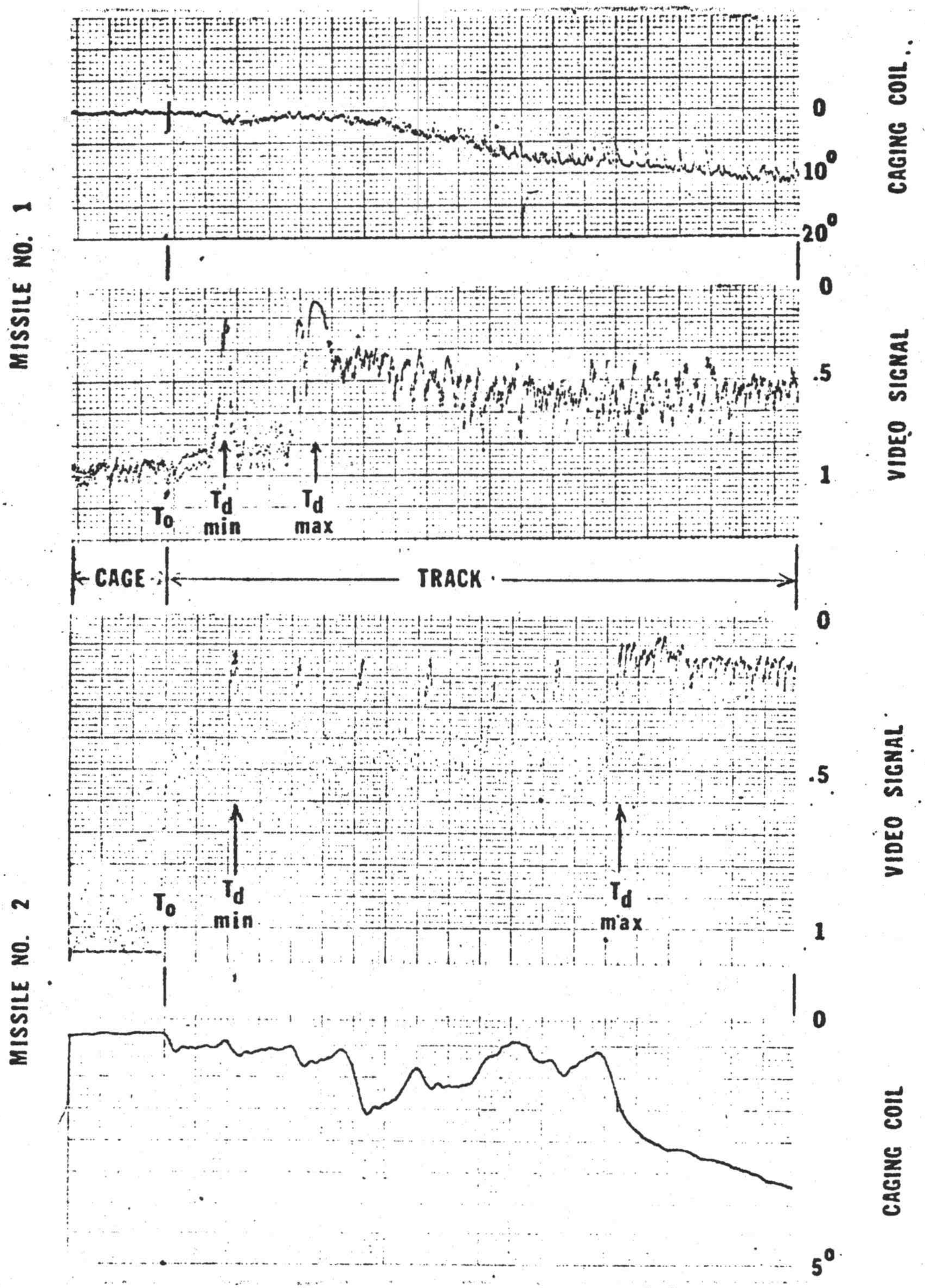

Figure 42. Missile Test Data (U)
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Figure 43. The T-39/ATR-1 Measurement Facility (U)

b. (U) The radiometer, the general characteristics of which are listed in Table XVIII, is equipped with an in-flight calibration standard which can be activated at the discretion of the operator. This unit, a miniature tungsten filament lamp, is installed in the unused center portion of the secondary mirror of the Track Radiometer unit and illuminates the entire radiometric, signal-processing chain with the exception of the primary mirror and dome. This standard permits accurate determination of radiometric responsivities during the measurement period by relating the response of the airborne standard to pre-mission laboratory irradiance response and spectral response calibrations.

c. (U) The irradiance response calibration of the ATR-1 radiometer incorporates techniques for establishing system linearity over a wide range of irradiances and for compensating long-term response instability. For this latter effect, the principle of compensation is that regardless of the particular variable which has changed to alter responsivity (detector bias or temperature, amplifier gain, chopping frequency, etc.), the net responsivity can be determined at any moment by measuring the output signal from a calibration standard mounted in the radiometer head. Since certain of the factors which tend to alter responsivity might also influence the stability of the calibration standard radiation, the input voltage of the calibration standard radiation is zener regulated and, as a safeguard, monitored on a separate channel of both data recorders. The radiation stability is maximized by aging the lamp at twice operating voltage for approximately 500 hours and by mounting it in the head so as to maintain fixed optical geometry with respect to the detectors. The potential variables left uncorrected by this method are the transmissions of the optical elements untraversed by the calibration standard radiation. This is dictated by the impracticability of mounting the lamp external to the irdome.

d. (U) Extensive laboratory testing and calibration over a five-year period have demonstrated that regardless of the particular combination of radiometer variables altering the responsivity, the master irradiance calibration curves are still reproducible to ±2 percent.

e. (U) The laboratory calibration process consists of irradiating the ATR-1 in the fine track mode with collimated blackbody radiation and, while holding responsivity constant at one level measured by the response to the calibration standard, running an irradiance input signal output curve by changing blackbody irradiances over a 10,000:1 range. The radiometer responsivity is then changed to, and held at, a new level by altering some convenient variable, such as detector temperature. The new responsivity level is measured and the next input-output curve is run. This procedure is repeated, building up a family of response curves for both PbS and InSb radiometers which span the extreme range of responsivity levels that might be encountered in flight.

f. ~~(S)~~ In preparation for this measurement program, the response of the ATR-1 radiometer to a modulated source was extensively investigated in the laboratory. A blackbody chopper was designed which provided

Table XVIII. ATR-1 Radiometer Characteristics (U)

| | |
|---|---|
| Radiometer Angular Limit | ±60° in azimuth<br>20° up, 50° down in elevation |
| Cooling | PbS - thermoelectric<br>InSb - liquid nitrogen transfer |
| Inflight Calibration | PbS and InSb both manual |
| Track Instantaneous Field of View | Circular, 6 mr diameter |
| Track Total Field of View | Circular, 12 mr diameter |
| Track Accuracy | ±1 mr at rates to 8°/second |
| Track Detector | Either PbS or InSb |
| Radiometer Field of View | Square 3 x 3 mr, aligned along track axis |
| Radiometer Detectors | Both PbS and InSb |
| PbS Minimum Measurable Irradiance | $3 \times 10^{-12}$ w/cm$^2$ |
| InSb Minimum Measurable Irradiance | $2 \times 10^{-11}$ w/cm$^2$ |
| Dynamic Irradiance Range | 3500:1 |
| Recording | Standard multiplex for aircraft measurements FM direct for pulsed/steady state measurements Galvanometer type for "quick look" |

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simulated jammer pulses of known irradiance levels. It produced a three-pulse group with a fixed 20 percent duty cycle. The pulse width was varied from 200 to 400 microseconds with an inter-pulse group spacing of 10 to 20 milliseconds. It was found that the pulse group repetition rate and the ATR-1 nutation rate combined in such a manner that 25 percent of the time the modulated signal was coincident with the steady state pulse. Figure 44 shows the characteristics of the radiometer signal produced by pulsed and steady state irradiances. Nutation of the steady state target image produces a wide pulse (approximately 3 milliseconds) which acts as a pedestal for the modulated jammer signal. Nominal irradiance responsivity calibration curves for modulated and steady state signals for both wavelength radiometer channels are illustrated in Figure 45.

g. (U) Figure 46 shows the nominal spectral responses of the PbS and InSb ATR-1 radiometers. These were measured using a Perkin Elmer Model 13 infrared spectrometer with a Littrow $CaF_2$ prism employed as a monochromator operating at minimum slit widths. The relative irradiant power in the exit beam at each wavelength is determined by means of the spectrometer's radiation thermocouple. The thermocouple spectral response was calibrated by the Naval Ordnance Laboratory, Corona, California.

h. ~~(S)~~ In order to recover the high frequency radiometer signals produced by the jammer pulses, the outputs of both wavelength channels are recorded direct on wide band FM tracks of an Ampex AR-200 magnetic tape recorder. A Sanborn Model 650 direct write oscillograph with 5 KHz galvanometers provides strip-outs for manual data reductions. Digital timing (which is generated aboard the aircraft), voice annotations, event indications and other associated data are fed through a signal conditioning unit for recording.

i. (U) The ATR-1 is installed in ADTC's T-39A aircraft, No. 870. The T-39A is a utility trainer aircraft which has been modified for this mission support role. As modified and with an aircrew of four, altitudes of 40,000 feet and speeds of mach .72 are obtainable. Usable mission time is approximately three hours.

j. (U) The data gathered with this instrumentation system was reduced, interpreted and and analyzed by computer and manual processes using magnetic and oscillographic tapes, aircraft parameters and performance data, ATR-1 calibration factors and FPS-16 radar data. The following sequence was used:

(1) Readout of in-flight radiometer and voltage controlled oscillator (VCO) calibrations for selection of appropriate calibration factors.

(2) Readout of the AAQ-4(J) and B-66(S) signal levels.

(3) Application of appropriate calibration factors and conversion of each signal to effective irradiance (He).

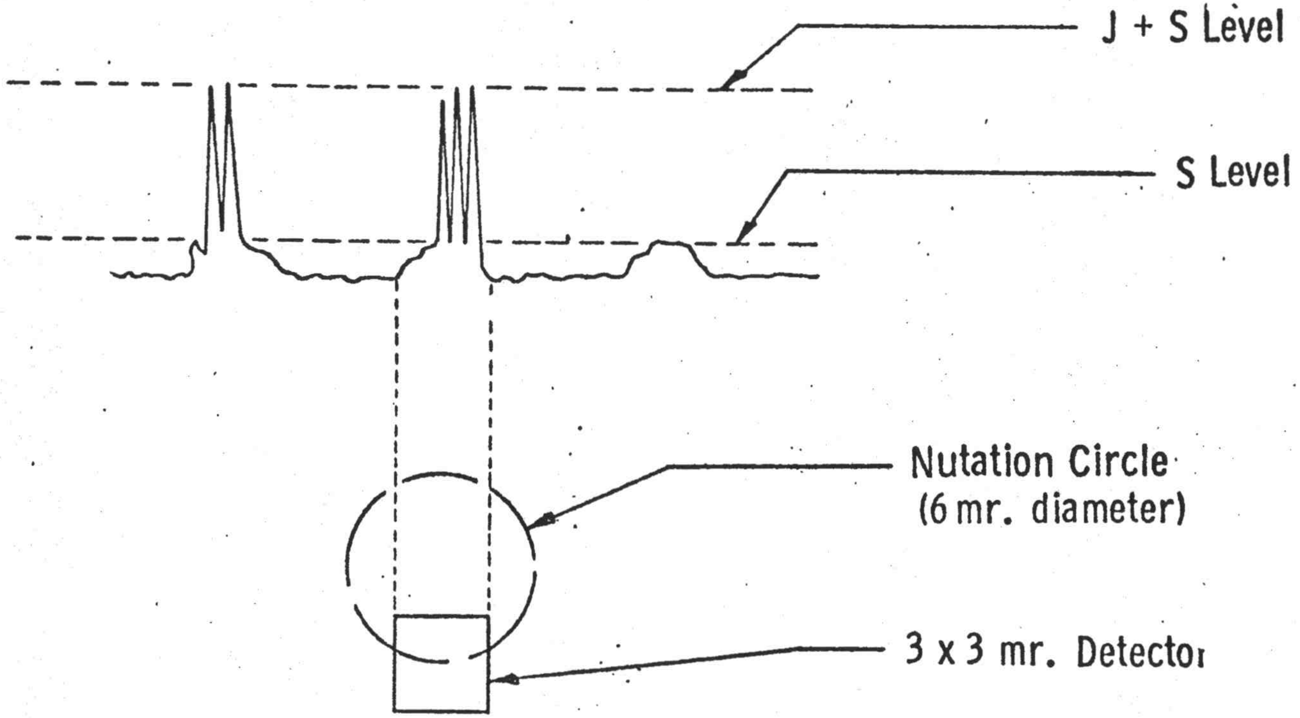

Figure 44. ATR-1 Radiometer Optical Geometry (U)

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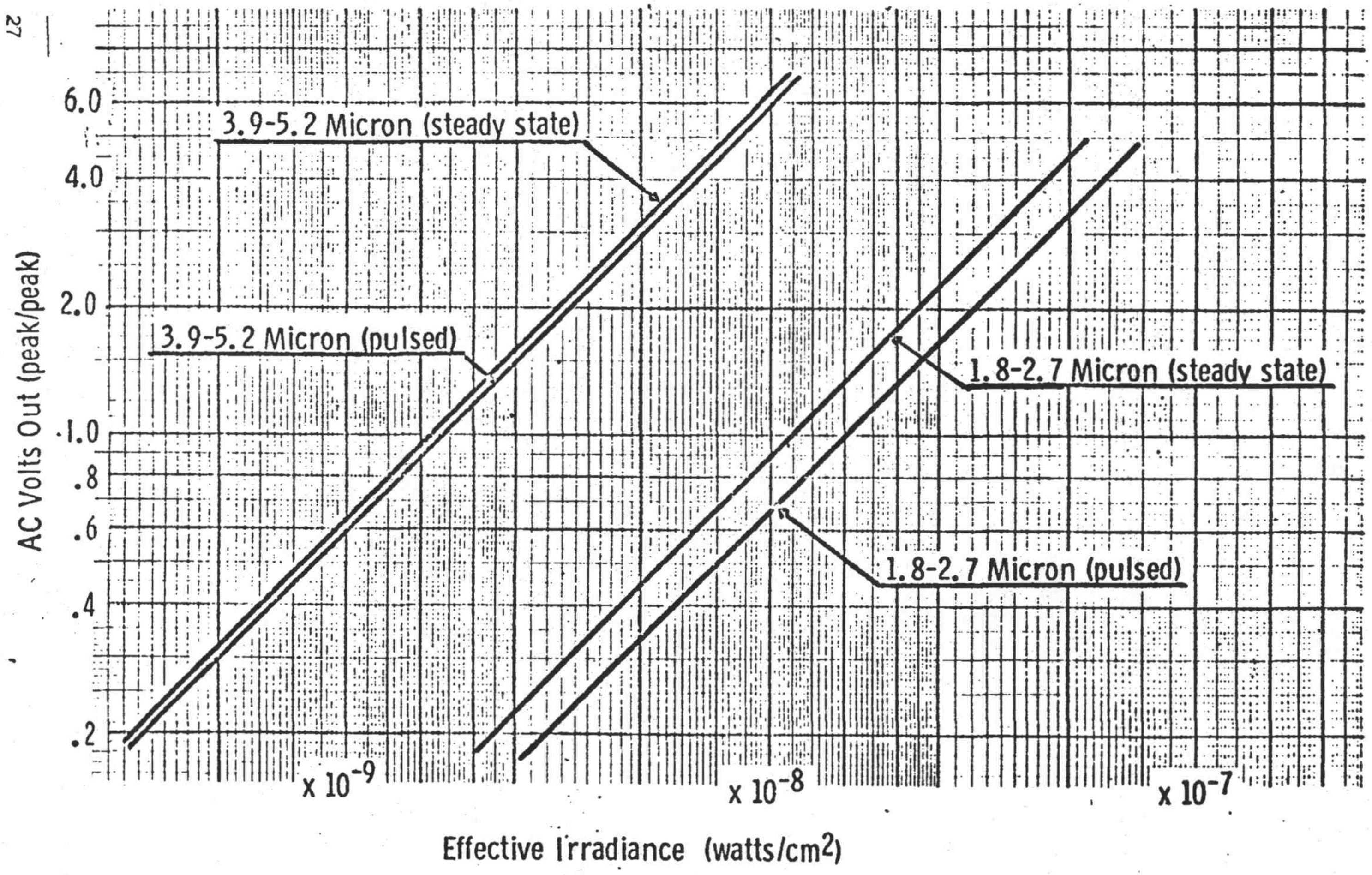

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Figure 45. Nominal ATR-1 Radiometer Irradiance Responsivities to Steady State & Pulsed Radiation (U)

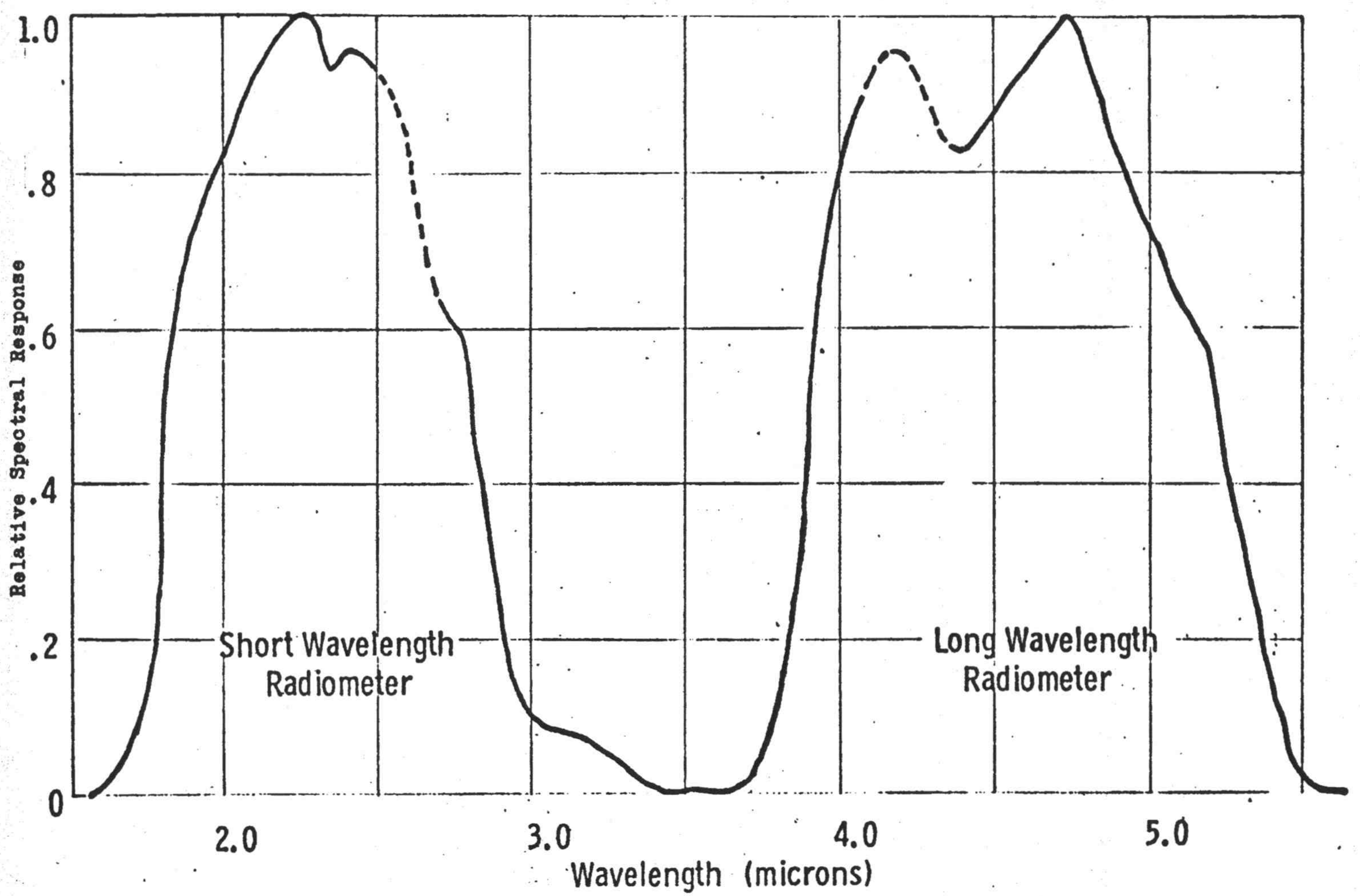

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Figure 46. Relative Spectral Responses of the ATR-1 Radiometers with the 1.8/3.7 Filter Unit (U)

(4) Determination of slant range and aspect angle from ground-based radar data.

(5) Computation of apparent effective radiant intensity (J and [redacted] defined by $HeR^2$ (effective irradiance X range squared), and tabulating or plotting this value in watts/steradian versus aspect angle for the various target performance parameters.

# SECTION IV

# RESULTS AND DISCUSSION

---

~~1. (S) A~~ total of 36 sorties were flown with the AIDES pod and/or the ATR-1 in support of this test program, and the data are summarized in Table XIX. The AIDES supported 26 sorties and the ATR-1 supported 21 sorties. Of these total flights, 11 were supported by both the ATR-1 and the AIDES. This was done to allow the ATR-1 to monitor the J/S ratio of the AAQ-4 at the same time that the AIDES was gathering decoy effectiveness data.

2. (U) Due to a major modification to the test item, the decoy and radiometric data of the jammer were invalid prior to Sortie No. 11. The only usable data from the first 10 sorties were EB-66 aircraft base line measurements.

3. (U) The following is a list of definitions of the terms, symbols and abbreviations which were used in the data tables and figures of this section:

J - Apparent Peak Effective Radiant Intensity of the AAQ-4 modulated output in watts/steradian in the 1.8-2.7 micron region.

[redacted] - Apparent Effective Radiant Intensity of the EB-66 plus the unmodulated output of the AAQ-4 in watts/steradian in the 1.8-2.7 micron region.

[redacted] Ratio of the modulated signal to the steady state target signal.

$J_t$ - Total Radiant Intensity in watts/steradian.

$T_o$ - Time at which missiles are switched from cage to auto-track.

$T_d$ - Time in seconds from $T_o$ required for missiles to be decoyed.

* - Denotes no-decoy and time given is the total time which missile remained in auto-track.

BG - Significant background present.

HG - Excessive gravitational or inertial forces present on missile.

EGT - Aircraft Exhaust Gas Temperature in degrees centigrade.

4. (U) <u>Decoy Effectiveness</u>

Table XIX. Project 4700Y086 Mission Summary (U)

| Project Sortie No. | Date | ADTC Mission No. | ADTC Instrumentation | Mission Time (CST) | Remarks |
|---|---|---|---|---|---|
| 1 | 3-11-69 | 1026 | AIDES/ATR-1 | 1230-1400 | AAQ-4 malfunction |
| 2 | 14-11-69 | 5004 | AIDES/ATR-1 | 0900-1030 | AAQ-4 malfunction |
| 3 | 17-11-69 | 1006 | AIDES | 1300-1430 | Air abort/AAQ-4 |
| 4 | 18-11-69 | 2008 | AIDES/ATR-1 | 1400-1530 | AAQ-4 fault lite |
| 5 | 19-11-69 | 3007 | AIDES | 0900-1030 | Productive |
| 6 | 24-11-69 | 1007A | AIDES | 0900-1030 | Productive |
| 7 | 24-11-69 | 1007B | AIDES | 1300-1430 | Productive (BG) |
| 8 | 25-11-69 | 2007A | AIDES/ATR-1 | 0900-1030 | Productive |
| 9 | 25-11-69 | 2007B | AIDES/ATR-1 | 1300-1430 | Grd. abort/F-4 |
| 10 | 26-11-69 | 3008 | ATR-1 | 1500-1630 | Productive-J/S |
| 11 | 2-12-69 | 2007A | AIDES/ATR-1 | 0900-1030 | Air abort/AAQ-4 |
| 12 | 2-13-69 | 2007B | ATR-1 | 1300-1430 | B-66 Baseline (BG) |
| 13 | 17-12-69 | 3008A | ATR-1 | 1100-1200 | Grd. mt. at Shaw AFB |
| 14 | 17-12-69 | 3008B | ATR-1 | 1300-1430 | Productive |
| 15 | 29-12-69 | 1007 | ATR-1 | 1300-1430 | B-66 Base line |
| 16 | 30-12-69 | 2006 | ATR-1 | 1600-1730 | Background bad |
| 17 | 15-1-70 | 4711 | AIDES | 1600-1730 | Productive |
| 18 | 20-1-70 | 2006 | AIDES/ATR-1 | 0830-1000 | Productive |
| 19 | 21-1-70 | 3006 | AIDES/ATR-1 | 0800-0930 | Productive |
| 20 | 26-1-70 | 1006 | ATR-1 | 1400-1500 | Productive-J/S |
| 21 | 27-1-70 | 2008 | AIDES/ATR-1 | 1400-1530 | Air abort/AAQ-4 |
| 22 | 30-1-70 | 5008 | ATR-1 | 0900-1030 | Productive |
| 23 | 2-2-70 | 1008 | AIDES/ATR-1 | 1230-1330 | Non-productive-WX |
| 24 | 3-2-70 | 2008 | AIDES/ATR-1 | 0830-0930 | Productive |
| 25 | 9-2-70 | 1007A | AIDES | 0730-0900 | Non-productive-H.G. |

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Table XIX. Project 4700Y086 Mission Summary (Cont) (U)

| Project Sortie No. | Date | ADTC Mission No. | ADTC Instrumentation. | Mission Time (CST) | Remarks |
|---|---|---|---|---|---|
| 26 | 9-2-70 | 1007B | AIDES | 1200-1330 | Non-productive-H.G. |
| 27 | 18-2-70 | 3008A | AIDES | 0700-0830 | Air abort/F-4 |
| 28 | 18-2-70 | 3008B | AIDES | 1130-1300 | Non-productive-H.G. |
| 29 | 20-2-70 | 5008 | AIDES | 1400-1530 | Productive |
| 30 | 24-2-70 | 2007A | AIDES | 0900-1030 | Non-productive-H.G. |
| 31 | 24-2-70 | 2007B | AIDES | 1330-1500 | Non-productive-H.G. |
| 32 | 26-2-70 | 4006 | AIDES | 1300-1430 | Air abort/AAQ-4 |
| 33 | 3-3-70 | 2008A | AIDES | 0900-1030 | Productive |
| 34 | 3-3-70 | 2008B | AIDES | 1330-1500 | Non-productive (BG) |
| 35 | 9-3-70 | 1007A | ATR-1 | 0830-1000 | Productive-J/S |
| 36 | 9-3-70 | 1007B | ATR | 1330-1500 | Productive-J/S |

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a. [redacted] Out of the 17 flights which the AIDES made after the modification to the test item, 6 produced good decoy effectiveness data. Four air aborts occurred, 3 due to test item malfunctions and 1 due to an F-4 malfunction. Two sorties were non-productive due to excessive background levels. The remaining 5 sorties were non-productive due to excessive gravitational and inertial forces on the missiles. These were caused by high-G maneuvers of the AIDES aircraft in attempts to obtain decoy data at intercept angles greater than 30 degrees.

b. (U) Results from Sorties 17, 18, 19, 24, 29 and 33 were analyzed using the criteria previously established for maximum and minimum decoy times. These results are presented in Tables XX through XXV. The azimuth and elevation angle and slant range, which existed at the time of decoy, are given for each pass.

c. (U) In an attempt to arrange these results in the most usable form, the data have been assembled and analyzed two ways. The first method was to analyze the data in terms of decoy probability. This requires a large data sample and for this reason could only be performed for the straight tail chase condition. Data from Sortie 17 is presented in Figures 47 and 48 as a graph of the Decoy Probability as a function of $T_d$(MIN) and $T_d$(MAX) respectively. Each graph includes curves for both missiles and for both military and cruise power settings.

d. (U) The second method of presentation is a correlation of average decoy time and intercept aspect angle. Decoy times are grouped and averaged according to azimuth and elevation angle interval. Figures 49 through 56 present average decoy times versus the intercept angle in the form of a matrix. The azimuth and elevation angles designate the rows and columns. Figure 50 provides the number of data samples which were used to calculate the average decoy times.

## 5. (U) Radiometric Measurements

a. (U) Infrared radiometric measurements were performed on the test aircraft with the AAQ-4 test item both operating and non-operating. These measurements were accomplished using the test procedures outlined in Section 2 and the ATR-1/T-39 measurement facility described in Section 3.

b. (U) The data are presented in both rectangular matrix and polar coordinate form. The radiation matrices illustrated in Figures 58 through 68 are the product of the computerized ATR-1 radiometer and FPS-16 radar data. A portion of this process is the grouping and averaging of all radiometric data that falls within a 5° cell of aspect angle as computed by the FPS-16 radars. Each individual matrix cell is combined with similar cells from all productive missions and then individually analyzed and interpreted as to its validity and accuracy. The resultant matrices have not been smoothed to conform to any predetermined radiation pattern; however, data cells which were obviously in error were deleted accounting for some of the unfilled matrix cells.

Table XX. Mission No. 4711, Project 4700Y086, 15 January 1970 (U)

|  | MISSILE NO. 1 |  | MISSILE NO. 2 |  |  |  |
|---|---|---|---|---|---|---|
| Run/ Pass | Td Min. | Td Max. | Td Min. | Td Max. | B-66 Power | Range (Ft) |
| 1-1 | 0.6 | 0.6 | .8 | 4.9 | CRU | 9-10K |
| 1-2 | 0.6 | 0.6 | .8 | 1.8 | CRU |  |
| 2-1 | .7 | 2.7 | .7 | 1.1 | CRU | 8-9K |
| 3-1 | 0.3 | 0.3 | .6 | 3.5 | MIL | 9K |
| 4-1 | 1.0 | 1.0 | .1 | 2.1 | MIL | 8-11K |
| 4-2 | .9 | 4.8 | 1.0 | 3.0 | MIL |  |
| 4-3 | 5.4 | 5.8 | .4 | *2.4 | MIL |  |
| 4-4 | 1.3 | 7.5 | .4 | 2.4 | MIL |  |
| 4-5 | .9 | 2.2 | 1.1 | 7.2 | MIL |  |
| 4-6 | .5 | 3.7 | .8 | 10.0 | MIL |  |
| 5-1 | .8 | 6.2 | 1.0 | 4.4 | MIL | 16K |
| 5-2 | .4 | 2.8 | 3.7 | 4.2 | MIL |  |
| 5-3 | 0.2 | 0.2 | 6.7 | 12.5 | MIL |  |
| 5-4 | .5 | 3.2 | 0.7 | 0.7 | MIL |  |
| 5-5 | 1.0 | 8.5 | 1.1 | 8.5 | MIL |  |
| 5-6 | 0.7 | 0.7 | 3.0 | 8.0 | MIL |  |
| 6-1 | 2.5 | 4.6 | .5 | 2.6 | MIL | 14-16K |
| 6-2 | .7 | 5.7 | .8 | 1.1 | MIL |  |
| 6-3 | 1.4 | 3.4 | 1.1 | 6.1 | MIL |  |
| 6-4 | .8 | 4.4 | 1.0 | 1.9 | MIL |  |
| 6-5 | 1.0 | 5.0 | 1.4 | 4.7 | MIL |  |
| 6-6 | 2.9 | 2.9 | *1.5 | *1.5 | MIL |  |
| 6-7 | 1.4 | 3.3 | 1.0 | 1.0 | MIL |  |
| 7-1 | 2.0 | 2.0 | .2 | 2.2 | CRU | 13-15K |
| 7-2 | 0.9 | 0.9 | .2 | 3.1 | CRU |  |
| 7-3 | .6 | 4.8 | 0.6 | 0.6 | CRU |  |
| 7-4 | .8 | 2.8 | .9 | 3.0 | CRU |  |
| 7-5 | 0.1 | 0.1 | .3 | 1.4 | CRU |  |
| 7-6 | 0.1 | 0.1 | .6 | 2.0 | CRU |  |
| 8-1 | 3.3 | 4.3 | .2 | 5.5 | MIL | 11-15K |
| 8-2 | 2.2 | 4.2 | 2.2 | 7.2 | MIL |  |
| 8-3 | 1.0 | 5.1 | .2 | 1.0 | MIL |  |
| 8-4 | 1.1 | 1.1 | 1.3 | 1.3 | MIL |  |
| 8-5 | .9 | 3.5 | 1.0 | 1.0 | MIL |  |
| 8-6 | .6 | 1.7 | 0.8 | 0.8 | MIL |  |
| 8-7 | .6 | 2.8 | 0.9 | 0.9 | MIL |  |

~~(SECRET)~~

Table XX. Mission No. 4711, Project 4700Y086, 15 January 1970 (U) (Cont)

| | MISSILE NO. 1 | | MISSILE NO. 2 | | | |
|---|---|---|---|---|---|---|
| Run/ Pass | Td Min. | Td Max. | Td Min. | Td Max. | B-66 Power | Range (Ft) |
| 8-8 | 0.9 | 0.9 | 1.1 | 4.1 | MIL | |
| 8-9 | .7 | 4.7 | .8 | 14.8 | MIL | |
| 8-10 | 1.4 | 1.4 | .2 | 11.8 | MIL | |
| 8-11 | 1.0 | 3.6 | 1.0 | 1.0 | MIL | |
| 8-12 | 0.25 | 0.25 | 0.15 | 0.15 | MIL | |
| 8-13 | 1.4 | 1.4 | 3.4 | 11.3 | MIL | |
| 8-14 | .9 | 1.9 | .9 | 6.9 | MIL | |
| 8-15 | 1.0 | 5.0 | 3.2 | 5.2 | MIL | |
| 8-16 | .6 | 4.3 | .6 | 9.8 | MIL | |
| 8-17 | 1.1 | 4.3 | 0.5 | 0.5 | MIL | |
| 8-18 | .9 | 2.9 | 1.0 | 1.0 | MIL | |
| 9-1 | .9 | 3.4 | 0.4 | 0.4 | CRU | 9-13K |
| 9-2 | .45 | .45 | .3 | 2.3 | CRU | |
| 9-3 | .4 | 1.4 | 0.4 | 0.4 | CRU | |
| 9-4 | .6 | 1.6 | 0.5 | 0.5 | CRU | |
| 9.5 | .5 | 2.5 | 1.6 | 1.6 | CRU | |
| 9-6 | .8 | 2.9 | 0.8 | 3.0 | CRU | |
| 9-7 | 1.0 | 1.0 | 0.6 | 0.6 | CRU | |
| 9-8 | 2.0 | 2.0 | 1.2 | 1.2 | CRU | |
| 9-9 | .7 | 1.7 | 0.5 | 0.5 | CRU | |
| 9-10 | .5 | 1.5 | 0.5 | 0.5 | CRU | |
| 9-11 | 0.5 | 0.5 | .4 | 2.4 | CRU | |
| 9-12 | 0.3 | 0.3 | 0.4 | 0.4 | CRU | |
| 9-13 | 1.4 | 1.4 | .1 | 2.0 | CRU | |
| 9-14 | 0.6 | 0.6 | .8 | 3.8 | CRU | 9-13K |
| 9-15 | 1.0 | 1.0 | 1.0 | 1.0 | CRU | |
| 9-16 | 1.0 | 2.0 | 0.9 | 0.9 | CRU | |
| 9-17 | .7 | 1.7 | .8 | 2.8 | CRU | |
| 9-18 | .8 | 1.8 | 1.0 | 3.0 | CRU | |
| 9-19 | 0.25 | 0.8 | .5 | 2.5 | CRU | |
| 9-20 | .7 | 1.7 | 1.7 | 5.2 | CRU | |
| 9-21 | 0.6 | 0.6 | .6 | 1.6 | CRU | |
| 9-22 | 1.0 | 1.0 | 1.1 | 1.1 | CRU | |
| 9-23 | 1.1 | 1.1 | 1.7 | 1.7 | CRU | |
| 9-24 | 0.7 | 0.7 | 0.8 | 0.8 | CRU | |

Aspect angle not shown due to lack of radar data. All data was taken near $0^{\circ}$ aspect angle.

~~(SECRET)~~

Table XXI. Mission No. 2006, Project 4700Y086, 20 January 1970 (U)

| | | | | MISSILE NO. 1 $T_d$ (Sec) | | | | MISSILE NO. 2 $T_d$ (Sec) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 2-1 | | | | 1.4 | 1.9 | | | 5.5 | 5.5 | MIL |
| 2-2 | | | | .9 | .19 | | | 1.0 | 2.0 | MIL |
| 2-3 | 8,800 | - 3.0 | 1.7 | 1.7 | *2.6 | - 3.9 | 1.6 | .8 | .8 | MIL |
| 3-1 | 20,760 | 2.1 | 1.9 | 2.0 | 2.0 | - | - | NT | NT | MIL |
| 3-2 | 19,000 | 5.0 | 1.5 | 3.6 | 3.6 | - | - | NT | NT | MIL |
| 4-1 | 19,000 | 10.0 | 1.2 | *3.8 | 3.8 | - | - | NT | NT | MIL |
| 4-2 | 18,700 | 7.4 | 1.4 | 2.2 | 2.2 | - | - | NT | NT | MIL |
| 4-3 | 17,000 | 3.0 | 1.5 | 4.9 | 4.9 | - | - | NT | NT | MIL |
| 4-4 | 15,300 | 1.0 | 1.5 | 2.1 | 3.1 | - | - | NT | NT | MIL |
| 4-5 | 13,000 | - 1.0 | 2.3 | .5 | .5 | - | - | NT | NT | MIL |
| 5-1 | 16,000 | 3.5 | 1.7 | .6 | *3.5 | - | - | NL | NL | MIL |
| 5-2 | 15,000 | 2.0 | 1.7 | 1.2 | 1.2 | - | - | *6.8 | *6.8 | MIL |
| 5-3 | 12,000 | 1.4 | 1.4 | 1.0 | 1.0 | - 1.7 | 1.8 | 2.2 | *7.7 | MIL |
| 5-4 | 10,000 | - 2.4 | 2.2 | .5 | 1.4 | - 2.4 | 2.2 | .6 | 9.9 | MIL |
| 5-5 | 8,500 | - 2.4 | 3.0 | .6 | .6 | - 2.5 | 3.4 | 1.9 | 3.9 | MIL |
| 5-6 | 7,000 | - 2.8 | 2.1 | 1.0 | 1.0 | - 2.8 | 2.1 | 1.1 | 1.1 | MIL |
| 5-7 | 6,000 | - 3.0 | 2.5 | .6 | 2.8 | - 2.8 | 2.8 | 1.9 | 7.0 | MIL |
| 5-8 | 4,800 | - 2.2 | 1.7 | 1.8 | *4.2 | - 2.6 | 1.7 | 1.2 | 2.2 | MIL |
| 5-9 | 7,000 | - 0.5 | 2.4 | 1.4 | 1.4 | - 0.5 | 2.4 | .7 | 6.8 | MIL |
| 5-10 | 6,700 | - 2.1 | 2.0 | .9 | 4.0 | - 2.2 | 1.9 | 1.2 | 5.2 | MIL |
| 5-11 | 6,300 | - 2.5 | 3.0 | 3.0 | .9 | - | - | NL | NL | MIL |
| 5-12 | 5,000 | - 2.9 | 1.8 | 1.7 | *5.8 | - 2.6 | 1.8 | .8 | .8 | MIL |

NT - No Test
NL - No Lock-on

~~SECRET~~

Table XXI. Mission No. 2006, Project 4700Y086, 20 January 1970 (U) (Cont)

| | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $T_d$ (Sec) | | | | $T_d$ (Sec) | | |
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 5-13 | 5,300 | - 0.2 | 2.6 | 3.8 | 3.8 | 2.0 | 1.8 | 6.8 | 13.9 | MIL |
| 5-14 | 4,700 | - 1.7 | .9 | 1.9 | 2.9 | - .8 | 2.3 | 1.1 | 7.0 | MIL |
| 5-15 | 7,400 | - .8 | 1.7 | 1.4 | 1.4 | - 3.0 | 1.8 | .3 | 12.1 | MIL |
| 5-16 | 6,800 | -12.7 | 1.6 | .5 | 2.4 | -12.2 | 1.5 | .7 | 4.7 | MIL |
| 5-17 | 5,600 | -10.2 | 1.2 | 2.5 | 2.5 | -10.2 | 1.2 | 2.3 | 2.3 | MIL |
| 5-18 | 4,900 | - 9.8 | .4 | .9 | 2.8 | - 9.8 | .4 | 2.1 | 5.9 | MIL |
| 5-19 | 6,000 | -17.6 | 3.7 | 2.7 | 2.7 | -17.6 | 3.7 | .8 | 2.9 | MIL |
| 5-20 | 6,700 | -10.5 | 2.1 | .8 | .8 | -13.7 | 3.1 | 5.2 | 10.1 | MIL |
| 5-21 | 15,500 | -21.0 | 3.9 | 1.2 | *2.5 | -21.3 | 4.0 | .2 | .2 | MIL |
| 5-22 | 14,900 | -20.2 | 3.3 | 1.9 | 2.2 | -20.2 | 3.3 | 1.3 | 1.3 | MIL |
| 5-23 | 13,300 | -17.0 | 2.7 | *3.4 | *3.4 | -17.0 | 2.7 | NT | NT | MIL |
| 5-24 | 12,600 | -16.0 | 2.7 | .3 | *1.9 | -16.0 | 2.7 | .2 | .2 | MIL |
| 5-25 | 10,800 | -14.7 | 3.1 | 1.3 | 1.9 | -14.7 | 3.1 | .2 | .2 | MIL |
| 5-26 | 5,000 | - 4.0 | 3.0 | 1.2 | 1.2 | - 4.0 | 3.0 | NT | NT | MIL |

NT - No Test
NL - No Lock-on

~~SECRET~~

~~(SECRET)~~

Table XXII. Mission No. 3006, Project 4700Y086, 21 January 1970 (U)

|  |  | MISSILE NO. 1 |  |  |  |  | MISSILE NO. 2 |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | $T_d$ (Sec) |  |  |  | $T_d$ (Sec) |  |  |
| Run/ Pass | Range (Ft) | AZ (Deg) | EL (Deg) | Min. | Max. | AZ (Deg) | EL (Deg) | Min. | Max. | B-66 Power |
| 1-1 | - | - | - | .4 | .4 | - | - | 1.6 | 1.6 | CRU |
| 1-2 | - | - | - | .6 | .6 | - | - | .7 | 3.6 | CRU |
| 1-3 | - | - | - | 1.3 | 1.3 | - | - | .4 | .4 | CRU |
| 2-1 | 8,000 | 3.0 | 21.6 | 1.7 | 1.7 | 3.5 | 23.6 | .1 | .1 | CRU |
| 2-2 | 9,000 | 2.2 | 17.0 | .9 | .9 | 2.1 | 16.0 | 1.9 | 1.9 | CRU |
| 2-3 | 10,000 | 1.7 | 13.2 | .7 | .7 | 1.7 | 13.2 | .7 | .7 | CRU |
| 2-4 | 11,000 | 1.3 | 10.7 | .5 | .5 | 1.2 | 10.1 | 2.7 | 2.7 | CRU |
| 2-5 | 12,000 | .6 | 8.8 | .8 | .8 | .4 | 8.1 | 5.2 | 5.2 | CRU |
| 2-6 | 13,000 | .4 | 7.4 | .2 | .2 | .1 | 6.9 | 2.8 | 2.8 | CRU |
| 3-1 | 11,600 | .9 | 19.5 | .9 | .9 | .9 | 19.5 | .9 | 3.0 | CRU |
| 3-2 | 11,000 | 0 | 12.9 | 2.4 | 2.4 | - .2 | 12.5 | 3.5 | 3.5 | CRU |
| 3-3 | 10,000 | -1.0 | 9.2 | 2.2 | 2.2 | -1.0 | 9.2 | 2.2 | 2.2 | CRU |
| 3-4 | 9,400 | - .8 | 7.4 | .5 | .5 | -0.8 | 7.3 | .9 | .9 | CRU |
| 3-5 | 7,000 | -2.0 | 4.7 | 1.2 | 1.2 | -2.0 | 3.7 | .4 | 2.5 | CRU |
| 4-1 | 14,600 | -2.3 | 15.5 | .8 | .8 | -2.0 | 14.6 | 3.2 | 3.2 | CRU |
| 4-2 | 14,700 | -1.7 | 12.3 | 4.3 | 4.3 | -1.4 | 12.7 | 3.0 | 3.0 | CRU |
| 4-3 | 14,600 | -1.5 | 10.7 | .4 | .4 | -1.5 | 10.6 | 1.0 | 1.0 | CRU |
| 4-4 | 13,300 | -1.2 | 7.9 | 5.5 | 5.5 | -1.2 | 7.9 | 5.1 | 5.1 | CRU |
| 4-5 | 12,500 | - .6 | 7.5 | .4 | .4 | - .6 | 7.5 | 1.8 | 1.8 | CRU |
| 4-6 | 10,800 | - .6 | 6.2 | .8 | .8 | - .2 | 5.7 | 4.2 | 4.2 | CRU |
| 4-7 | 9,600 | .1 | 5.3 | .4 | .4 | .1 | 5.3 | .6 | .6 | CRU |
| 4-8 | 8,600 | .2 | 4.7 | .5 | .5 | .2 | 4.7 | .9 | .9 | CRU |
| 6-1 | 4,400 | - .7 | 5.7 | 6.1 | 6.1 | - .5 | 5.2 | 9.7 | 9.7 | CRU |
| 6-2 | 4,400 | - .3 | 5.6 | 23.2 | 23.2 | - .2 | 5.3 | 19.5 | 26.2 | MIL |
| 8-1 | 17,900 | -1.4 | 20.9 | 2.7 | 2.7 | - | - | NL | NL | MIL |

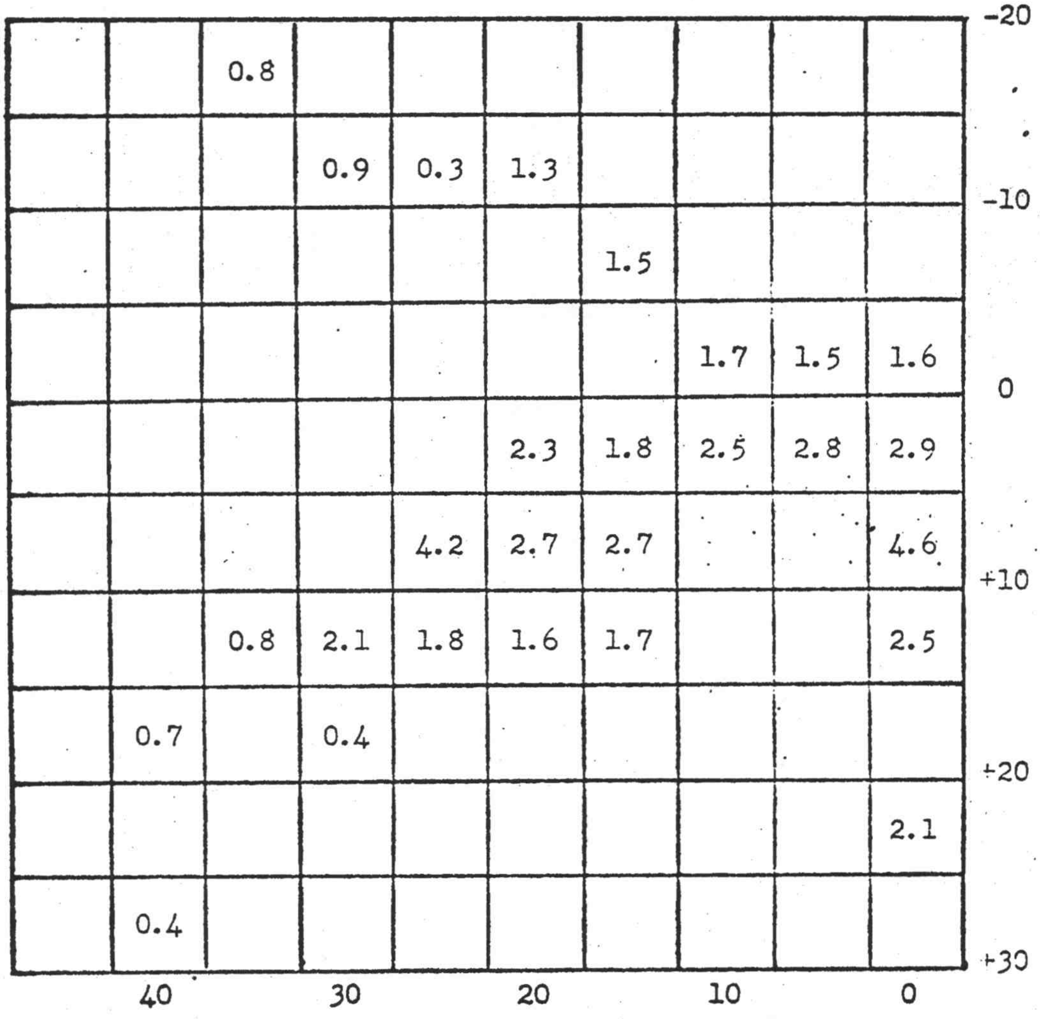
NL - No Lock-on

| | 40 | | 30 | | 20 | | 10 | | 0 | Elevation Angle-Degrees |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | | | | | | | | -20 |
| | | | 0.9 | 0.3 | 0.3 | | | | | -10 |
| | | | | | | 1.5 | | | | |
| | | | | | | | 1.7 | 1.5 | 1.6 | 0 |
| | | | | | 1.8 | 1.0 | 2.0 | 1.8 | 1.3 | |
| | | | | 2.1 | 2.1 | 2.7 | | | | +10 |
| | | 0.8 | 2.1 | 1.8 | 1.6 | 1.2 | | | 2.5 | |
| | 0.7 | | 0.4 | | | | | | | +20 |
| | | | | | | | | | 2.1 | |
| | 0.4 | | | | | | | | | +30 |

Azimuth Angle-Degrees

Figure 49. Average $T_d$(MIN)-Seconds, Missile No. 1, Military Power (U)

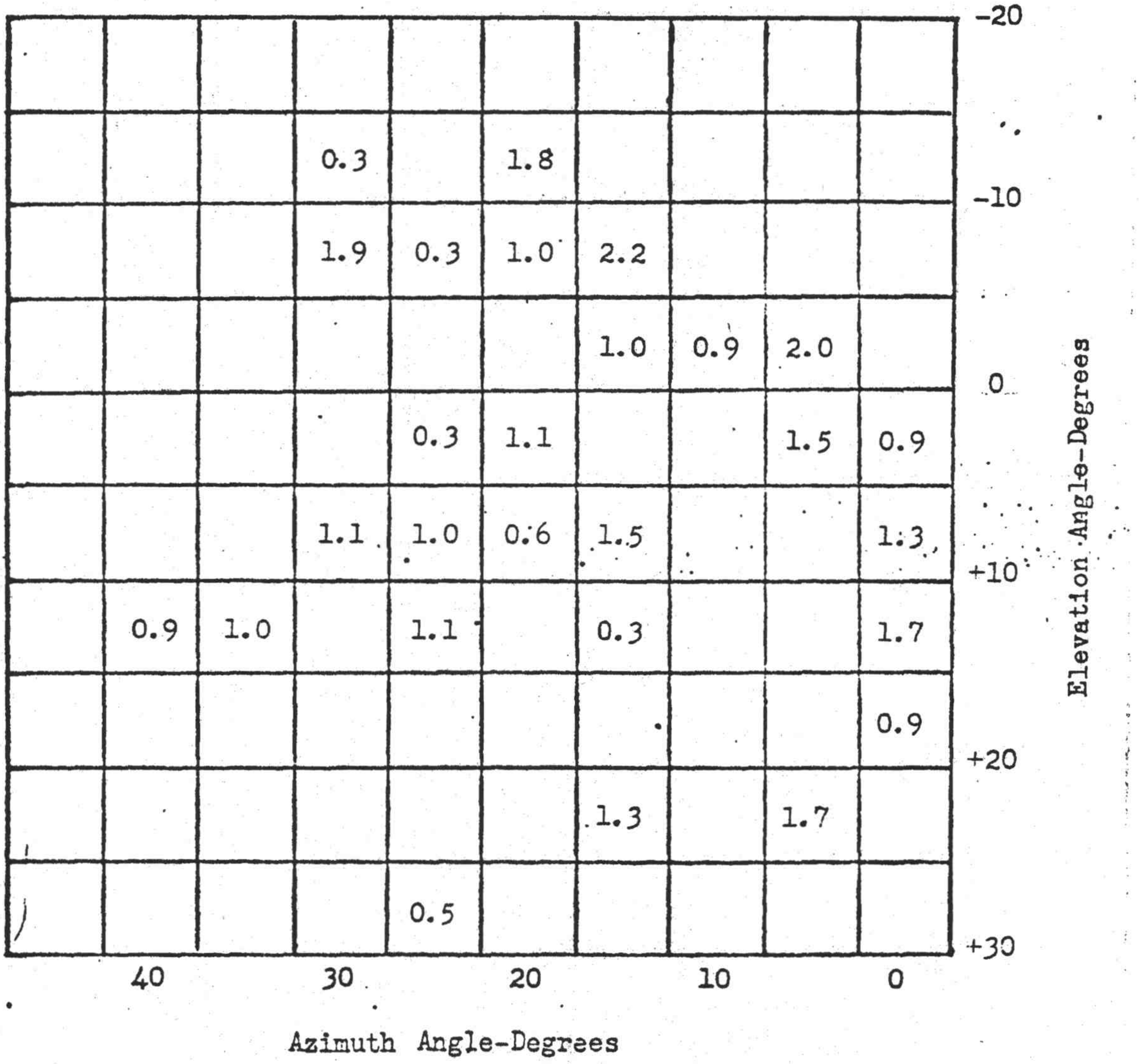
~~(SECRET)~~



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | | | | | | | |
| | | | 0.9 | 0.3 | 1.3 | | | | |
| | | | | | | 1.5 | | | |
| | | | | | | | 1.7 | 1.5 | 1.6 |
| | | | | | 2.3 | 1.8 | 2.5 | 2.8 | 2.9 |
| | | | | 4.2 | 2.7 | 2.7 | | | 4.6 |
| | | 0.8 | 2.1 | 1.8 | 1.6 | 1.7 | | | 2.5 |
| | 0.7 | | 0.4 | | | | | | |
| | | | | | | | | | 2.1 |
| | 0.4 | | | | | | | | |

Figure 50. Average $T_d$(MAX)-Seconds, Missile No. 1, Military Power (U)

~~(SECRET)~~

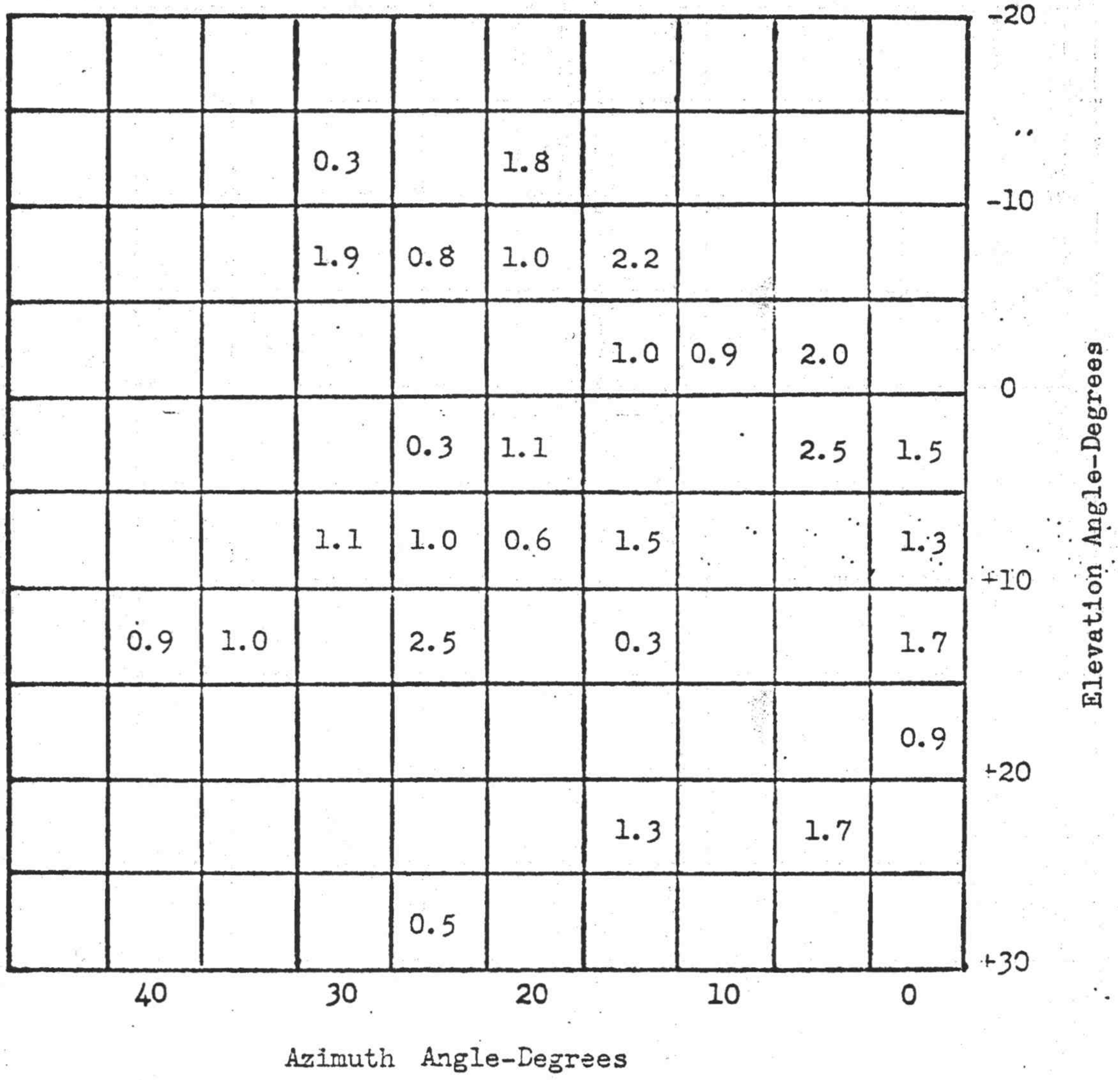


|  | 40 |  | 30 |  | 20 |  | 10 |  | 0 | Elevation Angle-Degrees |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  | -20 |
|  |  |  | 0.3 |  | 1.8 |  |  |  |  |  |
|  |  |  | 1.9 | 0.3 | 1.0 | 2.2 |  |  |  | -10 |
|  |  |  |  |  |  | 1.0 | 0.9 | 2.0 |  |  |
|  |  |  |  | 0.3 | 1.1 |  |  | 1.5 | 0.9 | 0 |
|  |  |  | 1.1 | 1.0 | 0.6 | 1.5 |  |  | 1.3 |  |
|  | 0.9 | 1.0 |  | 1.1 |  | 0.3 |  |  | 1.7 | +10 |
|  |  |  |  |  |  |  |  |  | 0.9 |  |
|  |  |  |  |  |  | 1.3 |  | 1.7 |  | +20 |
|  |  |  |  | 0.5 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  | +30 |

Azimuth Angle-Degrees

Figure 51. Average $T_d$(MIN)-Seconds, Missile No. 1, Cruise Power (U)

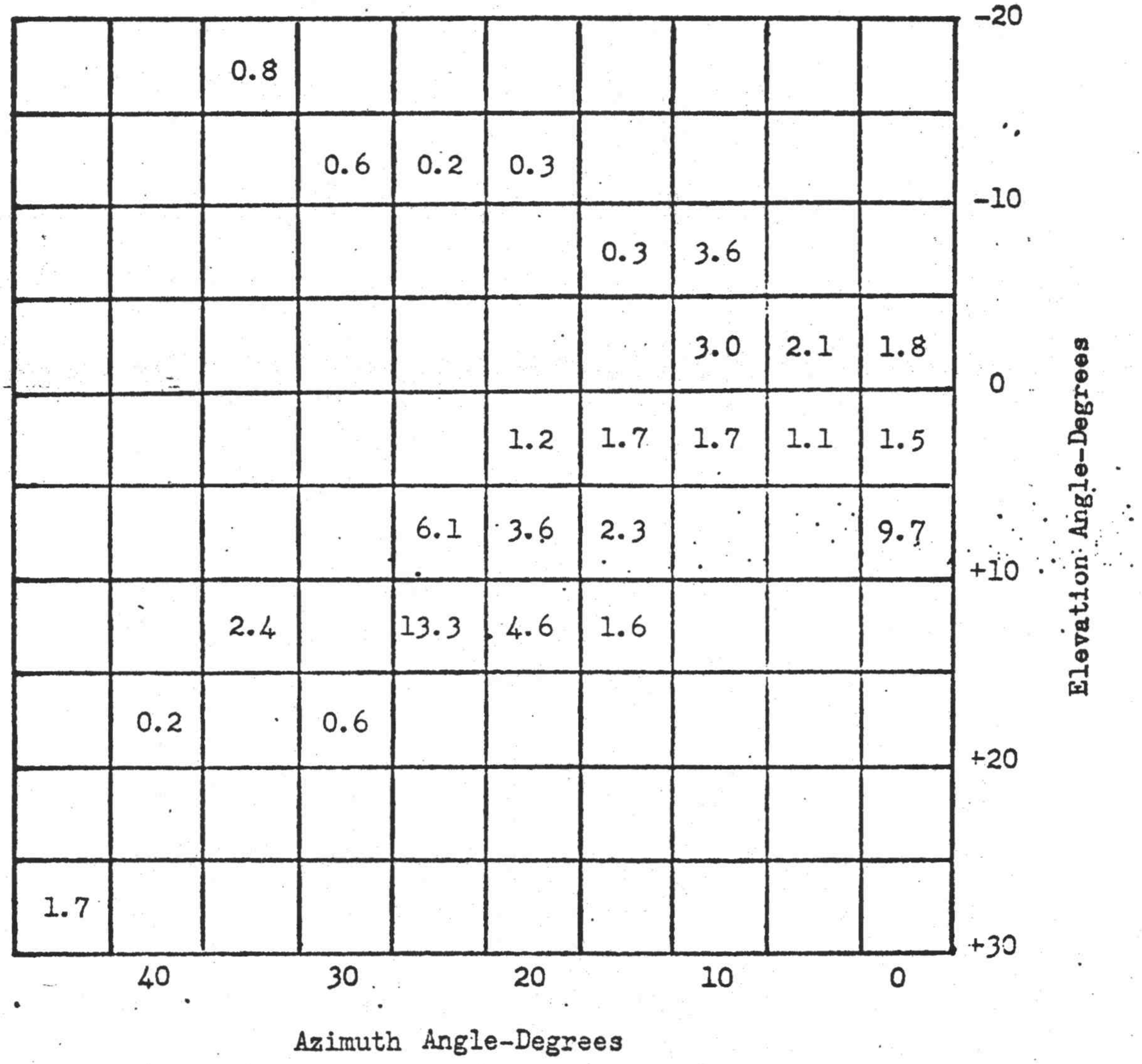
~~(SECRET)~~



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | 0.3 | | 1.8 | | | | |
| | | | 1.9 | 0.8 | 1.0 | 2.2 | | | |
| | | | | | | 1.0 | 0.9 | 2.0 | |
| | | | | 0.3 | 1.1 | | | 2.5 | 1.5 |
| | | | 1.1 | 1.0 | 0.6 | 1.5 | | | 1.3 |
| | 0.9 | 1.0 | | 2.5 | | 0.3 | | | 1.7 |
| | | | | | | | | | 0.9 |
| | | | | | | 1.3 | | 1.7 | |
| | | | | 0.5 | | | | | |

Figure 52. Average $T_d$(MAX)-Seconds, Missile No. 1, Cruise Power (U)

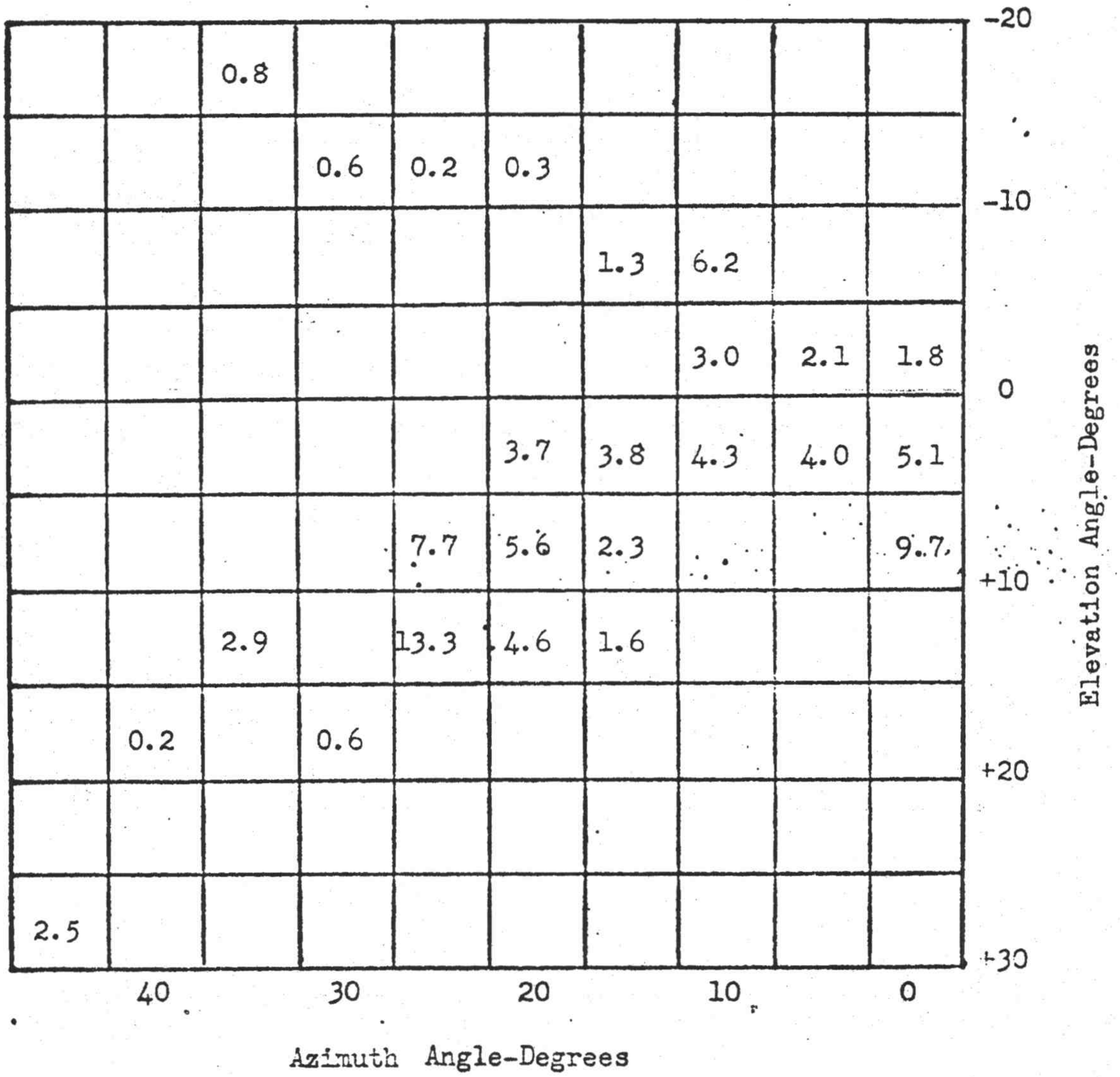
~~(SECRET)~~



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | | | | | | | |
| | | | 0.6 | 0.2 | 0.3 | | | | |
| | | | | | | 0.3 | 3.6 | | |
| | | | | | | | 3.0 | 2.1 | 1.8 |
| | | | | | 1.2 | 1.7 | 1.7 | 1.1 | 1.5 |
| | | | | 6.1 | 3.6 | 2.3 | | | 9.7 |
| | | 2.4 | | 13.3 | 4.6 | 1.6 | | | |
| | 0.2 | | 0.6 | | | | | | |
| | | | | | | | | | |
| 1.7 | | | | | | | | | |

Figure 53. Average $T_d$(MIN)-Seconds, Missile No. 2, Military Power (U)

~~(SECRET)~~



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | | | | | | | |
| | | | 0.6 | 0.2 | 0.3 | | | | |
| | | | | | | 1.3 | 6.2 | | |
| | | | | | | | 3.0 | 2.1 | 1.8 |
| | | | | | 3.7 | 3.8 | 4.3 | 4.0 | 5.1 |
| | | | | 7.7 | 5.6 | 2.3 | | | 9.7 |
| | | 2.9 | | 13.3 | 4.6 | 1.6 | | | |
| | 0.2 | | 0.6 | | | | | | |
| | | | | | | | | | |
| 2.5 | | | | | | | | | |

Figure 54. Average $T_d$(MAX)-Seconds, Missile No. 2, Military Power (U)

~~(SECRET)~~

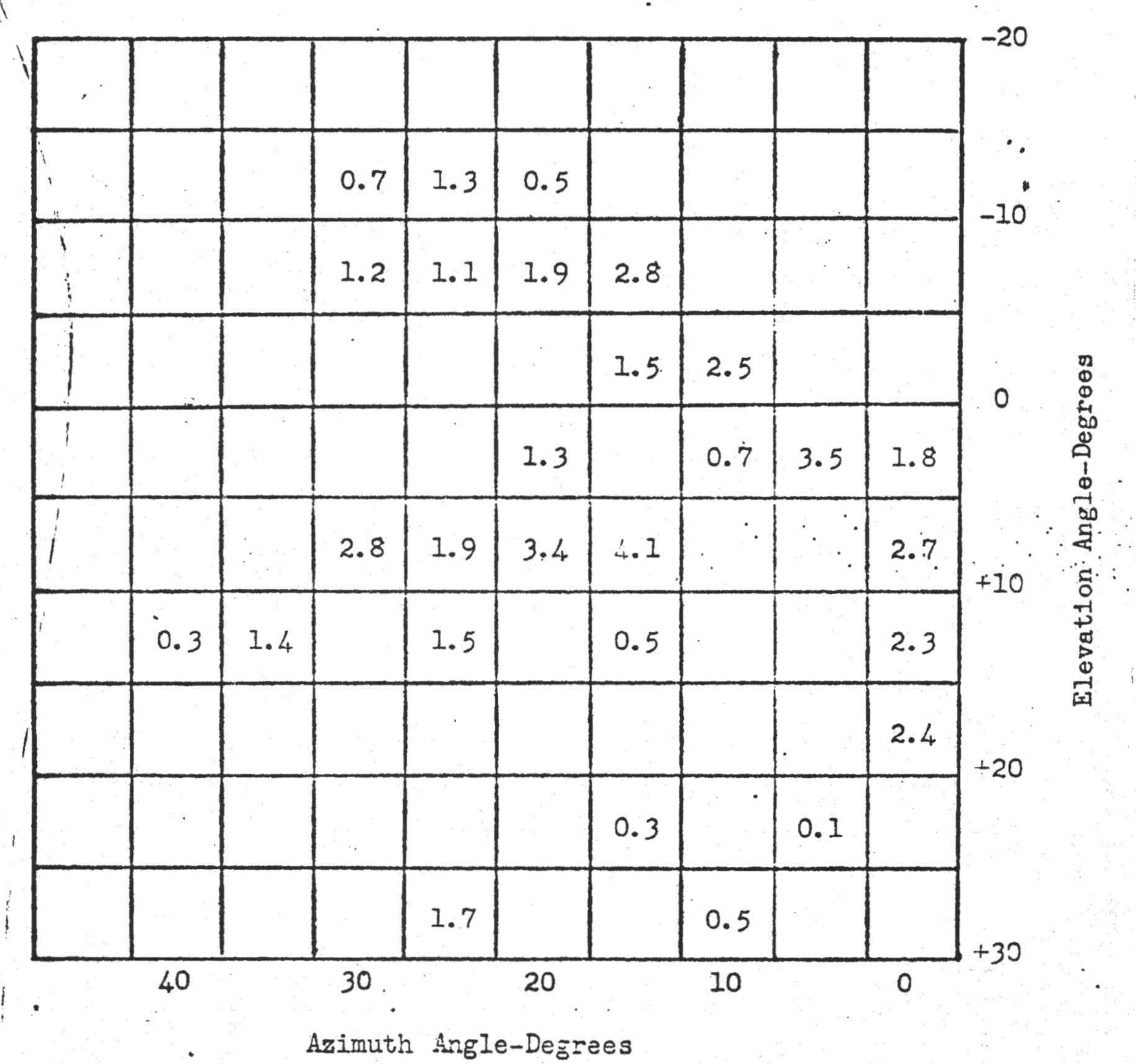
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | -20 |
| | | | 0.7 | 1.3 | 0.5 | | | | | -10 |
| | | | 0.5 | 1.1 | 0.9 | 0.3 | | | | |
| | | | | | | 0.2 | 1.1 | | | 0 |
| | | | | | 0.5 | | 0.7 | 3.5 | 0.7 | |
| | | | 1.4 | 0.9 | 0.5 | 0.7 | | | 2.7 | +10 |
| | 0.3 | 1.4 | | 0.2 | | 0.5 | | | 2.3 | |
| | | | | | | | | | 1.4 | +20 |
| | | | | | | 0.3 | | 0.1 | | |
| | | | | 1.7 | | | 0.5 | | | +30 |
| | 40 | | 30 | | 20 | | 10 | | 0 | |

Azimuth Angle-Degrees

Elevation Angle-Degrees

Figure 55. Average $T_d$(MIN)-Seconds, Missile No. 2, Cruise Power (U)

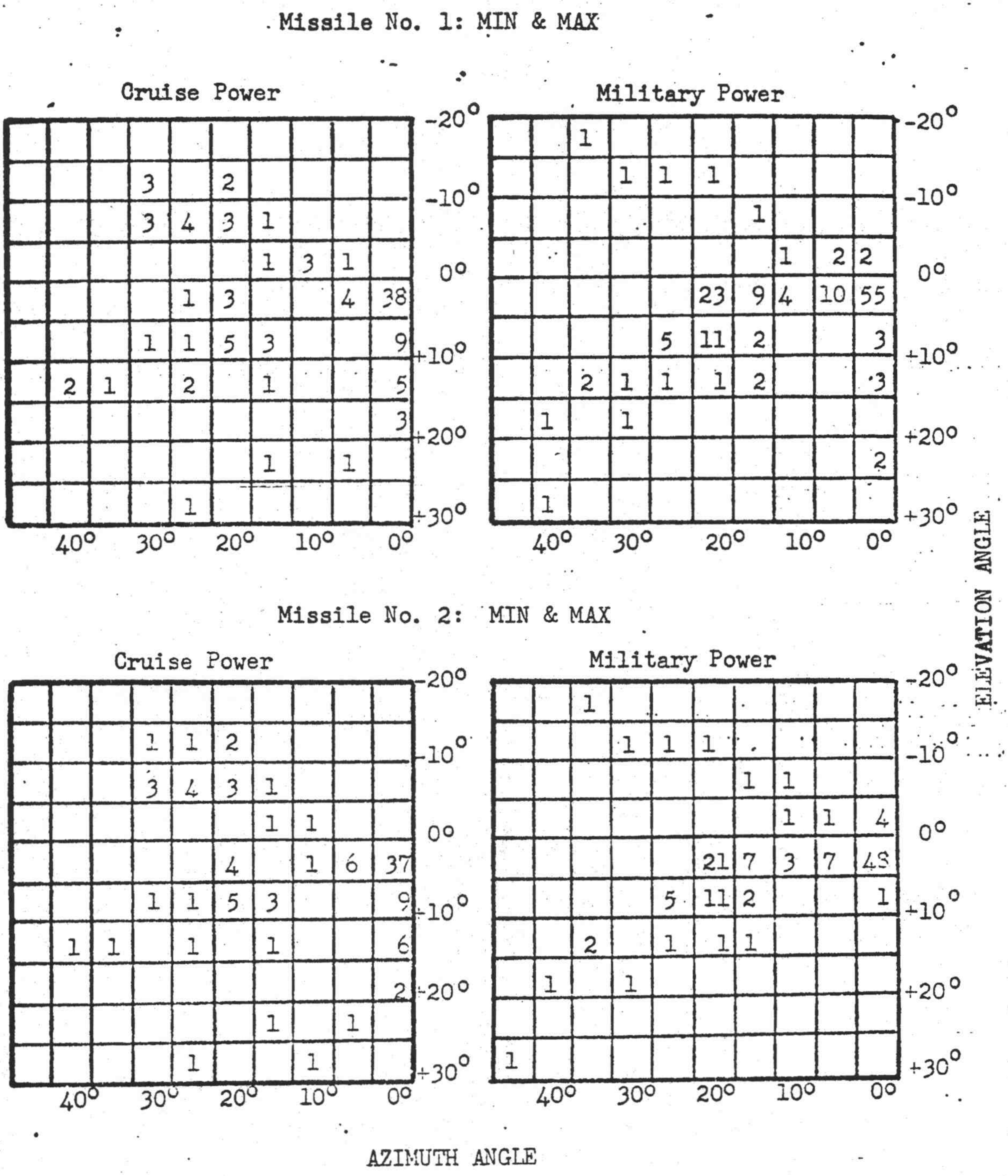
~~(SECRET)~~



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | 0.7 | 1.3 | 0.5 | | | | |
| | | | 1.2 | 1.1 | 1.9 | 2.8 | | | |
| | | | | | | 1.5 | 2.5 | | |
| | | | | | 1.3 | | 0.7 | 3.5 | 1.8 |
| | | | 2.8 | 1.9 | 3.4 | 4.1 | | | 2.7 |
| | 0.3 | 1.4 | | 1.5 | | 0.5 | | | 2.3 |
| | | | | | | | | | 2.4 |
| | | | | | | 0.3 | | 0.1 | |
| | | | | 1.7 | | | 0.5 | | |

Figure 56. Average $T_d$(MAX)-Seconds, Missile No. 2, Cruise Power (U)

~~(SECRET)~~



Missile No. 1: MIN & MAX

Cruise Power

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | 3 | | 2 | | | | |
| | | | 3 | 4 | 3 | 1 | | | |
| | | | | | | 1 | 3 | 1 | |
| | | | | 1 | 3 | | | 4 | 38 |
| | | | 1 | 1 | 5 | 3 | | | 9 |
| | 2 | 1 | | 2 | | 1 | | | 5 |
| | | | | | | | | | 3 |
| | | | | | | 1 | | 1 | |
| | | | | 1 | | | | | |

Military Power

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | | | | | | |
| | | | 1 | 1 | 1 | | | | |
| | | | | | | 1 | | | |
| | | | | | | | 1 | 2 | 2 |
| | | | | | 23 | 9 | 4 | 10 | 55 |
| | | | | 5 | 11 | 2 | | | 3 |
| | | 2 | 1 | 1 | 1 | 2 | | | 3 |
| | 1 | | 1 | | | | | | |
| | | | | | | | | | 2 |
| | 1 | | | | | | | | |

Missile No. 2: MIN & MAX

Cruise Power

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | 1 | 1 | 2 | | | | |
| | | | 3 | 4 | 3 | 1 | | | |
| | | | | | | 1 | 1 | | |
| | | | | | 4 | | 1 | 6 | 37 |
| | | | 1 | 1 | 5 | 3 | | | 9 |
| | 1 | 1 | | 1 | | 1 | | | 6 |
| | | | | | | | | | 2 |
| | | | | | | 1 | | 1 | |
| | | | | 1 | | | 1 | | |

Military Power

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | | | | | | |
| | | | 1 | 1 | 1 | | | | |
| | | | | | | 1 | 1 | | |
| | | | | | | | 1 | 1 | 4 |
| | | | | | 21 | 7 | 3 | 7 | 48 |
| | | | | 5 | 11 | 2 | | | 1 |
| | | 2 | | 1 | 1 | 1 | | | |
| | 1 | | 1 | | | | | | |
| | | | | | | | | | |
| 1 | | | | | | | | | |

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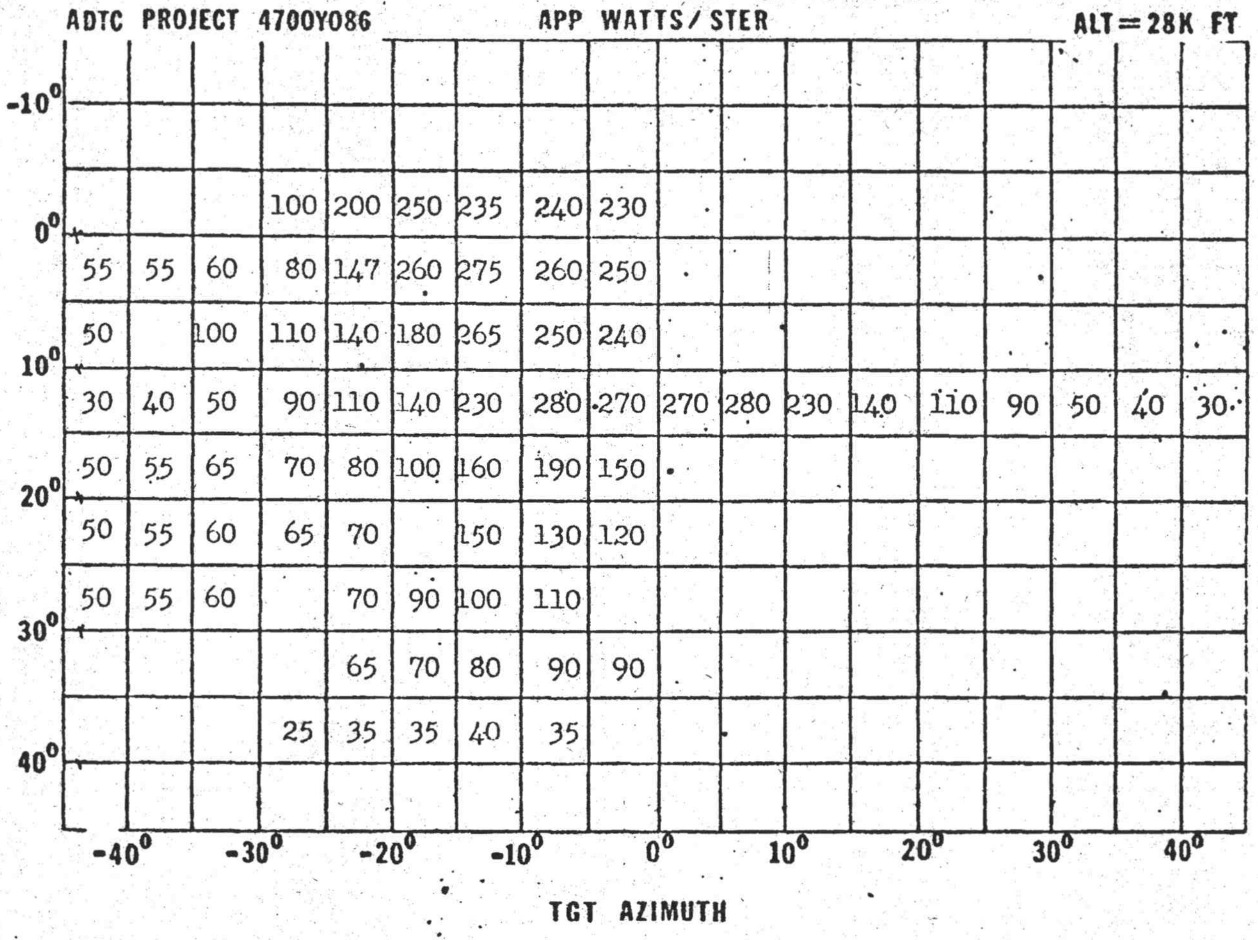
Figure 57. Number of Data Samples Used in Average $T_d$ Computations (U)

**ADTC PROJECT 4700Y086** **APP WATTS/STER** **ALT = 28K FT**



| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 100 | 200 | 250 | 235 | 240 | 230 | | | | | | | | | |
| 55 | 55 | 60 | 80 | 147 | 260 | 275 | 260 | 250 | | | | | | | | | |
| 50 | | 100 | 110 | 140 | 180 | 265 | 250 | 240 | | | | | | | | | |
| 30 | 40 | 50 | 90 | 110 | 140 | 230 | 280 | 270 | 270 | 280 | 230 | 140 | 110 | 90 | 50 | 40 | 30 |
| 50 | 55 | 65 | 70 | 80 | 100 | 160 | 190 | 150 | | | | | | | | | |
| 50 | 55 | 60 | 65 | 70 | | 150 | 130 | 120 | | | | | | | | | |
| 50 | 55 | 60 | | 70 | 90 | 100 | 110 | | | | | | | | | | |
| | | | | 65 | 70 | 80 | 90 | 90 | | | | | | | | | |
| | | | 25 | 35 | 35 | 40 | 35 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

Figure 58. Short Wavelength EB-66 Cruise Power Infrared Radiation Matrix (U)

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**ADTC PROJECT 4700Y086** **APP WATTS/STER** **ALT=28K FT**

TGT ELEVATION

|  |  | -40° |  | -30° |  | -20° |  | -10° |  | 0° |  | 10° |  | 20° |  | 30° |  | 40° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| -10° |  |  |  | 145 | 250 | 335 | 320 | 380 | 400 |  |  |  |  |  |  |  |  |  |
|  |  | 105 | 125 | 145 | 210 | 320 | 400 | 300 | 400 |  |  |  |  |  |  |  |  |  |
| 0° |  | 122 | 146 | 190 | 250 | 480 | 520 | 400 | 350 |  |  |  |  |  |  |  |  |  |
|  |  |  |  | 224 | 402 | 500 | 410 | 380 | 260 |  |  |  |  |  |  |  |  |  |
| 10° |  | 155 | 210 | 240 | 300 | 490 | 550 | 640 | 620 | 620 | 640 | 550 | 490 | 300 | 240 | 210 | 155 |  |
|  |  | 135 | 200 | 235 | 265 |  | 570 | 620 | 540 |  |  |  |  |  |  |  |  |  |
| 20° |  | 130 | 140 | 145 | 225 | 245 | 290 | 310 | 520 |  |  |  |  |  |  |  |  |  |
|  | 70 | 90 | 115 | 125 | 135 | 150 | 160 | 300 | 340 |  |  |  |  |  |  |  |  |  |
| 30° | 65 | 70 | 80 | 110 | 120 | 135 |  |  | 320 |  |  |  |  |  |  |  |  |  |
|  |  | 70 | 80 | 90 | 110 | 120 | 140 | 160 | 220 |  |  |  |  |  |  |  |  |  |
| 40° |  |  |  | 80 | 80 |  |  | 120 |  |  |  |  |  |  |  |  |  |  |

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Figure 59. Short Wavelength EB-66 Military Power Infrared Radiation Matrix (U)

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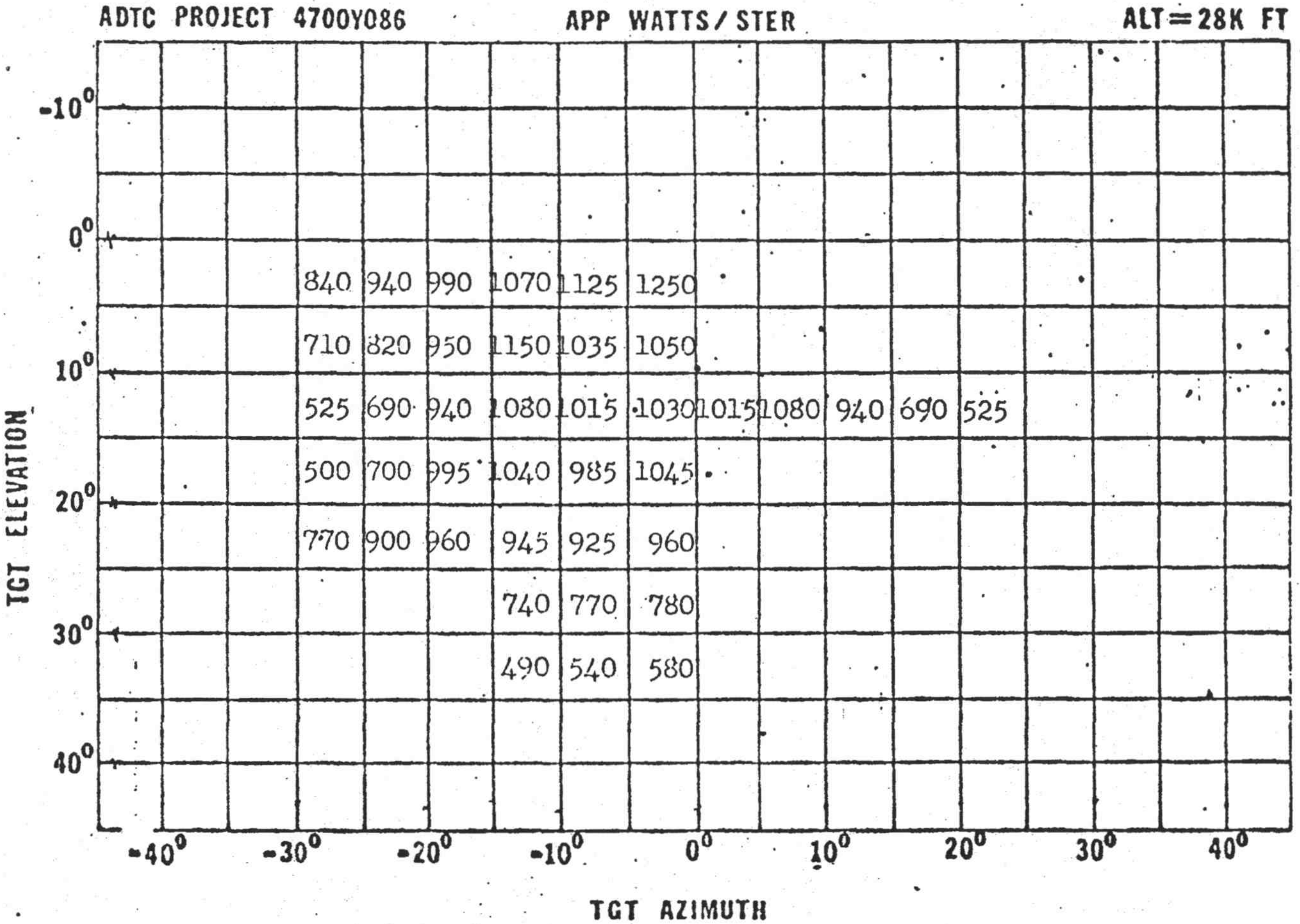

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 840 | 940 | 990 | 1070 | 1125 | 1250 | | | | | |
| 710 | 820 | 950 | 1150 | 1035 | 1050 | | | | | |
| 525 | 690 | 940 | 1080 | 1015 | 1030 | 1015 | 1080 | 940 | 690 | 525 |
| 500 | 700 | 995 | 1040 | 985 | 1045 | | | | | |
| 770 | 900 | 960 | 945 | 925 | 960 | | | | | |
| | | | 740 | 770 | 780 | | | | | |
| | | | 490 | 540 | 580 | | | | | |

Figure 60. Short Wavelength AAQ-4 Infrared Radiation Matrix (U)

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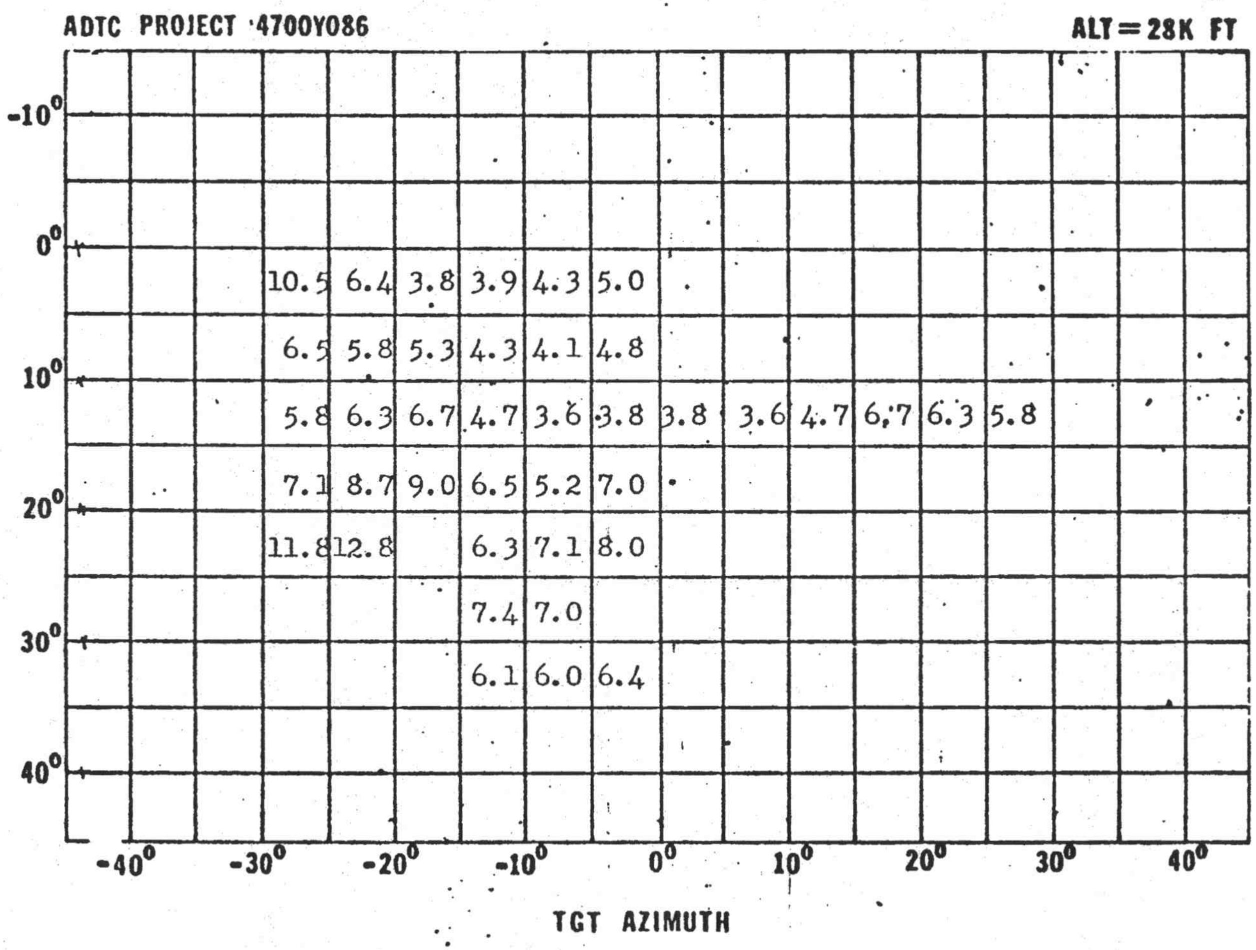

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 10.5 | 6.4 | 3.8 | 3.9 | 4.3 | 5.0 | | | | | | | | | |
| | | | 6.5 | 5.8 | 5.3 | 4.3 | 4.1 | 4.8 | | | | | | | | | |
| | | | 5.8 | 6.3 | 6.7 | 4.7 | 3.6 | 3.8 | 3.8 | 3.6 | 4.7 | 6.7 | 6.3 | 5.8 | | | |
| | | | 7.1 | 8.7 | 9.0 | 6.5 | 5.2 | 7.0 | | | | | | | | | |
| | | | 11.8 | 12.8 | | 6.3 | 7.1 | 8.0 | | | | | | | | | |
| | | | | | | 7.4 | 7.0 | | | | | | | | | | |
| | | | | | | 6.1 | 6.0 | 6.4 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

Figure 61. Short Wavelength Cruise Power J/S Ratio Matrix (U)

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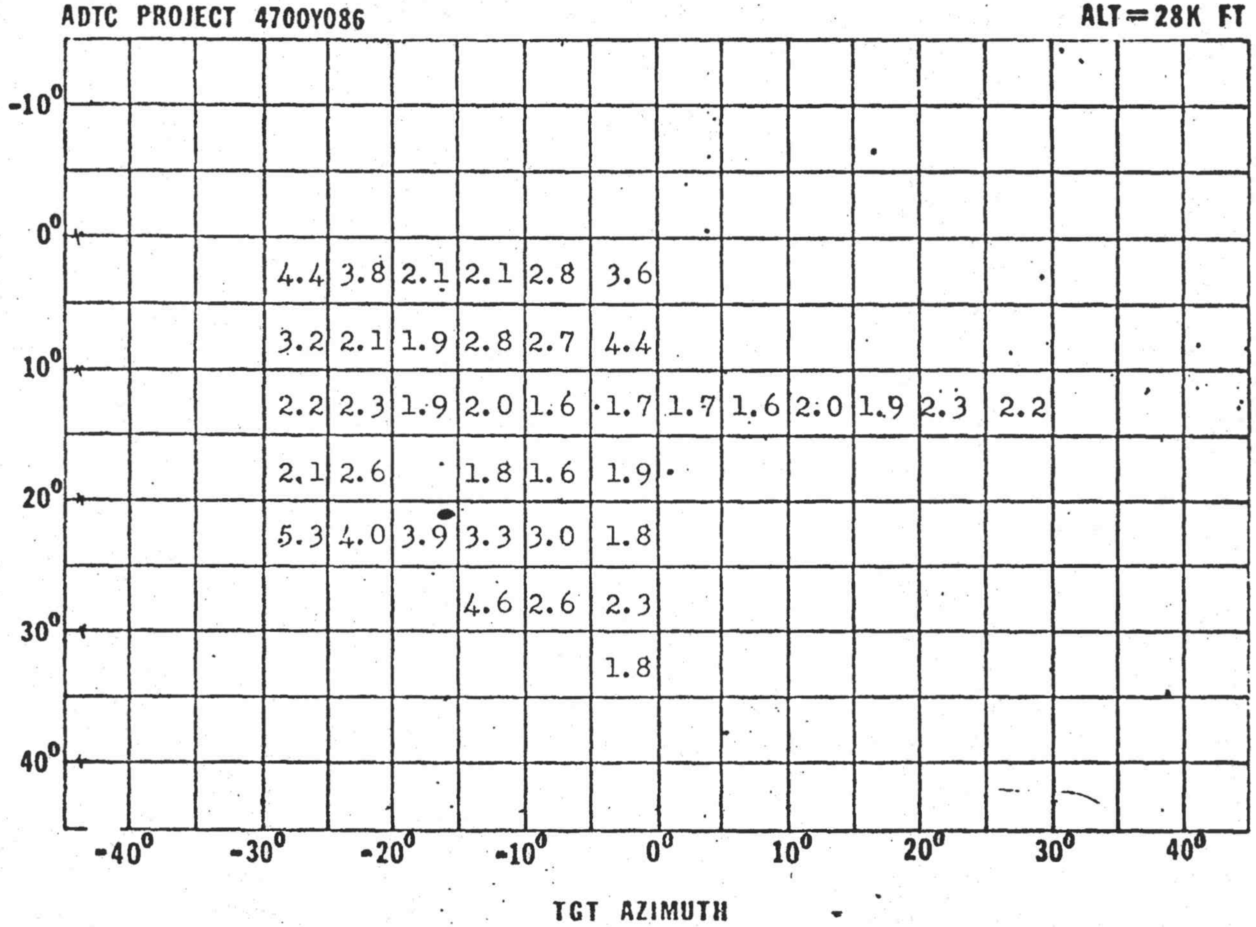

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.4 | 3.8 | 2.1 | 2.1 | 2.8 | 3.6 | | | | | | |
| 3.2 | 2.1 | 1.9 | 2.8 | 2.7 | 4.4 | | | | | | |
| 2.2 | 2.3 | 1.9 | 2.0 | 1.6 | 1.7 | 1.7 | 1.6 | 2.0 | 1.9 | 2.3 | 2.2 |
| 2.1 | 2.6 | | 1.8 | 1.6 | 1.9 | | | | | | |
| 5.3 | 4.0 | 3.9 | 3.3 | 3.0 | 1.8 | | | | | | |
| | | | 4.6 | 2.6 | 2.3 | | | | | | |
| | | | | | 1.8 | | | | | | |

Figure 62. Short Wavelength Military Power J/S Ratio Matrix (U)

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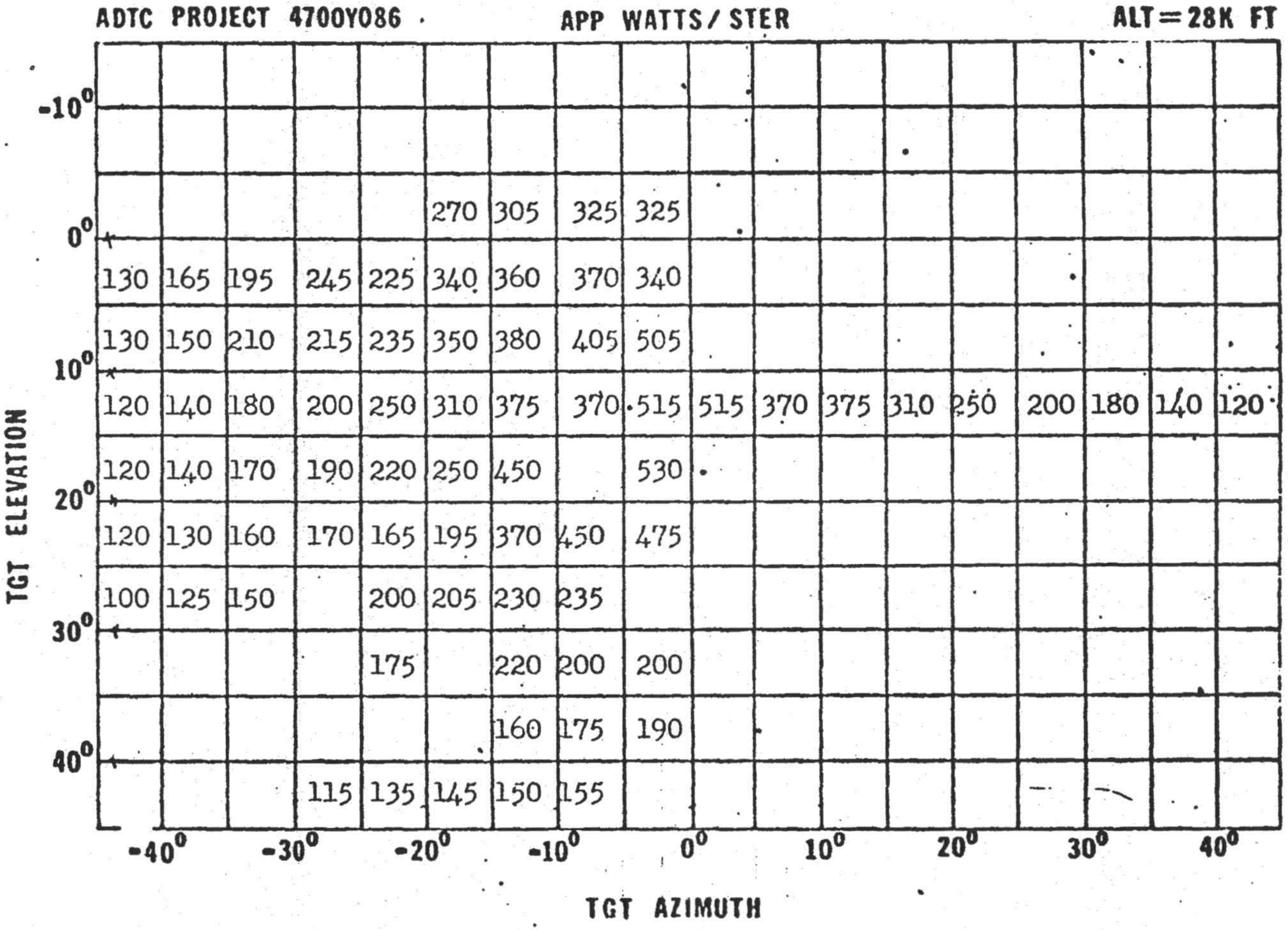

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | 270 | 305 | 325 | 325 | | | | | | | | | |
| 130 | 165 | 195 | 245 | 225 | 340 | 360 | 370 | 340 | | | | | | | | | |
| 130 | 150 | 210 | 215 | 235 | 350 | 380 | 405 | 505 | | | | | | | | | |
| 120 | 140 | 180 | 200 | 250 | 310 | 375 | 370 | 515 | 515 | 370 | 375 | 310 | 250 | 200 | 180 | 140 | 120 |
| 120 | 140 | 170 | 190 | 220 | 250 | 450 | | 530 | | | | | | | | | |
| 120 | 130 | 160 | 170 | 165 | 195 | 370 | 450 | 475 | | | | | | | | | |
| 100 | 125 | 150 | | 200 | 205 | 230 | 235 | | | | | | | | | | |
| | | | | 175 | | 220 | 200 | 200 | | | | | | | | | |
| | | | | | | 160 | 175 | 190 | | | | | | | | | |
| | | | 115 | 135 | 145 | 150 | 155 | | | | | | | | | | |

Figure 63. Long Wavelength EB-66 Cruise Power Infrared Radiation Matrix (U)

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ADTC PROJECT 4700Y086 APP WATTS/STER ALT=28K FT

TGT ELEVATION: -10°, 0°, 10°, 20°, 30°, 40°

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 225 | 285 | 390 | 515 | 600 | 650 | 665 |  |  |  |  |  |  |  |  |  |
|  | 210 | 260 | 275 | 350 | 525 | 680 | 740 | 690 |  |  |  |  |  |  |  |  |  |
|  |  | 200 | 265 | 420 | 580 | 805 | 800 | 740 |  |  |  |  |  |  |  |  |  |
|  |  |  | 410 | 632 | 770 | 840 | 755 | 700 |  |  |  |  |  |  |  |  |  |
|  | 350 | 400 | 435 | 555 | 670 | 800 | 825 | 865 | 865 | 825 | 800 | 670 | 555 | 435 | 400 | 350 |  |
|  |  | 385 | 480 | 485 | 595 | 730 | 765 | 780 |  |  |  |  |  |  |  |  |  |
|  | 164 | 255 | 385 | 470 | 515 | 550 | 545 | 650 |  |  |  |  |  |  |  |  |  |
| 145 | 150 | 225 | 336 | 420 | 450 | 450 | 480 | 500 |  |  |  |  |  |  |  |  |  |
| 135 | 140 | 167 | 236 | 250 | 270 |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 135 | 160 | 170 | 195 | 200 | 400 | 465 | 480 |  |  |  |  |  |  |  |  |  |
|  |  | 138 | 144 | 150 | 170 |  | 386 |  |  |  |  |  |  |  |  |  |  |

-40° -30° -20° -10° 0° 10° 20° 30° 40°

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Figure 64. Long Wavelength EB-66 Military Power Infrared Radiation Matrix (U)

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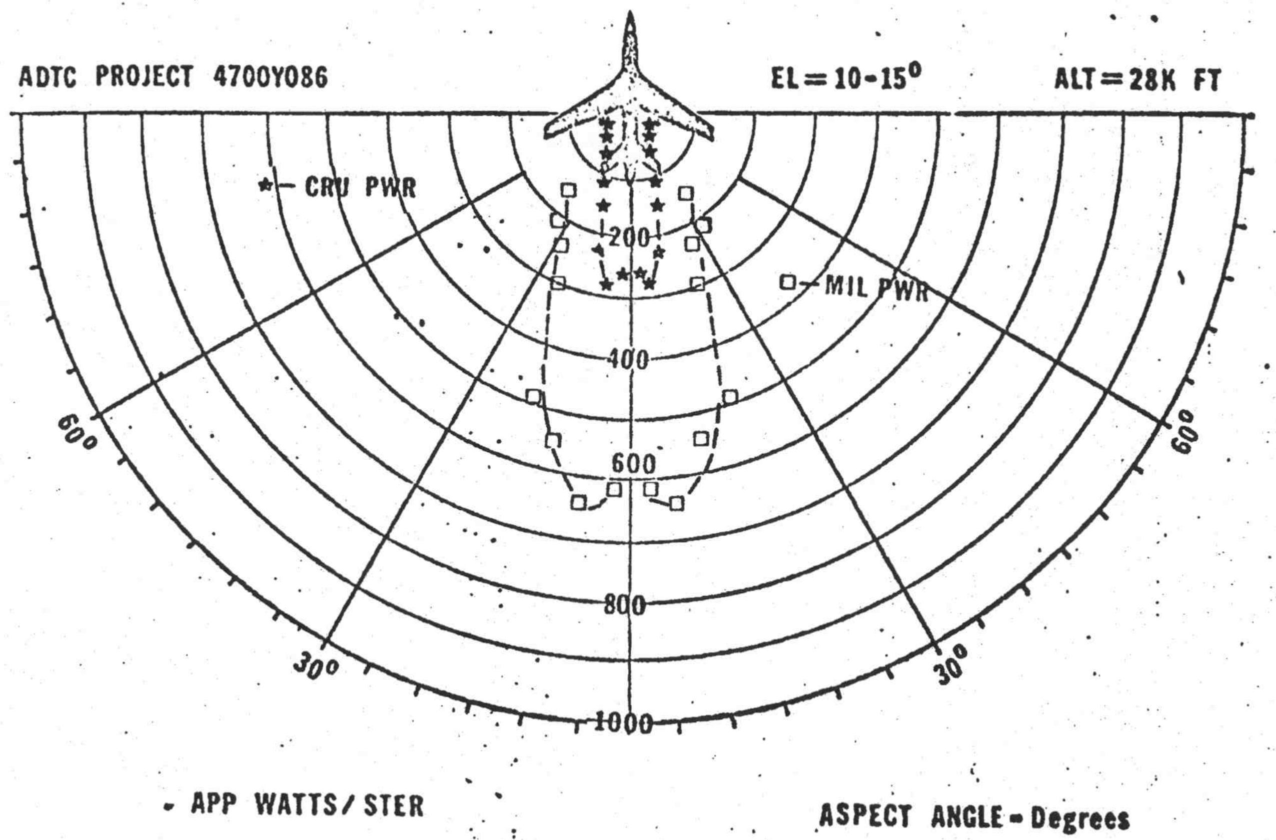

Figure 65. Short Wavelength EB-66 Infrared Radiation Profile (U)

~~(SECRET)~~

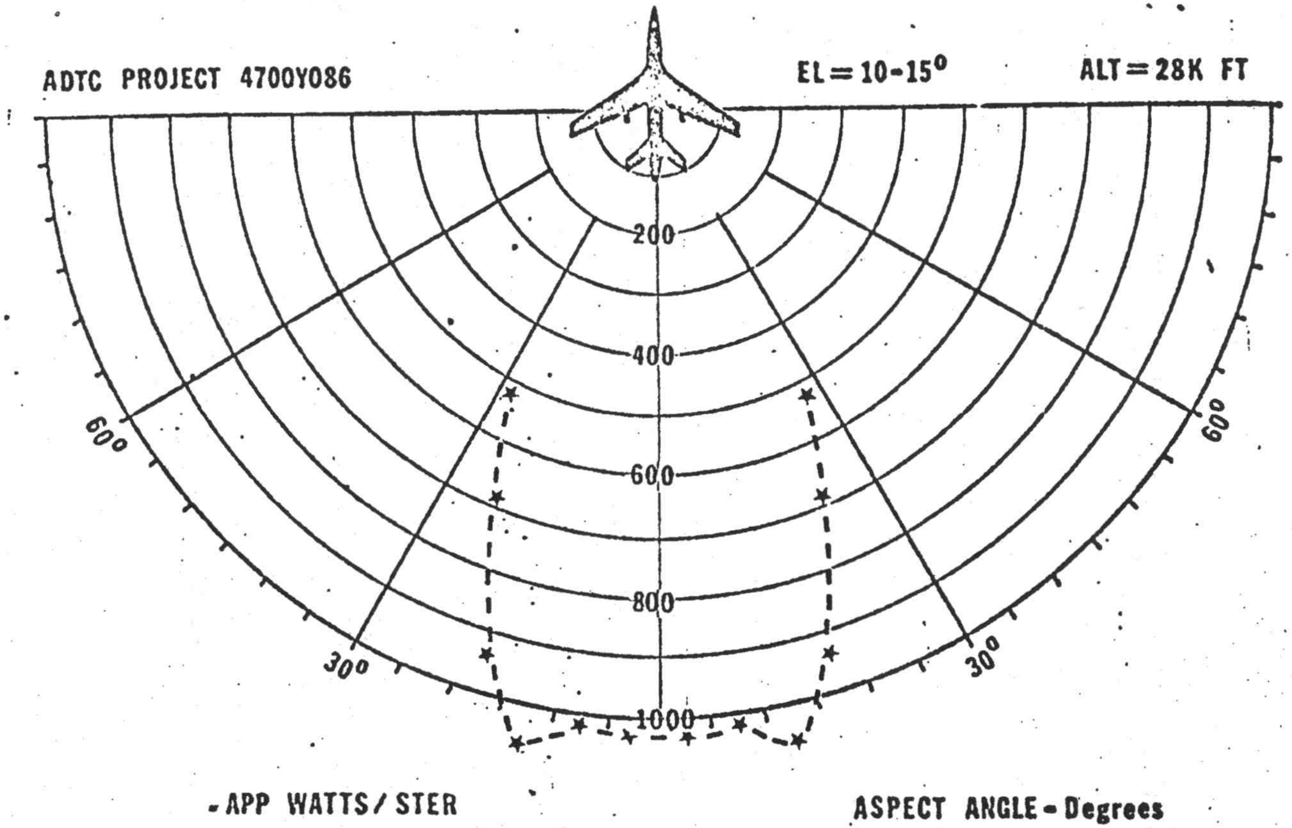

Figure 66. Short Wavelength AAQ-4 Infrared Radiation Profile (U)

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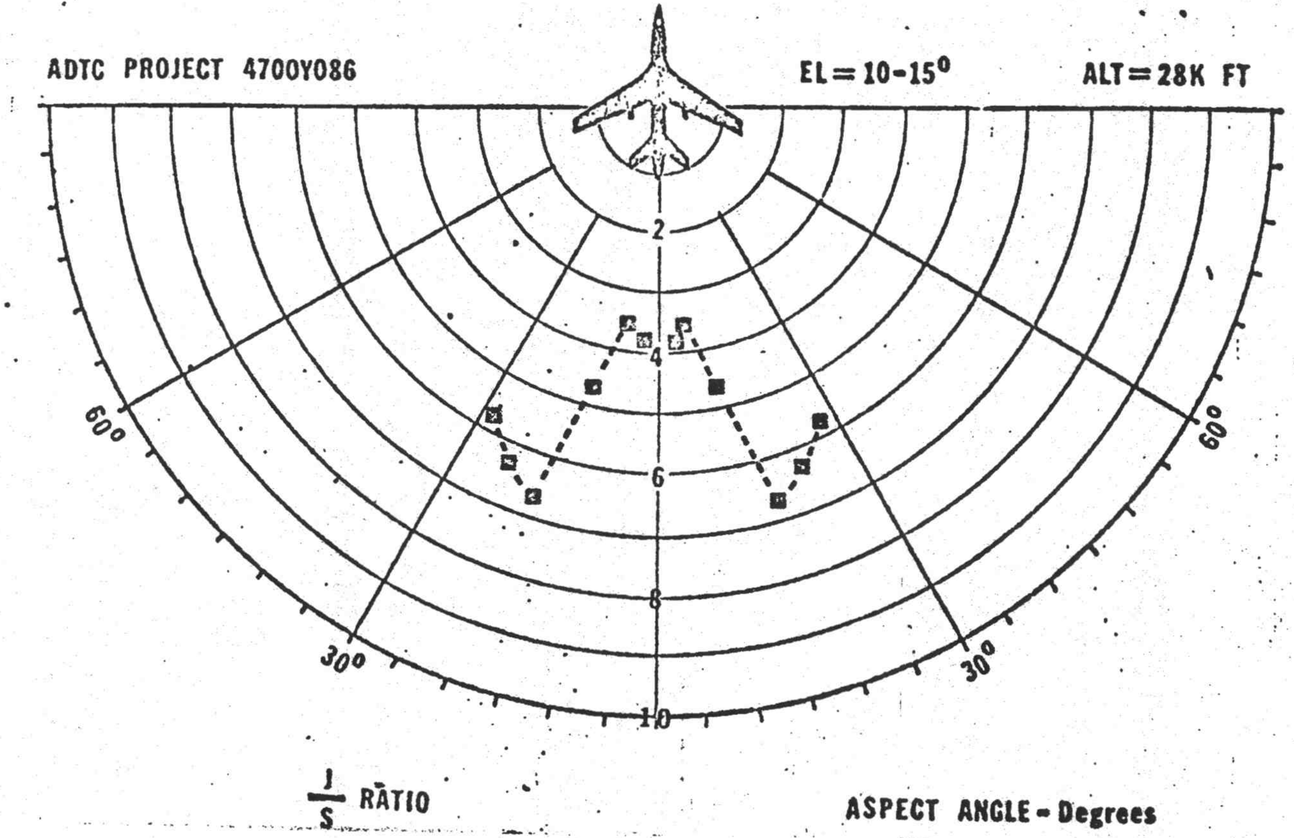

Figure 67. Short Wavelength Cruise Power J/S Ratio Profile (U)

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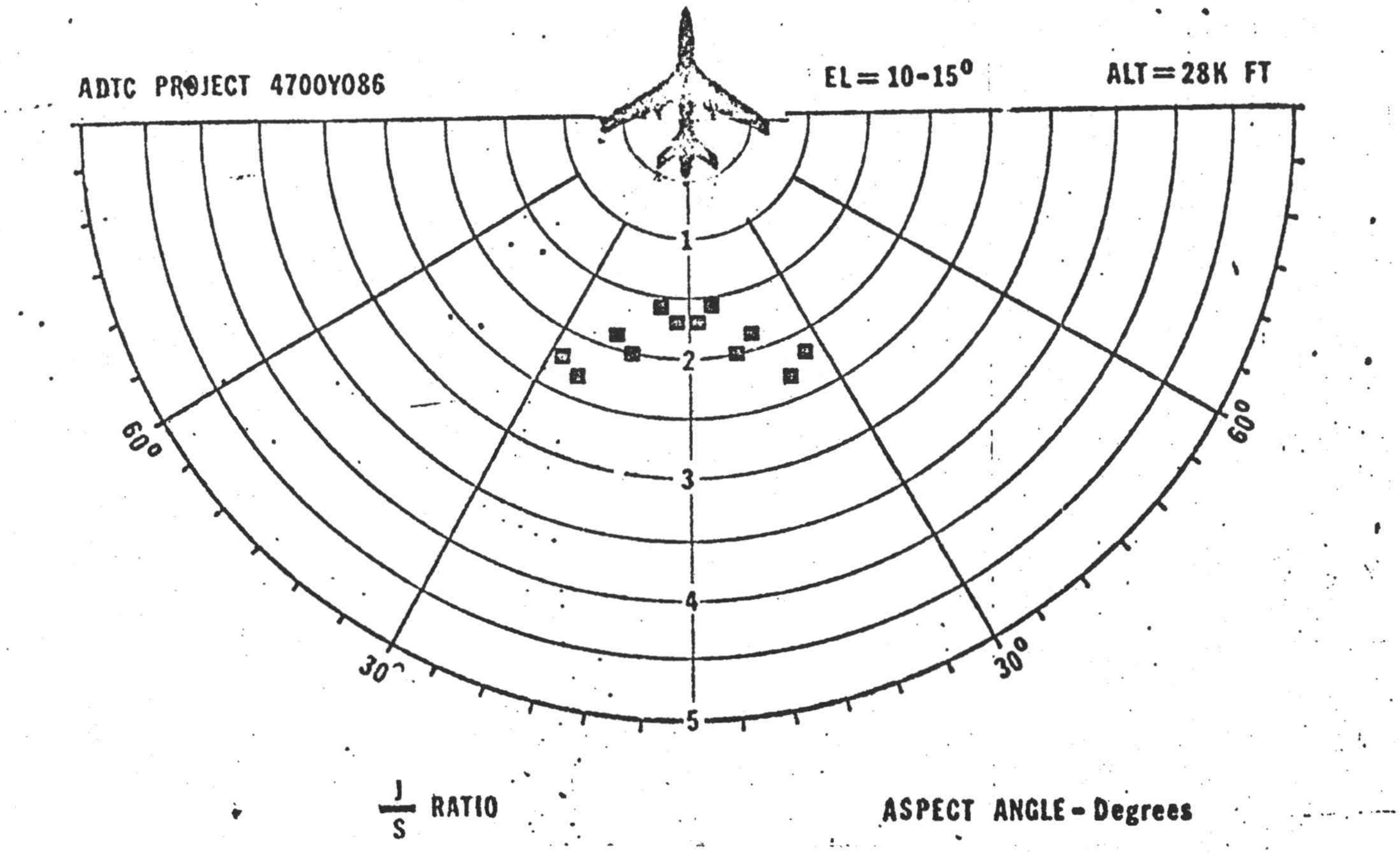

Figure 68. Short Wavelength Military Power J/S Ratio Profile (U)

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In addition, radiation symetry for both the AAQ-4 test item and the EB-66 test aircraft was assumed for the horizontal plane allowing the folding of the radiation data onto one side and plotting all 10° right data and 10° left data at 20° elevation in the same matrix cell. These data can then be unfolded as illustrated in all matrices at the 10 to 15° elevation cell to plot these values in polar coordinate form.

c. (U) Figures 58 through 60 contain the radiation matrices for the EB-66 at both cruise and military power and the AAQ-4 in the short wavelength spectral region, while Figures 61 and 62 contain their ratios (J/S). Figures 63 and 64 contain long wavelength radiation data gathered on the EB-66 test aircraft in both cruise and military power.

~~d. (S)~~ Illustrations of polar coordinate plotting of these data are contained in Figures 65 through 69 which depict radiation profiles from ±45° azimuth at an elevation angle of 10 to 15° for the EB-66 test aircraft, the AAQ-4 test item and the radio of AAQ-4 pulsed power to EB-66 steady state radiation (Figure 67 and 68). From the data gathered, polar plotting of nearly 200 horizontal or vertically oriented views of the target is possible. Selection of the most appropriate ones will be left to the discretion of project personnel.

~~e. (S)~~ These measurements presented in this section are for the 1.8-2.7 micron band and must be corrected in order to be applicable to the 1.7-2.7 micron band of the ATOLL missile. The EB-66 measurements should be increased by 6 percent and 3 percent, respectively, for military and cruise power settings. The AAQ-4 measurements must be increased by 20 percent. Figure 70 illustrates the different effective responses that the two pass bands have with respect to the spectral radiant intensity of the AAQ-4. The percentage difference was obtained by planimetric integration of the two resultant response curves.

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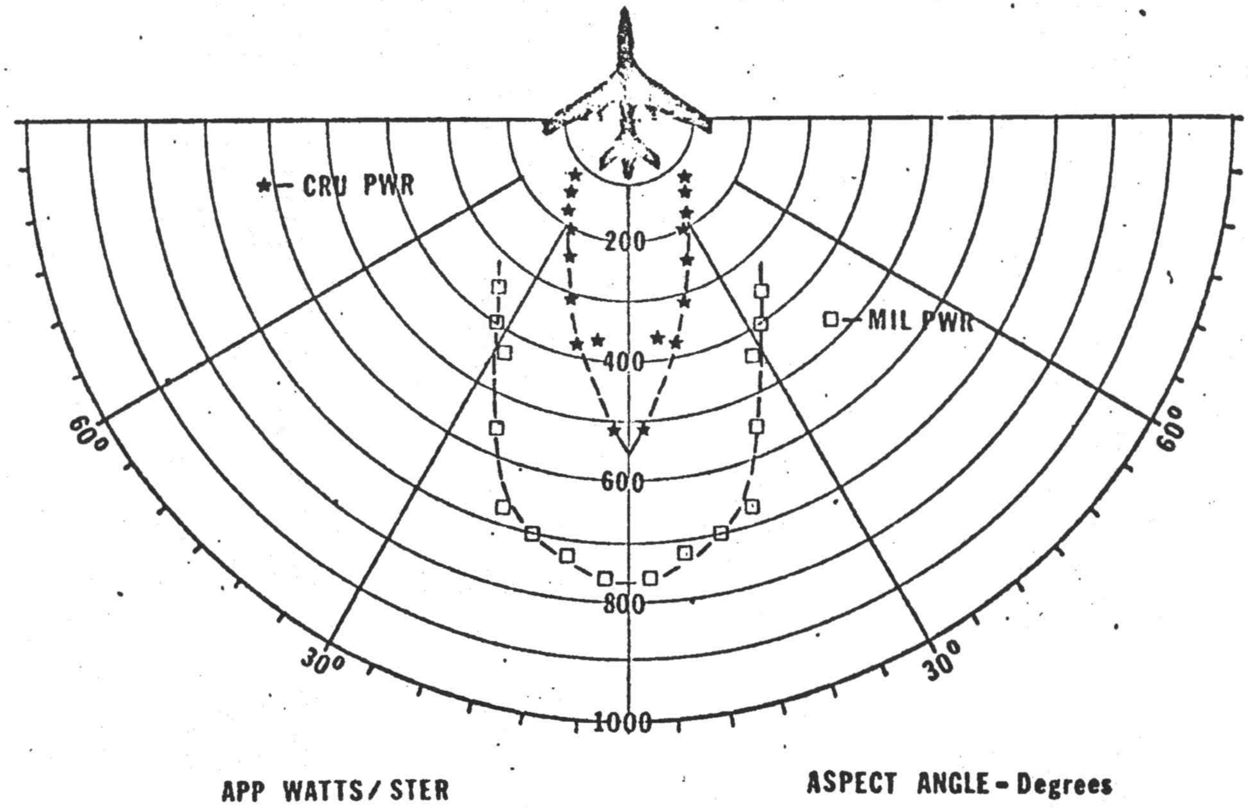

Figure 69. Long Wavelength EB-66 Infrared Radiation Profile (U)

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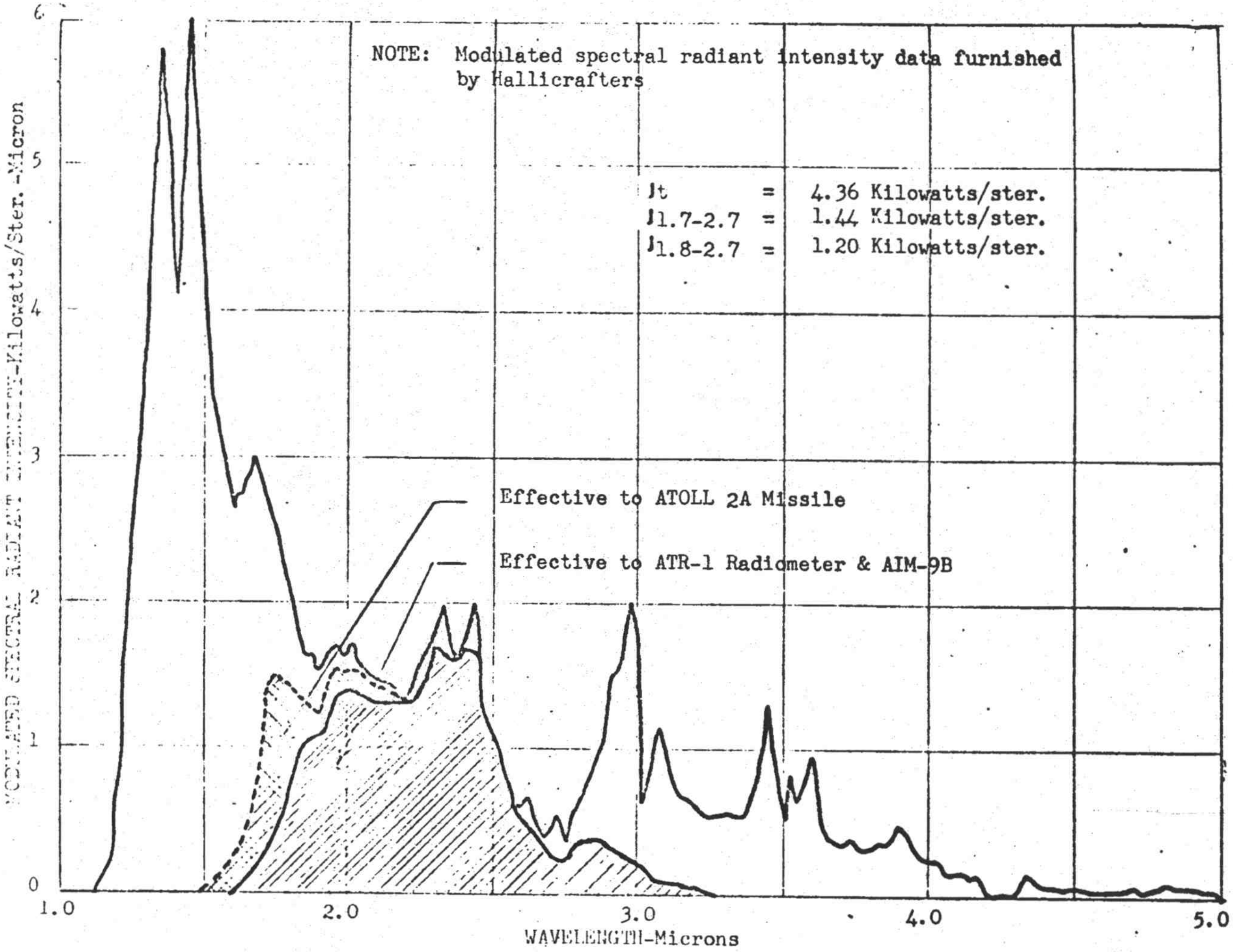

Figure 70. Modulated Spectral Radiant Intensity of AAQ-4 Lamp and Effective Radiant Intensity for the 1.7-2.7 and 1.8-2.7 Micron Bands (U)

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## SECTION V

## RESULTS AND DISCUSSION

---

1. (U) Five missions were flown by the AIDES pod in support of this test program and are summarized in Table XII. The first three missions were flown on F-4C #876 with Missile No. 2 only. The last two missions were flown on F-4D #716 with both missiles.

2. (U) The following is a list of definitions of the terms used in the data Figures 12 through 39 and Tables XIII through XV:

To - Time at which missiles are switched from cage to track.

Tj - Time at which QRC-399 is switched from standby to program.

Td - Time at which missile is decoyed.

T - Time at which missiles are switched from track to cage.

J - Jammer signal present.

S - Target signal present.

J+S - Jammer plus target signal present.

3. ~~(S)~~ The missions of 22 October and 4 November were both air aborts due to test item malfunction. During the mission of 23 October, the J/S ratio in military power was on the order of 2:1 with all runs of a straight tail chase profile. Table XIII summarizes these results. As shown, repeated decoy was accomplished only during Run No. 1 while the test aircraft was operating in cruise power. A single incident of decoy in military power occurred on Run 4, Pass 2.

4. ~~(S)~~ During the 24 October mission the test item was not operating properly. The output was fluctuating from zero up to approximately 2:1. All runs were of a straight tail chase. No decoy was accomplished during any of the runs. No radar data was available on this mission. At the beginning of each run the test item was placed in standby mode for ten seconds. This allowed the missiles to be placed on the target and tracking on the test aircraft when the QRC-399 was switched back into program. Figures 12 through 15 show this situation. These figures show the video for the zero signal level, tracking level for aircraft target only, and tracking level for target plus jammer. As can be seen, the video level (J/S) doesn't change as would be the case if decoy had occurred. When decoyed the video level drops to that for a zero signal condition.

5. ~~(S)~~ On 5 November, two sorties were flown. No data on the J/S ratio was obtained due to a malfunction of the AIDES short wavelength radiometer channel. An attempt to use the long wavelength data to ascertain the output of the QRC-399 was unsuccessful. All indications were that the test item was operating properly during both sorties. Tables XIV and XV and Figures 16 through 39 summarize these results. Analysis of these data suggest the following conclusions:

a. ~~(S)~~ Both missiles require a J/S ratio better than 2:1 for reliable decoy.

b. ~~(S)~~ Missile No. 1 decoys more quickly than Missile No. 2 due most probably to its higher tracking rate.

c. ~~(S)~~ Missile No. 2 breaks lock more quickly at the higher look angles.

d. ~~(S)~~ Even with a large J/S ratio, it is difficult to decoy either missile under a zero track rate condition.

Table XII. Project 4700BY76 Mission Summary (U)

| PROJECT MISSION NO. | DATE | ADTC MISSION NO. | ADTC INSTRUMENTATION | MISSION ALTITUDE | MISSION TIME (CST) | REMARKS |
|---|---|---|---|---|---|---|
| 1 | 22 Oct 69 | 3712 | AIDES/F-4C Facility<br>FPS-16 Radars | 20K Ft. | 1600-1700 | Air Abort-Test Item |
| 2 | 23 Oct 69 | 4708 | " " | " | 1800-1900 | No Radar Coverage |
| 3 | 24 Oct 69 | 5031 | AIDES/F-4C Facility | " | 1400-1600 | Bad Background Cond.<br>Test Item Intermittent |
| 4 | 4 Nov 69 | 2071 | AIDES/F-4C Facility<br>FPS-16 Radars | " | 1600-1700 | Productive Mission |
| 5 | 5 Nov 69 | 3011 | " " | " | 0900-1030<br>1300-1430 | " "<br>" " |

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## Table XIII. Mission No. 4708, 23 Oct 1969 (U)

### MISSILE NO. 2

| RUN-PASS | POWER SETTING | Tj (sec) | Td (sec) | PROFILE |
|---|---|---|---|---|
| 1-1 | CRU | 3.0 | 16.3* | Straight Tail Chase |
| 1-2 | " | 0 | 5.0 | " |
| 1-3 | " | 0 | 18.0 | " |
| 1-4 | " | 0 | 7.0 | " |
| 1-5 | " | 0 | 6.5 | " |
| 1-6 | " | 0 | 0.8 | " |
| 2-1 | CRU | ? | 11.0? | " |
| 2-2 | " | 0 | 8.0* | " |
| 2-3 | " | 0 | 7.0* | " |
| 2-4 | " | 0 | 9.0* | " |
| 2-5 | " | 0 | 10.0* | " |
| 2-6 | " | 0 | 10.0* | " |
| 2-7 | " | 0 | 14.0* | " |
| 2-8 | " | 0 | 10.0* | " |
| 2-9 | " | 0 | 33.0* | " |
| 3-1 | Mil | N.T. | N.T. | " |
| 3-2 | " | 0 | 10.0* | " |

* - No decoy
Td - T
N.T. - No Test

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Table XIII. Mission No. 4708, 23 Oct 1969 (U) (Cont)

MISSILE NO. 2

| RUN-PASS | POWER SETTING | Tj (sec) | Td (sec) | PROFILE |
|---|---|---|---|---|
| 3-3 | Mil | 0 | 5.0* | Straight Tail Chase |
| 3-4 | " | 0 | 9.0* | " |
| 3-5 | " | 0 | 9.0* | " |
| 3-6 | " | 0 | 7.0* | " |
| 3-7 | " | 0 | 20.0* | " |
| 4-1 | Mil | 4.5 | 34.4* | " |
| 4-2 | " | 0 | 1.0 | " |
| 4-3 | " | 0 | N.T. | " |
| 5-1 | AB | 0 | 13.0* | " |
| 5-2 | " | 0 | 7.0* | " |

* - No decoy
Td - T
N.T. - No Test

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Table XIV. Mission 3011-A, 5 Nov 1969 (U)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 1-1 | Mil | 4550 | -2.7 | 3.9 | 2.5 | 4550 | -2.1 | 4.0 | 1.9 | 4550 | -2.4 | 4.0 | Straight Tail Chase |
| 1-2 | " | 4350 | -1.3 | 5.2 | 13.5* | 4275 | - .97 | 5.0 | 13.5* | 4275 | - .97 | 5.0 | " |
| 1-3 | " | 4225 | -1.2 | 5.5 | 1.2 | 4225 | -1.4 | 5.0 | 13.4* | 4225 | -1.4 | 2.6 | " |
| 1-4 | " | 4350 | - .91 | 2.7 | 1.0 | 4380 | - .74 | 2.7 | 7.5* | 4500 | -1.1 | 2.5 | " |
| 1-5 | " | 4825 | - .92 | 2.5 | 6.2 | 5000 | -1.7 | 2.9 | 10.5* | 5190 | -1.1 | 3.3 | " |
| 1-6 | " | 5450 | -1.4 | 4.9 | .7 | 5500 | -1.5 | 5.3 | 11.6* | 6000 | -1.5 | 7.3 | " |
| 1-7 | " | 6355 | -1.6 | 7.3 | 1.4 | 6400 | -1.6 | 7.3 | 8.8* | 6775 | -2.4 | 7.0 | " |
| 1-8 | " | 7025 | -2.3 | 6.3 | 4.3 | 7025 | -2.3 | 5.7 | 6.0* | 7025 | -2.3 | 5.7 | " |
| 2-1 | Mil | 11330 | - .97 | 5.0 | 10.3 | 11450 | .34 | 4.5 | 19.2 | 11430 | -5.0 | 4.4 | + 10° Tail Chase |
| 2-2 | " | 10450 | 3.9 | 4.6 | 4.4 | 10050 | 4.8 | 4.4 | 12.7 | 9325 | - .94 | 4.2 | " |

* - No decoy
Td - T

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Table XIV. Mission 3011-A, 5 Nov 1969 (U) (Cont)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 2-3 | Mil | 6050 | -7.5 | 3.4 | .7 | 6050 | -7.5 | 3.4 | 6.8 | 4925 | -2.6 | 3.8 | Tail Chase |
| 3-1 | CRU | 13580 | -1.7 | 3.6 | 6.2* | 13280 | -1.5 | 3.4 | 6.4* | 13280 | -1.5 | 3.4 | Straight Tail Chase |
| 3-2 | " | 12875 | -1.1 | 3.6 | .4 | 12800 | -1.1 | 3.6 | 8.1* | 12275 | - .64 | 3.5 | " |
| 3-3 | " | 11790 | - .43 | 3.5 | .7 | 11790 | - .43 | 3.5 | 9.4* | 11325 | -1.2 | 3.6 | " |
| 3-4 | " | 11025 | -1.0 | 4.1 | 2.5 | 10925 | - .97 | 4.1 | 7.7* | 10725 | - .95 | 4.1 | " |
| 3-5 | " | 10225 | - .98 | 4.4 | 4.4 | 9975 | - .87 | 4.3 | 9.6* | 9125 | -1.2 | 4.4 | " |
| 3-6 | " | 9325 | -1.0 | 4.4 | 4.1 | 8975 | -1.3 | 4.4 | 7.8* | 8750 | -1.4 | 4.4 | " |
| 3-7 | " | 8300 | -1.5 | 4.5 | 6.6 | 7700 | -1.3 | 4.8 | 8.8* | 7425 | -1.2 | 4.9 | " |
| 3-8 | " | 5350 | -1.3 | 5.3 | 7.0 | 4425 | -1.3 | 5.2 | 9.7* | 3150 | - .79 | 5.8 | " |
| 3-9 | " | 3150 | -0.79 | 5.8 | 2.2 | 2875 | - .62 | 5.4 | 6.0 | 2650 | - .76 | 5.0 | " |
| 4-1 | Mil | 6980 | -8.6 | 3.7 | 8.6 | 7000 | -13.3 | 4.9 | 8.9 | 7000 | -13.3 | 4.9 | +13° Tail Chase |

* - No decoy
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Table XIV. Mission 3011-A, 5 Nov 1969 (U) (Cont)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 4-2 | Mil | 6825 | -9.0 | 4.8 | 4.1 | 6775 | -6.2 | 4.0 | 4.2 | 6775 | -6.2 | 4.0 | +13° Tail Chase |
| 4-3 | " | 6750 | -2.0 | 4.2 | 3.0 | 6725 | -1.7 | 4.4 | 12.0* | 6825 | -4.6 | 4.7 | " |
| 5-1 | " | 11500 | .25 | 4.2 | 8.3 | 11550 | .27 | 4.2 | 8.3* | 11550 | .27 | 4.2 | Straight Tail Chase |
| 5-2 | " | 11575 | .24 | 4.2 | 3.4 | 11600 | .22 | 4.1 | 11.3* | 11600 | .22 | 4.3 | " |
| 5-3 | " | 11600 | .44 | 4.2 | 3.5 | 11600 | .60 | 4.4 | 15.8* | 11475 | .82 | 3.9 | " |
| 5-4 | " | 10850 | .47 | 3.9 | .2 | 10850 | .47 | 3.9 | 8.9* | 10350 | .40 | 3.9 | " |
| 5-5 | " | 9525 | .22 | 3.6 | 4.7 | 9050 | .51 | 3.3 | 8.0* | 8750 | .66 | 3.5 | " |
| 5-6 | " | 7925 | .82 | 4.2 | 2.3 | 7580 | .99 | 4.1 | 9.2* | 7000 | 1.3 | 4.0 | " |
| 5-7 | " | 6375 | .82 | 4.0 | 10.5 | 5575 | .54 | 2.9 | ~~12.6~~* | 5450 | .43 | 2.7 | " |
| 5-8 | " | 5025 | .41 | 3.4 | 6.4 | 4700 | .47 | 4.5 | 9.0* | 4550 | .31 | 5.2 | " |
| 5-9 | " | 3975 | .48 | 5.2 | 8.8* | 3650 | .32 | 5.0 | 8.8* | 3650 | .32 | 5.0 | " |

* - No decoy
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Table XIV. Mission 3011-A, 5 Nov 1969 (U) (Cont)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 6-1 | Mil | | | 7.0 | | | | | 22.4 | | | | + 11° Tail Chase |
| 6-2 | " | 9975 | 5.6 | 4.1 | 2.0 | 9925 | 5.0 | 4.2 | 16.1 | 9850 | -2.6 | 4.7 | " |
| 6-3 | " | 9550 | -6.3 | 4.7 | 11.7 | 9225 | - .55 | 4.7 | 13.0 | 9175 | .87 | 4.5 | " |
| 6-4 | " | 8750 | 6.8 | 2.6 | 6.1 | 8575 | 2.8 | 2.9 | 8.6 | 8475 | .62 | 3.1 | " |
| 6-5 | " | 8350 | -4.4 | 3.9 | 3.7 | 8375 | -3.1 | 3.9 | .2 | 8350 | -4.4 | 3.9 | " |
| 6-6 | " | 9225 | 7.6 | 3.5 | 3.5 | 9250 | 5.3 | 3.6 | 10.6 | 9425 | - .27 | 3.7 | " |
| 6-7 | " | 9725 | -4.9 | 3.8 | 4.9 | 9775 | -2.6 | 4.4 | 4.8 | 9775 | -2.6 | 4.4 | " |
| 6-8 | " | 10025 | 2.1 | 4.4 | 2.7 | 10050 | 1.5 | 4.3 | 15.0 | 10200 | -2.8 | 4.1 | " |
| 6-9 | " | 10350 | -5.4 | 4.4 | .8 | 10350 | -5.0 | 4.4 | 6.9 | 10350 | -2.7 | 4.5 | " |
| 6-10 | " | | | | NO EQUIPMENT ON | | | | | | | | " |
| 7- | | TRACKING WITH NO TEST ITEM | | | | | | | | | | | |

* No decoy
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Table XV. Mission 3011-B, 5 Nov 1969 (U)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 1-1 | CRU | 11000 | -1.6 | 4.7 | 1.5 | 11000 | -1.4 | 4.7 | 8.7 | 10675 | -1.0 | 4.8 | Straight Tail Chase |
| 1-2 | " | 10700 | 1.0 | 4.4 | 2.1 | 10700 | .7 | 4.3 | 9.2 | 10725 | -1.3 | 4.3 | " |
| 1-3 | " | 10600 | - .4 | 4.5 | 6.5 | 10525 | - .6 | 4.7 | 13.5 | 10475 | -2.9 | 4.3 | " |
| 1-4 | " | 10450 | -1.9 | 4.3 | 0.1 | 10450 | -1.9 | 4.3 | 7.0 | 10450 | - .6 | 4.3 | " |
| 1-5 | " | 10550 | - .6 | 4.2 | 0.1 | 10550 | .6 | 4.2 | 12.1 | 10625 | -2.4 | 4.3 | " |
| 1-6 | " | 10750 | -2.5 | 4.4 | .3 | 10750 | -2.5 | 4.4 | .8 | 10750 | -2.5 | 4.4 | " |
| 1-7 | " | 10800 | -1.1 | 4.3 | .2 | 10800 | -1.1 | 4.3 | 4.7 | 10850 | - .4 | 4.4 | " |
| 2-1 | Mil | 11550 | - .7 | 3.6 | 1.8 | 11575 | - .6 | 3.6 | 16.1 | 11825 | .6 | 3.4 | + 10° Tail Chase |
| 2-2 | " | 12100 | - .1 | 3.4 | 3.3 | 12150 | - .4 | 3.4 | 44.8* | 10400 | -1.9 | 2.1 | " |
| 2-3 | " | 9200 | -1.0 | 1.4 | 1.5 | 9050 | -1.0 | 1.4 | 16.3 | 7300 | 1.8 | .8 | " |

* - No decoy
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Table XV. Mission 3011-B, 5 Nov 1969 (U) (Cont)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 2-4 | Mil | 7900 | .2 | 3.9 | 2.7 | 8050 | 0 | 3.9 | 33.6 | 7650 | -8.0 | 4.4 | + 10° Tail Chase |
| 2-5 | " | 6475 | -2.7 | 3.2 | 1.0 | 6450 | -2.5 | 3.2 | 8.7 | 6125 | 2.0 | 3.5 | " |
| 2-6 | " | 7025 | 4.3 | 4.0 | 8.3 | 7450 | 1.3 | 4.5 | 10.4 | 7550 | .6 | 4.6 | " |
| 2-7 | " | 8900 | -3.5 | 4.9 | 2.4 | 9000 | -3.0 | 4.9 | 16.5* | 9425 | -1.6 | 4.6 | " |
| 3-1 | AB | 5350 | 0 | 5.0 | 51.0* | 10025 | - .8 | 4.0 | 51.0* | 10025 | - .8 | 4.0 | + 8° Tail Chase |
| 3-2 | " | 10000 | 1.3 | 7.4 | 30.9* | 10475 | 5.3 | 10.7 | 30.9* | 10475 | 5.3 | 10.7 | " |
| 3-3 | " | 10550 | 4.2 | 11.0 | 32.5* | 11375 | -5.6 | 7.3 | 32.5* | 11375 | -5.6 | 7.3 | " |
| 3-4 | " | 11400 | -3.8 | 7.3 | 38.8* | 11625 | 4.4 | 10.4 | 38.8* | 11625 | 4.4 | 10.4 | " |
| 3-5 | " | 11600 | 2.4 | 9.6 | 44.4* | 12800 | -7.8 | 7.0 | 44.4* | 12800 | -7.8 | 7.0 | " |
| 4-1 | CRU | 9475 | -12.3 | 5.5 | 3.8 | 9600 | -9.0 | 5.0 | 2.4 | 9550 | -10.5 | 5.0 | -10° Off |

* - No decoy
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Table XV. Mission 3011-B, 5 Nov 1969 (U) (Cont)

| | | AT To | | | MISSILE NO. 1 | | | | MISSILE NO. 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-PASS | POWER SETTING | SLANT RANGE (Ft) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | Td (sec) | RANGE (FT.) | AZ (Deg) | EL (Deg) | PROFILE |
| 5-1 | CRU | 9250 | 17.8 | 6.4 | .7 | 9275 | 17.5 | 6.5 | 22.7 | 9200 | 2.42 | 4.4 | +18° Off |
| 6-1 | Mil | 8025 | - .6 | 3.9 | .75 | 7825 | - .6 | 3.8 | 15.3 | 7825 | -5.0 | 2.9 | +13° Tail Chase |
| 6-2 | " | 5850 | -2.6 | 3.9 | 5.5 | 5300 | -1.5 | 3.8 | 15.8 | 4600 | 1.0 | 4.0 | " |
| 6-3 | " | 4300 | - .6 | 4.6 | 6.8 | 4800 | -2.0 | 4.7 | 12.5 | 5250 | -5.5 | 5.0 | " |
| 6-4 | " | 6650 | -5.0 | 4.6 | 4.2 | 6900 | -3.0 | 4.7 | 12.9 | 7300 | 1.7 | 4.8 | " |
| 6-5 | " | 7925 | 1.0 | 4.2 | 2.6 | 7850 | .6 | 4.1 | ~~22.4~~ | 6600 | -6.3 | 3.5 | " |
| 6-6 | " | 5050 | -3.0 | 2.6 | 7.4 | 5400 | -2.2 | 3.5 | 18.5 | 6200 | .8 | 4.8 | " |

* - No decoy
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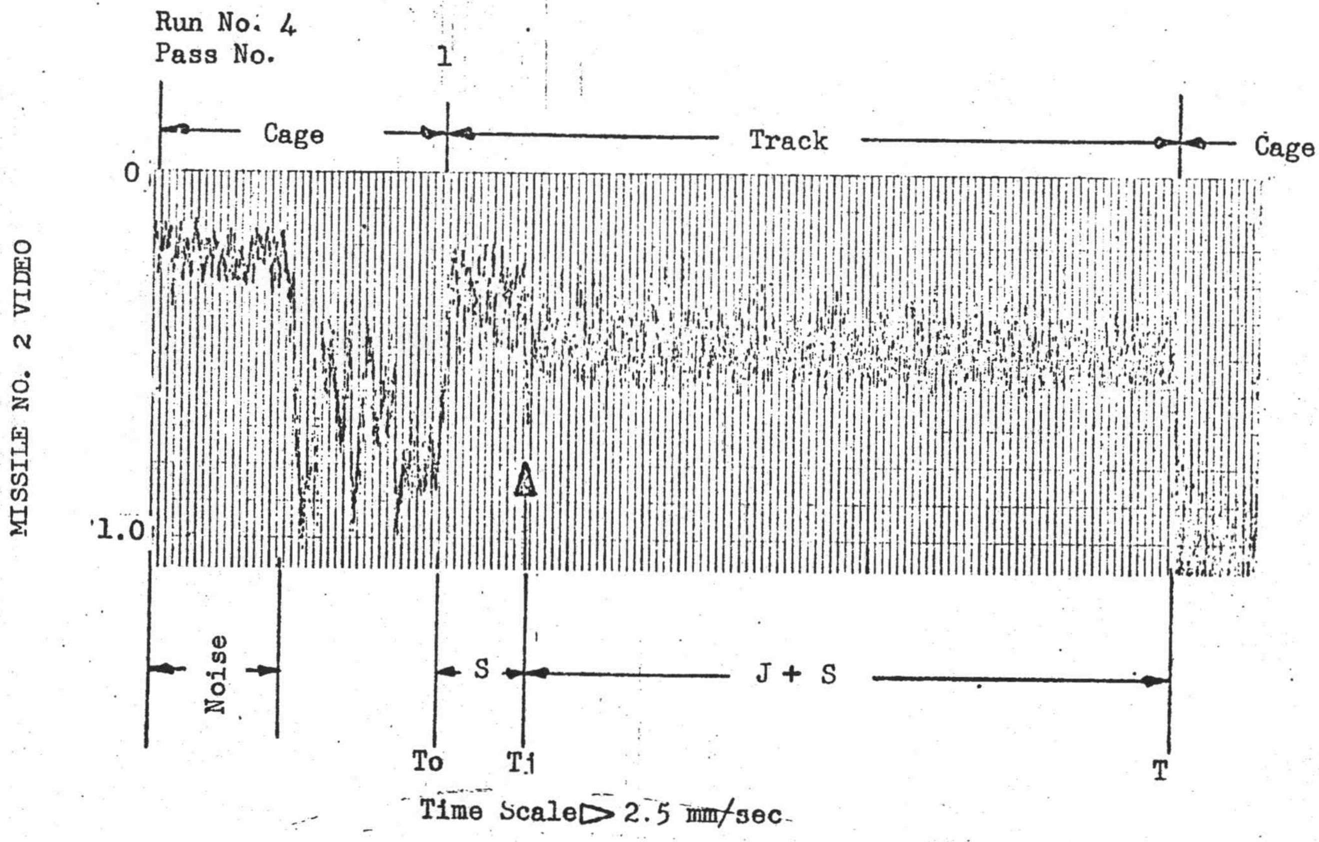

Figure 12. Mission No. 4708; Run 4, Pass 1; Military Power (U)

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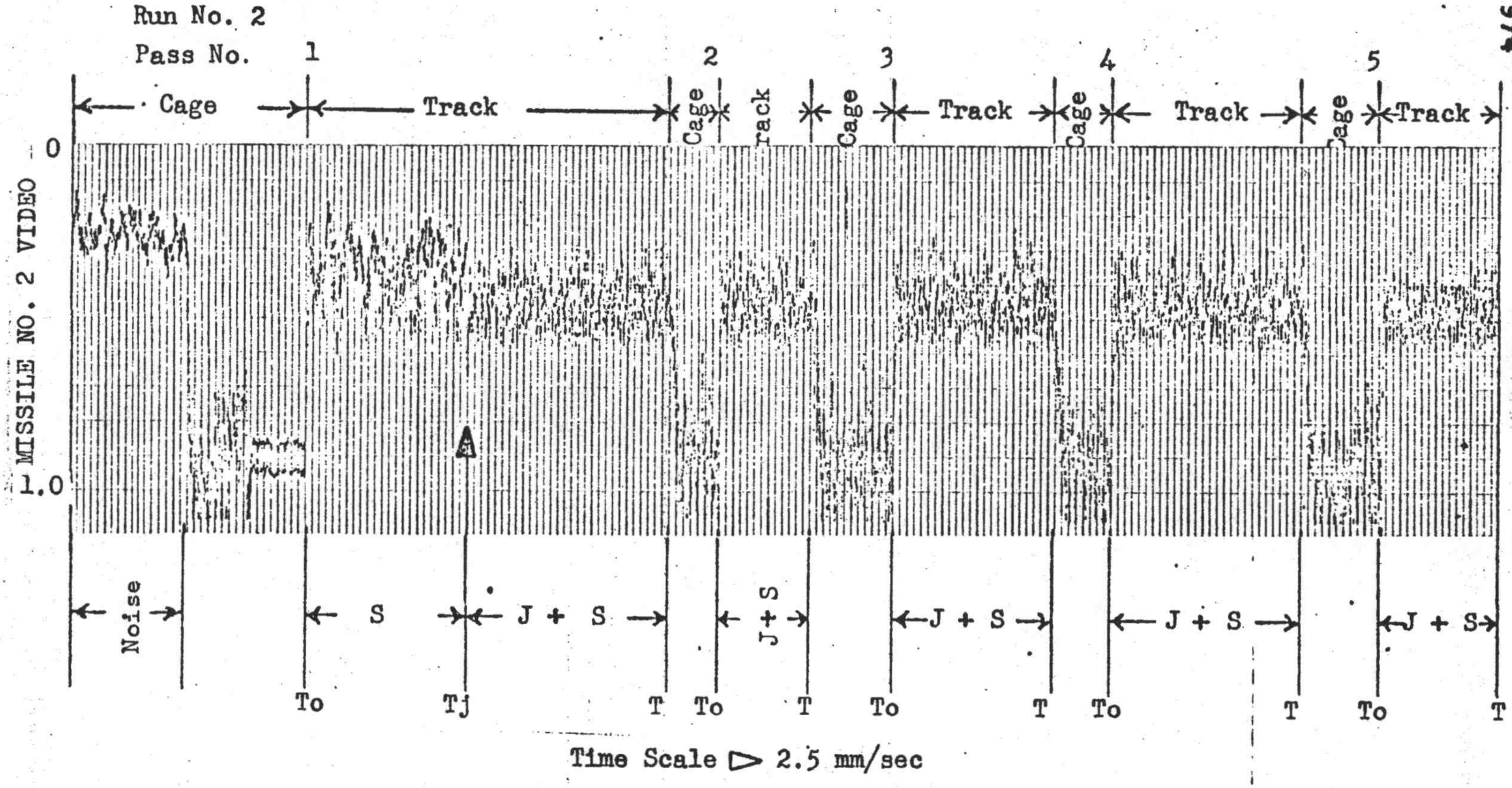

Figure 13. Mission No. 5031; Run 2, Pass 1, 2, 3, 4 & 5; Military Power (U)

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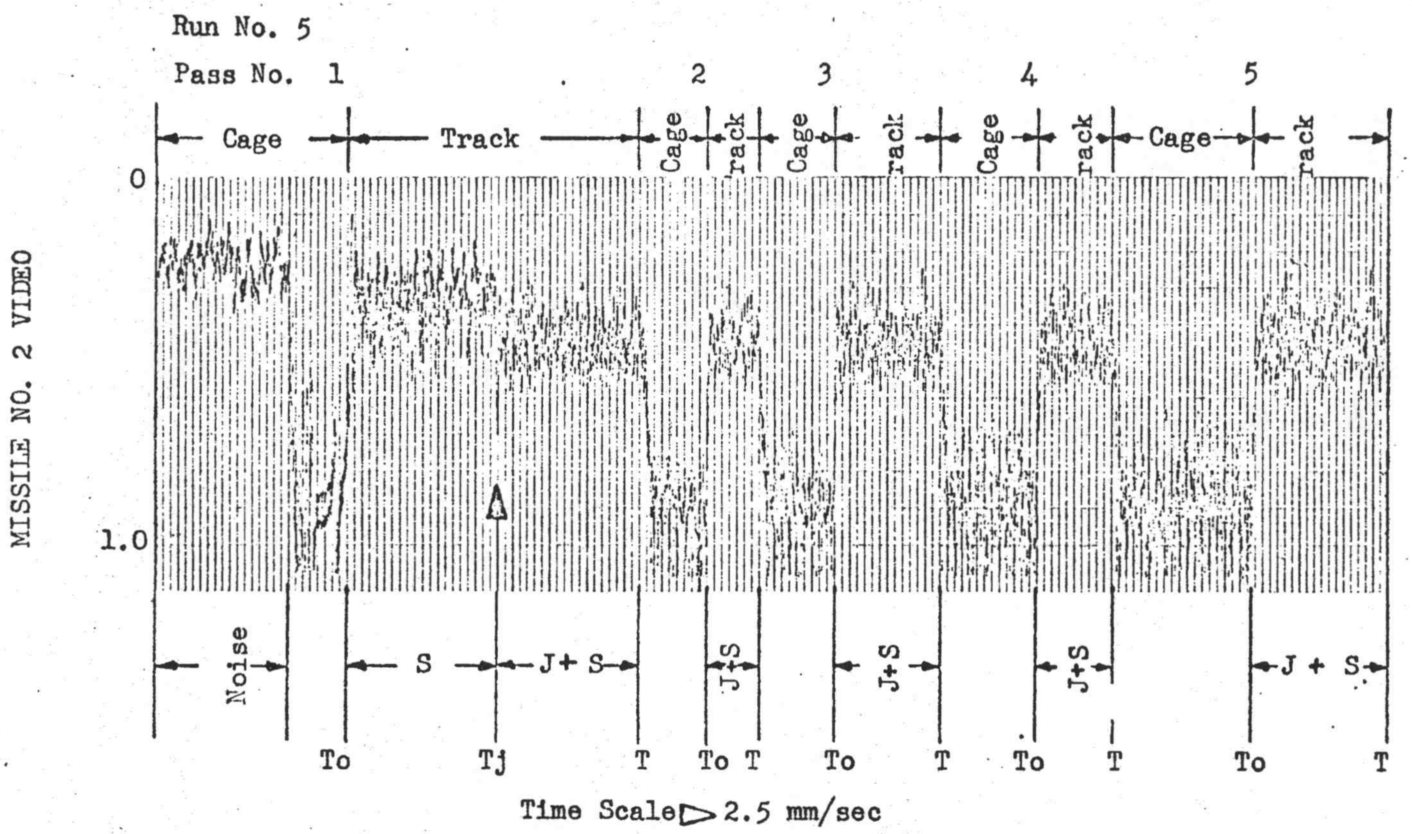

Figure 14. Mission No. 5031; Run 5, Pass 1, 2, 3, 4 & 5; Military Power (U)

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[redacted]

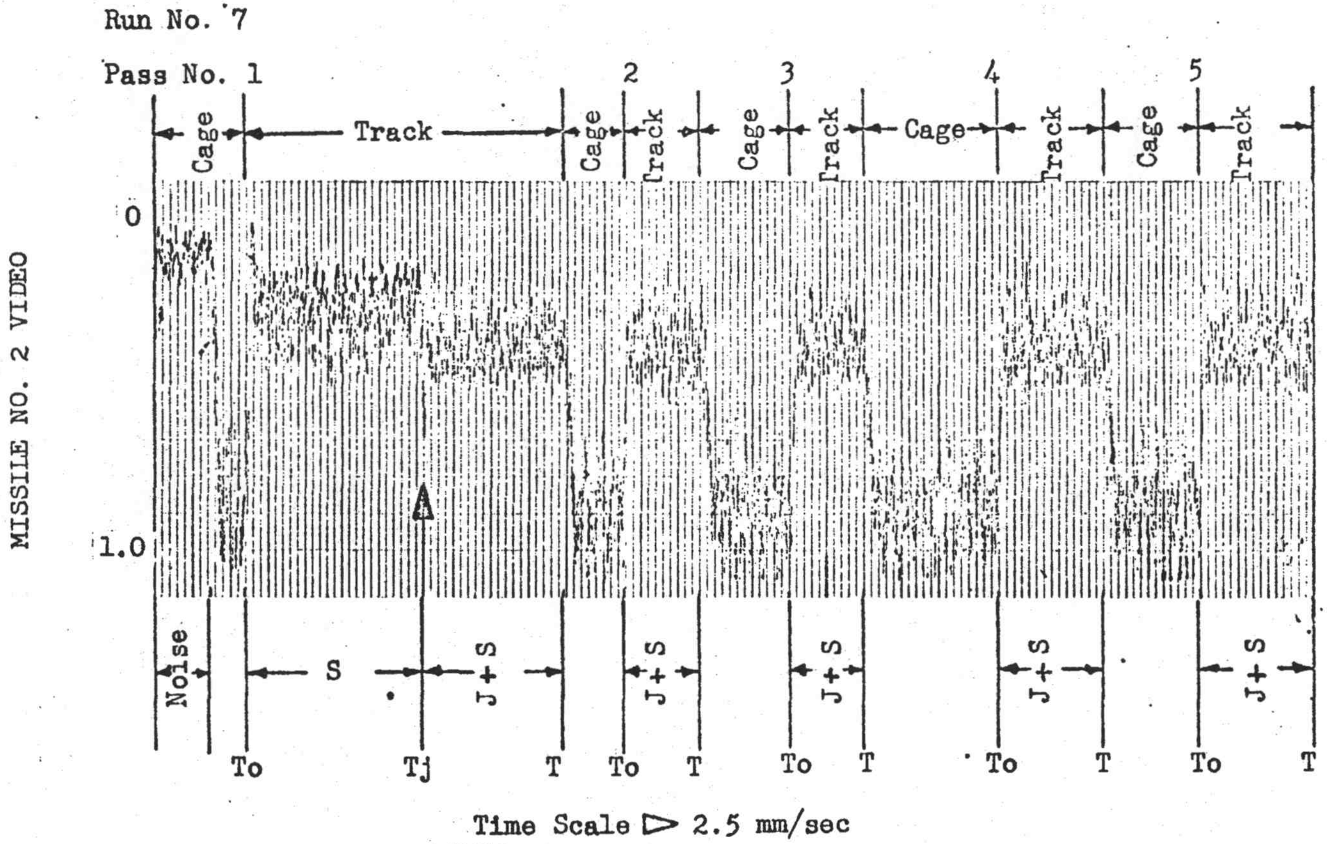

Figure 15. Mission No. 5031; Run 7, Pass 1, 2, 3, 4 & 5; Military Power (U)

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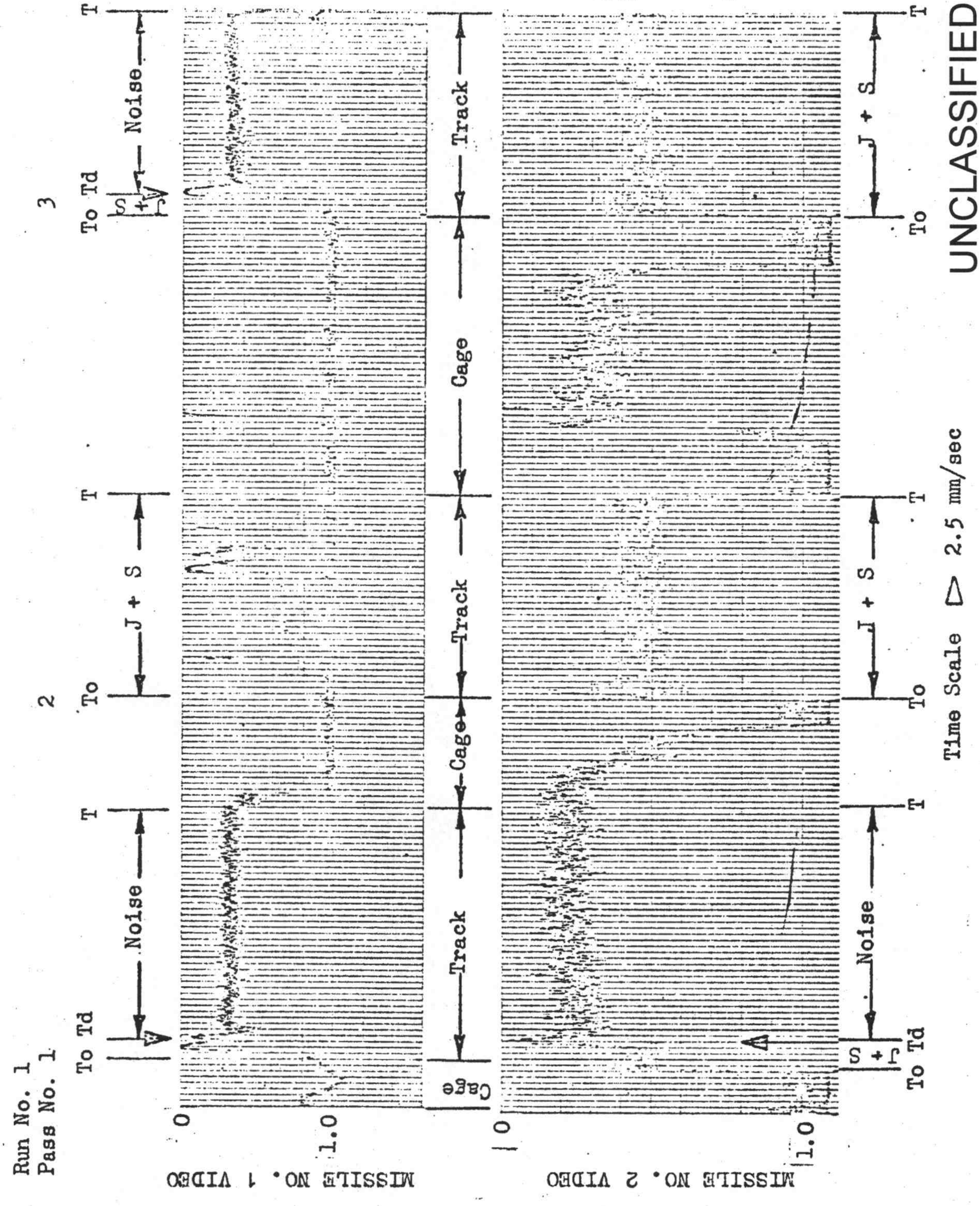

Figure 16. Mission No. 3011-A; Run 1, Pass 1, 2 & 3; Military Power (U) [redacted]

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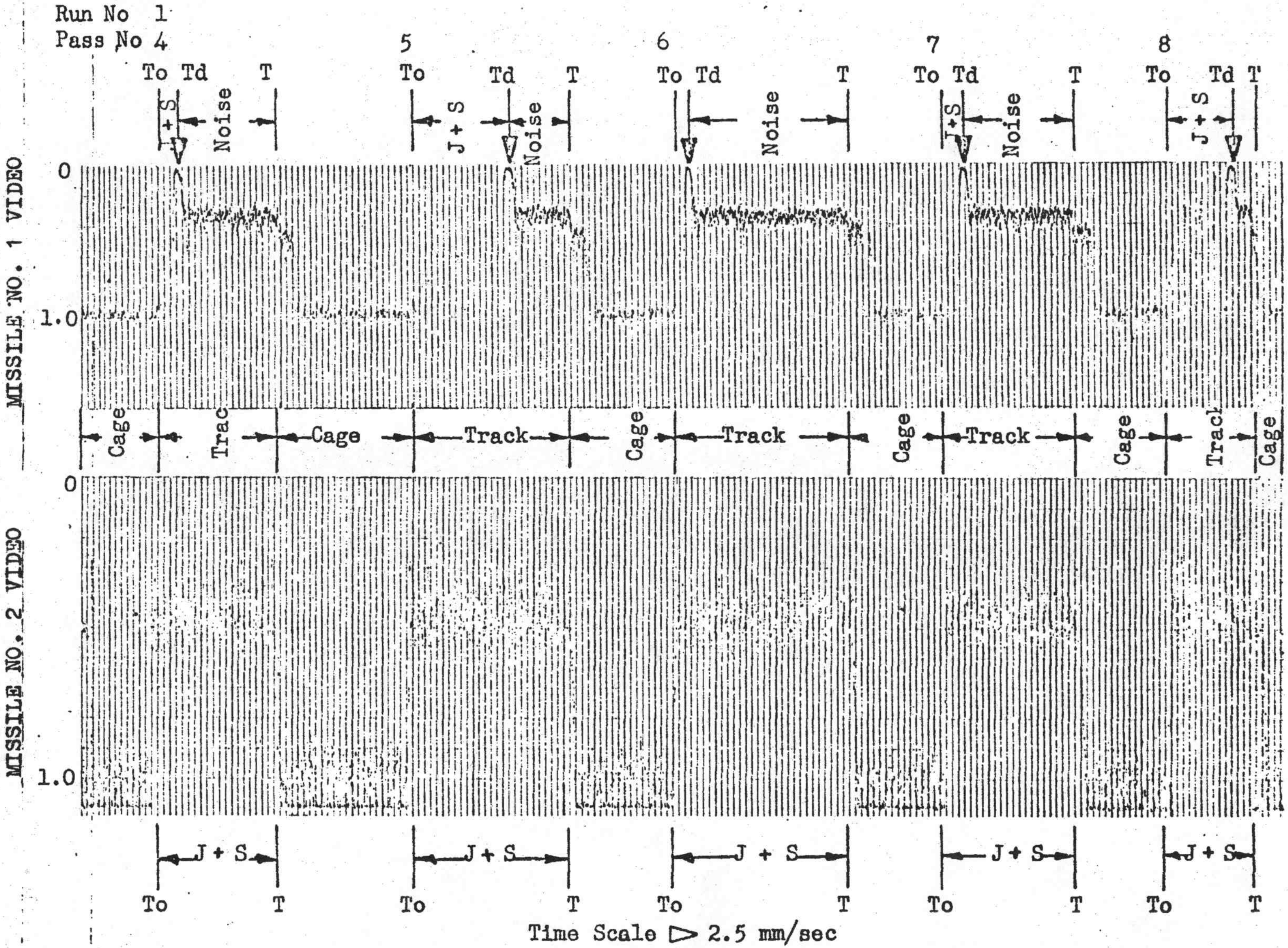

Figure 17. Mission No. 3011-A; Run 1, Pass 4, 5, 6, 7 & 8: Military Power (U) ~~(SECRET)~~

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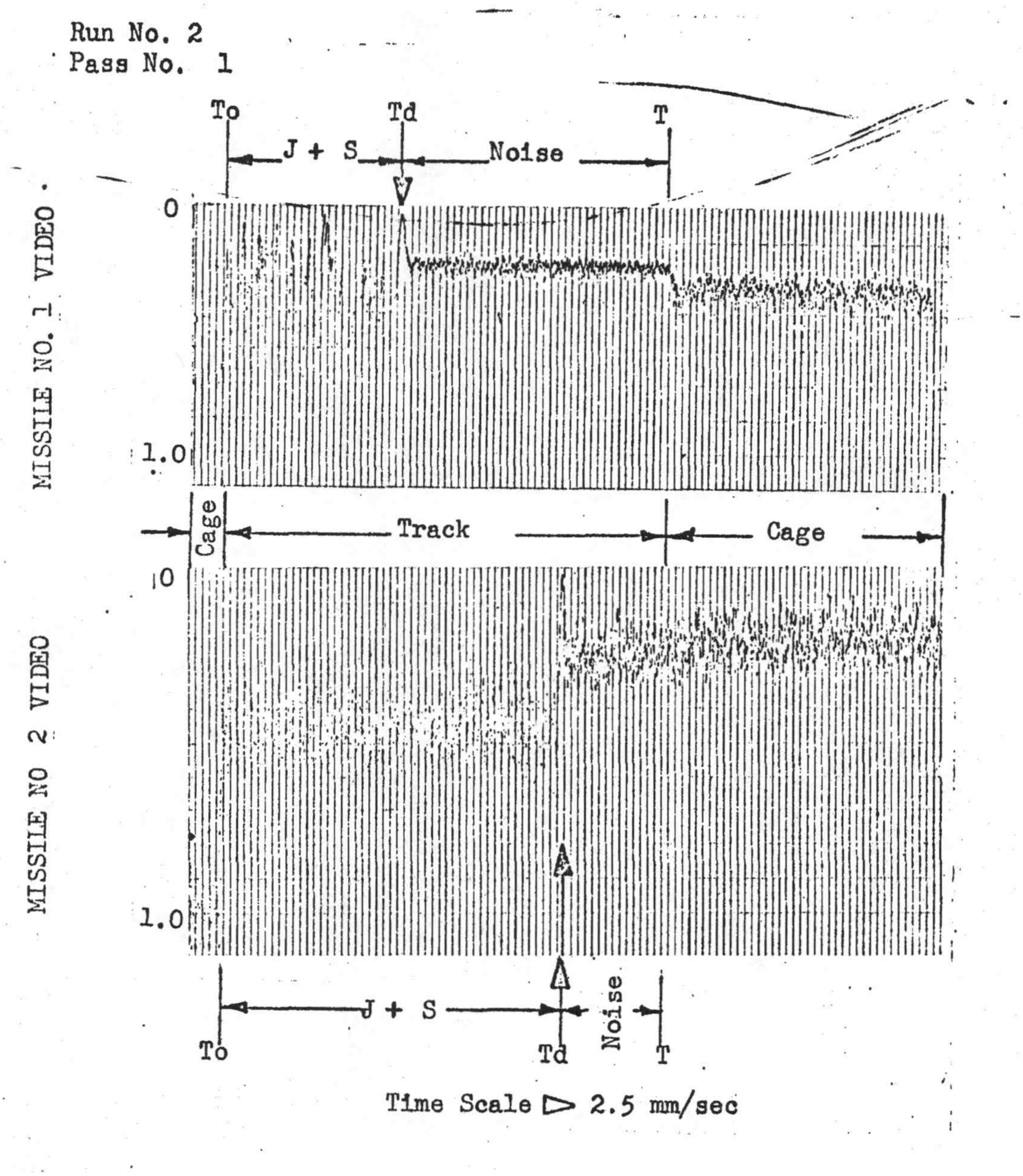

Figure 18. Mission No. 3011-A; Run 2, Pass 1; Military Power (U) ~~(SECRET)~~

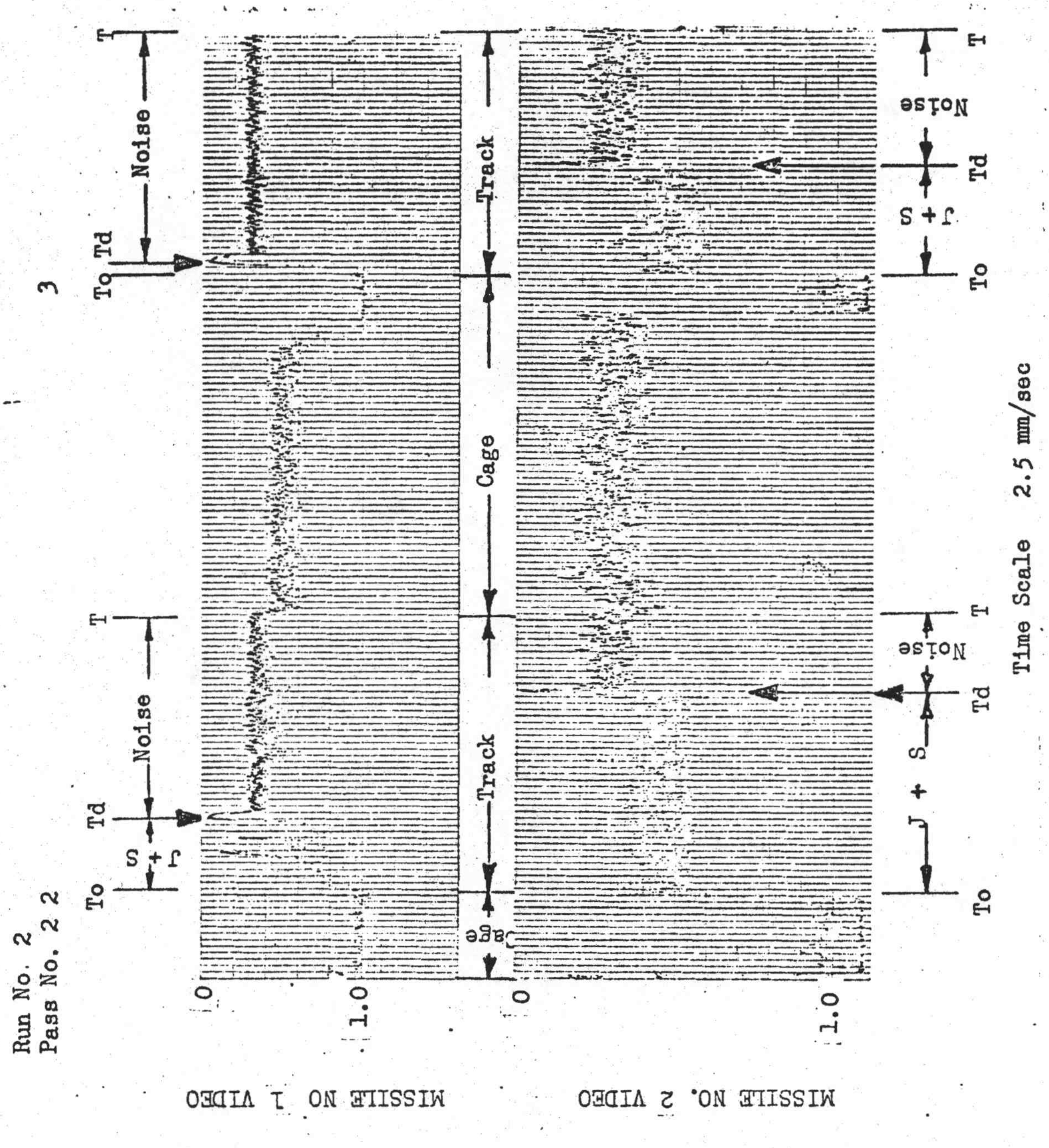

Figure 19. Mission No. 3011-A; Run 2, Pass 2 & 3; Military Power (U) ~~(SECRET)~~

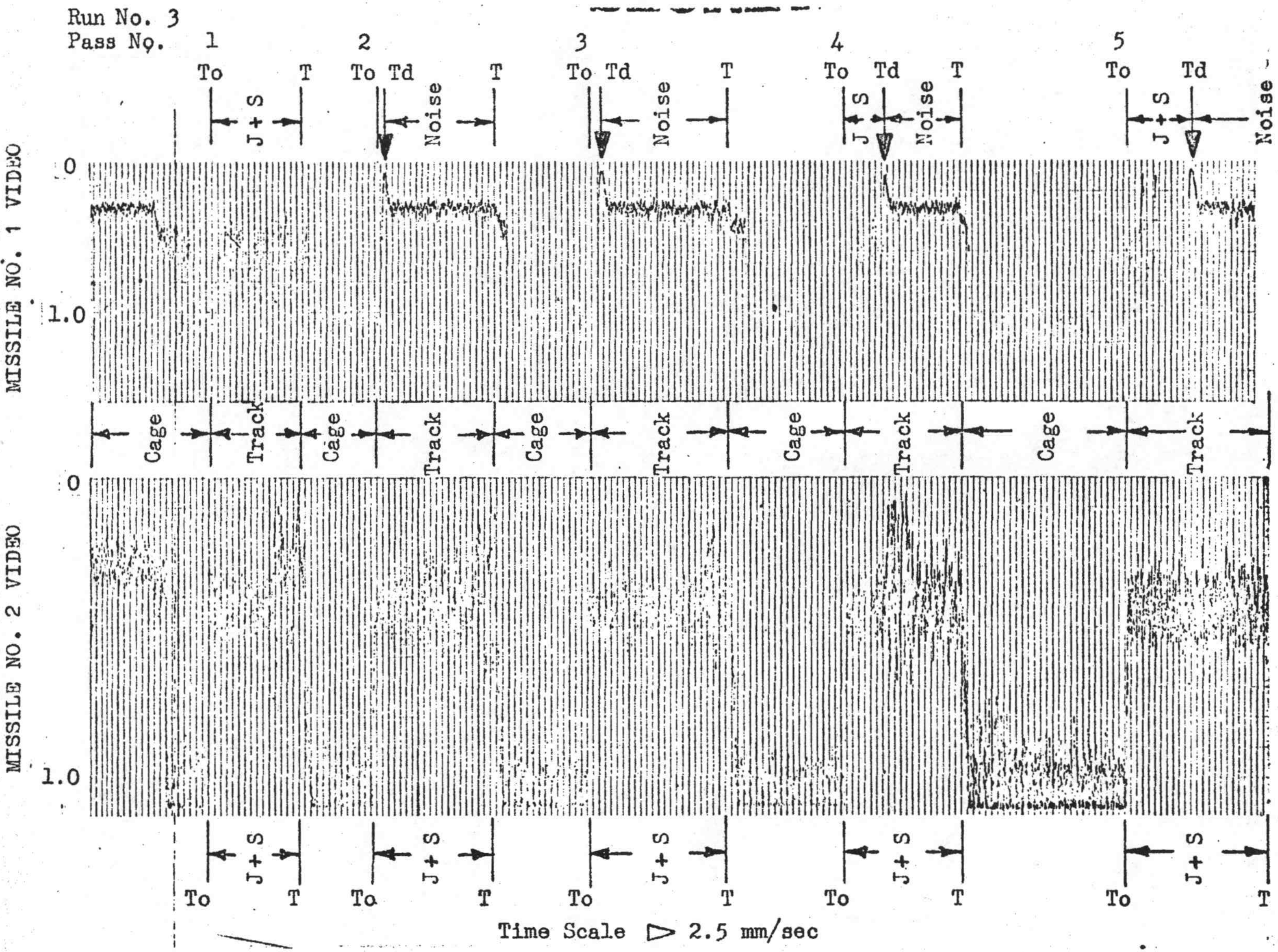

Figure 20. Mission No. 3011-A; Run 3, Pass 1, 2, 3, 4 & 5; Cruise Power (U)
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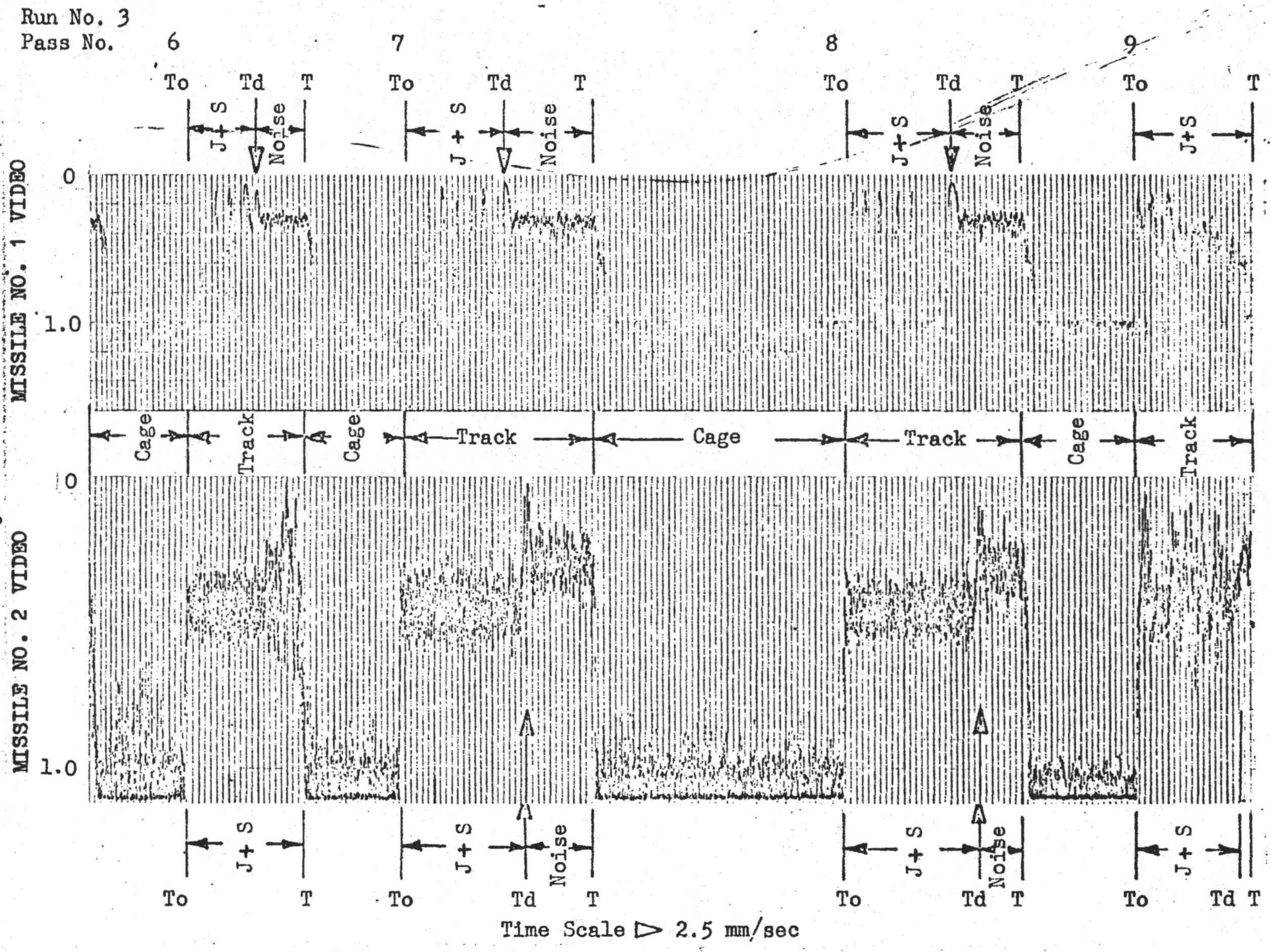

Figure 21. Mission No. 3011-A; Run 3, Pass 6, 7, 8 & 9; Cruise Power (U) ~~(SECRET)~~

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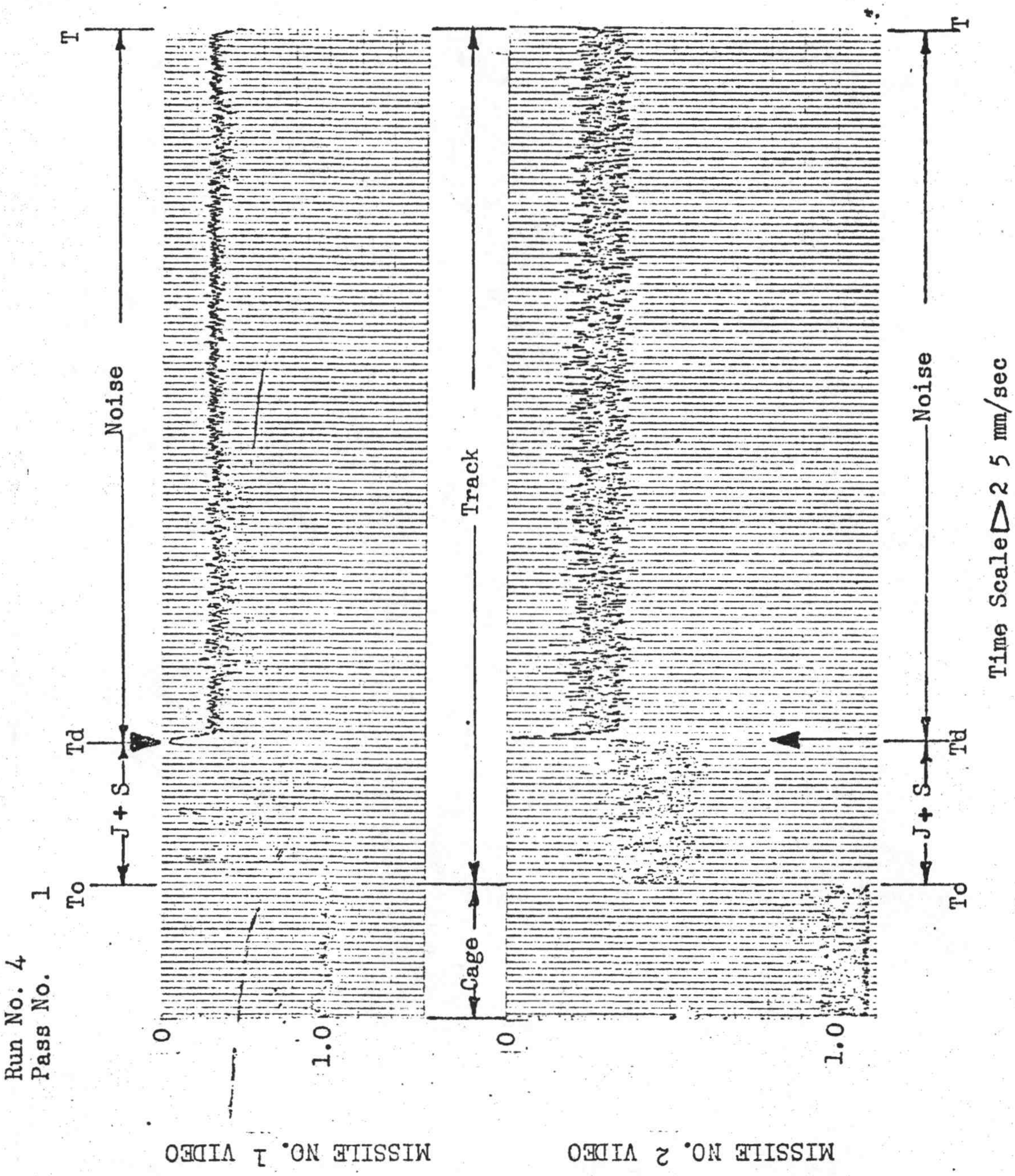

Figure 22. Mission No. 3011-A; Run 4, Pass 1; Military Power (U)

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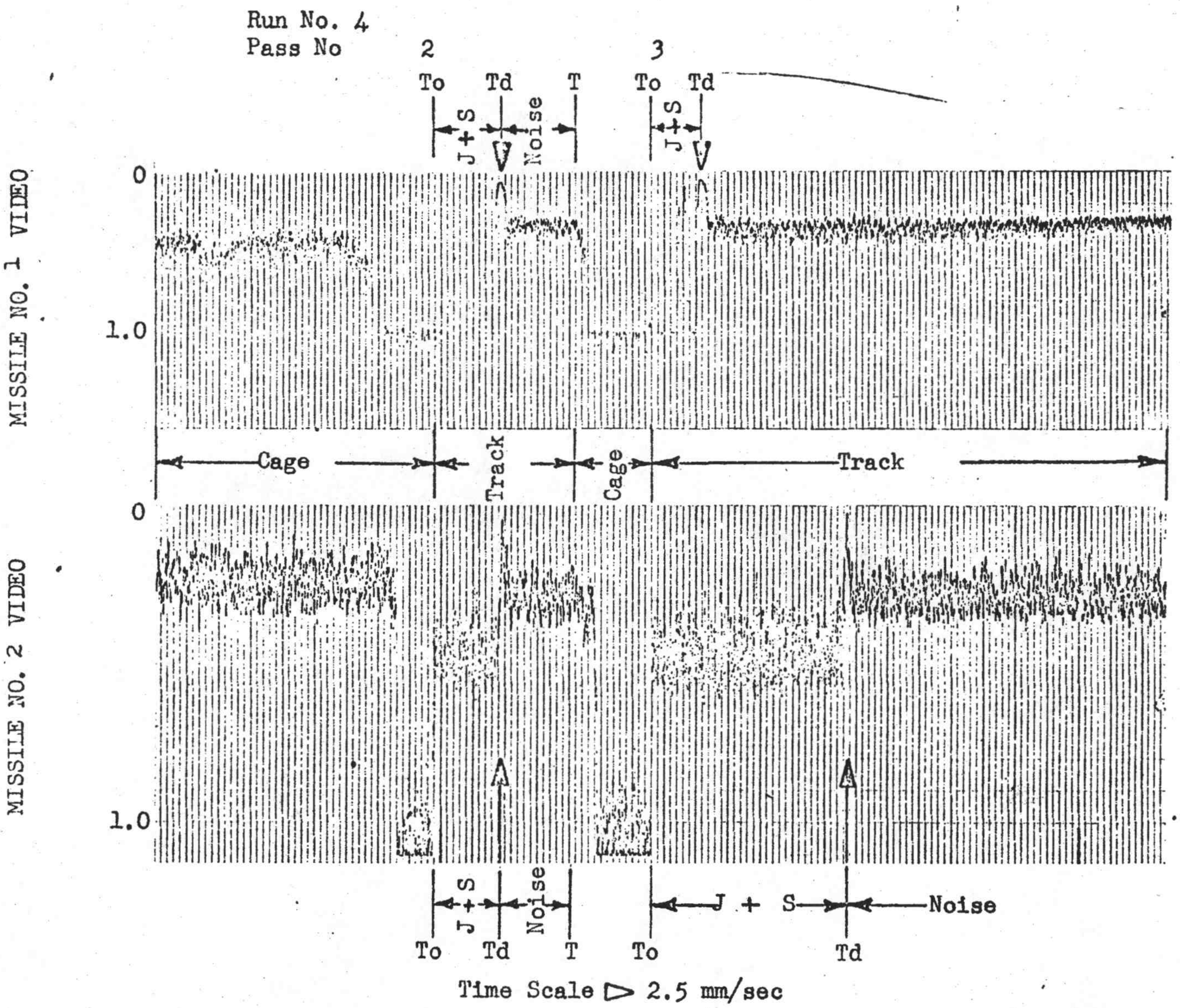

Figure 23. Mission No. 3011-A; Run 4, Pass 2 & 3; Military Power (U)
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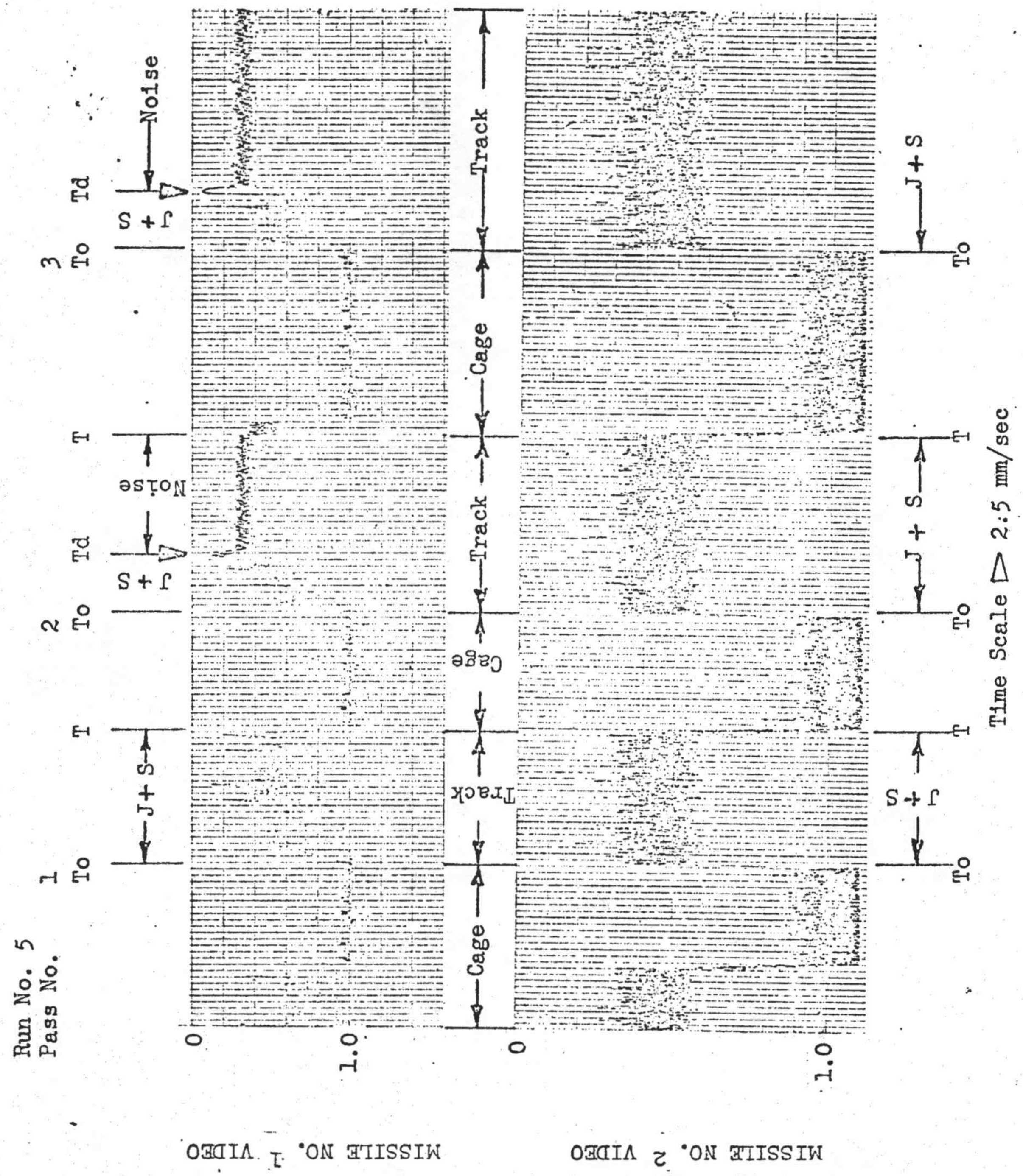

Figure 24. Mission No. 3011-A; Run 5, Pass 1, 2 & 3; Military Power (U) ~~(SECRET)~~

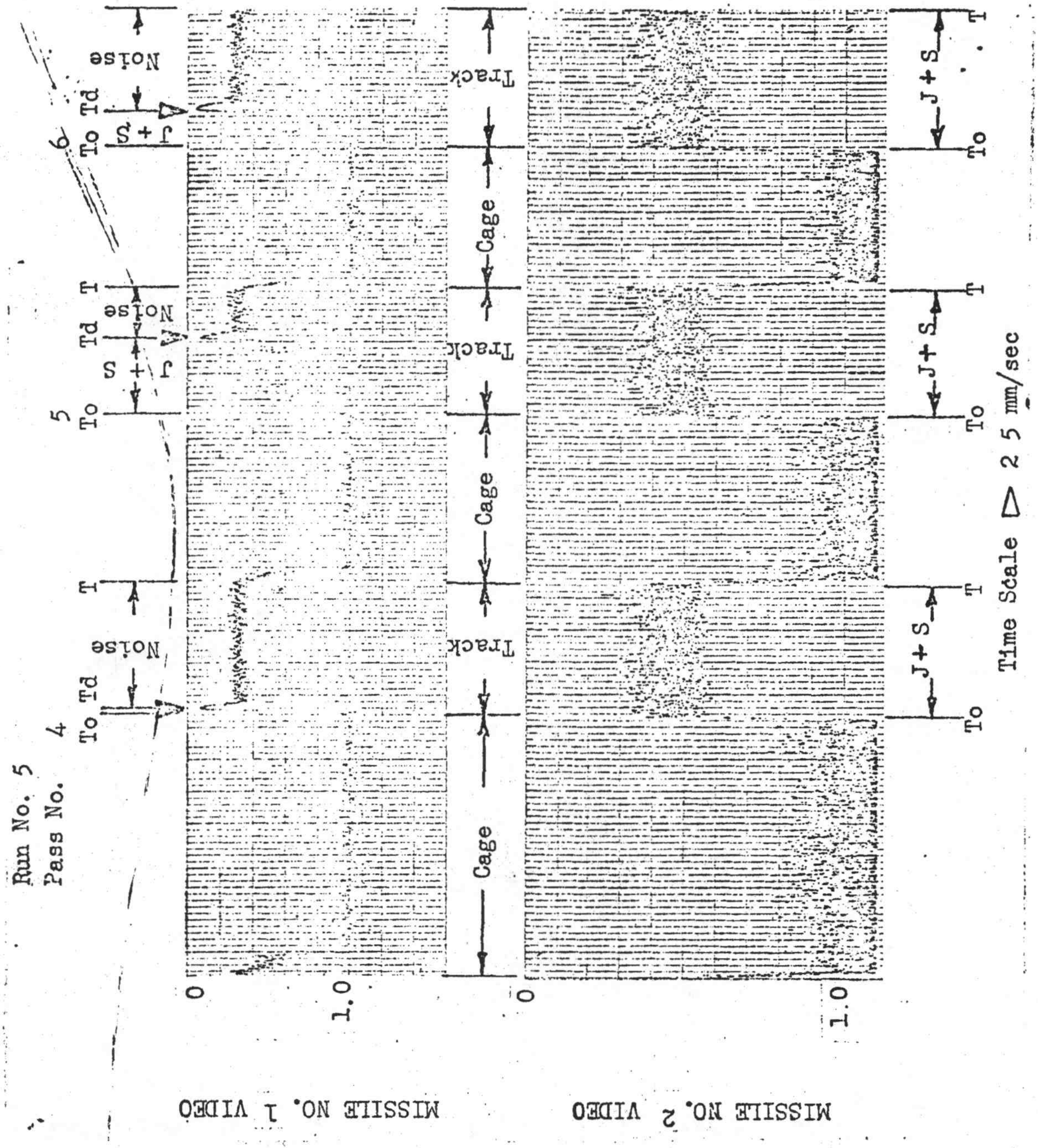

Figure 25. Mission No. 3011-A; Run 5, Pass 4, 5 & 6; Military Power (U) (~~SECRET~~)

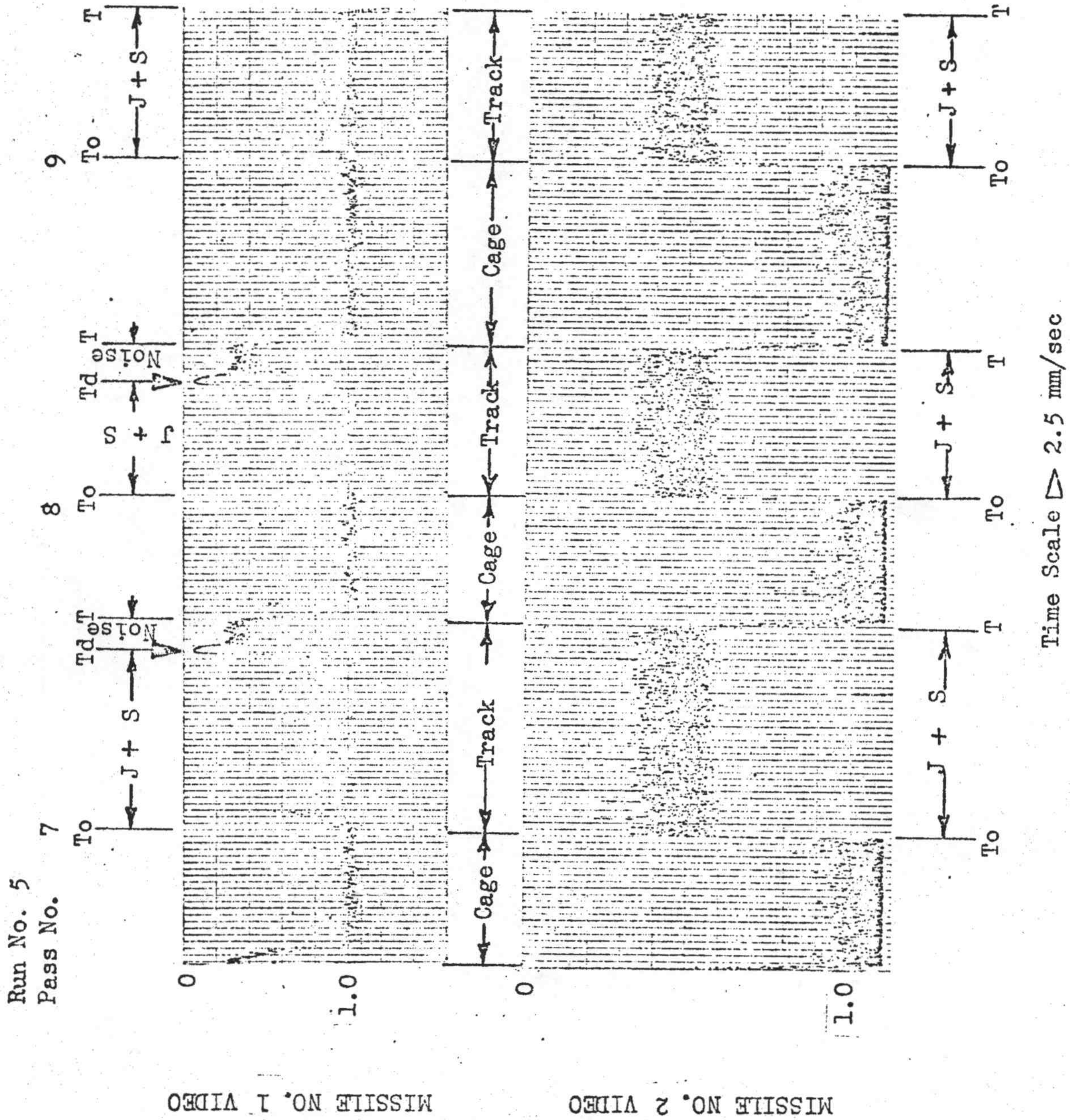

Figure 26. Mission No. 3011-A; Run 5, Pass 7, 8 & 9; Military Power (U) ~~(SECRET)~~

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[redacted]

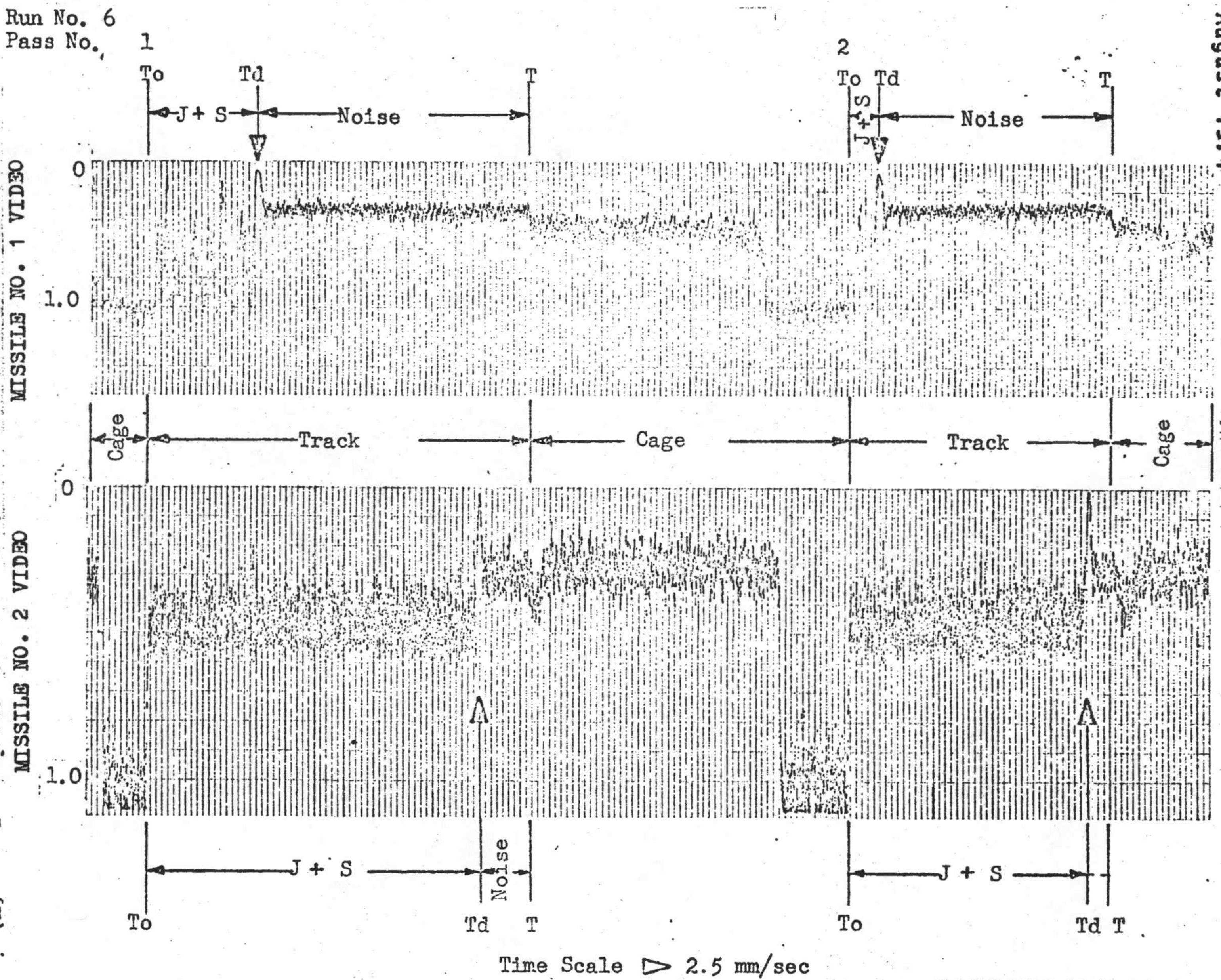

Figure 27. Mission No. 3011-B; Run 6, Pass 1 & 2; Military Power (U)

[redacted]

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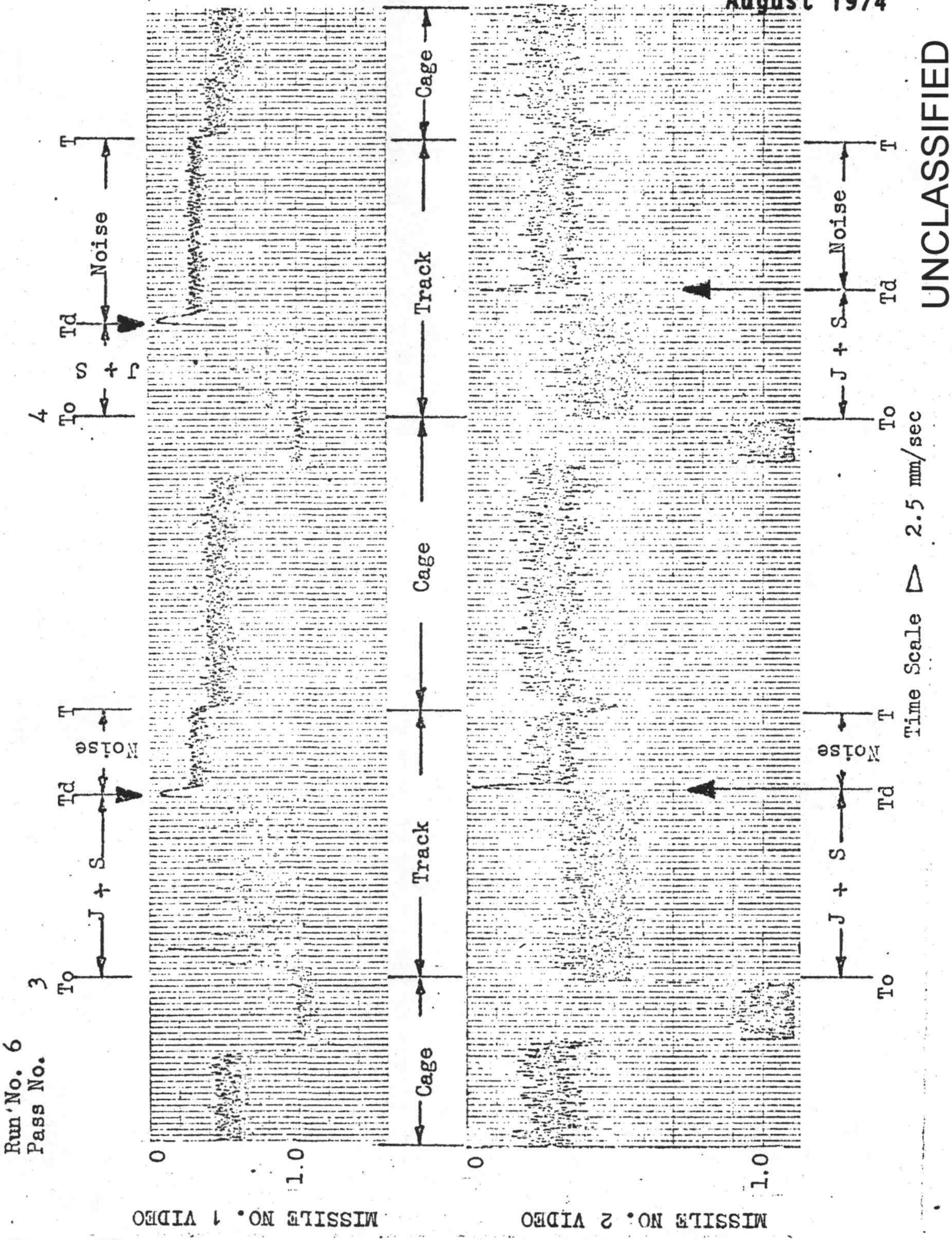

Figure 28. Mission No. 3011-B; Run 6, Pass 3 & 4; Military Power (U)
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[redacted]

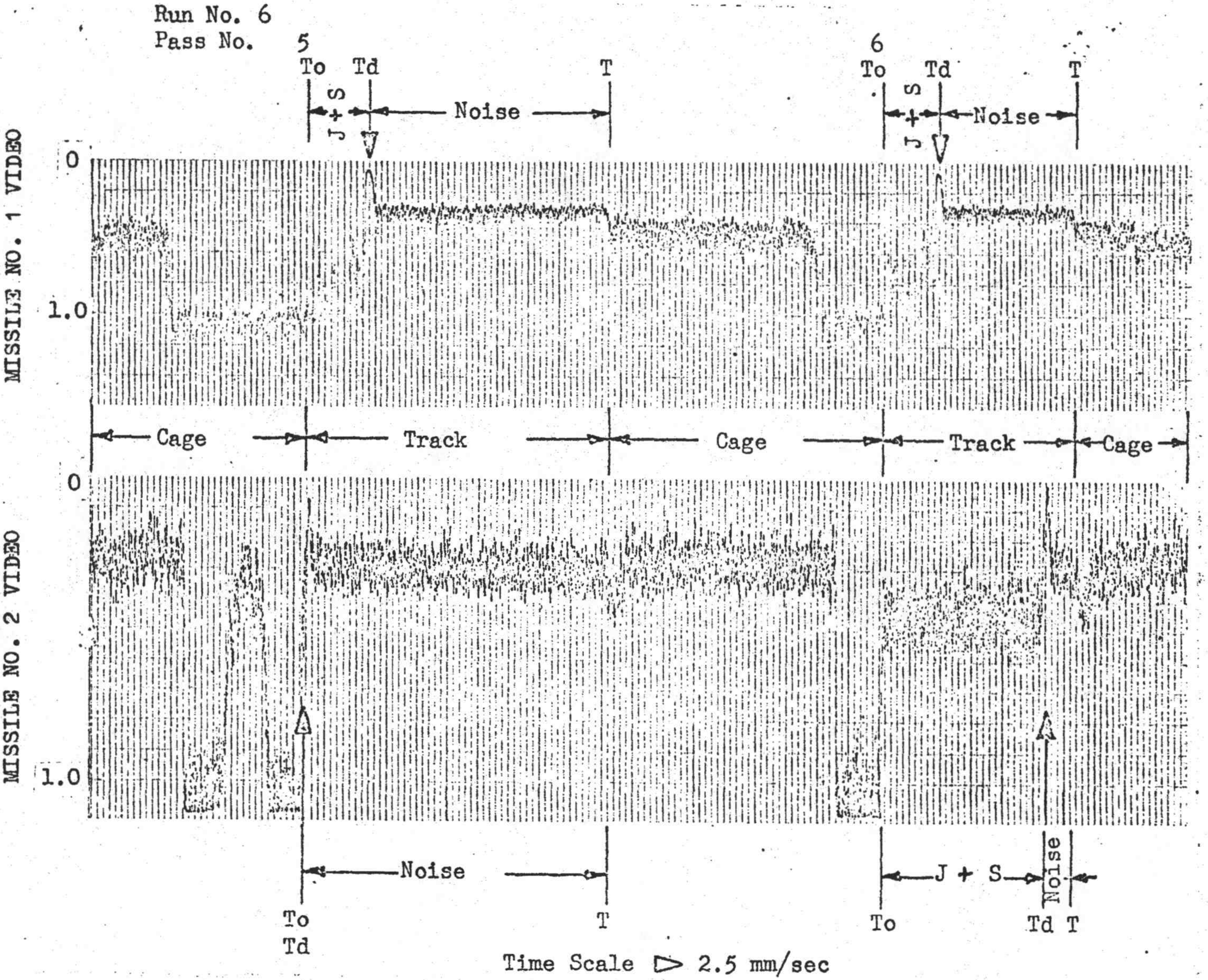

Figure 29. Mission No. 3011-B; Run 6, Pass 3 & 4; Military Power (U) [redacted]

[redacted]

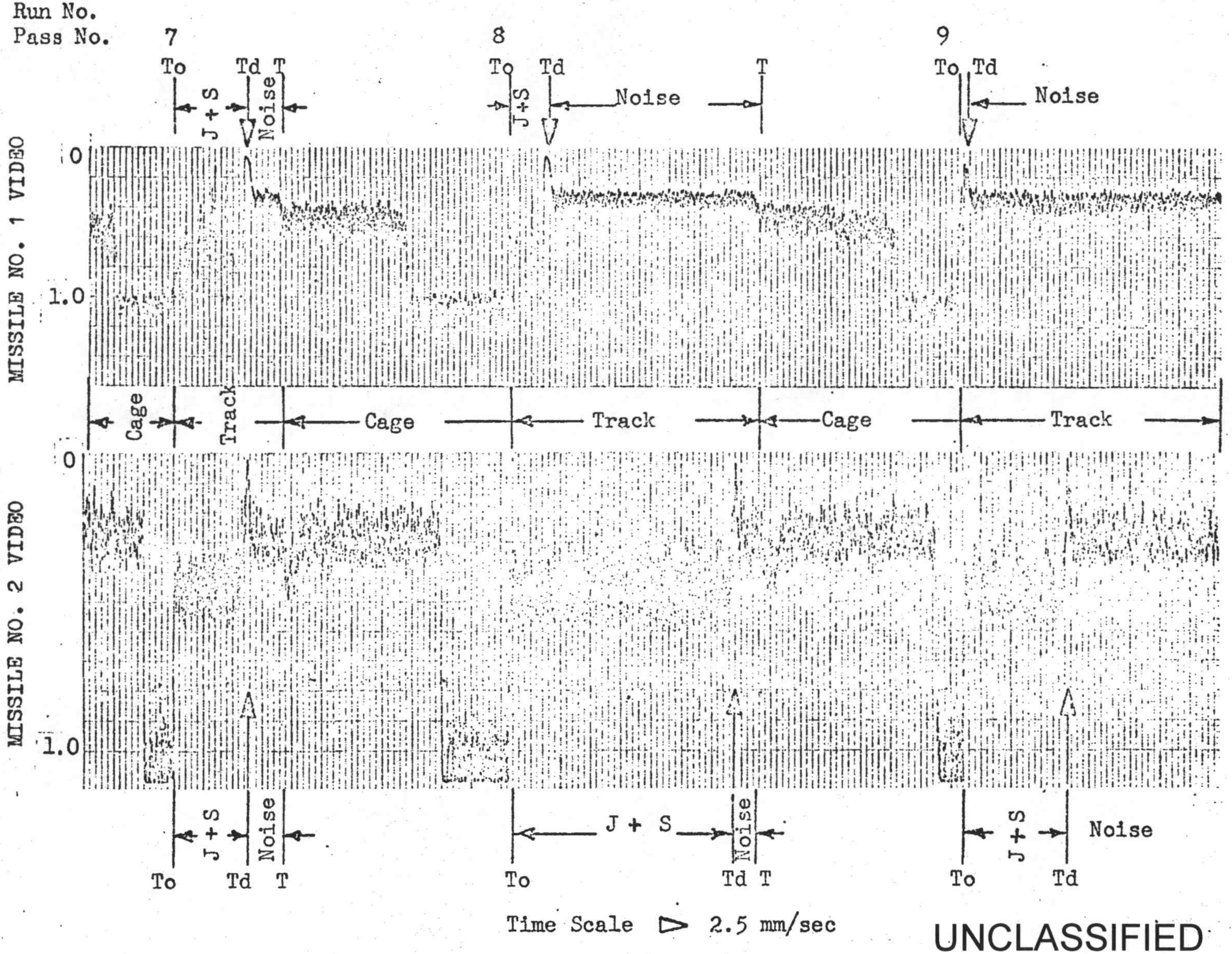

Figure 30. Mission No. 3011-B; Run 6, Pass 7, 8 & 9; Military Power (U)

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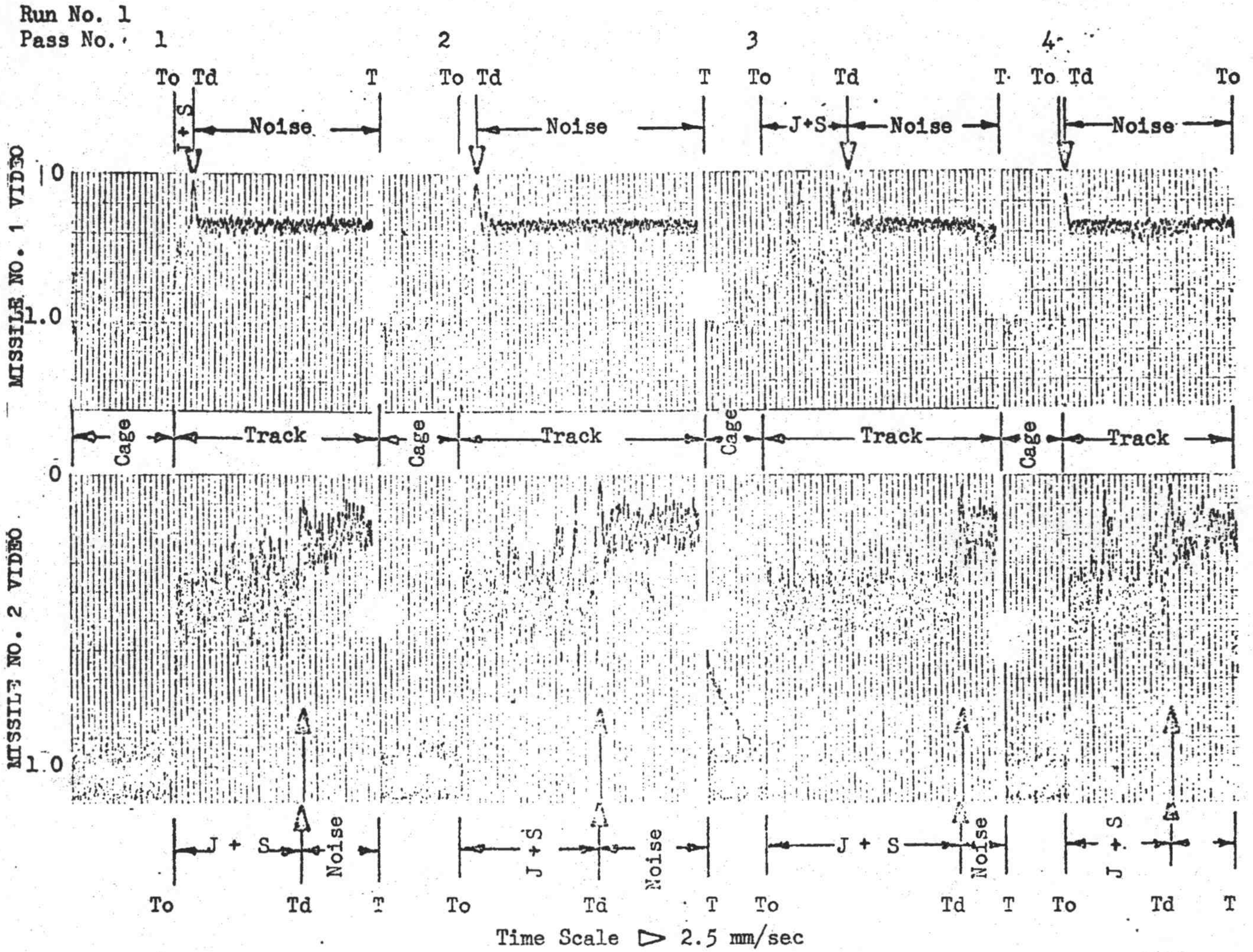

Figure 31. Mission No. 3011-B, Run 1, Pass 1, 2, 3 & 4; Cruise Power (U)
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