SM-65 SERIES D/SAMOS/MIDAS

FLIGHT TERMINATION SUBSYSTEM

Pacific Missile Range

Report No. ~~AE60-0769A~~ 1687

[redacted]

UNCLASSIFIED

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DOWNGRADED AT 3 YEAR INTERVALS; DECLASSIFIED AFTER 12 YEARS. DOD DIR 5200.10

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FOREWORD

This document supersedes Report No. AE60-0263, dated 30 June 1960 and Report AE60-0769, dated 28 September 1960. The primary purpose of this report is to inform the Range Safety Officer, Pacific Missile Range (PMR), of the configuration and operating characteristics of the flight termination subsystem to be used on Samos/Midas flights from Point Arguello Launch Site. The secondary purpose is to inform qualified personnel about the operations involved in the airborne flight termination subsystem, as required for test.

The satellite vehicle and satellite-vehicle systems described in this report are the Samos vehicle, Models 9205 and 4205, and Midas Model 7205.

The Samos/Midas program uses a modified version of the SM-65 Series D/IOC missile as a booster vehicle to launch a satellite from PMR. One of the subsystems which has been modified on the Series D/IOC missile for use in the Samos/Midas program is the flight termination subsystem.

To provide consistency between this report and other literature dealing with the Samos/Midas program, the SM-65 Series D missile will be referred to as the booster vehicle; the combination of booster and satellite vehicles will be referred to as the flight vehicle.

CONCURRENCE

Information contained in this Flight Termination Subsystem Report which pertains to the Samos satellite has been furnished, and consequently agreed to, by Lockheed Aircraft Corporation, Missiles and Space Division.

D. J. Gribbon
Manager, Satellite Systems

[redacted]

ADDENDA

The following information on primers is issued to holders of Report AE60-0769A, "SM-65 Series D/Samos/Midas Flight Termination Subsystem, PMR", revised 20 February 1961. It is to be inserted in the bound copies immediately following the title page.

Primers Used in the Booster Destructor Unit

The primers shown in the 27-04306-3 Destructor Unit in the booster, labled in Figure 1-3 and Figure 1-17 as BW-10004, and shown in Figure 1-18, will be replaced by BW-10081 primers in boosters 27-0006-3, -7 (108D), and on. The primer type designation "BW-10004" should be deleted from Figures 1-3 and 1-17, and the following effectivities should be observed:

Primers	Effectivities
BW-10004	27-0006-1, -2, -4, -5, -6.
BW-10081	27-0006-3, -7 (108D) through -29.

The following electrical characteristics (vendor's data) are identical for both the BW-10004 and BW-10081 primers:

(a)	Bridgewire Resistance:	0.3 ±0.1 ohm at 70° F 0.50 ±0.15 ohm at 350° F
(b)	Minimum Firing Current, (5 min):	0.450 amperes
(c)	Recommended Minimum Firing Current:	1.0 amperes
(d)	Ignition Time, 1-amp Current:	58 ±15 milliseconds
(e)	No-fire current (testing):	0.2 amperes
(f)	Spontaneous Detonation Temperature:	370°F

The two primers differ in the transmission time of the explosive front through the primer. The BW-10004 has no delay, and detonation of the high explosive may be assumed to occur within a few microseconds following initiation. Thus, firing time is equal to the ignition time.

The BW-10081 primer is 5/16-inch longer than the BW-10004 primer in order to accommodate a pyrotechnic delay consisting of a slow-burning powder train. The pyrotechnic delay time is 90 ±30 milliseconds. Thus, the minimum firing time is equal to 60 milliseconds plus the ignition time. The BW-10081 primers will fire the high explosive within 60 to 120 milliseconds following ignition, even though the electrical signal is removed simultaneously with ignition.

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ERRATA

The attached pages are furnished for insertion in bound copies of Report AE60-0769A, "SM-65 Series D/Samos/Midas Flight Termination Subsystem," dated 9 December 1960, to correct published information.

Insert this Errata sheet between pages ii and iii of the bound copy. Remove and destroy the following bound pages and insert the corrected pages in their place:

Title Page and ii
Pages iii and iv (Table of Contents)
vii and viii,
1-5 and 1-6,
1-27 and 1-28,
1-33 and 1-34,
1-37 and 1-38,
1-39 and 1-40,
4-7 and 4-8,
4-11 and 4-12,
4-13 and 4-14

Delete section II in entirety (pages 2-1 thru 2-4). Insert dummy sheet for Section II to indicate deletion of material.

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INTRODUCTION

The Samos/Midas program is designed to place a satellite reconnaissance vehicle into orbit around the earth. The experimental satellite vehicle is scheduled for launching from Point Arguello Launch Site within the Pacific Missile Range. The SM-65 Series D booster vehicle will go through a normal phase of powered flight. Following vernier cutoff, the satellite will be separated from the booster vehicle and will coast until the satellite engines ignite to propel it into its correct orbit.

To ensure the safety of the range and its environs, the capability of destroying both booster and satellite must exist. This destruct capability is required in case either erratic operation or premature separation takes place. In view of this requirement, Convair has so modified the SM-65 Series D missile flight termination subsystem that it will relay a destruct signal to the satellite vehicle.

The satellite vehicle adapter section contains a destructor which can be actuated by a destruct signal from the booster vehicle flight termination subsystem, or by premature separation circuitry if premature separation of the satellite from the booster vehicle should occur.

Range Safety is the responsibility of the Range Safety Officer. He maintains the capability of destroying both the booster and the satellite throughout the powered phase of booster-vehicle operation, i.e., until the sustainer cutoff (SCO) signal is given to the booster by the guidance-control radio link. The SCO signal "safes" the satellite destruct system; once this command is received, the Range Safety Officer can no longer destroy the satellite vehicle. He can, however, destroy the booster until either extensive range (possibly exceeding 1500 n. mi.) or battery life (possibly as long as 10 minutes) limit this capability.

NOTE

> The seeming inconsistency between the satellite and booster destruct initiator terminology is reconciled by the following explanation.

Comparison and Explanation of Booster and Satellite Destruct Initiator Terminology

In general, the term "primer" refers to a physically separate unit containing one or more squibs and a small powder charge. The term "squib" basically refers to a resistive wire, contained within the powder charge, whose temperature increases rapidly with conduction of current; "squib" is here used in the same sense as the term "bridgewire".

The booster destructor utilizes two physically separate primers, each with its own squib or bridgewire and powder charge. Ignition of the powder charge in either primer will result in detonation of the high explosive when the device is armed. Primer current refers to the current passing through the squib or bridgewire within the primer. In the diagrams, the primer bridgewires are shown by symbols normally used to represent fuses.

The satellite destruct initiator is a single primer employing two squibs or bridgewires. Sufficient current through either squib will ignite the powder charge within the primer and will cause detonation of the high-explosive shaped-powder charge. The satellite squibs are shown in the drawings as resistors enclosed in boxes.

The diagrams in this report are functionally correct; ignition of a single primer or squib in either stage will initiate destruction of that stage.

SECTION I

FLIGHT TERMINATION SUBSYSTEM

1.1 INTRODUCTION. The function of the flight termination subsystem (FTS) is to receive frequency-modulated signals from the ground transmitter, decode these signals into a command, and to destroy the flight vehicle upon command. The satellite vehicle is automatically destroyed upon premature separation. The flight termination subsystem has been designed to be compatible with the PMR Range Safety System ground equipment and operational procedures. Figure 1-1 shows a block diagram of the subsystem. The pod configuration of the SM-65 Series D booster vehicle is shown in Figure 1-2.

The basic flight termination subsystem consists of an essentially omnidirectional antenna, two range safety command receiving sets (operated in parallel for reliability) which are compatible with the Pacific Missile Range FRW-2 UHF ground destruct transmitter (GDT), power change-over switches, power sources, arming and safing devices capable of remote-control operation, and two destruct units (one in the Atlas booster and one in the adapter section for destruction of the satellite vehicle). The adapter section also contains two separation switches and two auxiliary batteries which are so connected as to ignite the adapter section destruct unit and destroy the satellite vehicle if separation of the satellite from the booster occurs before commanded separation.

An integrated schematic diagram of the flight termination subsystem is given in Figure 1-3.

1.2 COMMAND FUNCTIONS. The design of FTS equipment is based on the following ground transmitter operation: When the Range Safety Officer wishes to destroy the flight vehicle, he presses first the PRE-ARM button and then the DESTRUCT button on his console. These buttons cause the FM carrier signal being sent by the GDT to be modulated with combinations of designated tone channels. The frequency-modulated signals are received by two independently operated receiver sets. Each set decodes the signals into the PRE-ARM and DESTRUCT commands. The outputs from each set are separated through appropriate circuits to permit either or both sets to perform the required function.

1.2.1 PRE-ARM. When the Range Safety Officer depresses the PRE-ARM button, the ground transmitter signal is modulated by tone channels 1 and 5 for more than 100 milliseconds. The pre-arm command operates relays within the receivers. The logic circuit for the pre-arm function is discussed in Paragraph 1.6.1.

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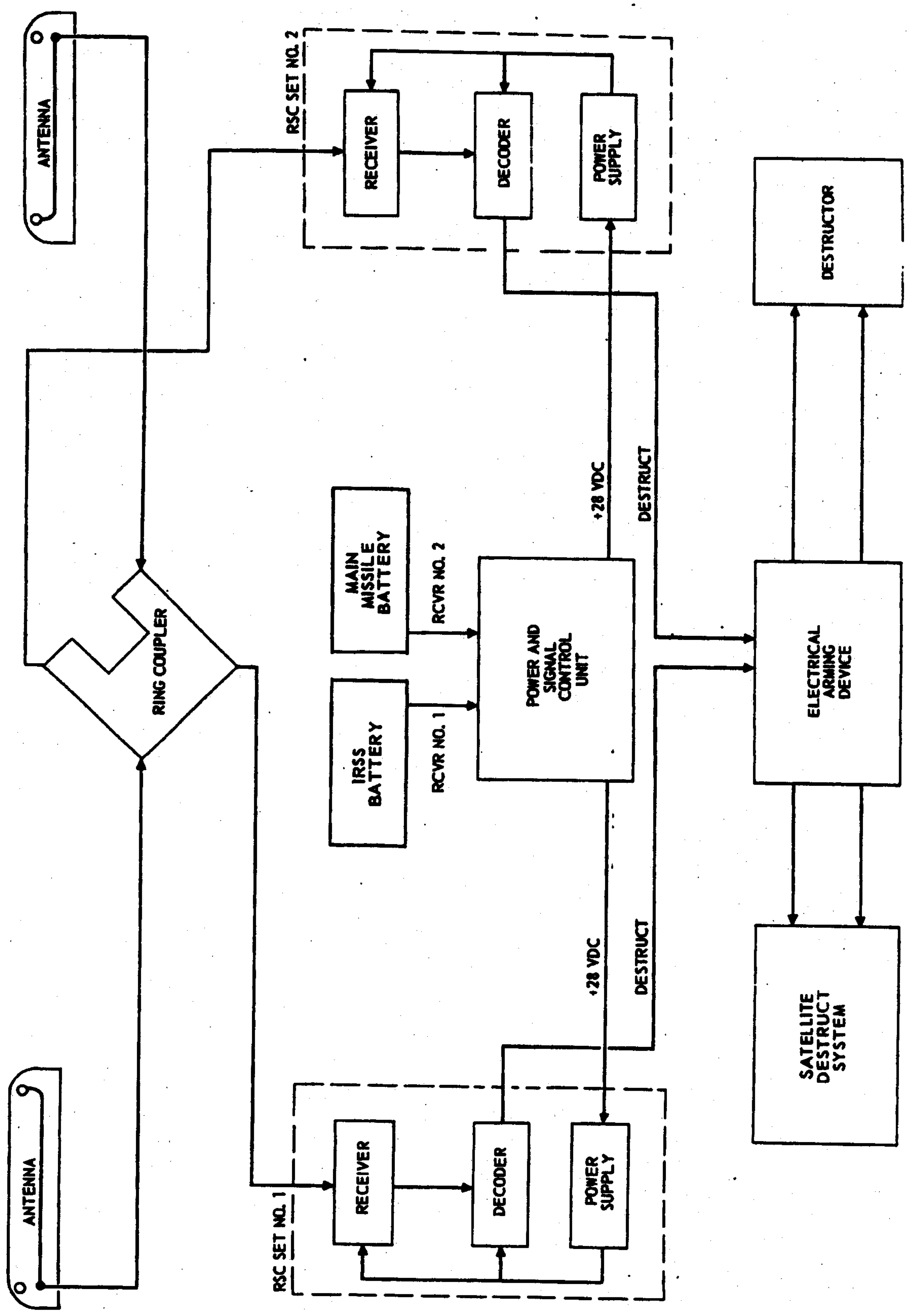

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Figure 1-1. Flight Termination Subsystem in SM-65 Booster Vehicle

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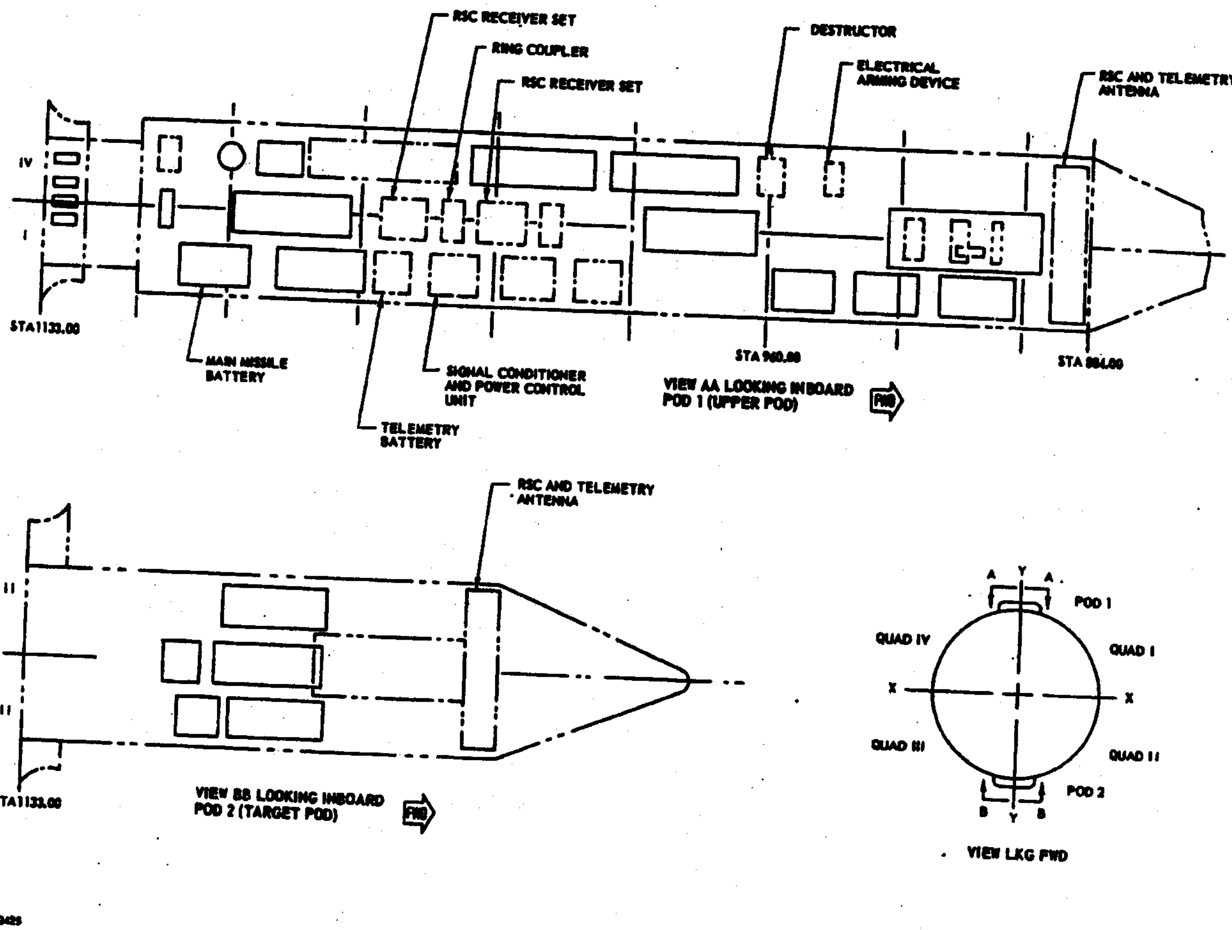


Figure 1-2. Booster Vehicle Pod Configuration

1.2.2 DESTRUCT. The destruct command, generated by modulating the carrier signal with tones 1 and 2, ignites the primers in the destructor units of the booster and satellite vehicles. This command is initiated by the RSO. The destruct logic circuitry is shown in Figure 1-4. Both destructors are so located with respect to the propellant tanks of their respective stages that, when detonated, they will rupture these tanks. The resultant combination of propellants will cause massive explosions that will destroy the flight vehicle.

1.3 PREMATURE SEPARATION. During the booster portion of powered flight, i.e., before sustainer cutoff, premature separation of the satellite vehicle from the booster will actuate separation switches located on the adapter section that cause a destruct signal to be sent to the satellite's destructor unit to destroy the satellite vehicle. However, under the condition of premature separation, the booster is not automatically destroyed but can be destroyed by RSO command. The sustainer cutoff (SCO) signal from the booster autopilot places the premature separation system in the SAFE condition. The vernier cutoff (VCO) signal performs a backup function for this safing operation. After normal separation, all of the receiving equipment and the destruct units remain on the Atlas/adapter stage so that there is then no way to destroy the satellite.

1.4 INPUT SIGNAL CHARACTERISTICS. The flight termination subsystem input signal characteristics are compatible with those of the Range Safety Ground Station. These characteristics are as follows:

a) Carrier frequency tolerance ±0.013%: ±0.010% allotted to the transmitter, and an additional 0.003% for doppler shift.

b) Carrier signal strength provided by the UHF ground transmitter is to be within the range between 950 microvolts per meter and 65 volts per meter.

c) A modulation deviation of 60 kc, ±10% peak deviation for any number of tones.

d) Equality of modulation-tone deviations ±10%.

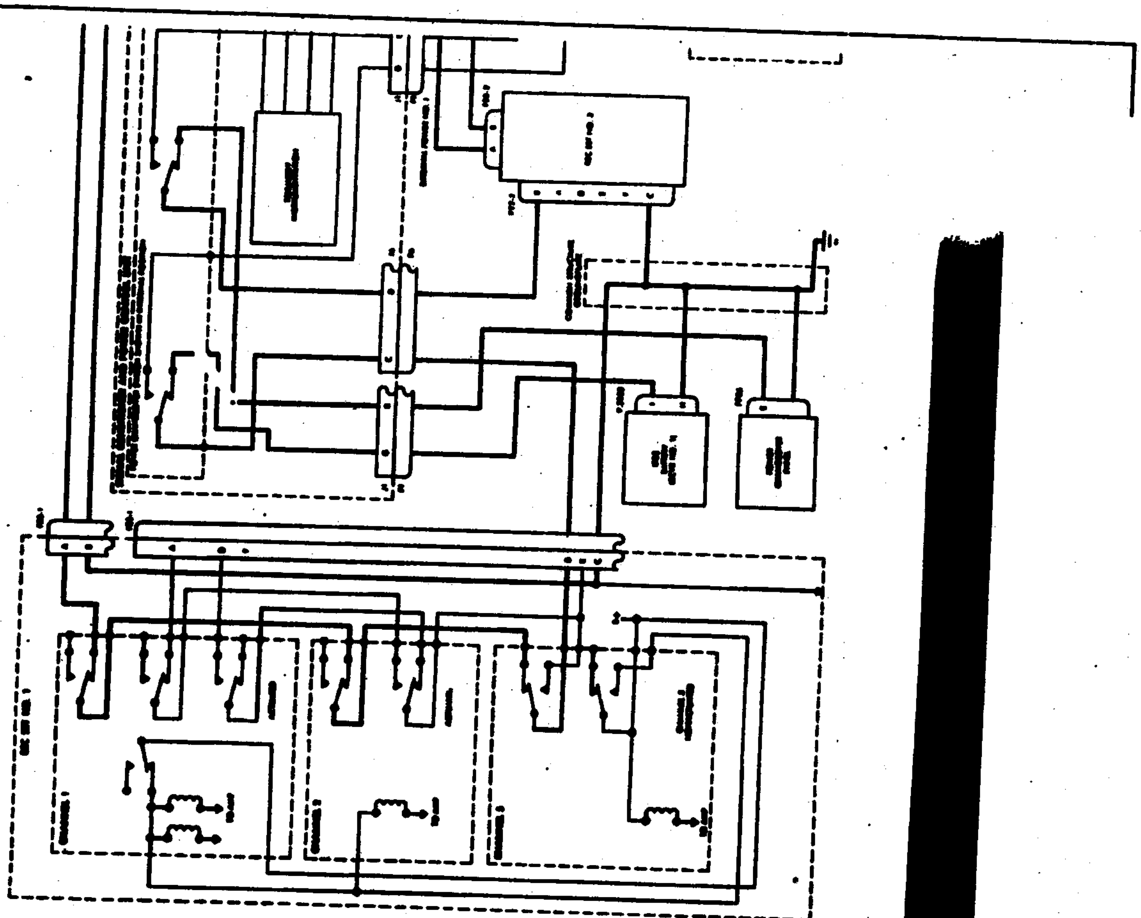
e) Tone frequency tolerances ±1.0%.

1.5 ANTENNA SYSTEM. The Flight Termination subsystem utilizes two single-cavity antennas mounted opposite each other. Each antenna cavity contains two range safety command probes, as shown in Figure 1-5.

The combined telemetry-and-command antenna was designed to require the least amount of space in the SM-65 Series D missile, yet provide the necessary antenna pattern coverage. At the telemetry frequencies, sufficient isolation exists between the telemetering antenna probe and the command antenna output to prevent possible interference with the command subsystem. Figure 1-6 shows a linearized mercator projection of the antenna radiation pattern for the Series D/Samos/Midas missile prior to staging. Figure 1-7 shows the antenna radiation pattern after staging. The method of determining the antenna radiation pattern is indicated in Figure 1-8.

The antenna patterns shown in the mercator plots were taken from a one-tenth-scale model, using a left-hand sense of illumination. The 3-db loss associated with the transition from linear to circular polarization has been accounted for in the plot, so the indicated signal intensities may be taken as actual values.

Figure 1-9 shows the interconnection of the antenna system components. The antennas are coupled to the receivers by a ring coupler, Figure 1-10; this prevents the failure of the RF link to one receiver package from affecting the other set in the dual system. The coupler provides a minimum of 20-db isolation between receivers.



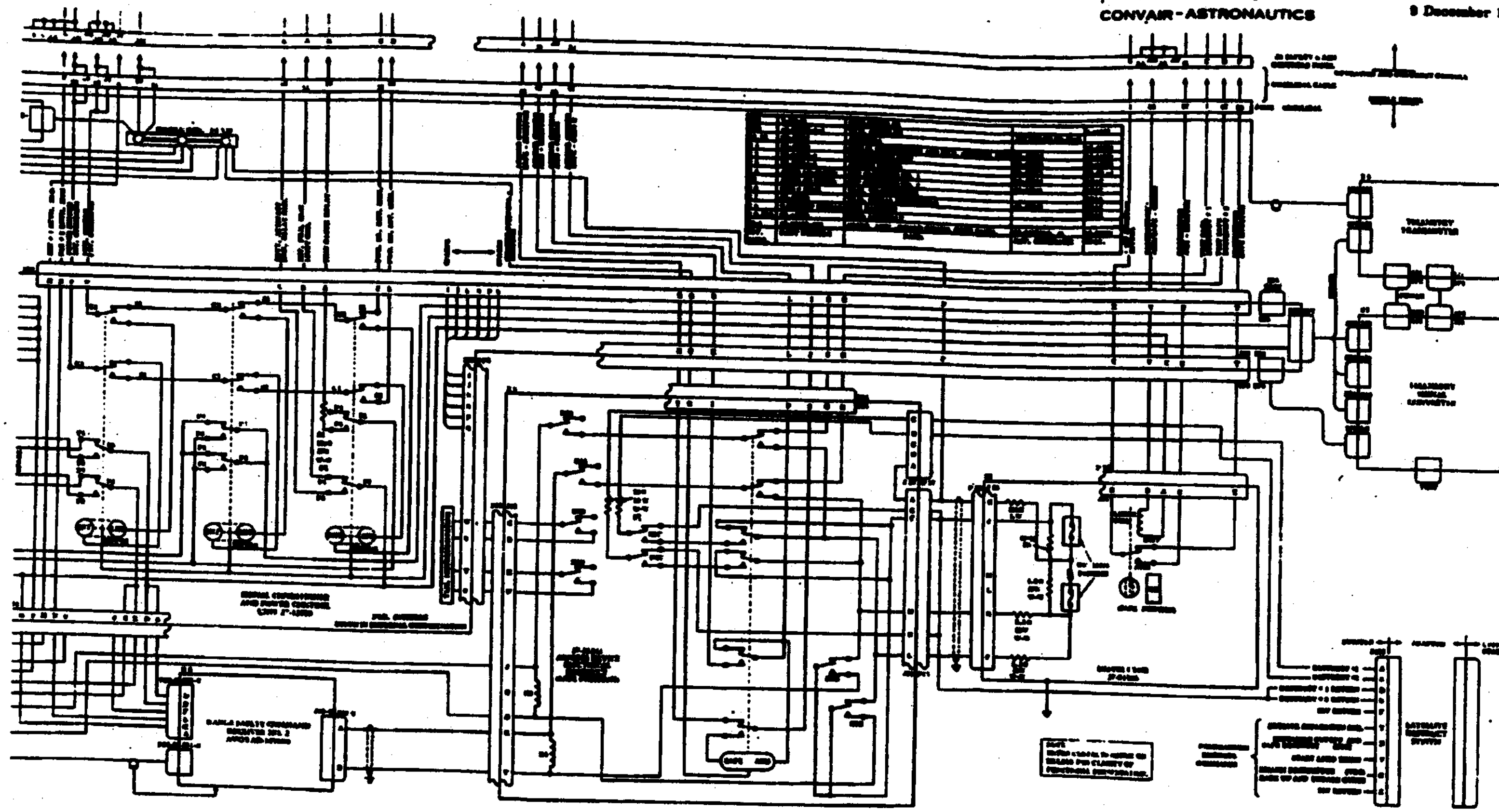


Figure 1-3. Integrated Electrical Schematic of Booster Flight Termination Subsystem

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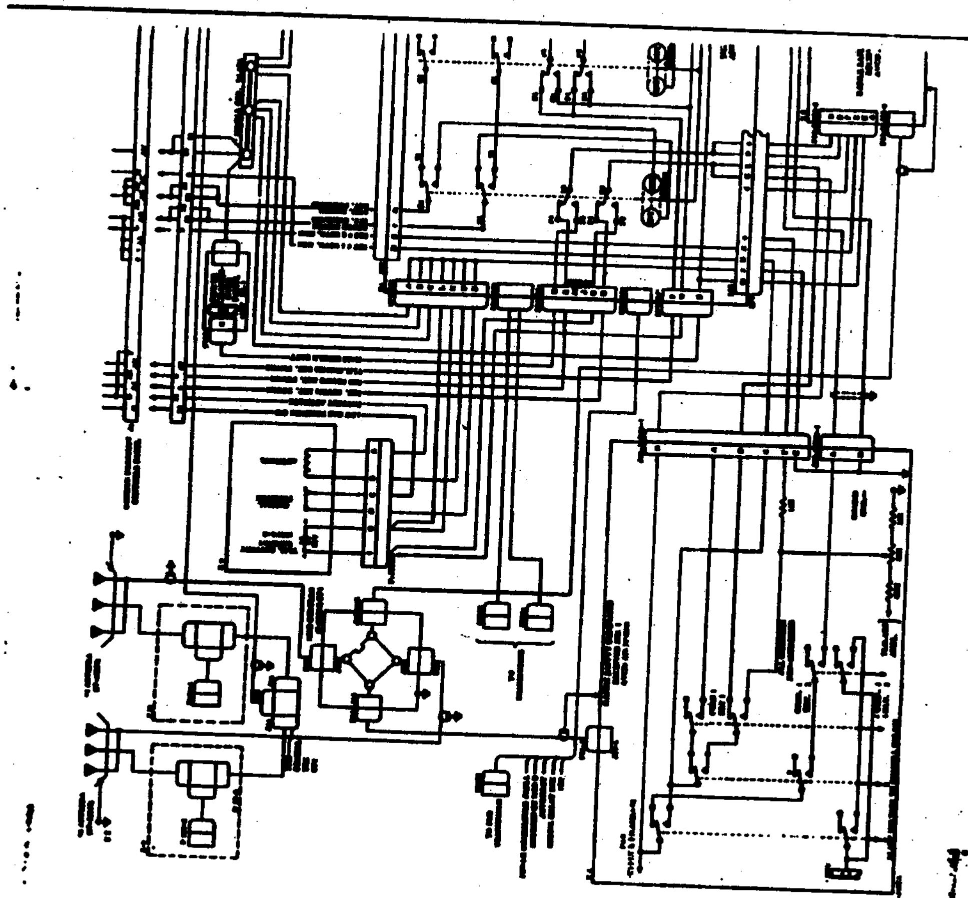

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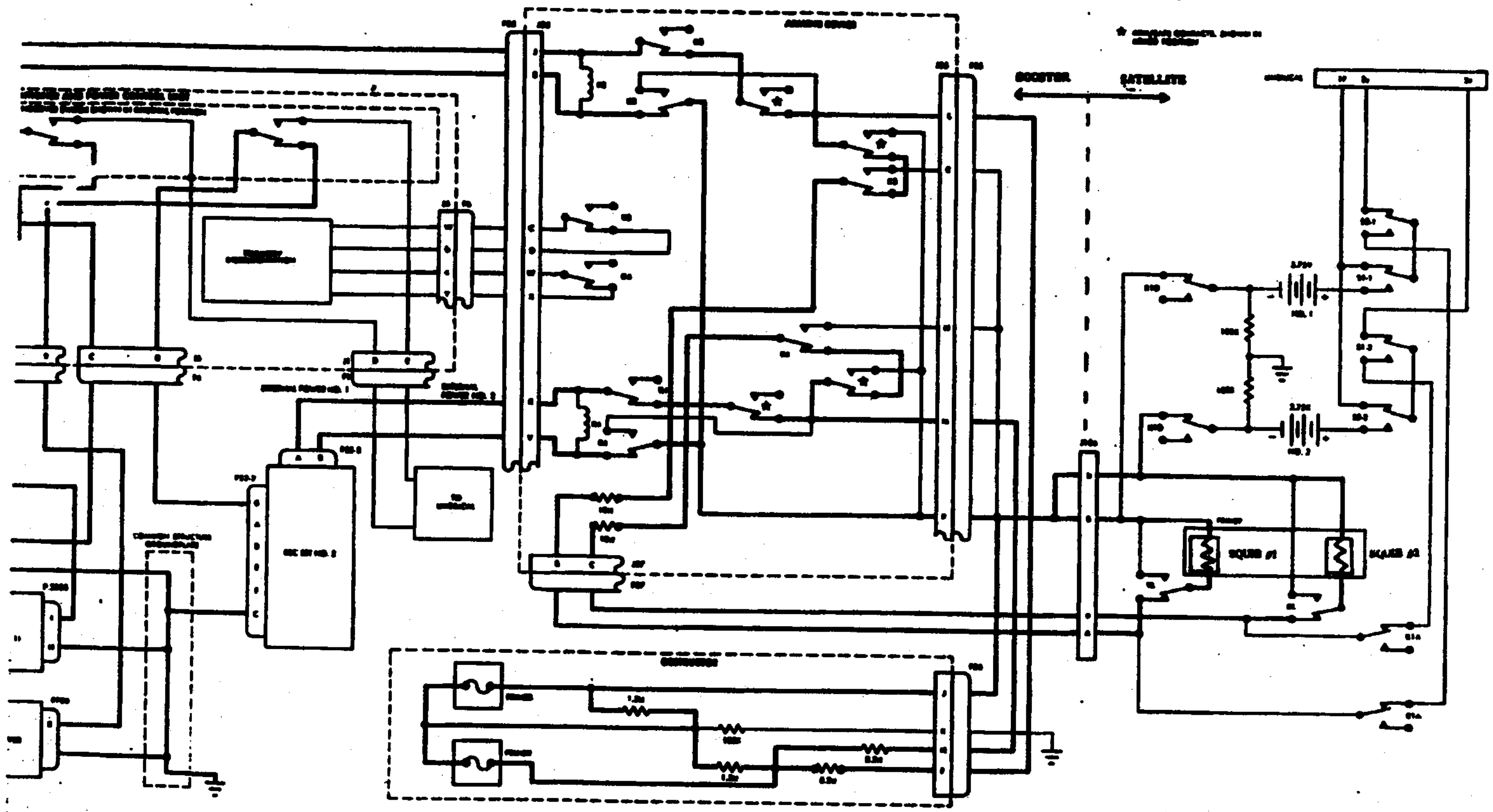

Figure 1-4. Flight Termination Subsystem - Destruct Circuit

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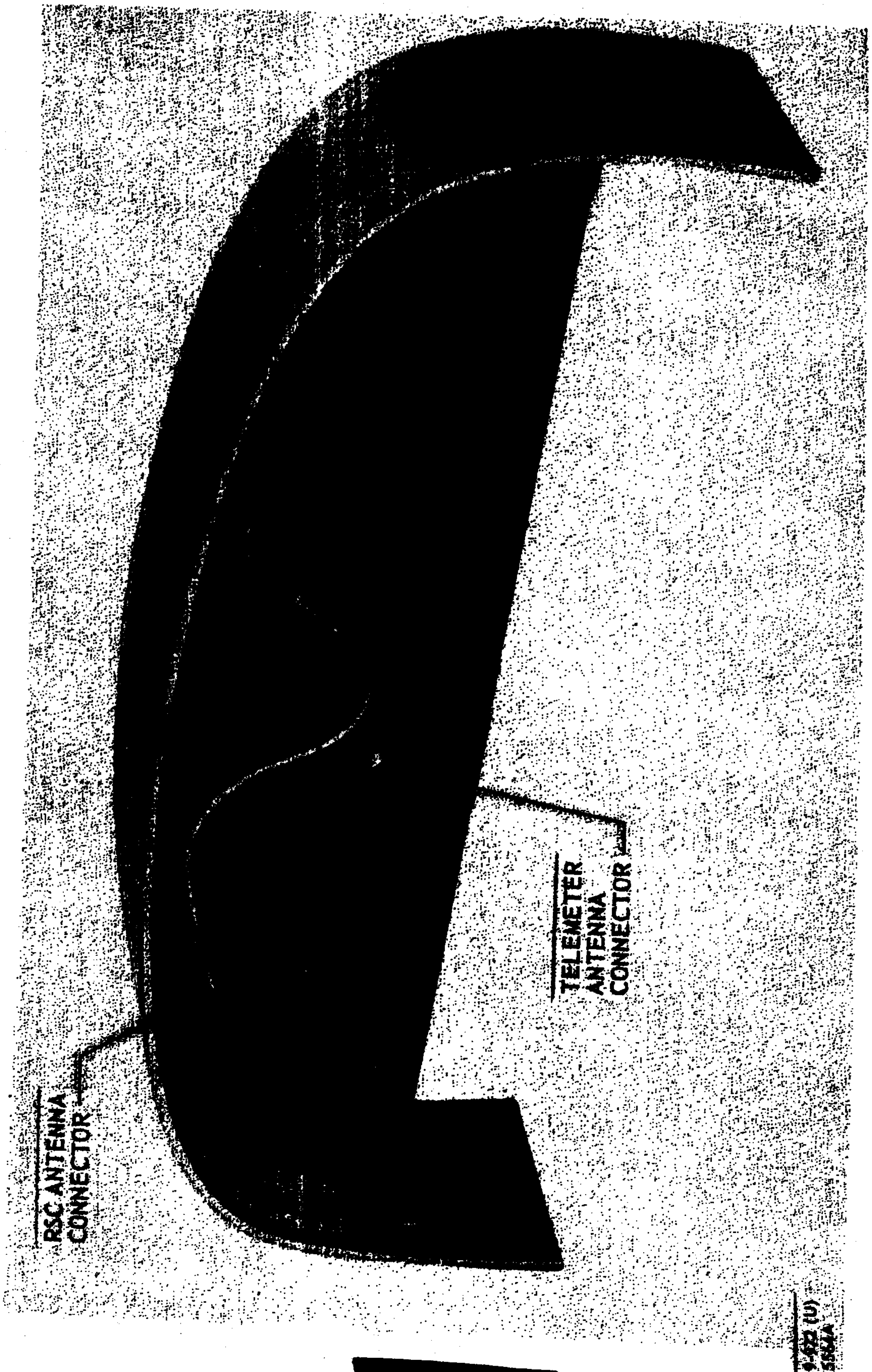

Figure 1-5. Range Safety Command & Telemetry Antenna

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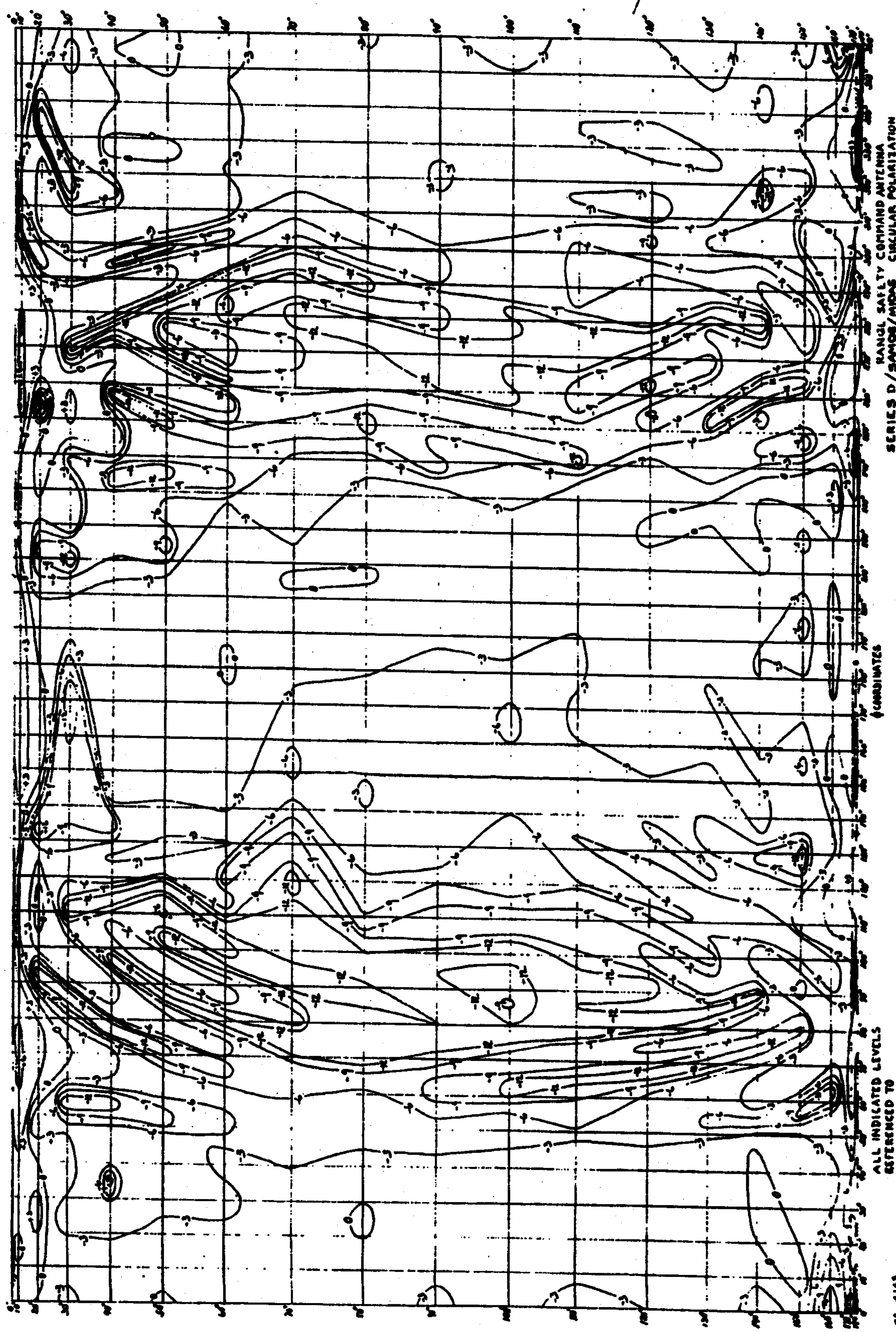

Figure 1-6. Antenna Radiation Pattern, Pre-Stage

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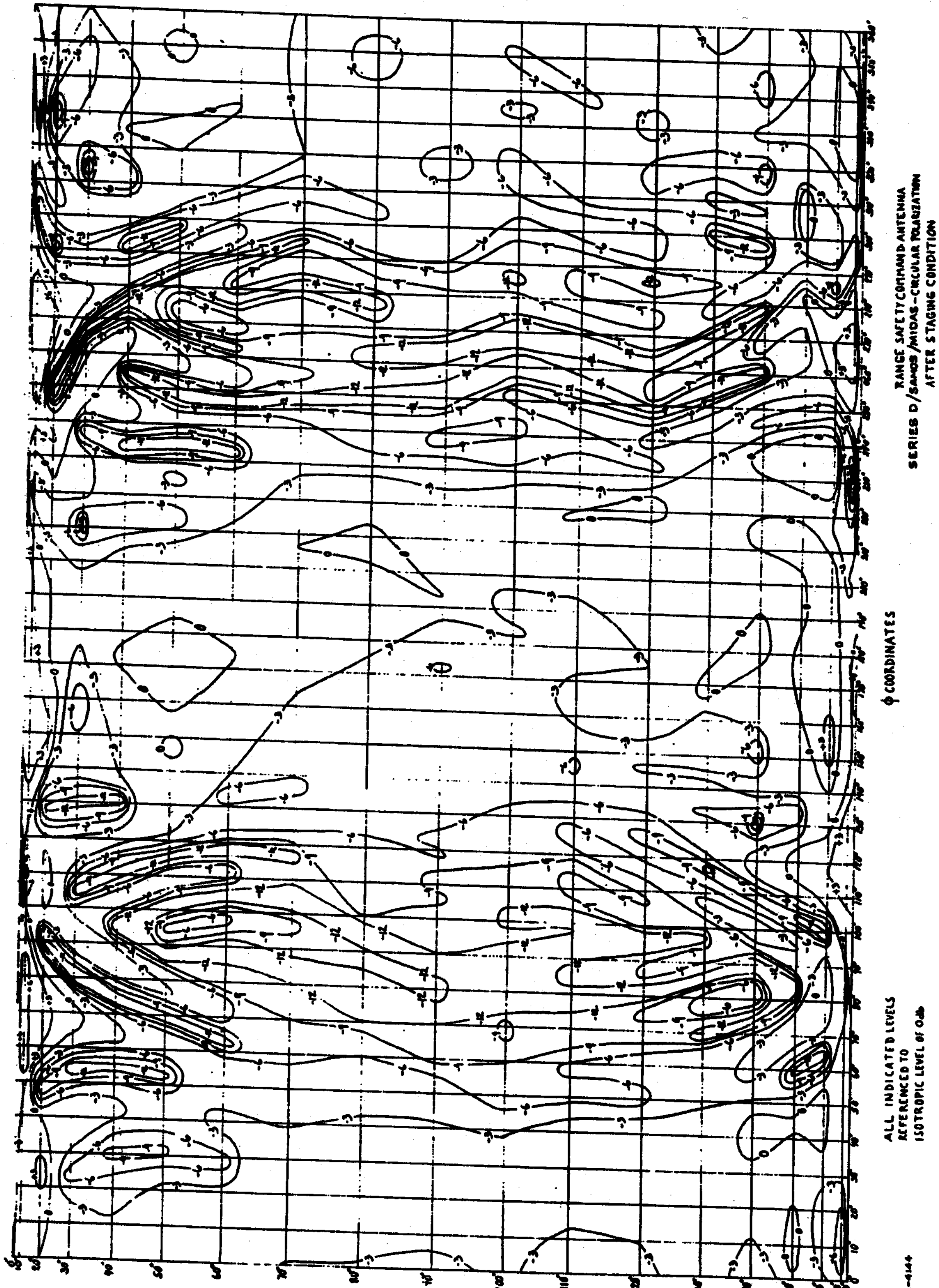

Figure 1-7. Antenna Radiation Pattern, Post-Stage

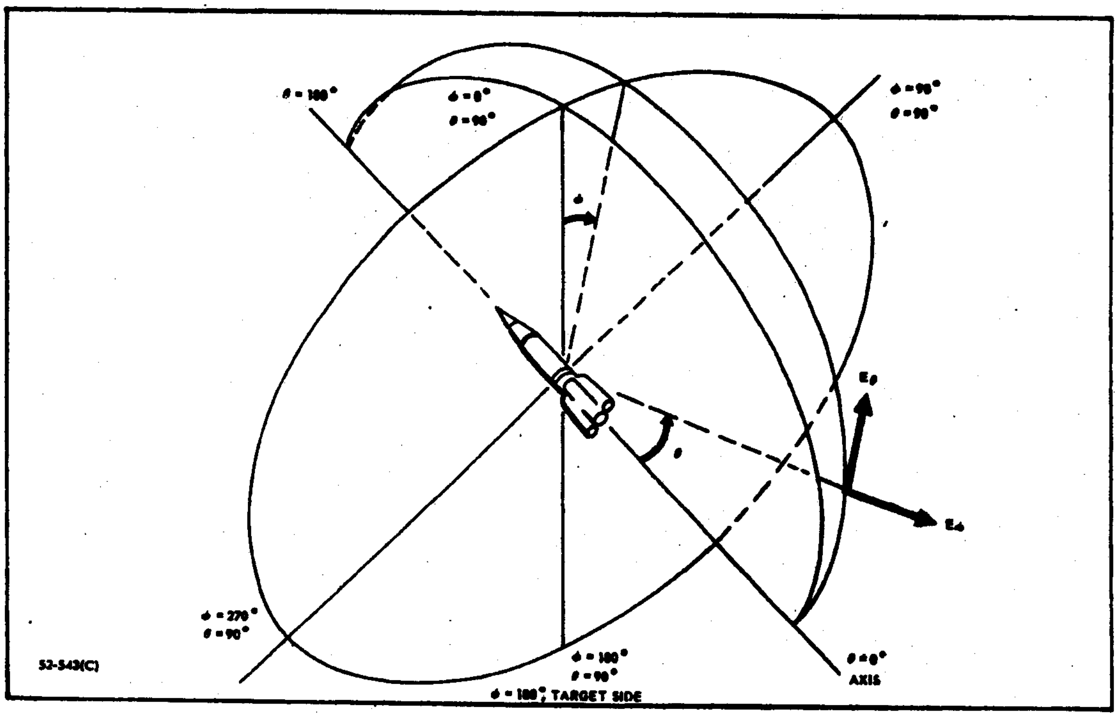

Figure 1-8. Missile Coordinate System

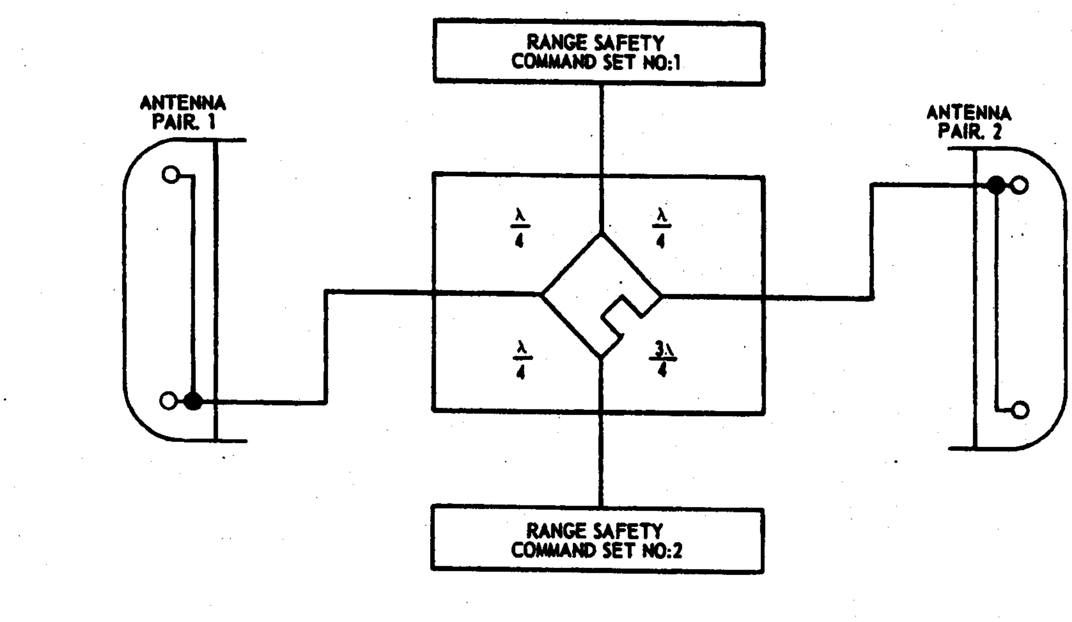

Figure 1-9. Schematic of Antenna System