SECTION 4
THOR GROUND SUPPORT EQUIPMENT

DESTRUCT SUBSTITUTION UNIT

The Destruct Substitution Unit (Igniter Signal Tester) contains two voltmeters that are substituted for the S & A mechanisms when destruct checks are made. The input load resistance is the same as the S & A mechanism so that the voltage readings will indicate the current required for destruct action. The configuration and schematic of the unit are shown in Figure 4-1.

IGNITER TEST SET

The Igniter Test Set is a special purpose multimeter used for electrically checking various circuits or components of the destruct system for:

a. Resistance measurements
b. Circuit continuity
c. Presence of stray current or voltage
d. Insulation breakdown
e. Shorts to "ground"

Figure 4-2 shows the set configuration; Figure 4-3, the circuit schematic.

OPERATION AND CONTROL CONSOLE

The operation and control console (shown in Figure 4-4) is used to:

a. Check range safety receiver operation
b. Run a closed-loop test of the DM-21 destruct system after mating
c. Monitor open-loop testing of the destruct system during the launch countdown

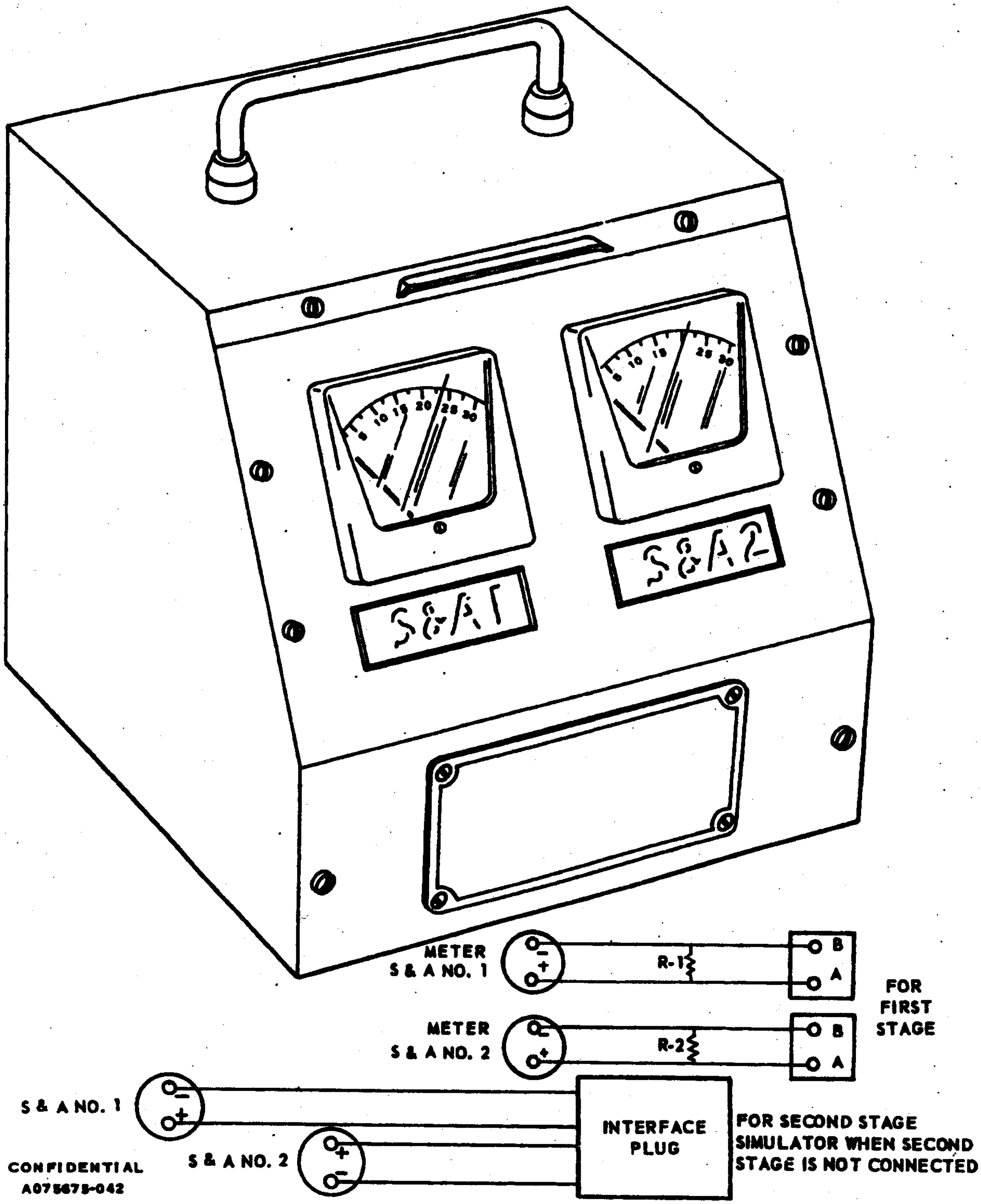

Figure 4-1 Destruct Substitution Unit

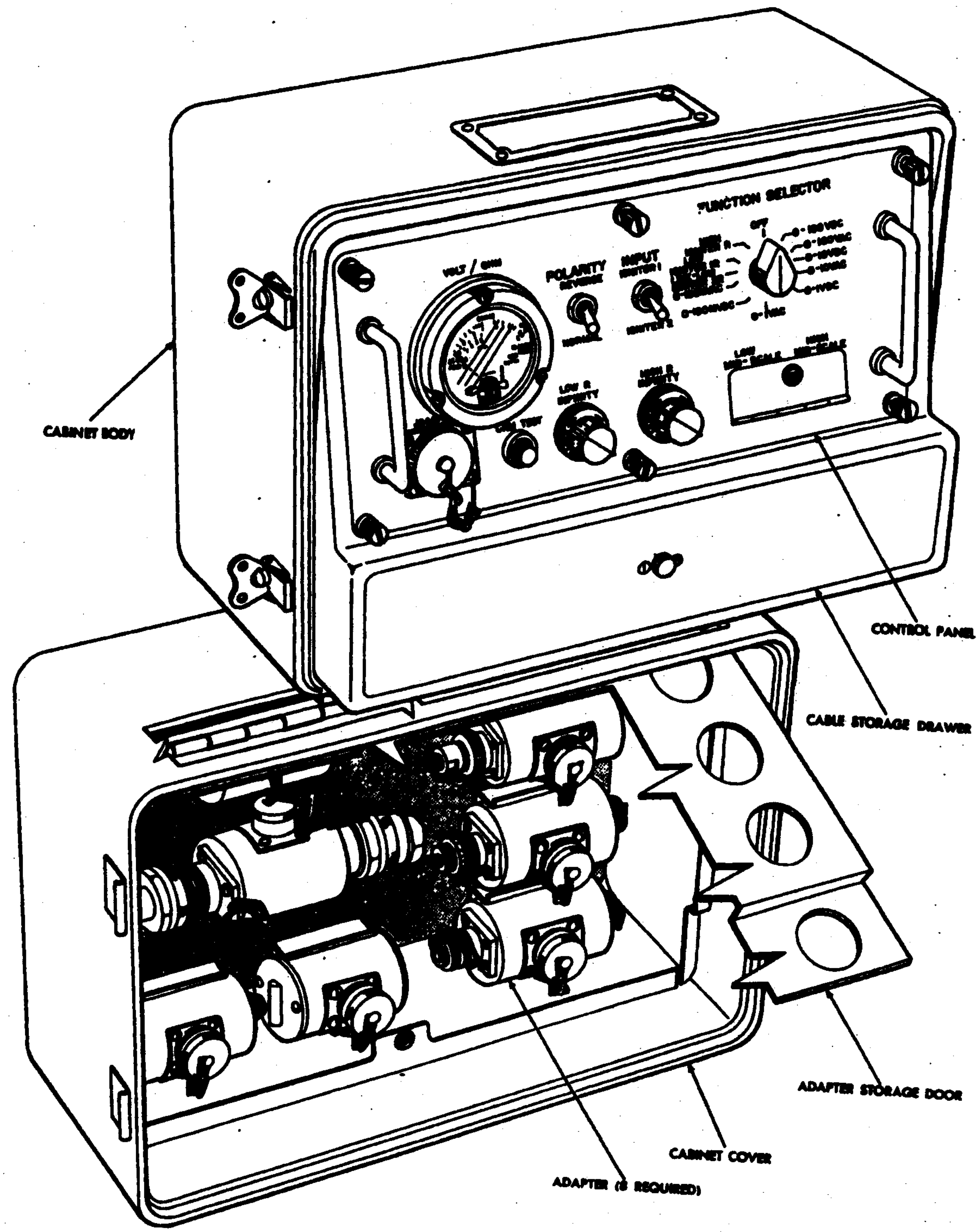

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Figure 4-2 Igniter Test Set

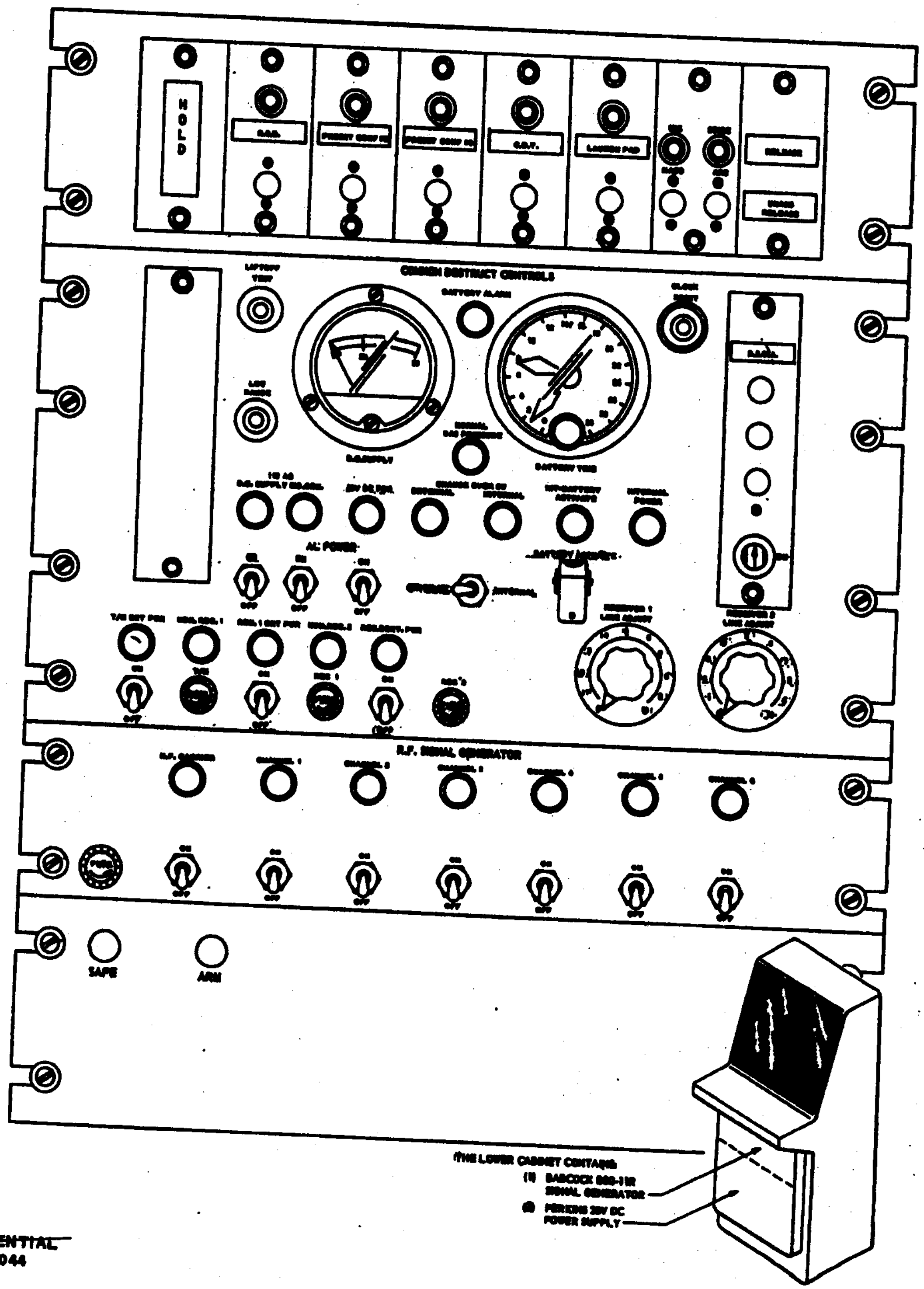

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Figure 4-4 Operation And Control Console

d. Check and monitor external power applied to the vehicle
e. Indicate SAFE/ARM condition of the S & A mechanism during countdown.

A portable version of this console is used in the vehicle assembly area for destruct assembly checks.

ANTENNA LOAD SIMULATOR AND COUPLER

All missile instrumentation systems will shortly be checked out by closed loop via coaxial, using Instrumentation Support Trailer DAC-2 (until closed loop capability is realized in CC-1 and CC-3). At the present time, the antenna load simulator is a reasonant hat whose configuration is such that it can be placed over any one of the vehicle cavity slot antennas. It shrouds the cavity slot antenna so that undesired external signals cannot enter and internal signals are not radiated. It is used during checkout of the receiving system in order to ascertain individual antenna and receiver sensitivities. A coupler assembly provides for coaxial connection between an RF signal generator and the antenna.

SPECIFICATIONS AND REFERENCES

Specifications

Each component in the system has been designed to operate under the environmental conditions expected to be encountered during the flight. Mechanical tests have been conducted to demonstrate adequacy of the explosive charge. All airborne electronic equipment installed conforms to the following military specifications:

MIL-E-9483	Electrical Equipment, Installation of, Guided Missiles and General Specifications for
MIL-E-8189A	Electronic Equipment, Guided Missiles, Installation of, General Specifications for

MIL-E-129A	Marking for Shipment and Storage
MIL-E-8500A	Interchangeability and Replaceability Physical Components for Aircraft (Including Guided Missiles)
MIL-E-5277A	Environmental Testing, Aeronautical and Associated Equipment

References

The following references provide additional information pertinent to the DM-21 flight termination system.

Douglas Aircraft Co., Inc. Report No. SM-37963 DM-21 Range Safety System, November 1960.

Douglas Aircraft Co., Inc. Report No. SM-27100 WS-315A Range Safety Command Destruct System, 3 August 1956, Revised June 1958.

Douglas Aircraft Co., Inc. Douglas Model DM-21 Space Research First Stage Vehicle DS-2110A Performance Specifications, 28 July 1960.

Douglas Aircraft Co., Report No. SM36031, Revision 1, Flight Test Vehicle Safety Proposal, Delta Program - Atlantic Missile Range, August 1960.

SECTION 5
ATLAS DESTRUCT SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The Atlas booster contains a compact missile flight safety system (MFSS) and telemeter kit. The missile flight safety system operates independently of the telemetry system, however, the two are interrelated from the standpoint of reliable missile flight safety operation, in that the telemetry carrier reception at the ground stations provides the necessary missile position and impact data.

The booster destructor utilizes two physically separate primers, each with its own bridge wire. Ignition of a lead styphnate primer results in detonation of the high explosive when the device is armed. The function of the booster destruct system 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 system has been designed to be compatible with the Pacific Missile Range Safety System ground equipment and operational procedures. A block diagram of the system is shown in Figure 5-1; in Figure 5-2, the arrangement of Atlas booster equipment is shown. Figure 5-3 is an integrated schematic of the booster flight termination system.

The basic destruct system consists of an omni-directional antenna, two range safety command receiving sets (operated in parallel for reliability and compatible with the Pacific Missile Range FRW-2 UHF ground destruct transmitter), power change-over switches, power sources, arming and safing devices capable of remote-control operations, and a destruct unit.

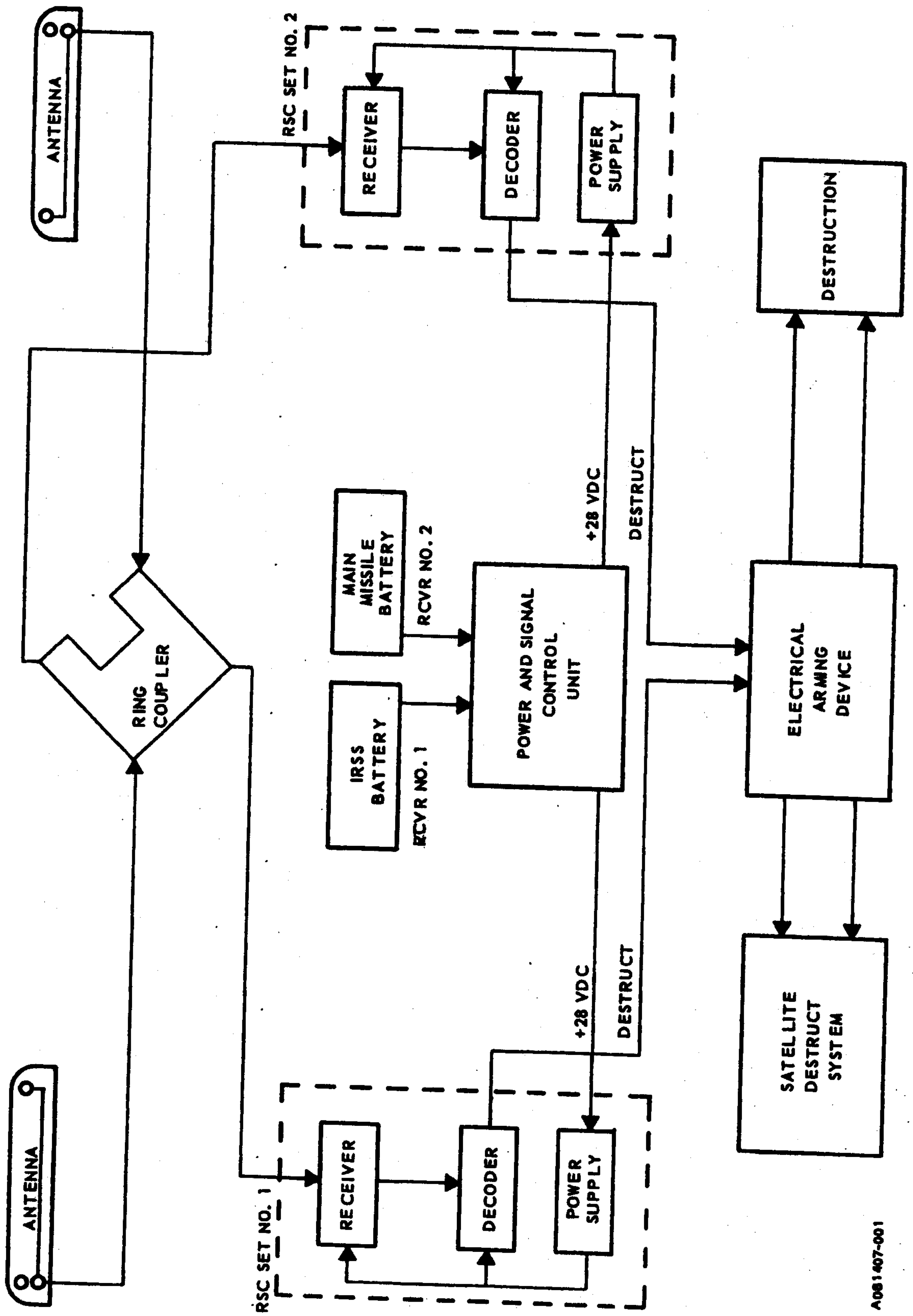

Figure 5-1 Flight Termination System in PG-1A Space

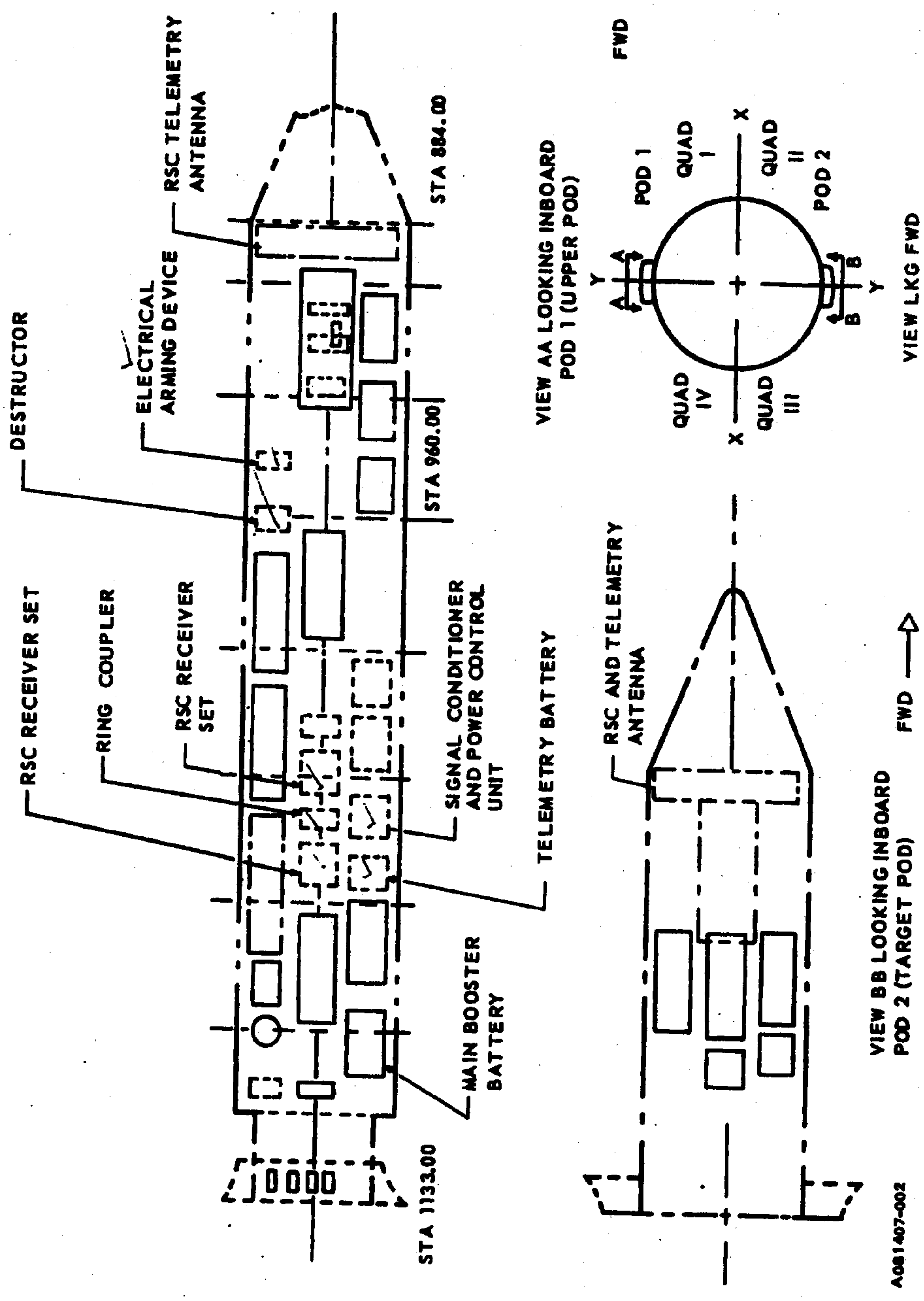

Figure 5-2 Atlas Booster Equipment Arrangement

INPUT SIGNAL CHARACTERISTICS

The Missile Flight Safety System is compatible with the range safety ground station in regard to input signal characteristics. The characteristics are:

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 equivalent to, or greater than, 950 microvolts 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%.

ANTENNA SYSTEM

Two single-cavity antennas mounted opposite each other are utilized by the missile flight safety system and each cavity contains two range safety command probes.

The combined telemetry and command antenna system was designed to require the least amount of space in the PG-1A space booster and yet provide adequate antenna pattern coverage.

To prevent possible interference with the command subsystem at telemetering frequencies, there is sufficient isolation between the telemetering antenna probe, and the command antenna output. Figure 5-4 shows the intercon- nection of the antenna system components. The antennas are coupled to the receivers by a ring coupler. This assures that failure of the RF link to one receiver package will not affect the other set in the dual system. The coupler provides a minimum of 20 db isolation between receivers. The interconnec- tion of antennas and receivers is accomplished by parallel junctions (ring coupler) to a re-entrant transmission line 3/2 wavelengths in circumference. Branch lines of 1/4 wavelength separate three of the junctions and a 3/4 wavelength separates the two remaining junctions. The antennas are con- nected to one pair of opposite junctions, and the receivers to the other pair.

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Figure 5-3 Integrated Electrical Schematic of Booster Flight Termination System

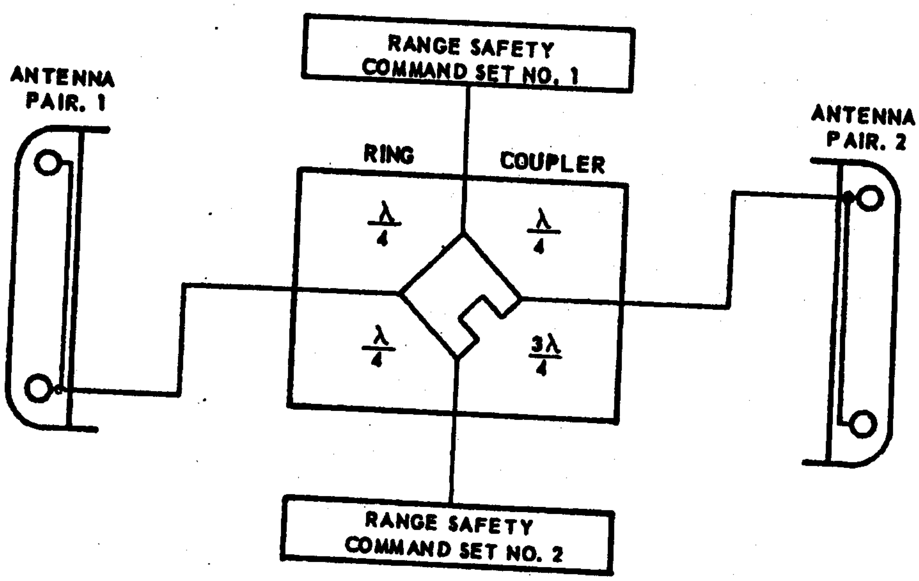

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Figure 5-4 Schematic of Antenna System

A signal arriving at No. 1 Antenna will be divided equally between the two branch lines and produce signals of equal amplitude and phase at each of the receiver terminals. At the other antenna terminal, the signals from Antenna No. 1 will be of equal amplitude, but in phase opposition because the 1/2 wavelength difference in transmission-line length along the two branches of this junction. The result, with no coupling between the junction of Antenna No. 1 and Antenna No. 2, is a voltage node at this point. Minimum isolation between antennas is 20 db. The loss from each antenna junction to each receiver is 6 db or less. There is a 3 db loss in obtaining a power division at the ring coupler. The remaining losses are in the RF cable and connectors. Besides providing the required isolation between antennas and receivers, the coupler serves to provide isotropic antenna radiation coverage about the missile. With the antennas mounted on opposite sides of the missile, the spacing between them is approximately four wavelengths. Separation of the antennas produces lobes at the small interference regions where the radiation patterns of the individual antennas overlap.

Signals from both antennas travel the same distance through the ring coupler to receiver No. 1. However, signals to receiver No. 2 must travel 1/2 wavelength farther from the target antenna than those from the upper antenna. Therefore receiver No. 1 acquires signals from both antennas in like phase, while receiver No. 2 acquires signals in opposing phase.

This arrangement makes the radiation pattern seen by one receiver complementary to that seen by the other receiver. When receiver No. 1 receives a strong signal, receiver No. 2 receives a weak signal, and vice versa. For all angles outside the interference region, both receivers receive signals of the same amplitude. As long as both receivers are operative, omnidirectional coverage is provided. If one receiver fails, the radiation pattern presented to the other provides coverage for 84.7% of the solid angle before staging the booster engines of the Atlas, and 85.9% of the solid angle after staging.

RECEIVERS

Description

The command receiver sets used are two government-furnished AVCO AD-319600 units MK I. These sets are tunable in one-megacycle steps from 405 to 420 megacycles. Retuning requires only the replacement of one crystal and some minor adjustments. These receivers are pretuned to the standard Pacific Missile Range frequency.

The deviation which is specified for these frequency-modulated receivers is ± 60 kc for any number of tones. The GFAE specified sensitivity for the receiver is 3 microvolts, but it should be noted that the subsystem specification of 950 microvolts per meter was calculated on the basis of receiver sensitivity of 10 microvolts and a -10 db gain (with respect to an isotropic radiator) in the antenna system; thus, there is an inherent margin of safety of approximately 13 db between the subsystems maximum sensitivity and the specified sensitivity.

Radiation patterns are shown in Figures 5-5 and 5-6.

Operation

Radio command signals are received as a combination of audio tones. A specific sequence of tones must be received before the receiver can generate the destruct command. When the Pre-Arm button on the RSO console is depressed, the ground destruct transmitter sends a signal that is modulated by tone channels 1 and 5; when the Destruct button is pressed with the Pre-Arm button remaining in the depressed state, tone 5 is deleted and tone 2 is substituted. The desired result is for tones 1 and 2 to be transmitted and for tone 1 not to be deleted during the transition from Pre-Arm to Destruct.

On reaching the receivers the audio tones are separated by electrical filters located in the decoder portions of the receivers (see Figure 5-7). The filter output is rectified, smoothed, and applied as a dc voltage to the grids of the

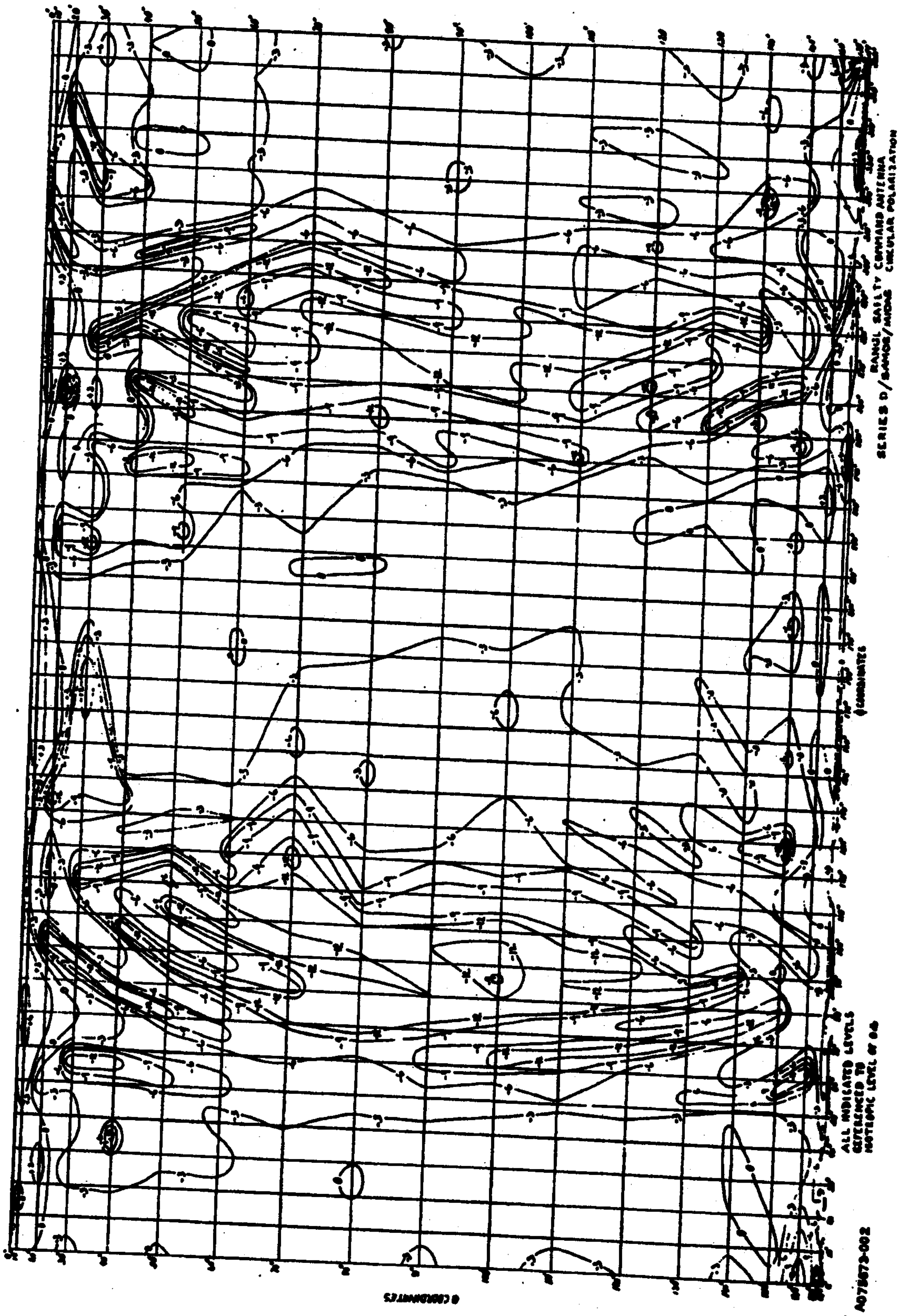

Figure 5-5 Antenna Radiation Pattern, Pre-Stage

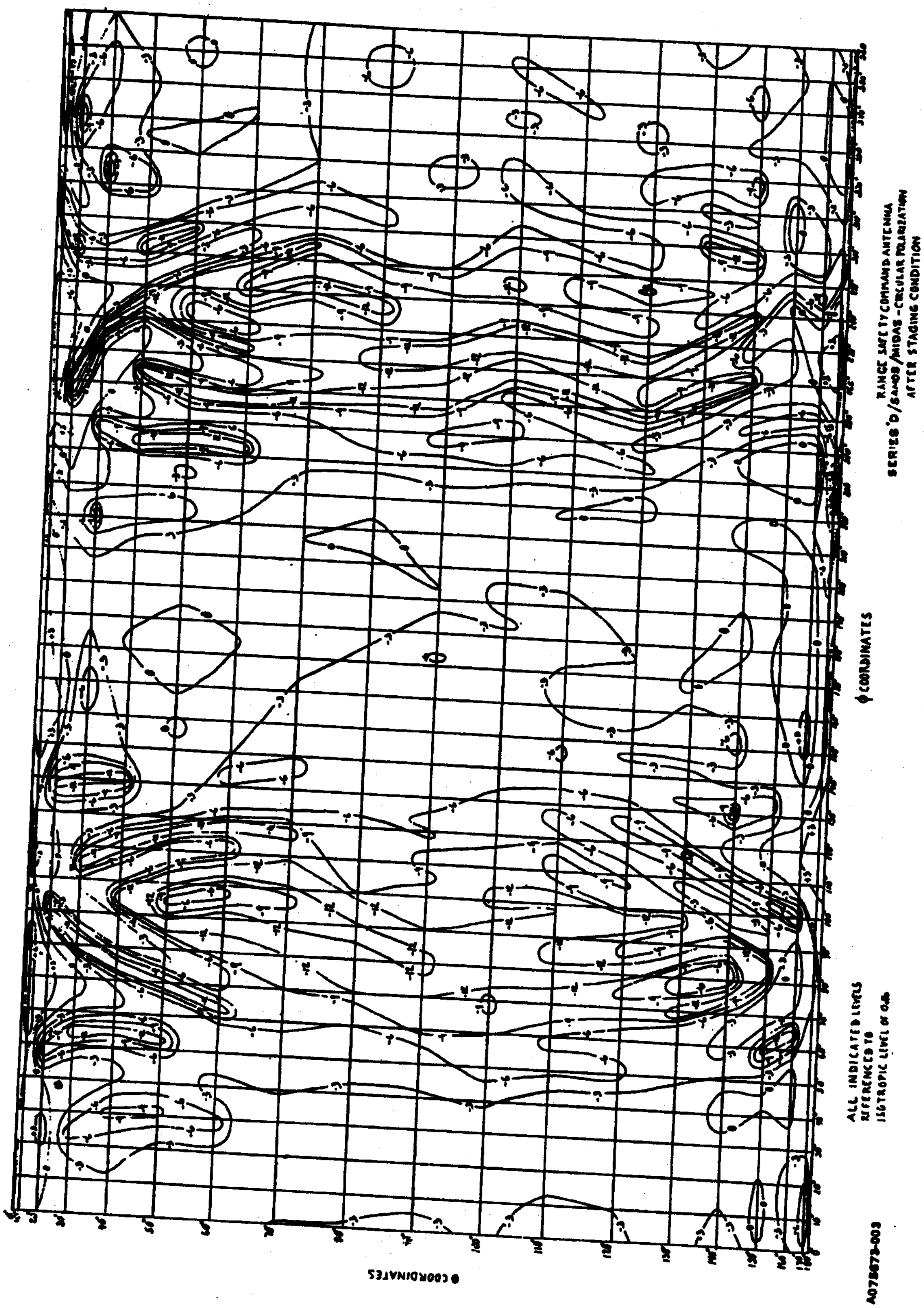

Figure 5-6 Antenna Radiation Pattern, Post-Stage

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corresponding channel relay amplifiers. Two type 5906 pentodes operate as dc channel relay amplifiers in each channel relay unit, the common plate load of which is a channel relay coil. The amplifiers are held in a cutoff state due to the absence of grid voltage. When a filter output is received, the amplifier is driven to saturation and this results in plate current energizing the channel relays. The relays complete the logic circuit required to provide a destruct command.

As a safety factor, the tone 5 relay has been designed with a dropout time of 100 to 250 milliseconds, in case tone 1 is briefly removed in the transition from tones 1 and 5 to 1 and 2. Since the receiver procurement specification (GFAE) does not stipulate this dropout time, the dropout time of channel 5 can vary from 5 milliseconds to 250 milliseconds. The maximum elapsed time between the depression of the Destruct button and the actual destruction of the missile is 470 milliseconds: 250 milliseconds (max) for channel 5 dropout, 100 milliseconds (max) for ignition of the primers, and 120 milliseconds (max) for primer pyrotechnic delay.

BOOSTER SIGNAL CONDITIONER AND POWER CONTROL UNIT

Primarily, this unit serves the telemetry subsystem. It also performs two functions for the missile flight safety system. It changes the system from internal to external power sources and vice versa, by means of a power changeover switch and it also serves as a junction box for electrical connections in the subsystem.

BOOSTER ELECTRICAL ARMING DEVICE

The purpose of the electrical arming device is to provide a means for placing the destruct system in a SAFE or ARM condition. In the SAFE condition both satellite and booster vehicle destructors are electrically isolated from the command destruct signal and a short circuit is placed across the booster vehicle destruct primers. There is a destruct signal path from each receiver set leading to this device.

Design of the arming-device circuit isolates both sides of the destructor primers from the ground return and from the energizing voltage until a destruct command is received. This minimizes the possibility of stray currents causing premature operation of the primers. This isolation from structural ground and power sources is provided even in the ARM condition. A high-resistance leakage path to structural ground is provided within the destructor unit for safe drainage of static charges from the destructor circuit. The common return lines from the satellite destruct circuit are isolated from ground by the same leakage resistor (in the booster destruct unit), and the two destruct signal lines to the satellite are each shorted to the common return lines through separate current-limiting resistors until the destruct command is given. Direct shorts are also placed across the input to the booster destruct unit until the destruct command is received. Current limit-ing resistors are provided within the booster destructor unit. Contacts with-in the electrical arming device provide an electrical indication of SAFE or ARM on the Operation and Checkout Console in the LOB.

BOOSTER DESTRUCTOR

The reliability of the destructor has been proven through qualification tests and actual flights; therefore, only one is used. The destructor is enclosed in a red-anodized aluminum box which measures 5.0 x 5.5 x 5.5 inches. Glass wool insulation protects the switch and explosive charge from abnormal temperature and moisture conditions. The destructor is capable of operating at temperatures up to 160°F for a soak period of four hours, and at temper-atures as low as -65°F for a soak period of eight hours. The destructor complies generally with Spec MIL-E-5272A for environmental testing.

PRIMER CIRCUIT

The primer circuit assures the firing of either or both primers within the destructor. The circuit has the primers in series and each primer is shunted by a resistance that requires only one-quarter of the current taken by the primer. This increases the reliability of igniting one primer should a broken wire or a short circuit occur in the other primer.

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

The electrical characteristics (vendor's data)

a. Bridge-wire 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 amp
c. Recommended minimum firing current: 1.0 amp
d. Ignition time, 1 amp current: 58 ± 15 milliseconds
e. No-fire current (testing): 0.2 amp
f. Spontaneous detonation temperature: 370°F.

EXPLOSIVE

Instantaneous detonation is initiated by the primer, which in turn explodes a booster charge adjacent to the main destructor charge. Detonation cannot occur unless the system is armed. The main destructor charge in the booster vehicle consists of approximately one pound of RDX (which consists of cyclonite, 3 to 5 percent wax, and from 1 to 1-1/2 percent graphite).

The RDX has a melting temperature of approximately 400°F and fumes at 550°F, but does not detonate at a temperature less than 680°F. It is not hygroscopic and has good storage stability. Destructive qualities are not affected by the environmental temperatures encountered during the flight. For normal storage conditions of -80°F to +160°F at 0 to 95 percent relative humidity, the RDX should be good in excess of five years.

MECHANICAL ARMING MECHANISM

The destructor is armed or disarmed mechanically by the rotation of a steel shaft located between the primer and the booster charges. There are two 1/8-inch holes in the shaft which are aligned or disaligned as it rotates between the primer and booster charges. An ARM or SAFE command from the Operation and Checkout Console produces a 28v dc impulse that actuates a Ledex solenoid. The downward motion of the solenoid is converted to rotary motion by three inclined ball races that force the shaft to rotate by cam action. A clutch permits the races to return without turning the shaft.

Successive actuations of the solenoid cause 90° rotations of the shaft in the same direction, alternately aligning (ARM) and disaligning (SAFE) the explosive train. A dual system utilizing two primers, shaft holes, and boosters ensures reliable destructor operation. A safety wire inserted through the housing assembly, via a third hole in the shaft, prevents accidental arming of the unit when not in use.

The destructor is monitored by a three-wire, two-position microswitch that controls the 28v dc indicator lights on the Operation and Checkout Console. A cam on the arming shaft actuates the microswitch, energizing the appropriate light to indicate whether the unit is in the ARM or SAFE position.

The mechanical arming device is shown in detail in Figure 5-8, and a schematic of the mechanism in Figure 5-9.

BOOSTER BATTERIES

Batteries provide the power for internal operation of the destruct system. The IRSS battery feeds power through the signal conditioner and power control unit to receiver No. 1. The main missile battery sends power through the signal conditioner for receiver No. 2. Both batteries also serve other elements of the booster vehicle, the instrumentation and range safety battery

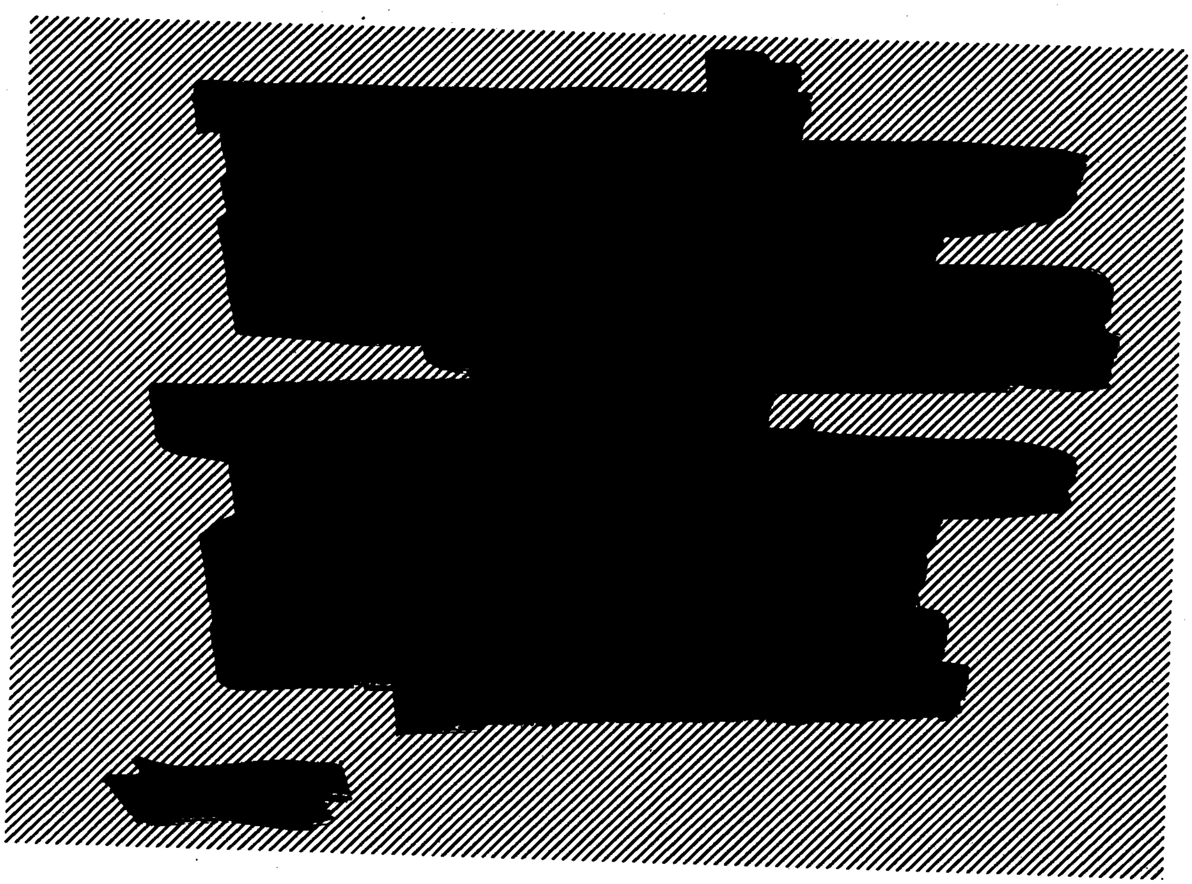

Figure 5-8 Mechanical Arming Device

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Figure 5-9 Destructor And Mechanical Arming Schematic serving the telemetry subsystem, and the main missile battery serving all other electrical components in the booster.

INSTRUMENTATION

Telemetered Data

Range safety command data telemetered during flight are as follows:

Measurement No.	Description
D110X	Destruct

Provision has been made to monitor the destruct outputs of the command sets.

Destruct

The booster destruct output is instrumented by means of relay contact closure. These contacts are isolated from the destruct voltage. Upon receipt of a destruct command, contact closure occurs simultaneously with the destruct output. This information is recorded on a continuous channel by telemetry, to provide accurate time-correlation destruct data.

SECTION 6
ATLAS GROUND SUPPORT EQUIPMENT

GENERAL

The ground support equipment for the Atlas Flight termination system is capable of performing all of the control and monitoring functions required for normal checkout and launch control of the system. This portion of the report will consider the functions of the test support equipment during prelaunch checkout.

The following test support equipment is used for checkout of the Atlas portion of the Flight Termination System.

a. Operation and checkout console, manufactured by Aerojet General and consisting of:
   (1) Common Destruct Controls Panel, AJG Part No. F-AFC-0156-1
   (2) Safety and Arm Controls Panel, AJG Part No. F-AFC-0157-1
   (3) RF Signal Generator, Babcock Radio Engineering, Inc. BSG-11
   (4) RF Signal Generator, Remote Control Panel AJG Part No. F-AFC-0157-2
   (5) DC Power Supply, Perkin Engineering Corp. Part No. MTR-28-30

b. Antenna Test Couplers (two required)

c. Destructor Substitution Test Unit (yellow box, one required)

The above equipment is identical to the equipment used for checkout and launch of the D/10C confidence missiles at VAFB except for a few minor changes, i.e., changes to up-date the equipment, and changes to make the O & C Console control panel usable specifically for Atlas launches.

LOCATION OF EQUIPMENT

The O & C Console is located in the LOB in the same room with the test conductor and main launch control panels. The O & C Console operator should be connected by the communications system directly with the RSO. The Antenna Test Couplers are connected directly over the airborne antennas so that tests may be made without outside radiation.

The yellow box is mounted on the missile and substituted for the RED Destructor Unit during all tests preceding the final countdown.

Cables from the O & C Console run down through the LOB basement, through the cable trough to the M & E Room, and up to the airborne umbilical and antenna test coupler through numerous terminal boards and junction boxes. Only one coaxial cable connection is completely provided. This cabling provides essentially a through wire connection between the umbilical and the O & C console.

DESTRUCTOR SUBSTITUTION TEST UNIT (YELLOW BOX)

A destructor-substitution box (Figure 6-1) is used to simulate the red destruct box as closely as possible during system tests.

Fuse tests are used to verify the destruct capability of the RSC subsystem and to detect the presence of stray currents in the primer circuit. The capability for destruct is determined by requiring each command to blow a 1.5-amp fuse. This fuse requires more current than the actual primers. A 62-milliamp fuse is used to detect the presence of stray currents. This fuse requires less than 20 percent of the minimum current required to ignite the primers. Stray currents of sufficient magnitude to blow the 62-milliamp fuse would have to be isolated and eliminated before the launch countdown could proceed. A 30-volt high-impedance voltmeter switched across the 1.5-amp destruct fuse provides a means for indicating when the fuse has blown. A 1-volt low-impedance voltmeter switched across the 62.5-milliamp

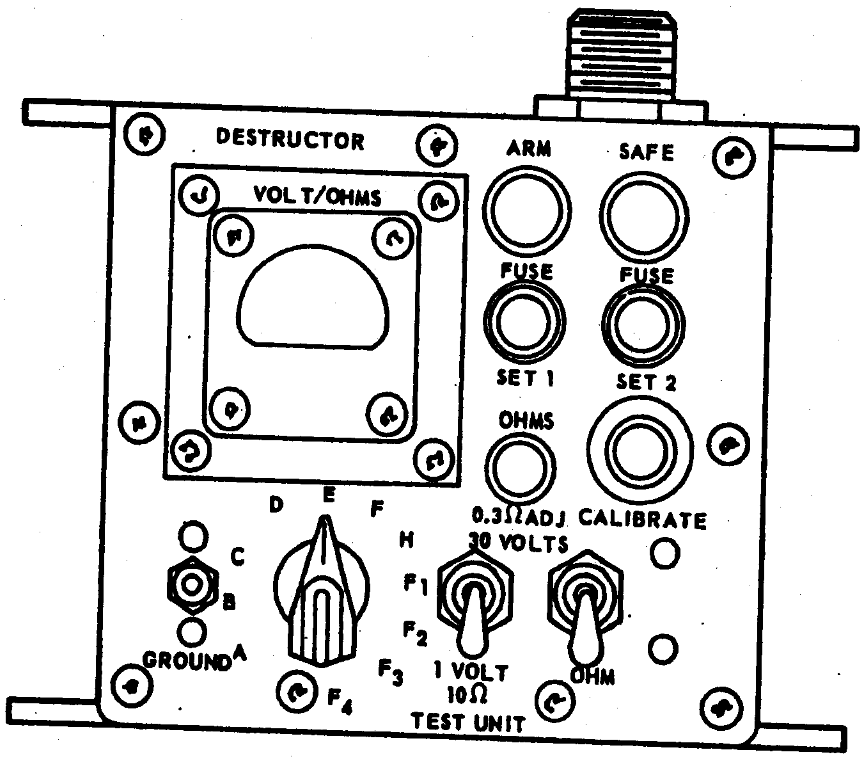

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Figure 6-1 Destructor Test Substitution Box fuse will measure the stray voltage. A rotary switch is also provided to place either the 30-volt or the 1-volt voltmeter on any pin of the input connector.

The resistance of the short placed across the primer by the electrical arming switch, is checked by converting the voltmeter to an ohmmeter. The conversion is accomplished by placing the voltmeter in parallel with the circuit under test and introducing a battery-resistor current source. The resistor is variable, allowing calibration of the ohmmeter. The ARM-SAFE circuit is checked by simulating the Arm-Safe switch with a Ledex stepping switch. This switch is designed to produce indications of proper external wiring connections, and light an ARM or SAFE lamp to indicate this condition. All components of the test box, except the voltmeter, can withstand the environmental effects of a static firing test. The voltmeter is a plug-in type and may be removed, since it is not required for the static firing tests.

The test capability of the destructor-substitution test box may be summarized as follows:

a. Check the capability of the battery to blow a 1.5-amp fuse in response to a destruct command.
b. Measure the destruct voltage to check battery condition.
c. Check for stray currents, in the primer circuit, of sufficient magnitude to blow a 62.5-milliamp fuse.
d. Measure the stray voltage on the primer line to determine whether potentially dangerous voltage pickup exists.
e. Measure the voltage on each connector pin prior to installing the red destructor box to ensure the operation is safe.
f. Check the operation of the ARM/SAFE circuit and provide a lamp indication of the ARM or SAFE status.
g. Measure the resistance of the electrical short across the primer circuit when in the safe condition.

A schematic drawing of the destructor-substitution test unit is shown in Figure 6-2.

[redacted]

ANTENNA TEST COUPLERS

One antenna test coupler should be mounted (bolted) over each of the airborne antennas whenever non-radiative tests of the range safety receivers are to be conducted using the RF Signal Generator in the O & C Console. The coaxial cable should connect one antenna test coupler to the RF Signal Generator and all other output terminals of the antenna test couplers should be loaded with the proper wattage loads (one RS and two telemetry). The range safety pick-up elements in the antenna test coupler are arranged to reject the telemetry signal (as in the airborne RSC/TLM antenna) so that telemetry tests may be conducted at the same time, if desired, and if coaxial cables are available for connection to the TLM receivers. These antenna test couplers must be removed for flight, countdown, or other tests in which the Ground Destruct Transmitter is being used for simulation.

OPERATION AND CHECKOUT CONSOLE

For launch (or test) all control and monitor operations can be performed by the operator of the O & C Console. Control and monitoring of the power changeover function, external power, and SAFE/ARM function, as well as command signal excitation are provided, as described in the following paragraphs.

RF SIGNAL GENERATOR (BSG-11)

The signal generator is designed to test FM receivers in the 406- to 420-megacycle range, with a provision for deviations up to ± 300 kc by one to six subcarrier tone frequencies. It contains a calibrating RF level meter, and provides crystal-controlled frequency-modulated RF carrier signals. The output level is continuously variable between 1 and 100,000 microvolts. On-off switches are provided for tones 1 through 6. A Deviation control knob and a Deviation meter are provided. The peak deviation indicated by the Deviation meter is correct only when a single tone is being used. If additional tones are turned on, and the Deviation control knob is not adjusted, the resulting peak deviation will be the single-tone deviation times the number of tones turned On. Each tone will have the same deviation as set for any other single tone, since the generator does not contain a compressor. A carrier frequency selection switch, ac power On-Off, and carrier signal On-Off switches are also provided.

During tests, the output of the signal generator must be connected to one or the other of the antenna test couplers through the coaxial line. The attenuation of the coaxial line should be determined, and the fiducial ring on the signal generator attentuator should be adjusted so that the attenuator indicates the signal level impressed on the antenna test couplers.

The Deviation control should be adjusted to indicate ± 30 kc deviation with only one tone turned on; this setting will cause ± 60 kc deviation when two tones are applied, as is necessary for command operation. Commands may then be given to the MFSS by operation of the tone switches.

RF SIGNAL GENERATOR REMOTE CONTROL PANEL

Since the RF Signal Generator is located beneath the table top of the O & C Console and is rather inaccessible, a remote control RF signal generator panel is provided above the table top (see Figure 2-3). This panel can be activated by placing the Remote/Local control switch of the RF Signal Generator in the Remote position. This remote control panel allows the operator to easily turn ON or OFF the carrier signal or any of the six tones.

DC POWER SUPPLY (PERKIN MTR-28-30)

The DC Power Supply in the O & C Console furnishes all the external power required to operate, control, and monitor the MFSS and the telemetry portion of the IRSS during test and launch. Its nominal output voltage should be 28v dc. Its maximum specified current is 40 amp. The maximum current drain for the telemetry units and the range safety receivers under No Command conditions is about 12 amperes. Under command destruct tests the maximum current drain may approach 22 amperes.

SAFETY AND ARM CONTROL PANEL

The necessary control and monitoring relays to accomplish arming or safing of the Atlas portion of the MFSS are contained behind the Safety and Arm Control Panel (see Figure 6-3).

The Safety/Arm switch is normally in an OFF position, and is a momentary-type switch to both the ARM and SAFETY positions. Operation of this switch and the associated circuitry behind the panel arms or safes both the booster Arming Device and the booster Destruction Unit. The position of the airborne arm/safe units is indicated by the ARM and the SAFE indicator lights. For tests made only when the Yellow Box is installed, the Destruct 1 and Destruct 2 lights will illuminate if a destruct command is received and the MFSS is in the Safe condition. The Ready light will illuminate whenever the airborne MFSS is in the Armed condition and is operating on internal power.

COMMON DESTRUCT CONTROLS PANEL

Relays and additional circuitry necessary to perform the following functions are mounted behind the Common Destruct Controls (Figure 6-4). Power is applied to the 28v dc power supply by turning the dc supply switch (S-13) to ON. When the Signal Generator switch (S-1) is turned ON, power is applied to the signal generator, the timer reset mechanism, and a relay which applies the 28v dc power to the control panel. As soon as power is applied to the control panel, the Normal Gas Pressure indicator should illuminate, indicating that sufficient gas pressure is contained in the primary battery storage tank for activation. When the 28v dc power switch (S-2) is turned ON, the External (power changeover) light should illuminate. The Safety light on the Safety and Arm Controls Panel should also illuminate.

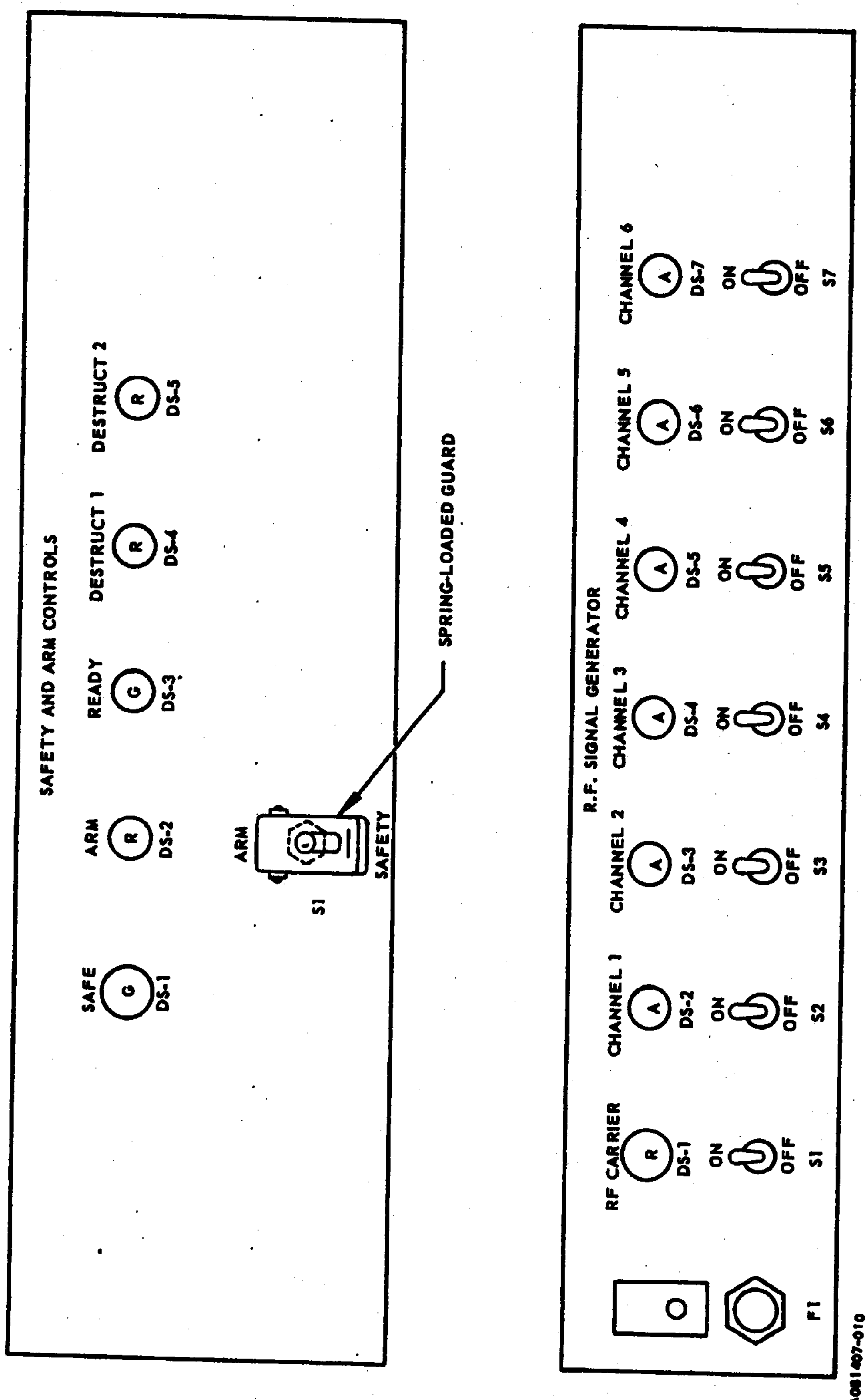

Figure 6-3 Safety and Arm Controls Panel and RF Signal Generator Remote Control Panel

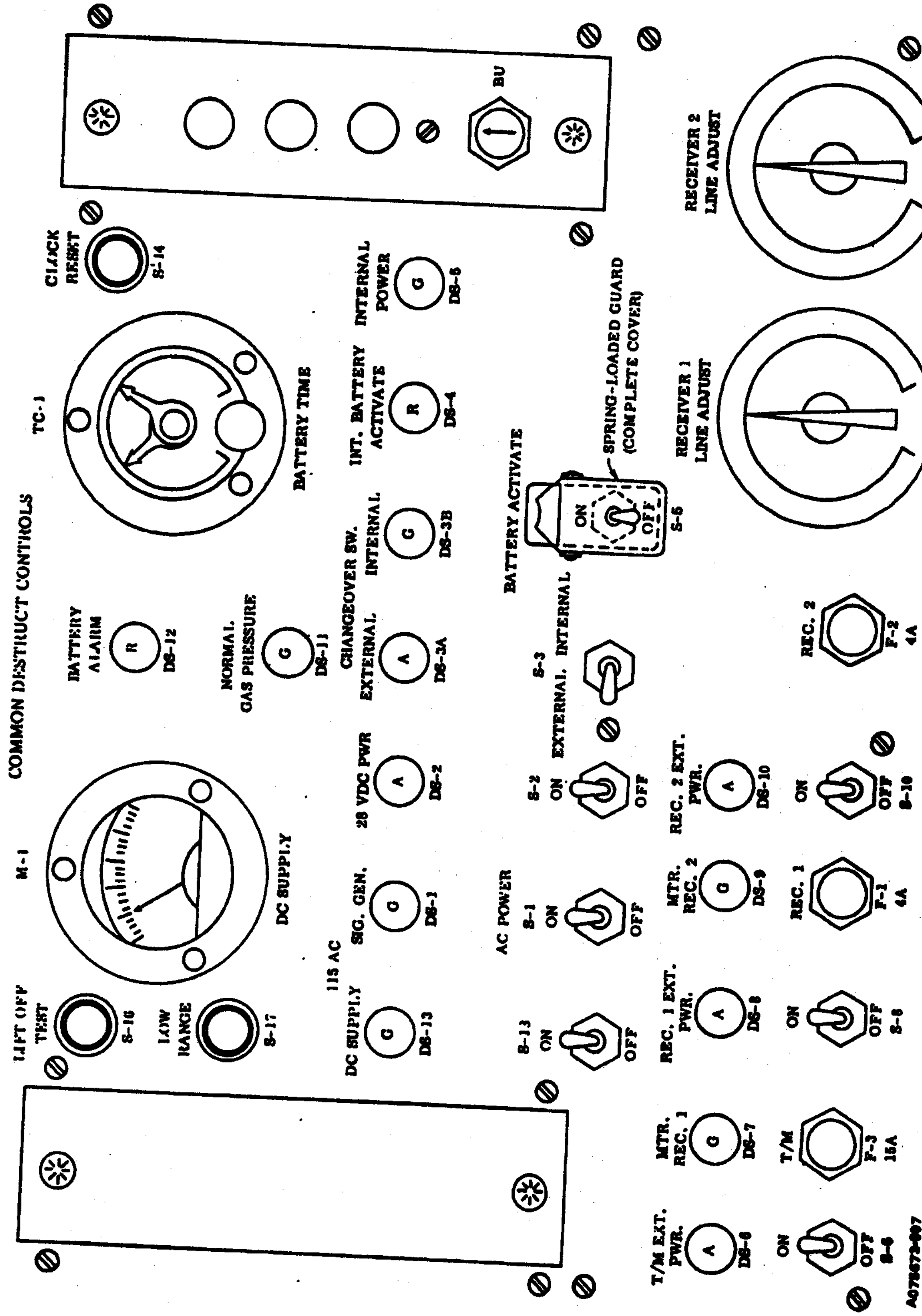

Figure 6-4 Common Destruct Consoles Panel, O & C Console

When the changeover switch (S-3) is in the External position, external power may be applied to the receivers by turning on REC 1 EXT PWR and REC 2 EXT PWR switches (numbers S-8 and S-10). Switch S-6 turns on the external power to the telemetry system. If the EXT PWR switches are left ON and the Changeover SW is placed to Internal power position, the REC 1 EXT PWR and REC 2 EXT PWR indicator lights are turned off, since the airborne power changeover switch then opens the external power circuit.

When the changeover switch is in the External power position, the voltage applied to the receivers may be adjusted by means of Receiver 1 Line Adjust and Receiver 2 Line Adjust potentiometers (R-1 and R-2). Since no voltage monitoring lines are returned to the O & C console from the airborne receivers, R-1 and R-2 should be adjusted to give a specified current to each receiver. This current may be measured (possible as a difference in readings when each receiver is OFF and then ON) on the current meter, M-1; the normal scale is 0 to 60 amps and the low scale, obtained by pressing Low Range switch (S-17), is 0 to 15 amperes. R-1 and R-2 should be set as far counter-clockwise (minimum resistance) as possible and the current should be adjusted correctly by slowly increasing (or decreasing) the Voltage Control Knob on the 28v dc Power Supply.

Prior to activating the battery, the Battery Time Clock (TC-1) must be preset at some specified time (about 10 minutes) so that sufficient battery life is available for the launched missile. The exact value to be set into timer TC-1 should be obtained from the countdown procedure. If this time is exceeded, because of checkout time or hold time, and the Battery Alarm light goes on, the RSO has the authority to hold the flight until the battery is replaced. In order to activate the battery, the panel power changeover switch must be in the Internal position. Pressing the Battery Activate switch (S-5) will activate the battery. The INT. Battery Activate Indicator light will illuminate, and the Normal Gas Pressure indicator light will be extinguished. When the internal battery becomes activated, the Internal Power indicator light will illuminate and the Battery Time clock will start timing down from its preset value. The Battery Alarm light (DS-12) will illuminate when the timer indicates zero time.

The Liftoff test switch (S-16) is a momentary switch placed across two leads running to the liftoff switch at the launch pad and also to other consoles, such as the Test Conductors console and the Range Safety Officers console. This switch performs no function in checkout or launch control of the MFSS.

MTR. REC. 1 and MTR. REC. 2 (DS-7 and DS-9) are monitor lights which illuminate when tone 5 is received by the MFSS receivers. Relays in the Common Destruct Control Panel assembly are activated by the monitor signals returned from each receiver. Monitor lights at the RSO console, as well as monitor lights on the Common Destruct Control Panel, are illuminated when these relays are activated.

SATELLITE ARM/SAFETY MONITOR

A small indicator box containing two monitor lights and a transfer switch has been added to the O & C Console. The monitor lights indicate the SAFETY or ARM status of the Satellite Destruct System. Thus, the O & C Console operator has continuous visual monitoring capability for the Arm/Safety status of the satellite destruct system as well as the booster destruct system.

SECTION 7
SYSTEM OPERATION

AGENA D CHECKOUT

The following preflight checks are performed on the Agena D destruct system:

a. Agena D Destruct Checkout: Verify proper functioning of all ground control and monitoring, booster command destruct, premature separation destruct, and both primary and backup in-flight disarming circuits. Also verify proper premature separation destruct switch lanyard length (distance at which premature separation destruct occurs), and verify that the destruct charge firing zone is clear of interference.

b. Agena D System Run: Includes functioning of ground control and monitoring, booster command destruct, premature separates destruct, and primary disarming (in-flight) destruct circuitry.

c. Agena D Destruct Initiator Checkout: Done at the explosive checkout area, this verifies the electrical and functional integrity of the destruct initiator.

d. Range Safety Destruct Check: Utilize Agena D, booster, blockhouse, and destruct transmitter to verify the operation of the entire system and monitor for stray power in Destruct Detonator circuits (See "System Checkout").

e. Agena D Destruct Monitoring: In effect from R-1 Day until range safety destruct check on Launch Day.

f. Range Safety Destruct Checks: Repeat item (d) just before installation of the Agena D and booster destruct packages.

g. Agena D Destruct Package Installation: Performed after all non-essential personnel have been cleared from the pad. This includes stray voltage test of Agena D harness, electrical connection of the destruct package, and removal of the safety pin from the destruct initiator.

THOR CHECKOUT

Prelaunch checkout of the destruct system includes the following:

a. Range safety receivers are checked for sensitivity of 6 microvolts or less (using O&C console signal generator)

b. DM-21 destruct system is checked operationally (using O&C console signal generator)

c. During R-1 day and launch countdown, operational checks are made first using external power (see "System Checkout")

d. Condition of vehicle batteries is noted and their "ON" times are monitored

e. Stray current and voltage checks are made

f. Resistance measurements are made on each connector pin prior to installation of the S & A mechanism

g. SAFE/ARM condition of the S & A mechanism is monitored continuously at the Operation and Control Console.

Step-by-step procedures will be contained in the launch countdown manual prepared by the LMSC Flight Test Working Group at Vandenberg Air Force Base.

ATLAS CHECKOUT

Specific released checkout documents must be consulted in order to determine the exact tests performed on the MFSS equipment. Test documents should include the following basic tests, using the O & C Console only (not the GDT).

a. Sensitivity tests (in Safe condition. test Destruct 1, Destruct 2 MTR. REC. 1 and MTR. REC. 2 lights)

b. Capability tests (minimum specified sensitivity-blow two 1.5 ampere fuses)

c. Stray current tests, using 62.5 MA fuses:

   (1) In Safe condition, give Destruct command

   (2) In Arm condition, give Monitor command (tone 5)

(3) In Arm condition, give Power Changeover commands

(4) In Arm condition, Changeover Switch on Internal power give Off-Safe Command.

SYSTEM CHECKOUT

The R-1 day and countdown tests should be similar to the checkout tests except that (at least the countdown) they will be made using the Range Ground Destruct Transmitter (GDT) in place of the O & C Console signal generator. For these tests, the antenna test couplers must be removed from the missile. The booster destruct substitution unit and Agena D destruct simulator will be used for these tests. Since there is no means of adjusting the power output of the GDT, these tests will not indicate the maximum sensitivity requirements of the MFSS, although they will show compatibility of the airborne destruct system with the range GDT. In order to conserve flight batteries, all preflight tests are made on ground power. The minimum number of test operations should be performed on the MFSS during the Final Countdown after the actual destruct units are connected. The actual destruct units are explosive devices, fully certified by the vendor and prechecked by the ordnance group, and are not subjected to system type tests after installation and connection in the missile.

If an Abort or Hold is encountered during the launch countdown, the O & C Console operator may turn the 28v dc PWR switch (S-2) to OFF. This action immediately Safes the booster airborne circuitry, switches it to External power, and then turns off the External power; however, the power changeover External position light remains illuminated. This OFF-SAFE capability of the O & C Console was designed for emergency conditions. The dc power supply still remains ON and ready for immediate use.

IN-FLIGHT OPERATION

Range Safety Command Destruct

When the Range Safety Officer wishes to destroy the flight vehicle, he presses first the "Pre-Arm " button and then the "Destruct" button on the console.

This causes the FM carrier signal being sent by the ground destruct transmitter to be modulated with combinations of designated tone channels. These frequency-modulated signals are received by two independently operated receiver sets. Each set then decodes the signals into the "Pre-Arm" and "Destruct" commands. The outputs from the sets are separated through appropriate circuits to permit either or both sets to perform the required function.

When the "Pre-Arm" button is depressed by the Range Safety Officer, the ground transmitter signal is modulated by tone channels 1 and 5 for more than 100 milliseconds. Relays within the receivers are operated by this command.

The destruct command, generated by modulating tones 1 and 2 with the carrier signal, initiates the primers in the destruct units of the booster and satellite vehicles. The destructor units are located so that when detonated they will rupture the propellant tanks of their respective stages, causing a destruct action which results in an explosion that destroys the flight vehicle. The destruct logic circuitry is shown in Figure 7-1. The Range Safety Officer monitors the vehicle trajectory and if the vehicle becomes erratic and uncontrollable and approaches the range safety limits he sends a destruct command signal which is received by the booster and relayed by appropriate circuitry to the satellite. The Agena circuitry in the command destruct condition is shown in Figure 7-2.

The range safety command signal, after operating the booster relays, supplies the firing energy from the booster destruct electrical system directly to the satellite/vehicle destruct initiator. As a safeguard, the booster vehicle destruct initiation circuit incorporates 4 ohm/min limiting resistors to provide additional RF energy interference protection and to limit the current supplied to the satellite vehicle. This assures that the booster can be destructed even though a short-circuit may occur in the satellite detonator circuit system.

[redacted]

Figure 7-1 Destruct Logic Circuitry

[redacted]

Premature Separation Destruct

Conditions for premature separation destruct are shown on the circuit configuration of Figure 7-3. The premature separation destruct signal is initiated by the two lanyard-operated switches, S-1 and S-2, closing the destruct auxiliary battery circuit. This supplies energy to the destruct-charge initiation detonators.

Switches S-1 and S-2 are actuated when lanyard operation releases the switch-actuation detent. As the satellite vehicle separates from the adapter the lanyard is withdrawn from the detent, permitting actuation of the switch. The lanyard length is so adjusted for 1 to 1.5 inch separation of the satellite from the booster is required for actuation.

PROGRAMMED SEPARATION AND SYSTEM SAFE GUARD

The circuit configuration for normal, programmed separation is shown in Figure 7-4. The discrete command sequence and backup command system are indicated. In accordance with a normal ascent sequence of event the booster MECO/SECO discrete command initiates relays K3, K4 in the destruct "J" box. Operation of relays K4, K3 in the destruct "J" box opens the two destruct circuits between the auxiliary batteries and the destruct-charge initiation detonators.

Continuing the normal ascent trajectory, a VECO discrete signal backs up the disarm sequence through relays K1, K2 in the destruct "J" box. Operation of relays K1, K2 in the destruct "J" box opens the other side of the two destruct circuits between the auxiliary batteries and the destruct-charge initiation detonators.

The Agena D is now disarmed and destruction will not take place upon separation.

In the event that the Agena D engines fail to start, the Agena D will follow essentially the same trajectory as the booster and will impact in the ocean

[redacted]

[redacted]

range corridor. However, if erratic, uncontrolled operation of the Agena D occurs under engine thrust, after separation the vehicle will break up under these maneuvers.

GROUND HANDLING AND SAFE/ABORT

The self destruct system must be maintained in a safe condition whenever personnel are near the vehicle (Figure 7-5). The position of the separation switches, and of the SAFE/ARM Ledex, is monitored by ground equipment through the J-100 electrical umbilical plug. The Ledex switch can also be stepped to either the safe or the arm position by ground circuitry through the J-100 plug. The Ledex is put into the arm position prior to launch.

The destruct system can be placed in a safe condition if the electrical umbilical falls off prematurely (see Figure 7-6). PIN R, M, U (PLUG P800) IS EXCITED THROUGH A PLUG AT THE BASE OF THE FIRST-STAGE BOOSTER. The +28 V Safe/Abort discrete on pins R, M, U (plug P800) will excite the Ledex if it is in the armed position safing it. Also on pins R, M, U (Plug P800), this discrete will excite relays K4, K5, in the Safe/Abort "J" box, blowing (1) the He valve squibs and (2) the N_2 valve blowdown squib. This provision is available until the booster leaves the ground.

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APPENDIX A
PROGRAM 162

Program 162 will utilize the Agena D satellite vehicle, serial numbers 1151 through 1157. The Agena D, boosted by the Thor DM-21 vehicle, will incorporate the Flight Termination System described in Sections 1, 2, 3 and 4 and applicable portions of Section 7 of this document.

The applicable portions of Section 7 are as follows:

1. All the text with the exception of the first paragraph under the title, "Ground Handling and Safe/Abort." This will read, "The self destruct system must be maintained in a safe condition whenever personnel are near the vehicle (A-4). The position of the separation switches, and of the safe/arm Ledex is monitored by ground equipment through the J-900 auxiliary umbilical plug. The Ledex switch can also be stepped to either the "safe" or the "arm" position by ground circuitry through the J-900 plug. The Ledex is put into the arm position prior to launch."
2. Figure 7-1 in Section 7 remains the same. Figures 7-2 through 7-6 are not applicable to Program 162 and the applicable Figures A-1 through A-5 are included in this Appendix. Refer to Section 7 for detailed description.

Any deviations from or specific additions to these systems dictated by future requirements will be covered by revision to Appendix A as required.

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BOOSTER ADAPTER KITS

In the event that a rearrangement in the scheduling of Program 162 boosters warrants a decision to use an Agena D/Thor B* instead of an Agena B/Thor B, or an Agena B/Thor D** instead of an Agena D/Thor D, two adapter kits are available through LMSC to permit this flexibility in booster assignments. Figures A-6 and A-7 are electrical schematics illustrating the interconnecting wiring of Agena D/Thor B and Agena B/Thor D flight termination systems.

The two adapter kits and their drawing numbers are listed below.

	Drawing No.
(1) Agena D to Thor B configuration	
Junction Box Assembly - Adapter Kit	1347668
Wiring Diagram and Schematic — Adapter "J" Box	1347969
Vehicle Wiring Modification — Agena D to Thor B Adapter Kit	1348799
(2) Agena B to Thor D configuration	
Relay "J" Box Assembly - Adapter Kit	1347667
Wiring Diagram and Schematic — Adapter "J" Box	1347969
Vehicle Wiring Modification — Agena B to Thor D Adapter Kit	1348798

* Thor B: Thor booster modified to interface an Agena B booster.

** Thor D: Thor booster modified to interface an Agena D booster.

[redacted]

[redacted]

[redacted]

APPENDIX B
PROGRAM 102

[redacted] incorporate the Flight Termination Systems described in Sections 1, 2, 3, and 4, and applicable portions of Section 7 of this document.

Any deviations from or specific additions to these systems dictated by future requirements will be covered by revision to Appendix B as required.

APPENDIX C
PROGRAM 1001

[redacted] the Flight Termination Systems described in Sections 1, 2, 5, and 6, and applicable portions of Section 7 of this document.

Any deviations from or specific additions to these systems dictated by future requirements will be covered by revision to Appendix C as required.

APPENDIX D
MIDAS PROGRAM

The MIDAS Program will utilize the Agena D satellite vehicle, serial numbers 1301 and up. The Agena D, boosted by the Atlas SM-65D vehicle, will incorporate the Flight Termination Systems described in Sections 1, 2, 5, and 6, and applicable parts of Section 7 of this document.

Any deviations from or specific additions to these systems dictated by future requirements will be covered by revision to Appendix D as required.

APPENDIX E

SNAPSHOT PROGRAM

The Sanpshot Program will utilize the Agena D as a satellite and the Atlas SM-65D as a first-stage booster. The flight termination system for the satellite stage will be published as Appendix E of this document six months prior to launch.

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APPENDIX F
PROGRAM [redacted]

[redacted] incorporate the Flight Termination Systems described in Sections 1, 2, 5, 6, and in applicable portions of Section 7 of this document.

DISTRIBUTION

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AFSSD/TDC (DCLMT) ATTN: Lt. Col. Allred Air Force Unit Post Office Los Angeles 45, California	25
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