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TRAINING MANUAL

J-3 CR SYSTEM
CORONA PROGRAM

Declassified and Released by the N R O

In Accordance with E. O. 12958

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31 DECEMBER 1967

FOREWORD

This training manual is to be used for training purposes only. It is intended that distribution be limited to activities conducting an approved training program in the J-3 CR system. Due to the extensive and revealing nature of the contents, the manual requires safeguarding in strict accordance with the classification.

LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:
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SECTION A

INTRODUCTION TO THE J-3 PROGRAM

A-1.0 PURPOSE

The purpose of the J-3 program is to provide to the customer a global surveillance capability for acquiring photographic intelligence data. This is accomplished by a controllable satellite vehicle containing high-resolution panoramic cameras, an indexing-cartographic camera, and two separate re-entry vehicles for returning the exposed film to earth.

A-1.1 This reconnaissance program consists of highly specialized and closely associated groups of personnel who design and manufacture the major components, plan the utilization of this equipment, control the equipment during ascent and orbital flight, retrieve the recovery vehicle, process the film, interpret the film images, and function as cartographers and data analysts. A condensed chart showing the combined organizational arrangements of these groups and the flow of the product is shown in Figure A-1.

A-1.2 The J-3 payload consists of a high-resolution panoramic and geodetic camera system mounted in suitable structures and attached to the Agena booster vehicle. The Agena accomplishes injection into orbit and provides a stable platform during orbital operation. Two independent satellite recovery vehicles (SRV's) de-orbit the exposed film. One SRV contains the photography taken during the first part (A mission) of the orbital flight. The second SRV contains photography taken during the second part (B mission) of the orbital flight (see Figure A-4).

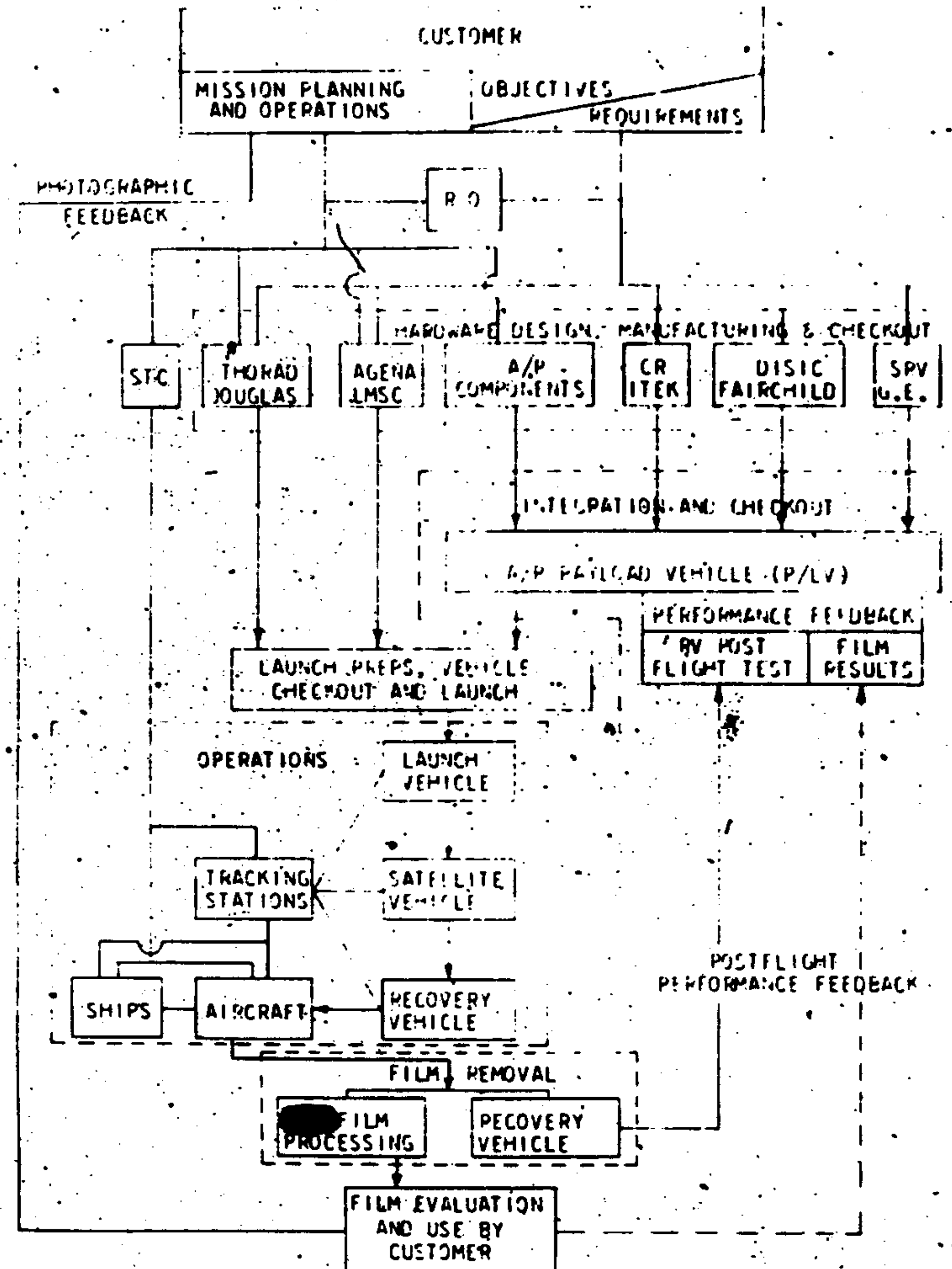

Figure A-1 Composite Organization Chart and Hardware Flow

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A-2.0 PROGRAM CAPABILITIES

Two high-resolution cameras operating in tandem provide the panoramic photography. A geodetic camera (DISIC or Dual Improved Stellar Index Camera) provides terrain and stellar photography.

This system is commanded from tracking stations around the world. In a single orbital mission, approximately 11 percent of the earth's habitable land area can be photographed in stereo by the panoramic system, and 47 percent by the cardiographic lens in single-lens stereo. Flight altitudes may be pre-launch-selected between 80 and 200 nautical miles, with the 80 NM altitude being preferred.

An in-flight filter and exposure control change capability permits films with different light characteristics (including color) to be accommodated, as well as variations in target illumination from equatorial to polar sun angles as low as 4 or 5 degrees.

The flight equipment is presently qualified for a 14-day orbital life, during which time two recovery vehicles are de-orbited to deliver film from the A mission and from the B mission.

A-3.0 CONCEPTS

A-3.1 Differences Between J-1 and J-3 (see Section BB)

The J-3 system is an evolution of previous systems having the same general purpose. However, many improvements in resolution and capability have been incorporated in the J-3. The J-3 system utilizes a dual, constantly rotating panoramic camera with one improved double stellar index camera housed in a 60-inch diameter structure; whereas the J-1 system used two oscillating panoramic cameras and two stellar index cameras housed in a 60-inch diameter structure. Many advantages in resolution, stability, and economy accrue from the new design. A detailed description of the J-1 system may be found in Appendix BB.

Since 1959, eight different models have been operational, each an improvement on its predecessor both in capability and reliability. See section AA-1.0.

A-3.2 Integrated Effort

From its inception, the systems have been produced through the integrated efforts of various associate contractors. These contractors are: LMSC - Agena and Instrument Vehicle; Itek Corp. - Main Camera Systems; General Electric Co. - Satellite Recovery Vehicle; Fairchild Co. - Stellar Index Cameras and other devices. See Figure A-1, above.

A-3.3 Factory-to-Launch

To achieve the greatest efficiency and product reliability from testing efforts, a factory-to-launch concept has been developed. This concept minimizes redundant testing, disassembling, and handling during assembly and checkout. The payload vehicle is shipped to the launch site in flight configuration, and minimal checks at the launch site are performed to ensure confidence.

All components are given rigorous functional tests, both before and after environmental tests. All complete systems are given similar tests, with the addition of a vacuum chamber orbital simulation test. Special ground support equipment has been produced to facilitate testing and handling at all levels of assembly.

During the entire course of production, from manufacture to launch, quality assurance monitoring is performed. Log books record operating and calendar life (LOL/LCL) status, failure trends modifications, and all other variables affecting quality and reliability.

A-3.4 Qualification Testing

Reliability is enhanced by the performance of tests which seek to simulate the actual environmental-conditions to which an equipment is subjected in flight. The payload vehicle is also tested for compatibility with the Agena.

According to the circumstances in which various tests are performed, these tests simulate vibration, thermal-altitude, shock, acceleration, and any special environments which are found necessary.

A-3.5 Nomenclature

To achieve a uniformity of understanding throughout this text, Figure A-2 through A-5 establish standard nomenclature, and Figure A-6 defines the coordinate systems.

A-4.0 OPERATIONS ANALYSIS

Operations analysis considers the following:

a. Mission planning
b. Systems performance evaluation
c. Film evaluation (pre-and postflight)
d. Operational support

A-4.1 Mission planning involves selection of requirements for photographic targets and programming of the vehicle command system to satisfy these requirements.

A-4.2 System performance evaluation consists of comparing flight performance data, both photographic and telemetric, with baseline

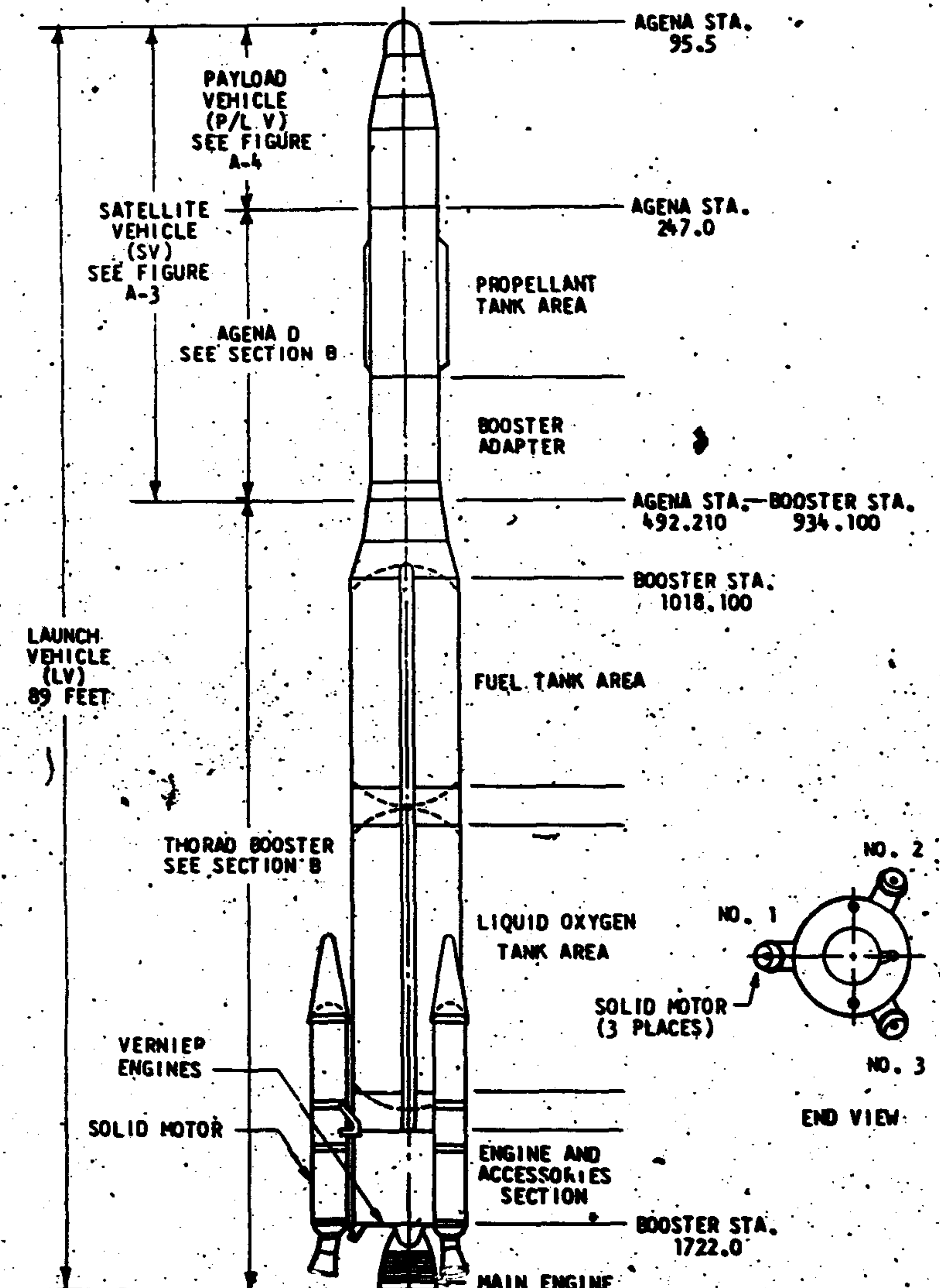

Figure A-2 Nomenclature of the Major Components of the Launch Vehicle

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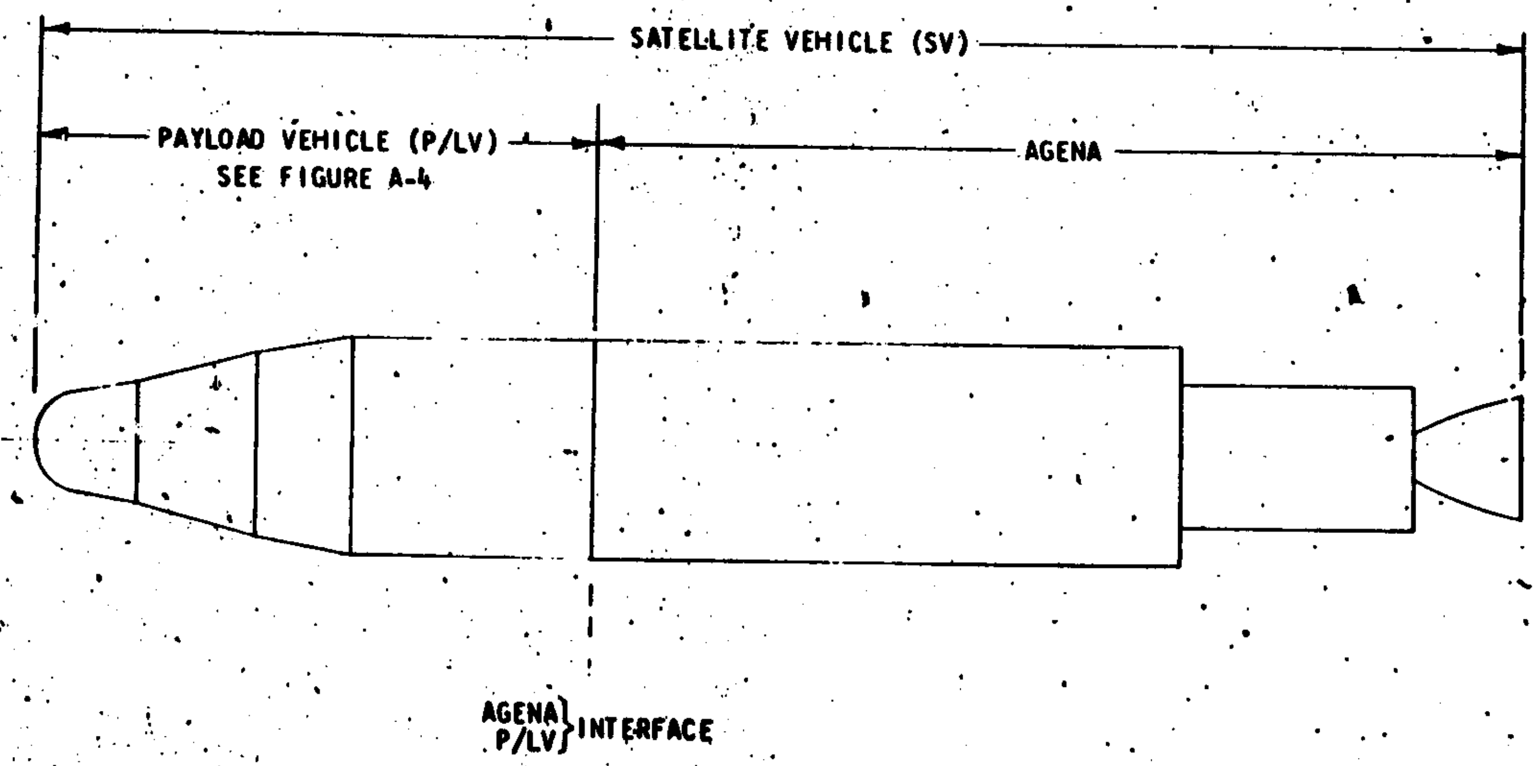

Figure A-3 Nomenclature of the Major Components Composing the Satellite Vehicle

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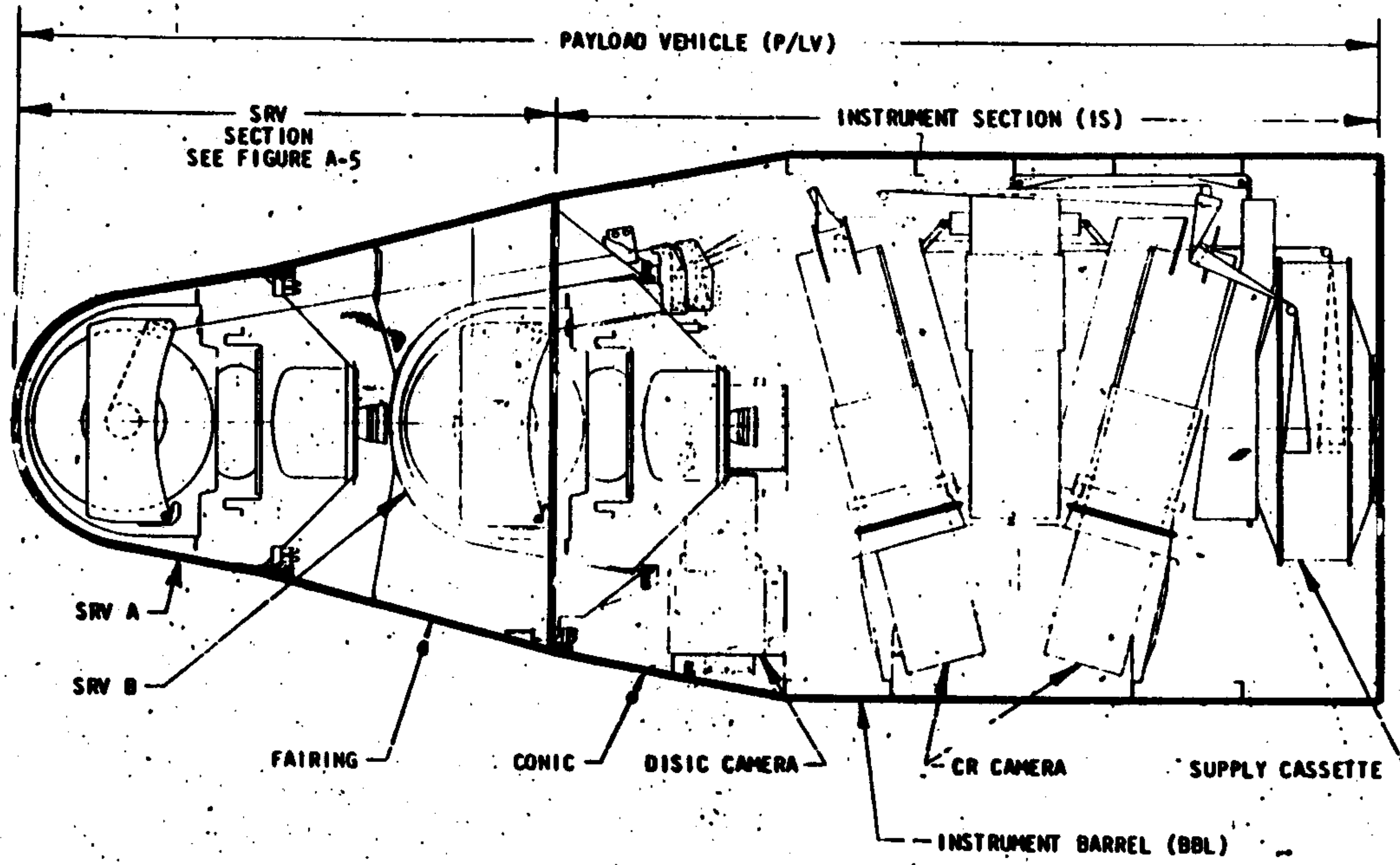

Figure A-4 Nomenclature of the Major Separable Components of the Payload Vehicle

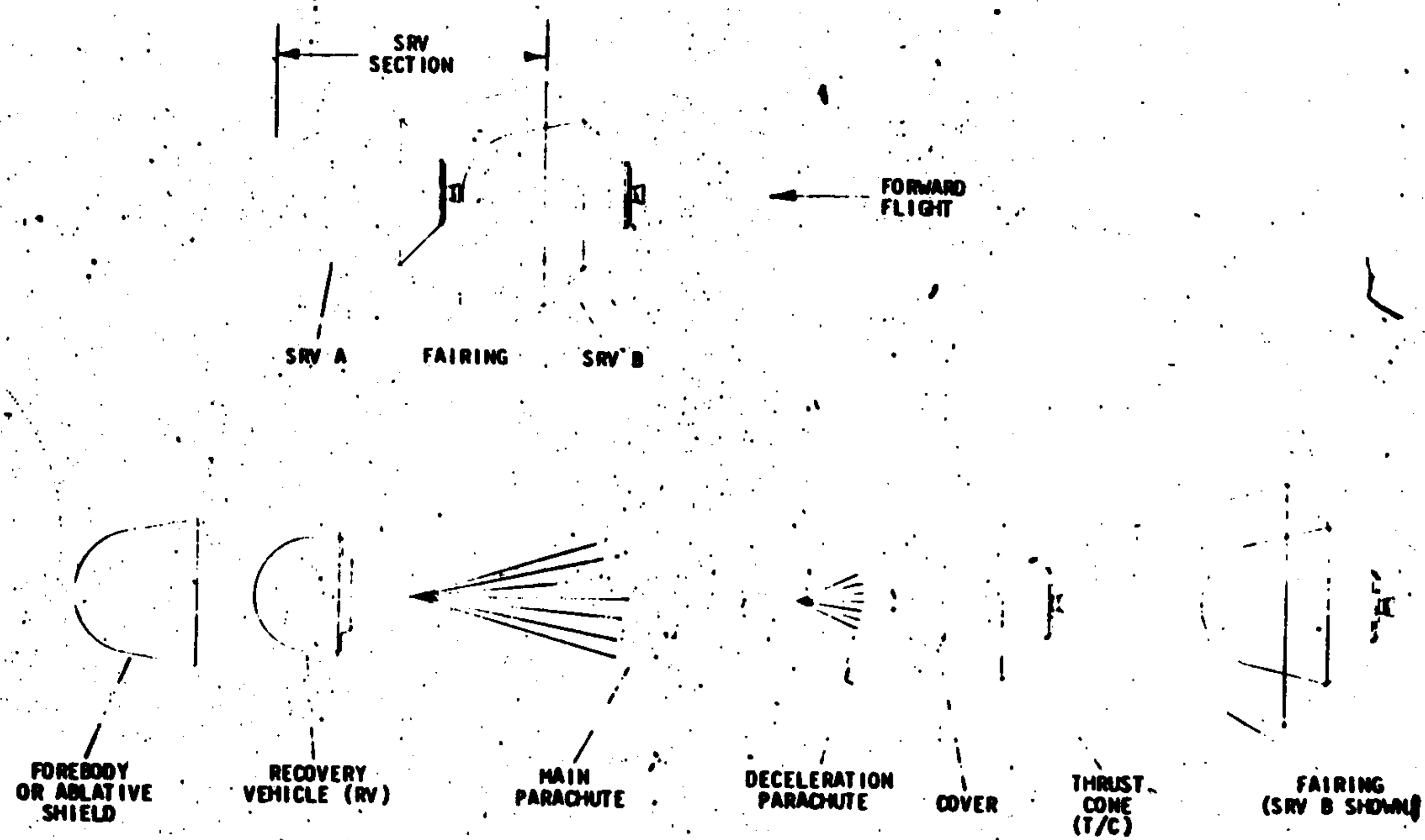

Figure A-5 Nomenclature of the Major Separable Components of the Satellite Recovery Vehicle

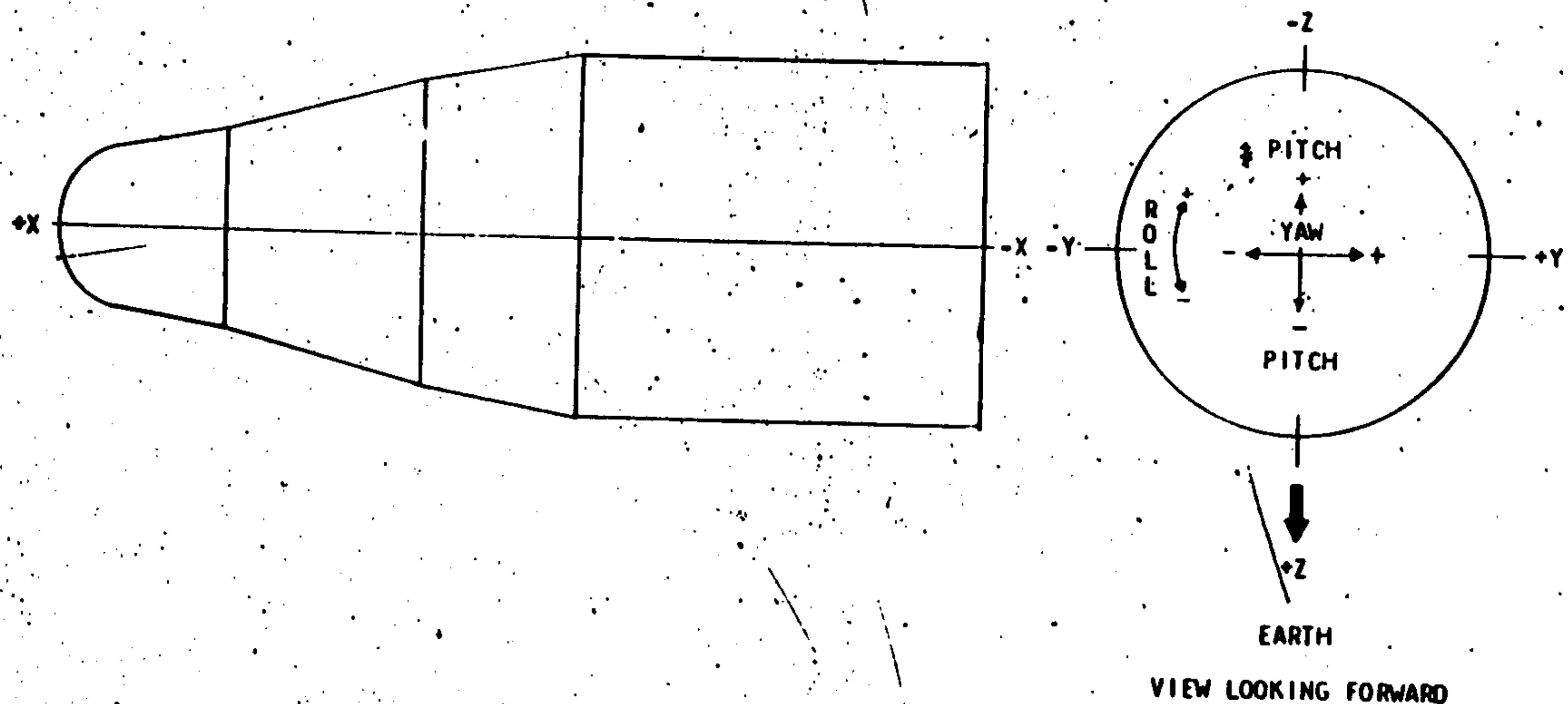

Figure A-6 Sign Conventions

data for diagnosis of anomalies and establishing of recommendations for improvement.

A-4.3 Film Evaluation

a. Preflight evaluation assures that the system is operating within limits photographically.

b. Postflight evaluation is used to compare predicted performance with actual performance.

A-4.4 Operations support consists of computational activity before and during the flight, wherein orbital parameters, ephemeris, and launch windows are predicted and updated. After the flights, support consists of analysis of the thermal model and all other available data to diagnose anomalies and suggest improvements.

A-5.0 DESCRIPTION OF SYSTEMS AND COMPONENTS AND THEIR OPERATION

A-5.1 Launch Vehicle

The Douglas Thorad SLV-2G serves as the first-stage launch vehicle for the system. See Figure A-2.

The LMSC Agena SO-1B serves as the second stage of the launch vehicle and as a stable platform from which the camera system operates. See Figure A-3. The Agena provides the electrical power, commands, T/M and three-axis stabilization to the camera system.

A-5.2 Payload Vehicle

A-5.2.1 Structures

The camera system is mounted in a magnesium thorium monocoque spaceframe consisting of an instrument barrel, a conic section supporting one satellite recovery vehicle (SRV) held internally,

[redacted]

and a fairing section supporting the second SRV (which additionally acts as the nose cone for the launch vehicle). See Figure A-4.

Thermal control of the system in orbit is, in general, achieved passively by means of coatings with various thermal properties which enable them to heat or cool the system. The thermal behavior of the system is predicted and analyzed by means of a thermal math model.

Absolute mechanical, electrical, and thermal interfaces exist between all separable units of the system. Also to be considered are the abstract interfaces, such as those between the recovery forces and the recovery vehicle (RV).

A-5.2.2 CR Instrument

The constant-rotating (CR) camera subsystem consists of a stereoscopic pair of high-resolution, 24-inch focal length cameras. The camera system is supplied with unexposed film by the supply cassette subsystem and divested of exposed film by the two take-up subsystems, one of which is mounted in each of the two satellite recovery vehicles. Fully loaded, each SRV has the capacity to retain half of the total film supply.

To avoid image smear, image motion control is needed by the CR instrument to compensate during film exposure for forward movement of the satellite, earth rotation, and oblateness of the earth's surface.

Exposure control for the CR and DISIC cameras is provided to compensate for varying light conditions and various types of film used in the system.

A-5.3 DISIC

The Dual Improved Stellar Index Camera (DISIC) is a three-lens cartographic/geodetic camera system that takes simultaneous interlocking photographs of star patterns and terrain. It can operate teamed with the CR cameras, or independently. Like the CR cameras, the DISIC film take-up load is divided between the two SRV's.

A-5.4 Support Subsystems

A highly accurate digital clock records a binary time word on each exposure of film. The clock output is telemetered via the Agena to the tracking stations to correlate clock time with Greenwich Mean Time (GMT). Fiducial marks and other correlative data for precise orientation and positioning of imagery are also recorded on each exposure.

A pressure make-up unit (PMU) maintains internal pressure in the instrument section during CR camera operations above a critical level necessary to suppress electrostatic discharge (corona effect) which would otherwise leave static marks on the film.

A system of real time and stored commands controls the system during orbital operations. These commands are provided by and through the Agena.

The electrical power to operate the system is provided by a complement of batteries carried by the Agena, except for the SRV which has on-board batteries used during flight recovery.

Diagnostic and control data are transmitted by the Agena telemeter system to the tracking station. Digital tape recorders are mounted in the two SRV's to record the outputs of certain selected functions, making it possible to acquire selected operational and diagnostic data. The clock output is also recorded on the digital tape recorder to data correlation.

A pyro system provides motive power for the mechanical operations requiring high energy for a short time. These devices are used for separation functions, ejection of various doors, and cutting of film.

A-5.5 <u>Satellite Recovery Vehicle (SRV)</u>

The satellite recovery vehicle system makes it possible to return exposed film to earth, and two SRV systems are required on each payload to contain the quantity of film exposed.

The SRV system includes the following:

a. A capsule to contain the film take-up system and ancillary devices (i.e., batteries, beacon, T/M transmitter, digital tape recorder, recovery programmer).

b. A thrust cone to mount de-orbiting devices.

c. A thermal shield to protect the capsule against the heat of re-entry.

d. A parachute to lower the capsule to earth without exceeding its structural limits.

A-5.6 <u>Recovery Operations</u>

The recovery function comprises the following functions of the SRV:

a. Separation from the satellite vehicle.

b. De-orbiting by means of a retro rocket mounted on the thrust cone, which is then jettisoned (spin stabilized).

c. Re-entry into the atmosphere while being protected thermally by the thermal shield, which is then jettisoned.

d. Descent by parachute for either air recovery or water impact.

Air recovery is the normal mode of recovery, and after such recovery the capsule is flown to [redacted] for processing of film.

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SECTION B

AGENA

B-1.0 PURPOSE

The purpose of the Agena vehicle is to provide the second-stage thrust and guidance to inject the J-3 payload system into the desired orbit after the first-stage Thorad booster falls away. On-orbit, the Agena then provides the payload system with operating power, commands, communications, a stable platform, and a recovery re-orientation attitude.

B-1.1 Function

The principle functions of the Agena vehicle are summarized ~~as follows~~:

a. Injects the Payload/Agena into the desired orbit between 80 and 200 nautical miles (NM). See Figure B-1.

b. Provides a stable platform for the payload.

c. Adjusts the orbit to overcome orbital decay (see Figure B-2.)

d. Provides one VHF and two UHF command links with the ground tracking stations.

e. Provides stored program commands to operate the equipment when not in range of tracking stations.

f. Provides a telemetry system to obtain operational and diagnostic data about the onboard equipment, and to record this data for later playback as well as real time data transmission when the Agena is over a tracking station.

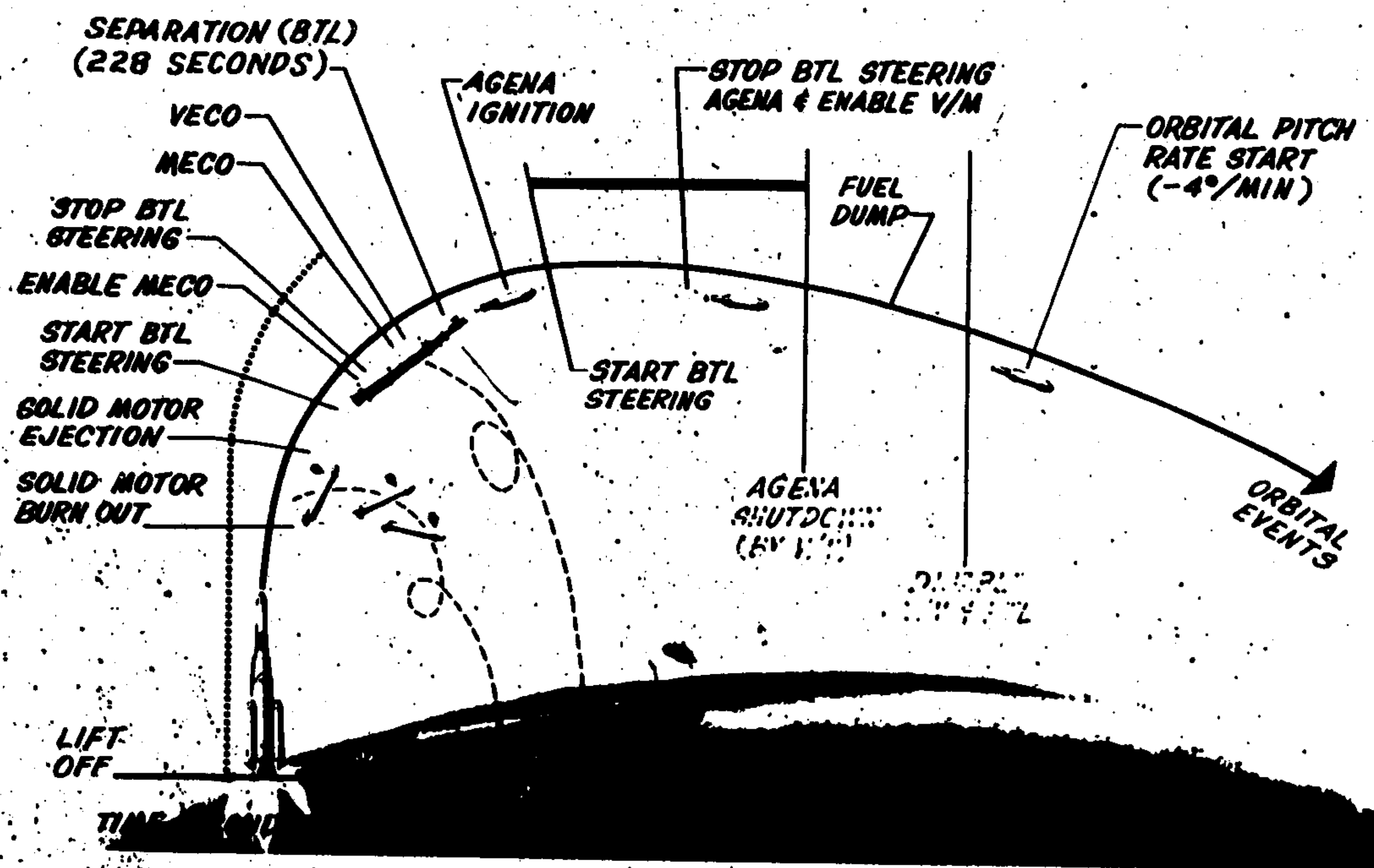

Figure B-1 Ascent Sequence of Events

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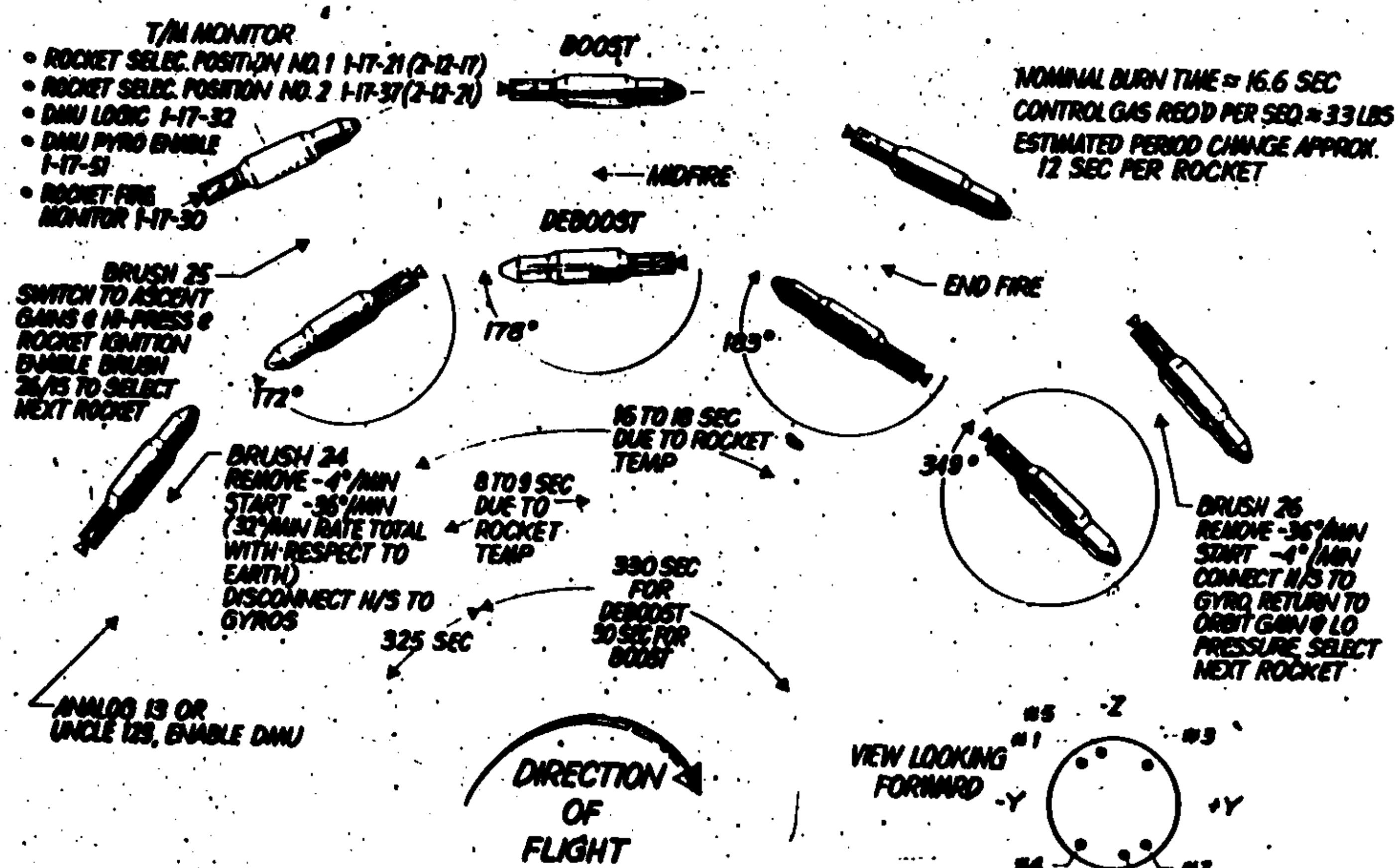

Figure B-2 Drag Make-Up Sequence (DMU)

g. Provides electrical power for the life of the mission.

h. Provides an Agena/Payload attitude suitable for deorbiting the satellite recovery vehicle (SRV), and subsequently returns the Agena/Payload to normal orbital flight attitude.

B-2.0 DEFINITIONS AND COORDINATE SYSTEMS

B-2.1 General Definitions

The launch vehicle may be defined as the complete vehicle as launched in support of a given mission and prior to any staging or other in-flight separation of components or systems (i.e., payload vehicle, Agena vehicle, and primary booster). See Figure A-2.

B-2.1.1 Interface Definition

Interfaces may be defined as the physical junction and associated mechanical and electrical hardware between major launch vehicle systems as specified by associate contractor design responsibilities, and also all of the physical, functional, and environmental characteristics of the launch vehicle that directly affect interface hardware design.

B-2.2 Launch Vehicle Coordinate System

Coordinate systems for the launch vehicle are expressed in terms of station numbers and mutually perpendicular axes (see Figure A-2). Station numbers identify position in inches along the longitudinal axis of the launch vehicle. Axes are labeled X, Y, and Z, with plus or minus signs assigned to directions along the axes. The axes perpendicular to the launch vehicle longitudinal axis divide the cross section in quadrants numbered clockwise when looking forward. Angular position is identified in degrees from the reference axis or in a particular quadrant. The axes are fixed with respect to the launch vehicle, regardless of attitude or flight phase.

B-2.2.1 Agena Coordinates

Agena D station numbers increase in the aft direction from an arbitrary reference point forward of the vehicle designed LMSC Station 0 to Station 526.00. Vehicle movement about the axes is termed as pitch, roll, or yaw. These motions are shown in Figure B-3. The angular reference system provides a clockwise 360-degree orientation about the longitudinal or X axis of the vehicle.

B-2.3 <u>Launch Facilities</u>

Facilities for Thorad/Agena launches are available only at the Western Test Range (WTR).

B-2.4 <u>Agena Vehicle Summary</u>

The Agena D is a standardized vehicle that can be configured to perform as an intermediate stage booster or as an orbital vehicle. There are essentially five subsystems (SS) categories of equipment that make up the Agena vehicle. These are (a) spaceframe (SS/A), (b) propulsion (SS/B), (c) electrical (SS/C), (d) guidance and control (SS/D), and (e) communications and control (SS/C&C).

B-2.5 <u>Agena Assembly Procedures</u>

The basic Agena D (Figure B-4) is assembled into the defined configuration and tested by the LMSC Agena D Manufacturing organization under Air Force contract. After tests as a complete system, the vehicle is accepted by the Air Force Satellite Systems Division (AFSSD) in an initial DD250 procedure. The basic vehicle is then assigned by AFSSD to using programs as Government-Furnished Equipment (GFE). See Figure B-5 for factory-to-launch

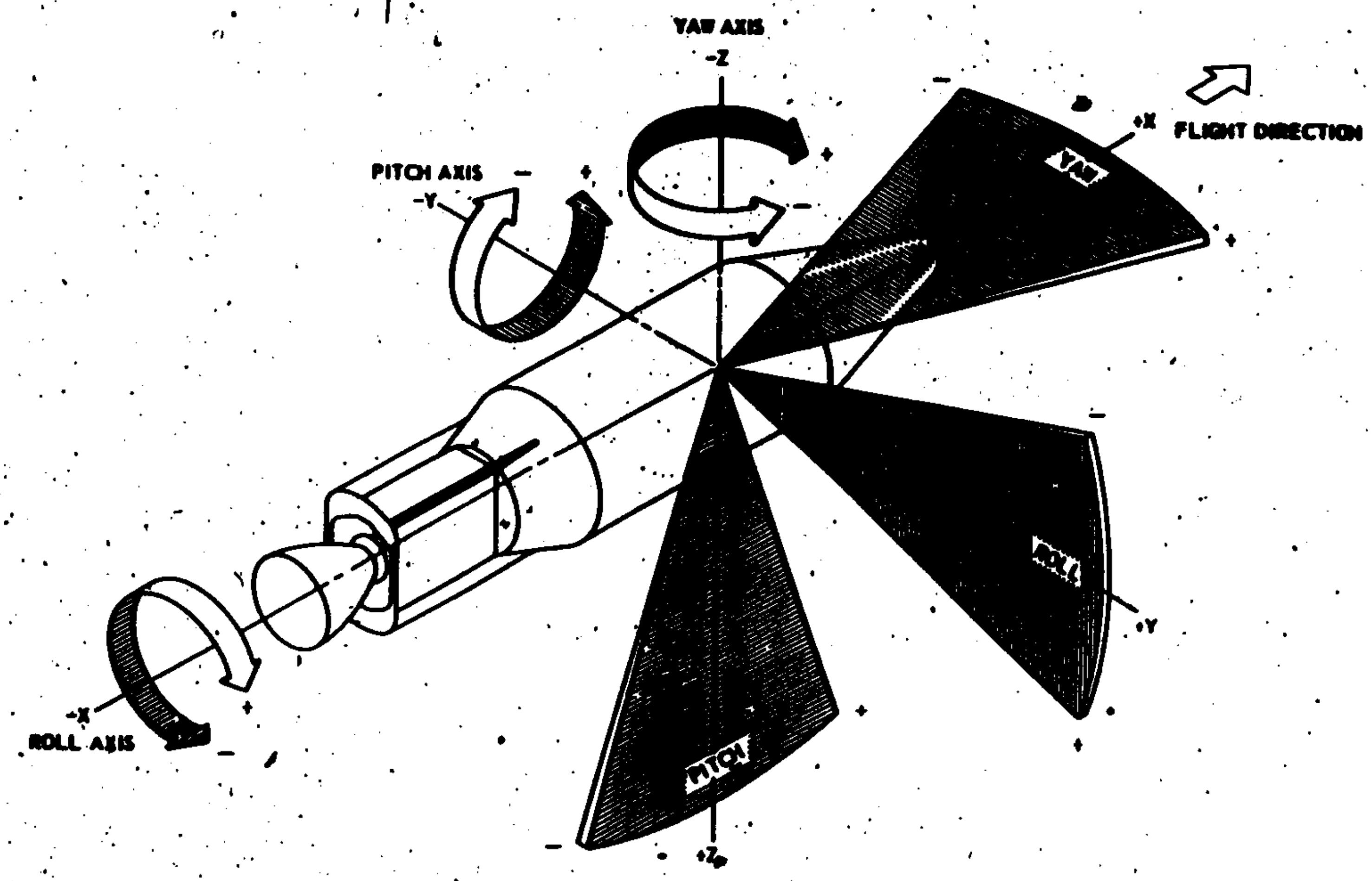

Figure B-3 Agena D Fixed-Axis and Movement Designations

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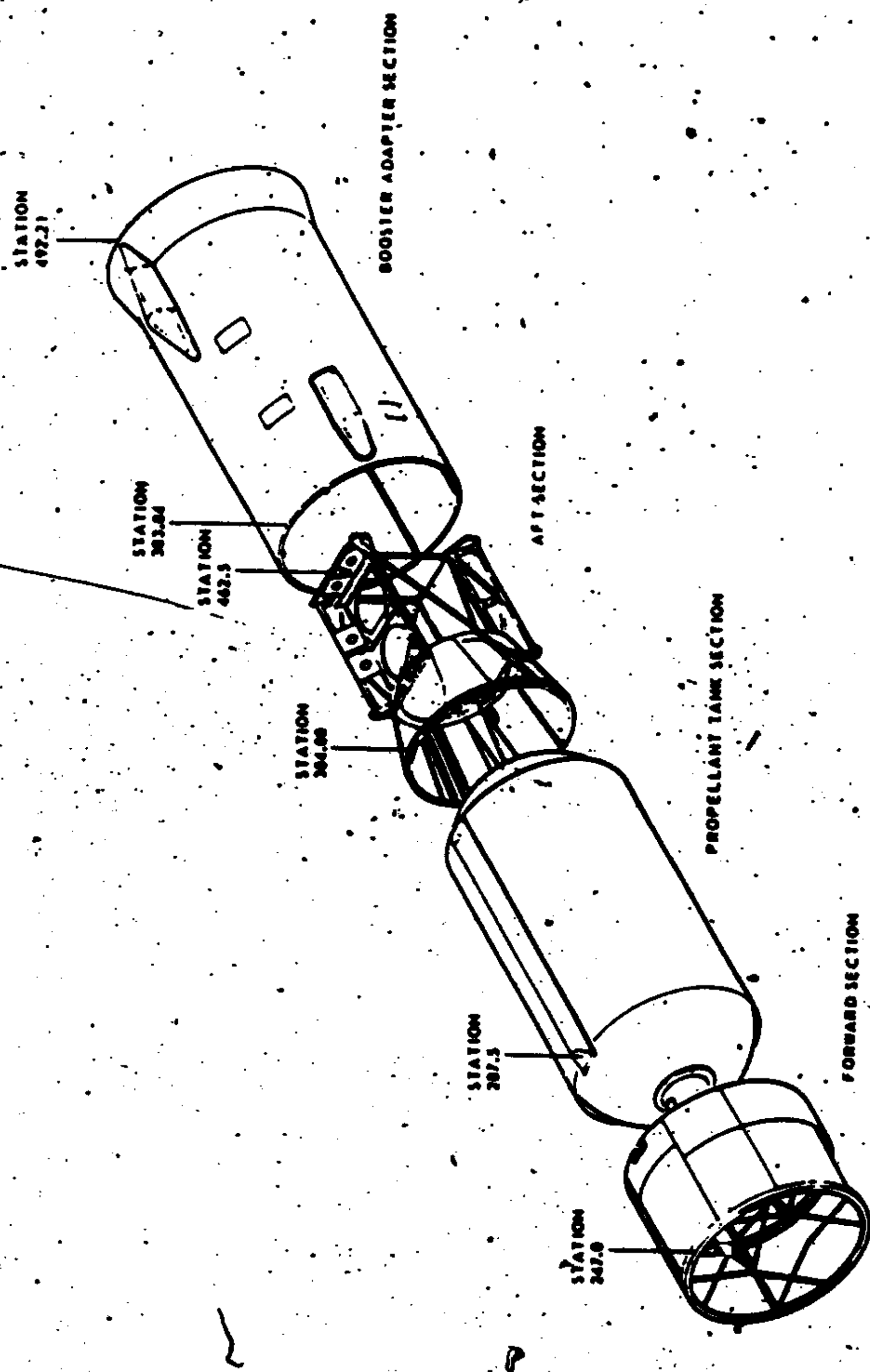

Figure B-4 Basic Agena Vehicle

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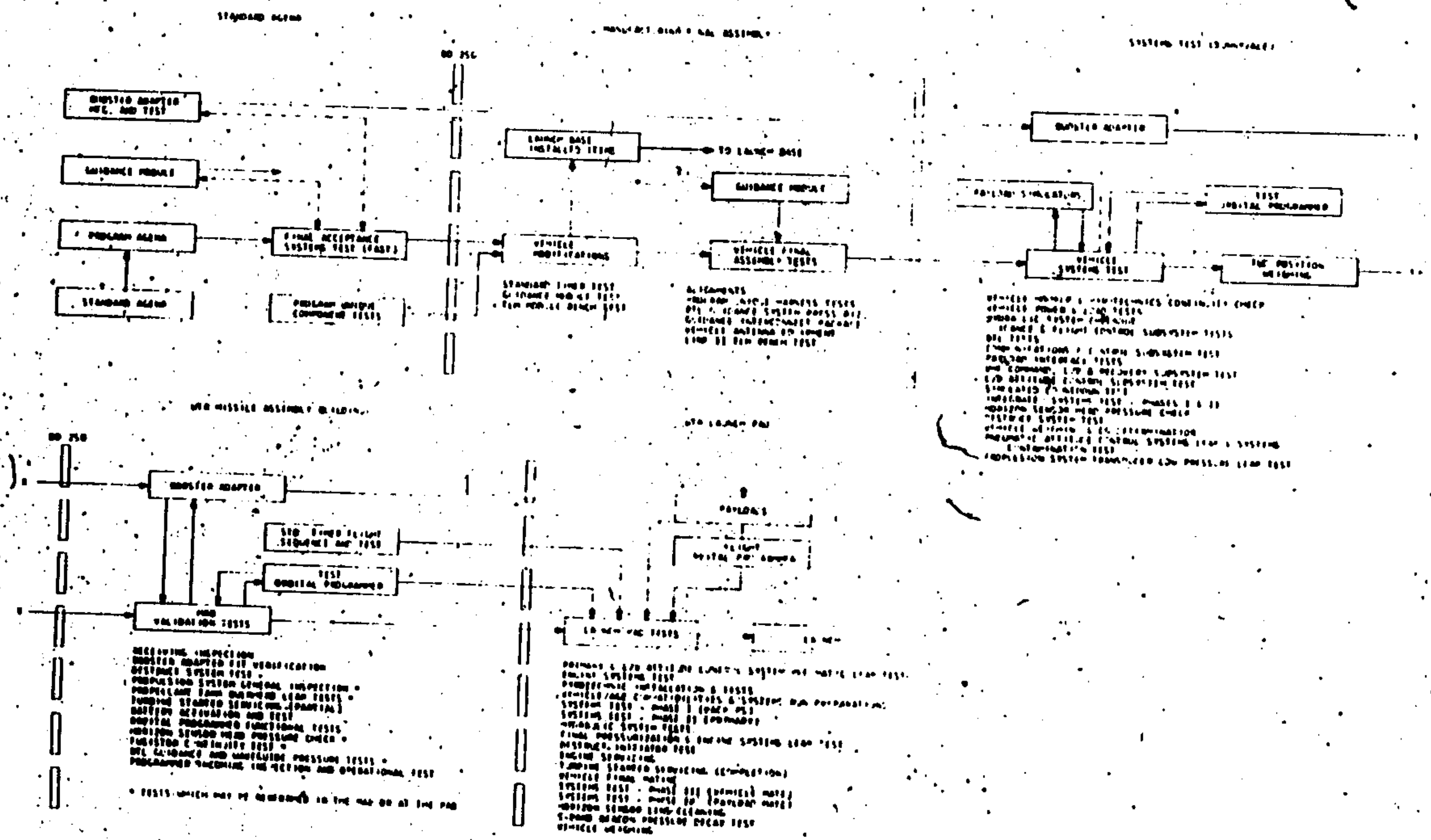

Figure B-5 Factory to Launch Test Sequence

sequence. In A/P applications, the vehicle, under LMSC direction, is modified by the addition of optional and program-peculiar equipments.

B-3.0 AGENA STRUCTURES

B-3.1 Forward Section

The forward section houses basic Agena system components (Figures B-6 and B-7). Space and mounting are also provided for certain mission optional components and kits. The section is completely enclosed and is 40.5 inches long, extending from Station 247 to Station 287.5.

The forward section structure is a welded truss-type tubular aluminum frame, to which are bolted external rings, longerons, skin assemblies, and access doors. Mounting brackets and shelves are provided within the interior on the tubular frame for the installation of components. Components may also be attached to the tubular frame directly by means of rubber-covered clamps.

Removable beryllium panels provide the principal access to components in the forward section. Additional access, when necessary, can be obtained by removal of beryllium fixed skins which are bolted to rings and longitudinal members. With equipment installed, the vehicle cannot be erected or transported without flight or dummy panels in place.

B-3.2 Tank Section

The tank assembly (Figure B-8) is an integral part of the vehicle spaceframe, and provides the supporting structure and exterior surface for the center portion of the vehicle. The assembly is constructed of aluminum sheet formed and welded together to make up the dual tank structure. Overall tank length, including the fore and aft hemispherical tank ends, is 129 inches. The minimum

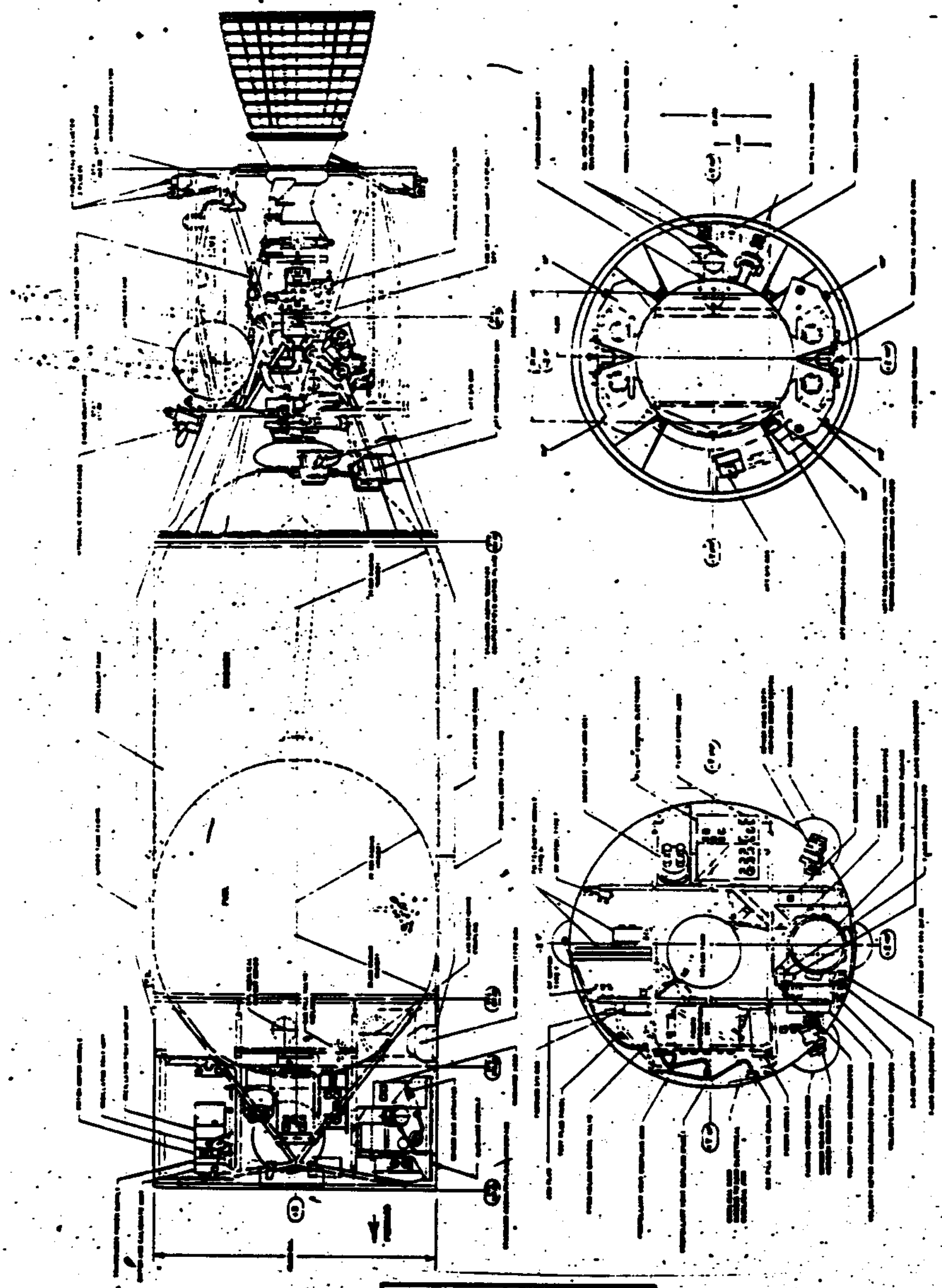

Figure B-6   Agena Inboard Profile

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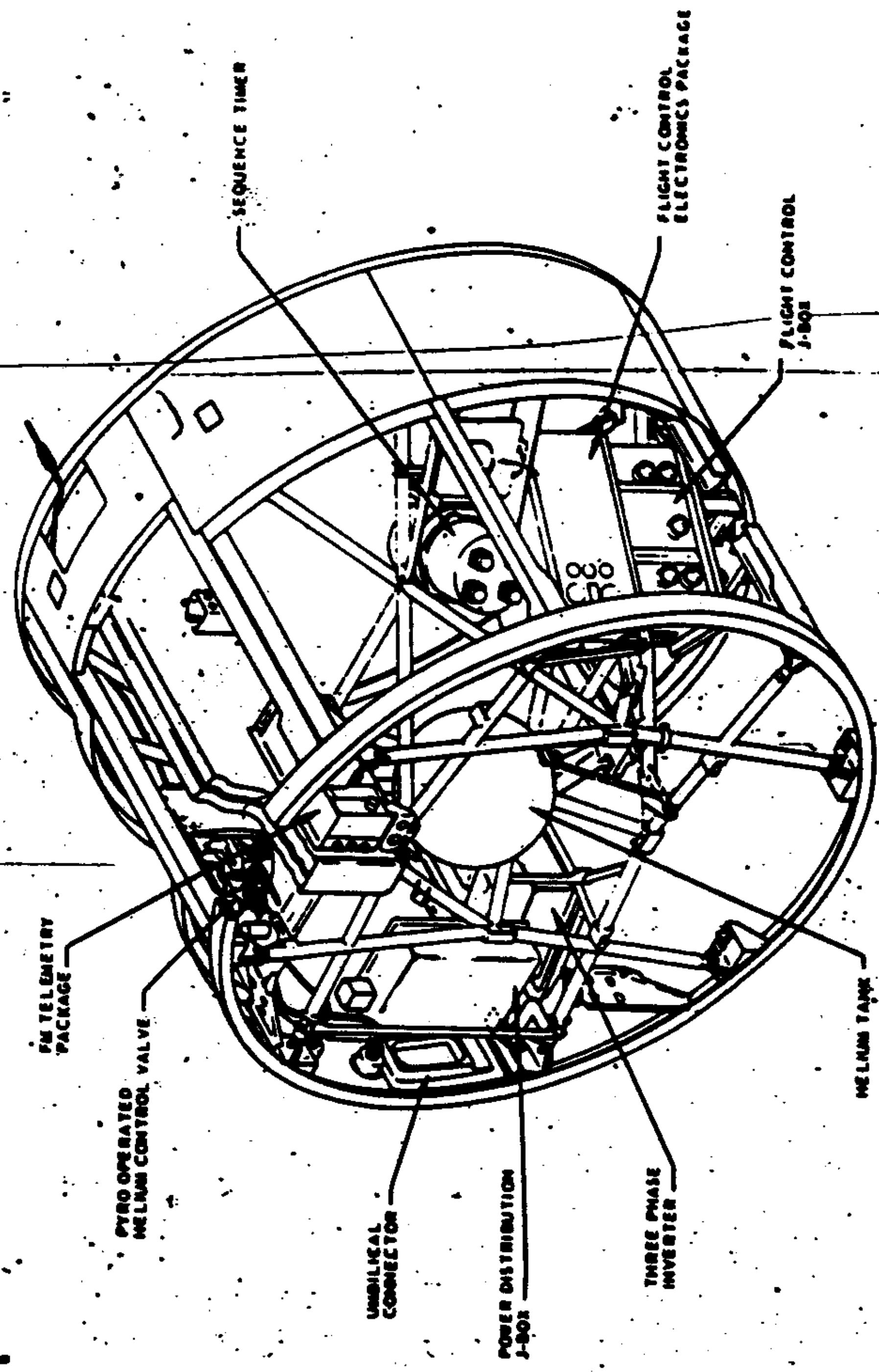


Figure B-7 Forward Section, Basic Vehicle

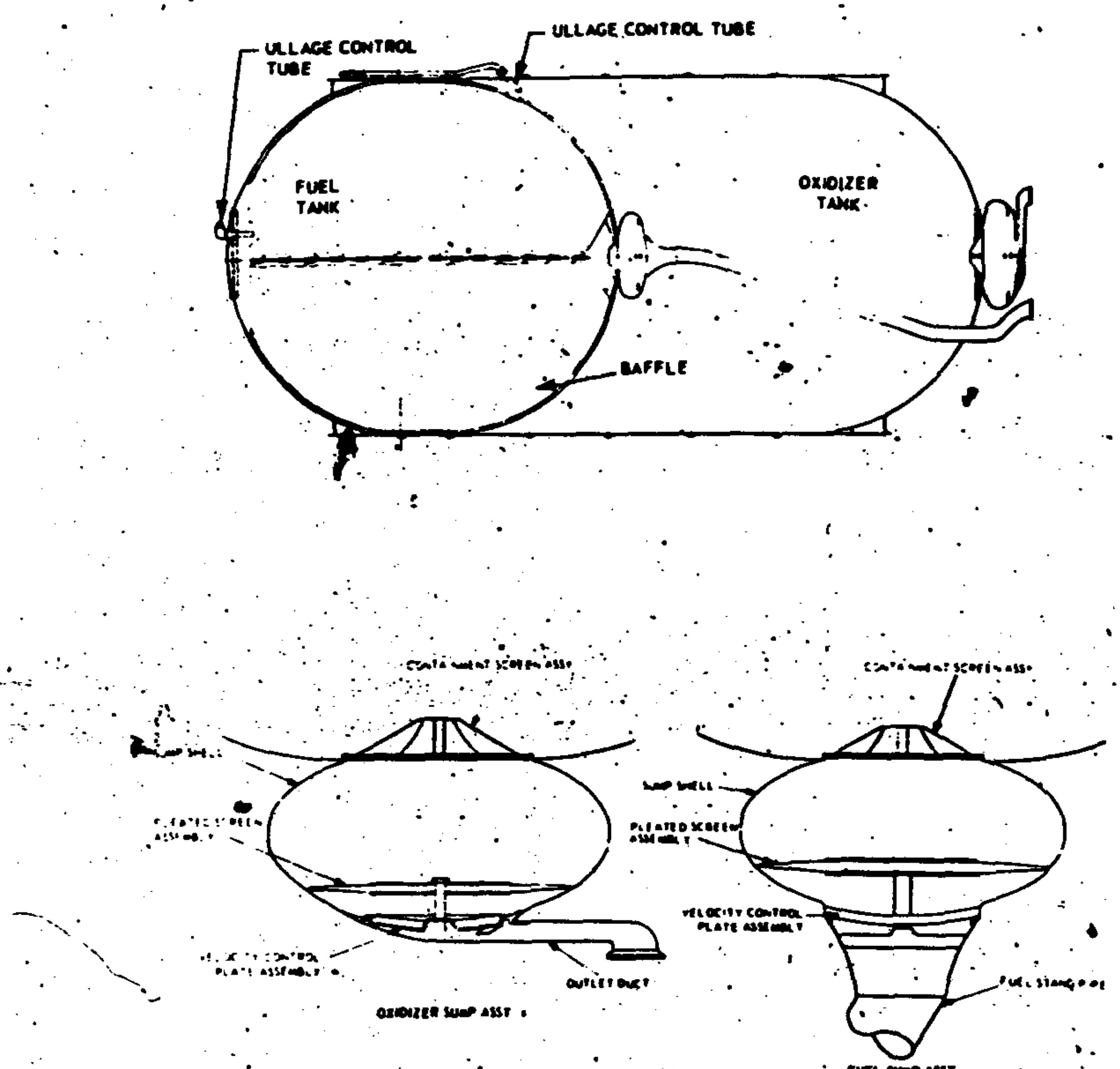


Figure B-8 Tank Section and Sump Details net volume of the fuel tank with baffles is 75.9 cubic feet, or a total of approximately 568 gallons. The minimum net volume of the oxidizer tank with baffles installed is 98.4 cubic feet, or approximately 736 gallons. Two external fairings, mounted longitudinally along the tank section, provide a passageway for the interconnecting plumbing and wiring between the forward and aft sections. In addition, the fairings serve as tunnels for transmitting air from the forward section to the aft section during on-pad air conditioning and ascent venting.

B-3.3 Aft Section

The aft section provides a structural continuity from the tank section to the booster adapter and supports the rocket engine. The aft rack structure is comprised of magnesium structural members, magnesium skins, and tubular aluminum braces. The aft equipment rack provides mounting facilities for gas storage, basic optional, and other equipment items.

The aft section extends 79.5 inches from Station 383.84 to Station 462.5, and terminates in an aft bulkhead which supports the attitude control jets and booster separation guide rollers. The guide rollers engage the four guide rails mounted on the inside of the booster adapter.

B-3.4 Booster Adapter

The booster adapter (Figure B-9) provides the structural interface between the standard Agena and the first-stage booster.

The booster adapter contains two retrorockets mounted at the 0-degree and 180-degree angular positions. The separation components consist of four separation roller rails and a mild detonating fuse (MDF) separation device which is installed on the interior of the adapter. The adapter also houses a self-destruct system that is

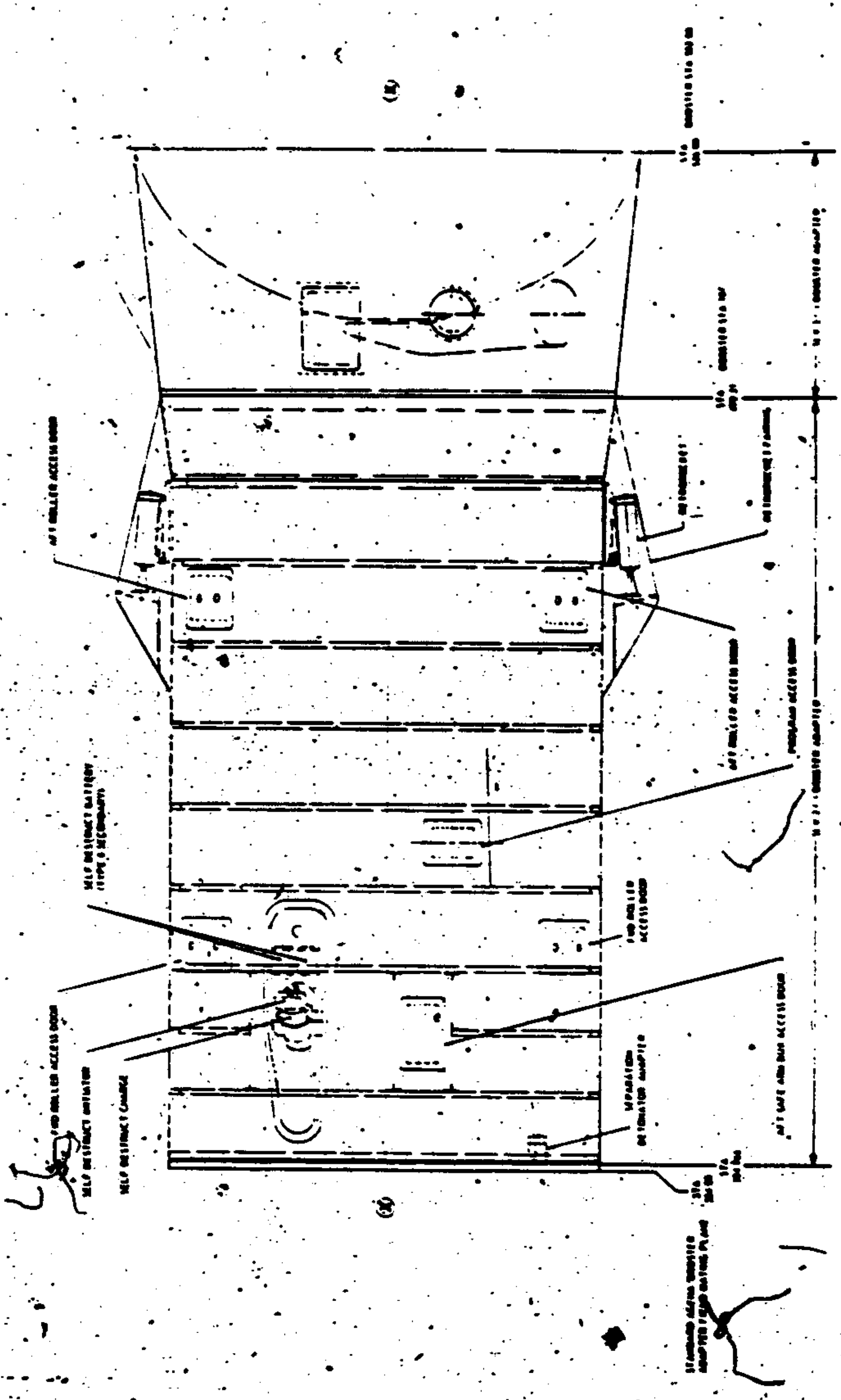


Figure B-9 Booster Adapter

designed to rupture the propellant tanks and destroy the vehicle during the ascent phase in the event of hazardous or uncontrollable flight conditions.

B-4.0 PROPULSION SUBSYSTEM

B-4.1 General

The propulsion subsystem includes engines, motors, and pyrotechnical devices used by the Agena in the performance of the mission as an intermediate stage booster and an orbital vehicle. The principal unit in the propulsion subsystem is the main, or BAC Model 8096, primary propulsion system (PPS), which performs single-burn missions.

Agena propulsion may be considered in terms of three component systems: (a) the propellant tank pressurization, (b) the engine, and (c) the feed, load, and vent system. Figure B-10 shows the propulsion system schematic for the engine.

B-4.1.1 Rocket Engine System

The engine develops a rated thrust of 16,000 pounds in vacuum for a total duration of 240 seconds. Fuel is unsymmetrical dimethylhydrazine (UDMH); the oxidizer is inhibited red-fuming nitric acid (IRFNA).

The thrust chamber assembly is an integral unit consisting of the combustion chamber, nozzle throat section, divergent nozzle section, and a radiation-cooled titanium nozzle extension (see Figure B-11). The expansion ratio is 45:1. The thrust chamber and nozzle are regeneratively cooled by oxidizer entering through passages in the thrust chamber wall before injection into the combustion chamber. The fuel and oxidizer ignite hypergolically in the rocket engine thrust chamber.

An engine electrical control system provides for starting,

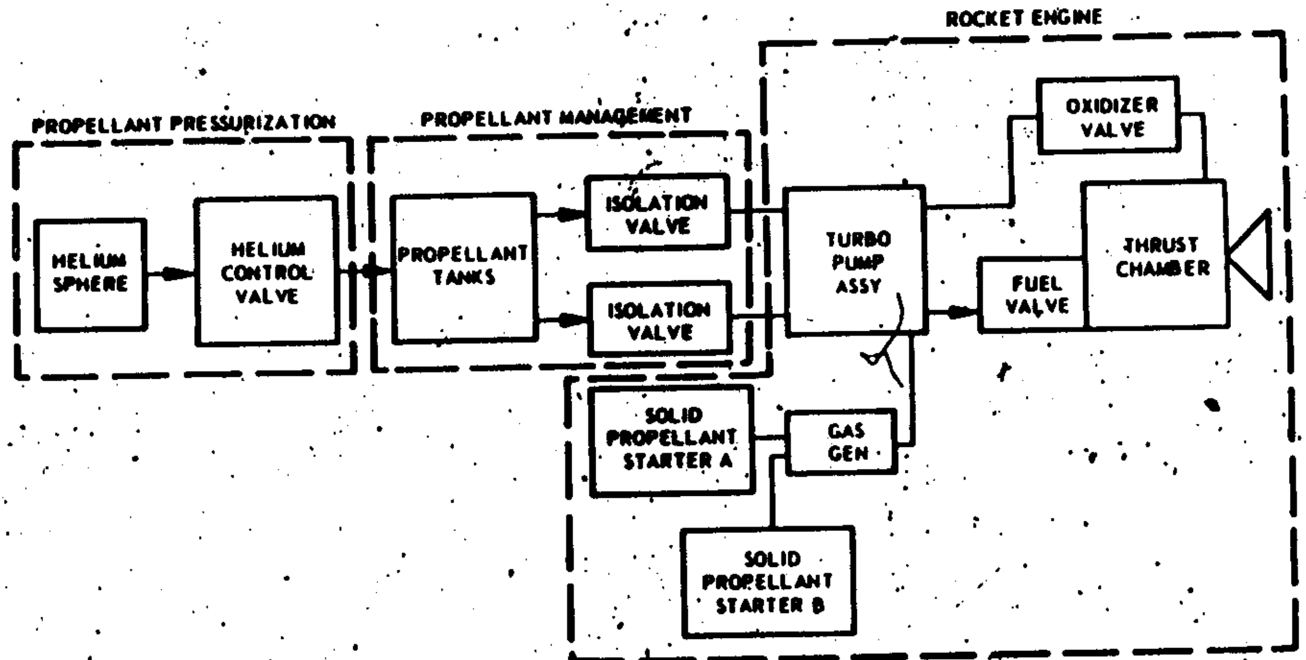
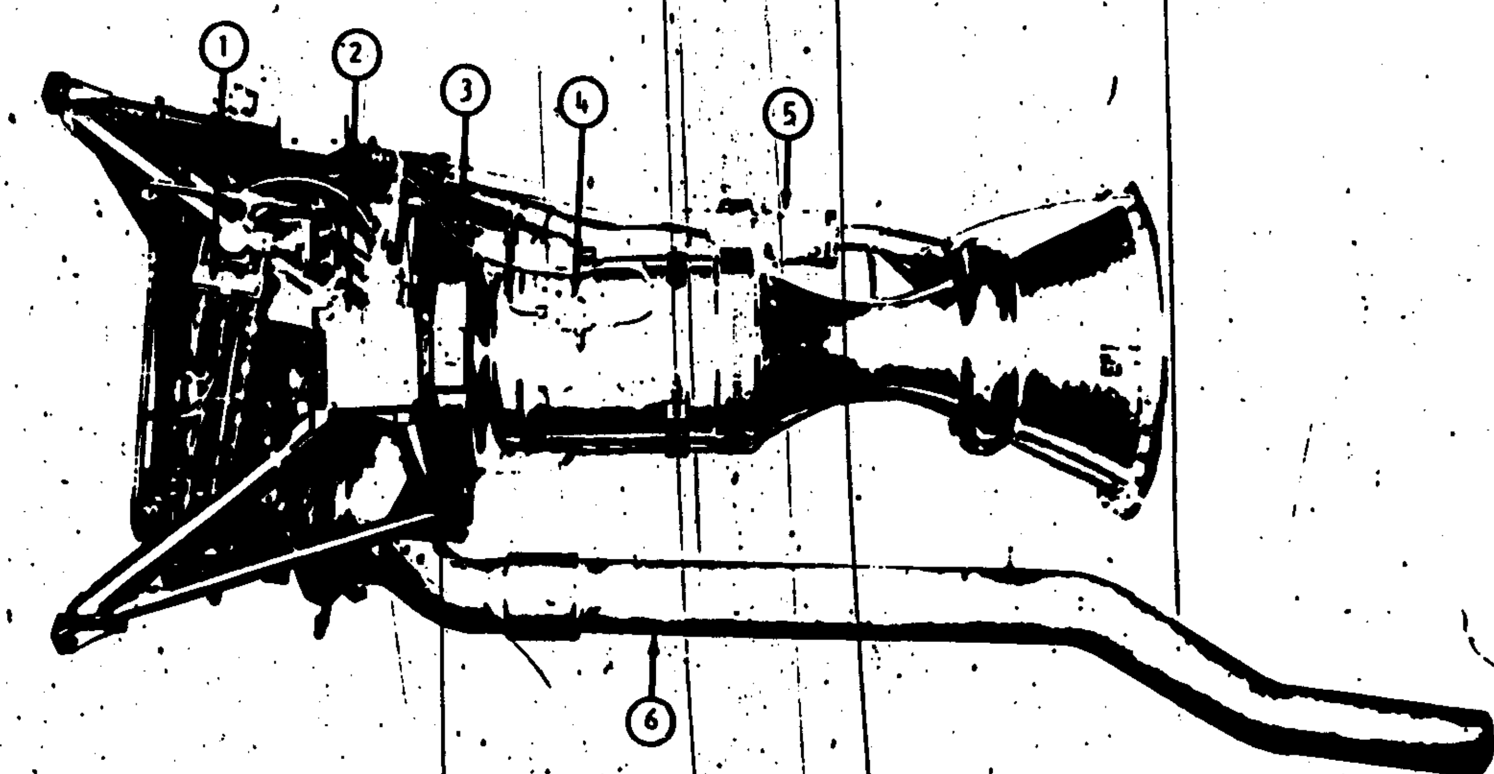


Figure B-10 Propulsion System Schematic



1. GAS GENERATOR VALVE AND SOLENOID VALVE
2. RELAY BOX ASSEMBLY
3. GIMBAL RING
4. THRUST CHAMBER PRESSURE SWITCH
5. OXIDIZER VALVE
6. TURBINE EXHAUST DUCT

Figure B-11 BAC Model 8096 Agena Engine

operating, and, shutting down the rocket engine in response to signals from the Agena guidance and control system. The engine is gimballed and provides vehicle attitude control in pitch and yaw during engine operation by means of lateral and vertical thrust chamber movement.

The turbopump assembly supplies fuel and oxidizer under pressure from the propellant tanks to the rocket engine thrust chamber and gas generator. The assembly consists of a single-stage, impulse-type turbine, a fuel pump, and an oxidizer pump which are gear-coupled to the turbine shaft (see Figure B-11).

The gas generator provides the hot gases required to start and maintain the turbine operation which, in turn, drives the propellant pump. The gas generator assembly consists of a small combustion chamber, a single-engine starter-igniter, a gas generator bipropellant valve and associated solenoid valve, and the gas generator fuel and oxidizer venturis.

Control of the propellant flow from the turbopump to the engine thrust chamber is provided by a pressure-operated oxidizer valve and by a fuel valve.

B-1.1.1.1 Pressurization System

The pressurization system uses high-pressure helium gas to pressurize the propellant tanks to provide the required propellant pressures at the rocket engine propellant pump inlets. The system (Figure B-12) consists of gas storage, pyro-operated helium control valve, and the associated tubing that connects these components to the propellant tanks and the fill and dump couplings.

The pressurization system maintains the desired pressures in the propellant tanks at the engine turbopump inlets. It maintains these pressures from the start of the countdown (propellant loading operation) until the completion of rocket engine shutdown. Approxi-

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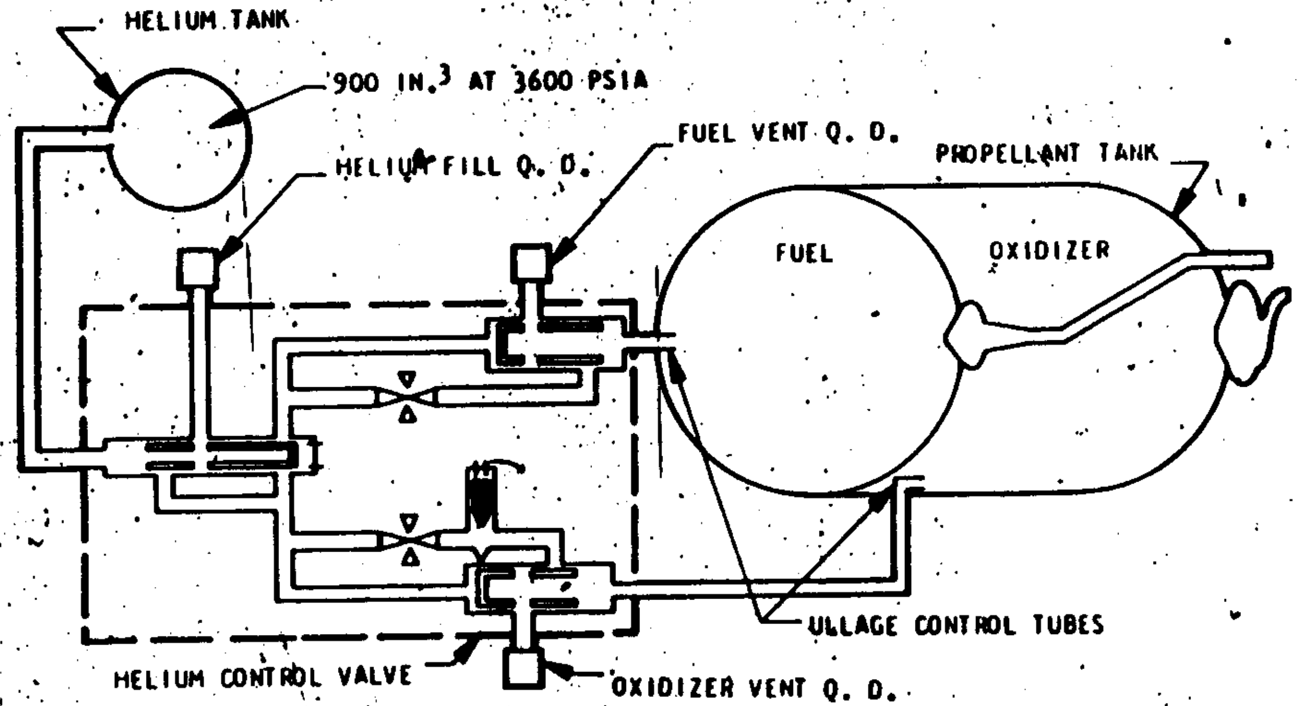

Figure B-12   Tank Pressurization System

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mately 1.5 seconds after start of the initial engine burn, the pyro-operated helium control valve (POHCV) opens in response to a signal from the guidance and control system sequence timer. When the control valve is open, helium gas flows through fixed orifices (one for oxidizer and one for fuel) to pressurize the propellant tanks. After a predetermined interval of time, the oxidizer tank is isolated by closing a portion of the POHCV. The isolation of the oxidizer tank serves two purposes: (a) creates a sufficient bias to maintain the internal pressure of the fuel tank above that of the oxidizer tank, and (b) prevents oxidizer vapors from mixing with fuel vapors through the pressurization system plumbing. This pressurization of the propellant tanks is sufficient for subsequent engine operations.

B-4.1.1.2 Propellant Feed, Load, and Vent System

The feed, load, and vent system is comprised of the following main components: two propellant-fill couplings, two propellant-vent couplings, one helium-fill coupling, four strainers, four bellows, and two ullage-control tubes which are a part of the propellant tank assembly. The system interfaces with launch-pad AGE to provide for loading propellant and helium port closure after vehicle liftoff, to prevent leakage. The system also permits dumping of the propellants out of the tanks and helium from the helium storage spheres.

B-5.0 BASIC GUIDANCE AND CONTROL EQUIPMENT

The basic Agena guidance and flight control system consists of guidance equipment, flight control equipment, and flight programming equipment. This equipment is described in the following paragraphs.

B-5.1 Guidance Equipment

The basic guidance system detects changes in the attitude of the vehicle, initiates signals to control vehicle attitude and flight direction, and controls the periods of rocket engine operation. The system components include an inertial reference package (IRP), a horizon sensor (H/S), an accelerometer and velocity meter, and a guidance J-box. The guidance components are packaged in a guidance module (Figure B-13) located in the forward lower section of the vehicle, its underside forming a part of the exterior surface of the vehicle.

B-5.1.1 Inertial Reference Package

The inertial reference package is the primary attitude-sensing component of the guidance system. Contained within its temperature-controlled interior are three single-degree-of-freedom, rate-integrating gyroscopes, each individually oriented so that it senses the angular displacement of the vehicle about one of its three major axes. The gyros used are two hermetically sealed integrating gyro (HIG) units to sense pitch and yaw and one miniature integrating gyro (MIG) unit to sense roll.

The functions of the IRP are as follows:

a. To accept input signals from the horizon sensor, BTL (Bell Telephone Laboratory) commands, and the program rate circuitry (ascent timer). These signals change the IRP reference attitude in accordance with the input signals.

b. To detect the difference between the attitude of the vehicle and the IRP reference attitude, and to generate an error signal with an amplitude that is proportional to the difference in attitude.

B-5.1.2 Horizon Sensors

[redacted]

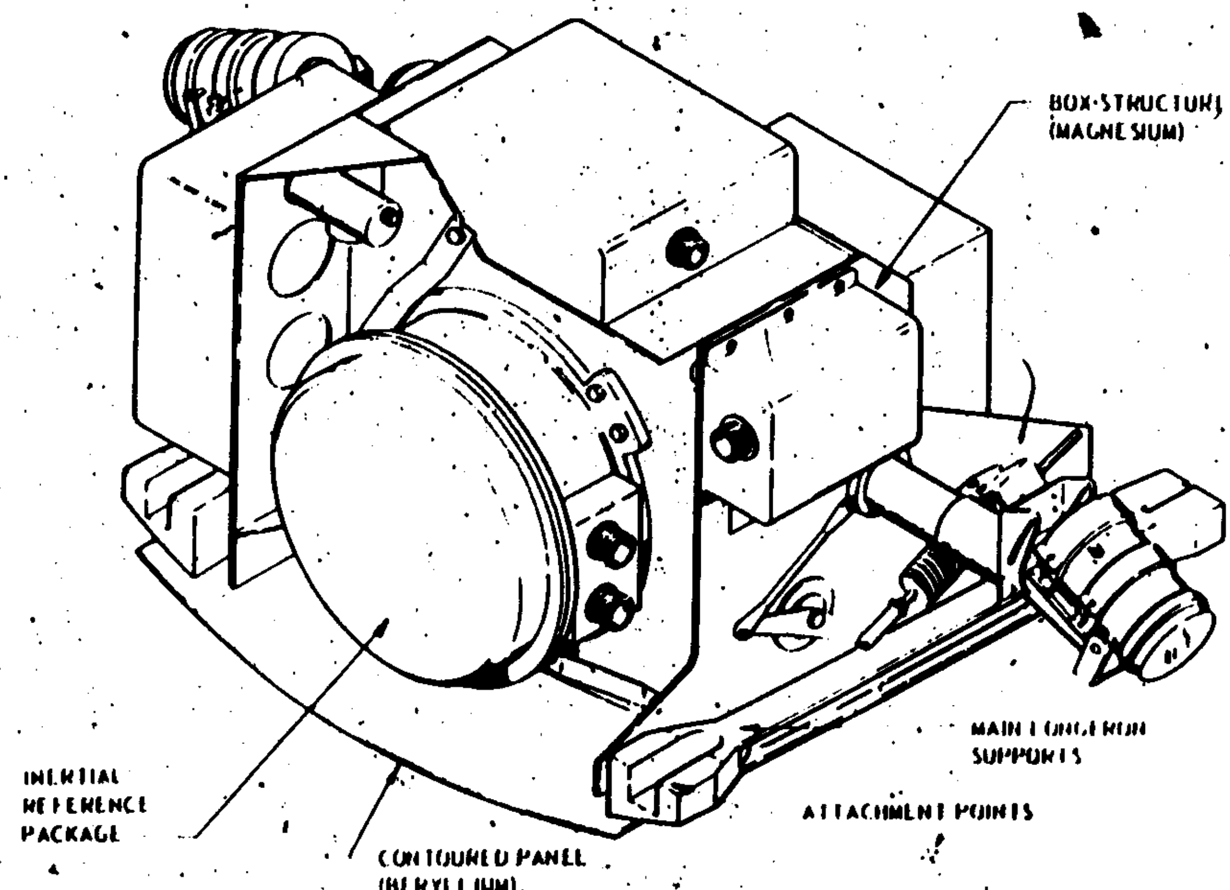


Figure B-13 Guidance Module

The Barnes Mod IIC infrared horizon sensor (H/S), the second attitude sensing component of the guidance system, consists of two sensors and a signal mixer. Each sensor head scans the space below the vehicle, detects the discontinuity in the infrared (IR) radiation between earth and space, and generates a corresponding output signal (Figure B-14). The signal mixer analyzes these two signals and develops a pitch attitude error signal and a roll attitude error signal whenever the vertical axis of the vehicle does not intersect the center of the earth.

A circuit in the mixer unit minimizes the effect of "cold" clouds which have tended to cause erroneous signals in earlier horizon sensors. If the horizon sensor sees a full sun in space or on the horizon, the signal generated will be the same as that of space. A spurious-signal detector circuit will inhibit the H/S head signal if the horizon sensor field-of-view grazes the sun in space.

The Agena is generally programmed to start the engine in a slightly nose-up condition during first burn. This is done to ensure an optimum trajectory in the event of minimum boost apogee.

B-5.1.3 BTL Steering Commands

At booster engine ignition and as the vehicle lifts off the launch pad, Western Electric Company (BTL ground station) transmits RF (radio frequency) steering commands to assure proper attitude during ascent and injection into orbit. These commands are divided into two categories: commands to the Thorad booster and commands to the Agena satellite upon separation from the booster. This program uses the commands to "guide" the vehicle into the desired orbit, rather than engine re-start and a second burn. The BTL steering commands actuate relays within the BTL canister to provide 400 Hz alternating current to the torquing amplifier and demodulator associated with the pitch and yaw IRP channels. The

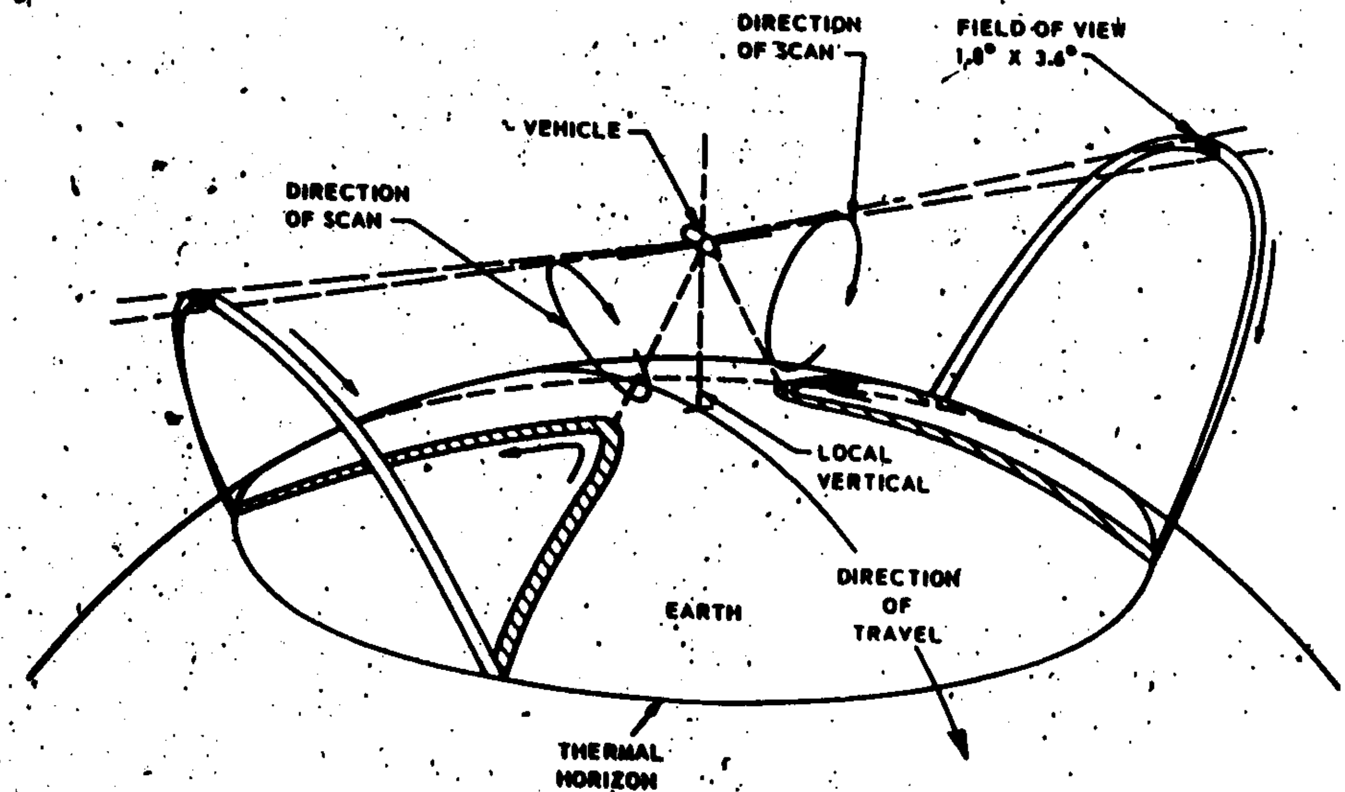


Figure B-14 Sensor Head Scanning Paths

phasing of the 400 Hz signal determines the pitch up, pitch down, yaw left, and yaw right responses. The rate of response is 2 degrees per second, which provides fine adjustments to the preprogrammed rates and times supplied by the primary (ascent) timer.

B-5.1.4 Velocity Meter

The velocity meter is one of the major sensing elements of the guidance system. Its purpose is to terminate the thrust of the rocket engine after the vehicle has increased its velocity by a predetermined increment. The velocity meter does not measure velocity; instead, it measures acceleration (change in velocity) and integrates this quantity to determine velocity.

The Bell Aerospace Corporation velocity meter consists of a pulse-output accelerometer and a pulse counter. The accelerometer senses acceleration along its sensitive axis and produces output pulses at a rate that is proportional to the second acceleration. The pulse counter counts these output pulses and energizes the thrust termination circuit when the total count reaches the preselected binary number that has been set into the counter.

B-5.1.5 Sun Detector Assembly

A horizon sensor head inhibit device may be required to minimize the effect of the sun on the horizon sensor system. The sun detector assembly consists of a cadmium-selenium detector, transistors, resistors, a relay, and a potentiometer - all enclosed in a cylindrical body. The field-of-view of the detector extends two degrees on either side of the horizon sensor field-of-view. Thus, it "sees" the sun just before the horizon sensor does and disables the head just before the sun enters the sensor's field-of-view. The device removes the horizon sensor roll output from the IRP roll gyro and grounds the gyro torque input line during the inhibiting period.

B-5.1.6 Guidance Junction Box

The guidance J-box provides a distribution center for the signals and voltages entering and leaving the guidance module. It also functions as a central point for routing signals between the various components within the guidance module. In general, it is made up of relays and terminal boards mounted in a single chassis.

B-5.2 Flight Control System Equipment

The flight control system controls the vehicle attitude and direction of flight. Elements of the control system displace the vehicle about its three axes in response to signals from the IRP. The flight control equipment consists of a flight control electronic unit, a pneumatic control system, a hydraulic control system, and a flight control junction box.

B-5.2.1 Flight Control Electronic Unit

The flight control electronic unit processes the attitude error signals from the IRP and distributes them to the control system. Processing consists of modifying and amplifying the signals and directing them through five electronic channels to actuate the pitch, roll, and yaw mechanisms of the hydraulic control systems. The gas thrust valves are connected in pairs to the roll and yaw pneumatic channels, whereas the pitch pneumatic channel gas thrust valves are connected independently. Each hydraulic actuator is controlled through a single hydraulic channel.

B-5.2.2 Pneumatic Control System (Primary)

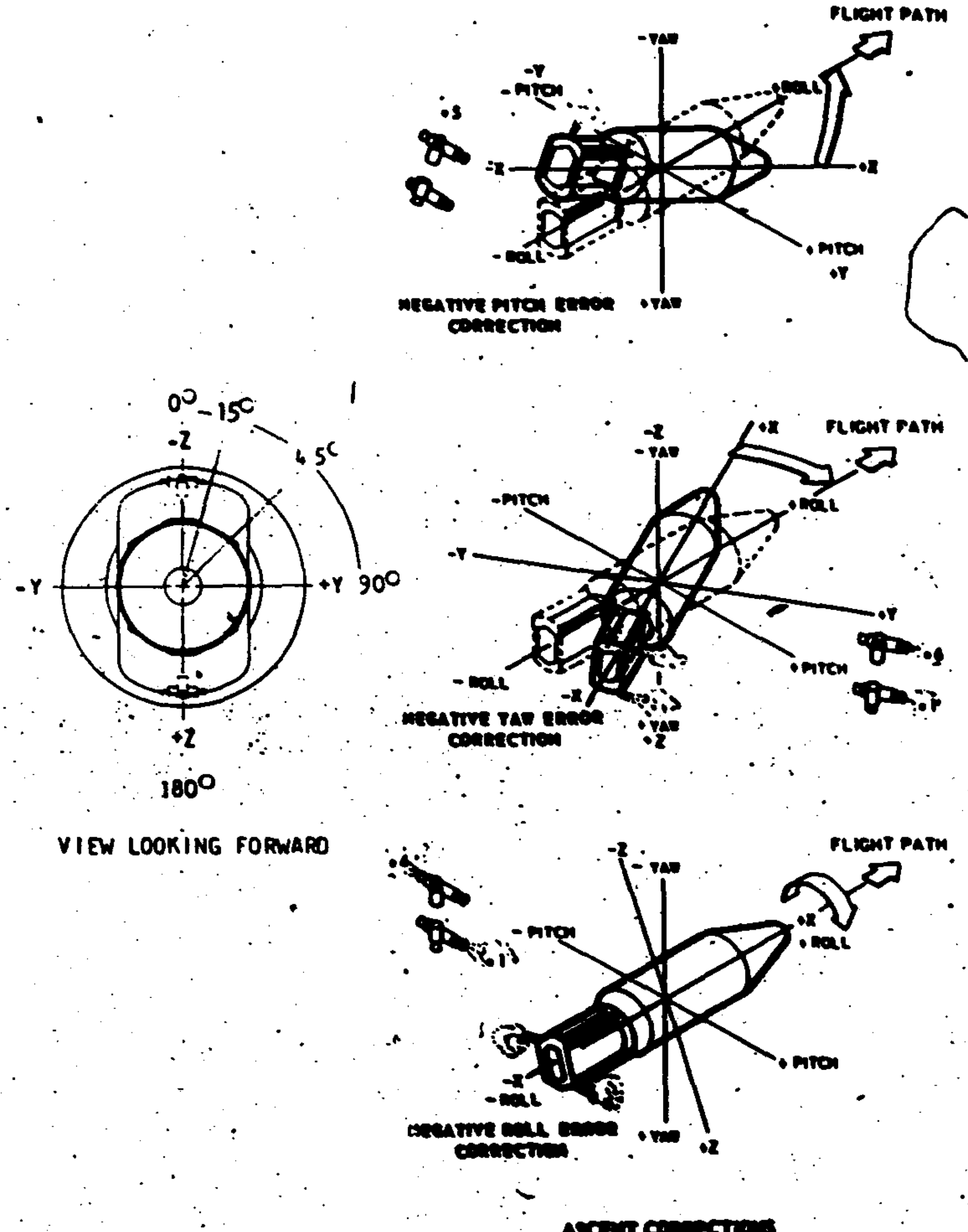
The pneumatic control system exerts control forces on the vehicle by release of cold gas through thrust valves (attitude control, etc.) to produce three-axis corrective torques. The system consists of six thrust valves in two clusters, a pneumatic regulator, and a 2200 cu. in. control gas storage sphere. The location of the pneumatic system hardware and the thrust valves required for correcting various attitude errors are depicted in Figure B-15. The thrust valve cluster nozzles provide a thrust of ten pounds when in the high-pressure mode (100 psia), and a thrust of one-half pound when in the low-pressure mode (5 psia). The high-pressure mode is normally used during ascent and recovery portions of the flight, while the low-pressure mode is used during the orbit phase of the mission. The pneumatic control gas consists of a mixture of nitrogen and Freon, normally. The percentage of mixture is flight-peculiar and dependent upon mission requirements. Different mixtures provide different densities, loaded weight, specific impulse, and total available impulse.

The pneumatic system is activated at booster/Agena separation, and provides pitch, yaw, and roll (high gain) attitude control during the coast phase. At Agena ignition, the pneumatic system continues to provide roll control, but the pitch and yaw controls are transferred to the hydraulic control system. At engine shutdown the pitch and yaw control is returned to the pneumatic system.

For orbital missions the IRP, horizon sensor, and gas jets can be used to provide active attitude control as described above. Pitch, yaw, and roll attitude is maintained in the low-pressure mode (low gain) during orbit.

B-5.2.3 Pneumatic Control System (Lifeboat)

In the event of failure by the primary pneumatic control system, the Lifeboat (LB) pneumatic control system may be utilized to provide a successful recovery and prevent the mission from being a failure. The Lifeboat pneumatic system is a unique and separate system completely isolated from the primary system. The



ANGULAR REFERENCE DESIGNATIONS:
THE ANGULAR REFERENCE SYSTEM PROVIDES A CLOCKWISE, 360 DEGREE ORIENTATION ABOUT THE X AXIS. COUPLED WITH A FORE AND AFT STATION, THIS SYSTEM CAN LOCATE ANY EQUIPMENT OR ATTACHMENT.

Figure B-15 Pneumatic Flight Control System pneumatic control system exerts control forces on the vehicle by release of cold gas through the LB thrust valves to produce corrective torques which align the vehicle with the magnetic fields of the earth. The system consists of six separate thrust valves, a pneumatic regulator, and a 900 cu. in. gas storage sphere. The location of the pneumatic system hardware and the thrust valves required for correcting various attitude errors and roll rates are depicted in Figure B-16. The gas mixture normally used in the primary pneumatic system is also used in the Lifeboat pneumatics system. This gas mixture is normally a trade-off between the mixture density, loaded weight, specific impulse, and total available impulse, and is vehicle-peculiar for each flight.

The Lifeboat pneumatic system is normally isolated by means of a solenoid operated valve, and is activated only by the Lifeboat electronic timer in the event of failure of the primary pneumatic system (see Figure B-17).

B-5.2.4 Hydraulic Control System

The hydraulic control system guides the vehicle during periods of engine operation (see Figure B-18). Directional control in pitch and yaw is accomplished by gimballing the rocket engine thrust chamber by means of hydraulic actuators controlled from the flight control electronic unit. Hydraulic power for the actuators is supplied from a hydraulic power package driven by high-pressure UDMH.

B-5.2.5 Flight Control Junction Box

The flight control junction box with its integral flight control patch panel is the principal junction point for distribution of electrical signals within the guidance and control system. The flight control patch panel provides the means of varying the interconnection

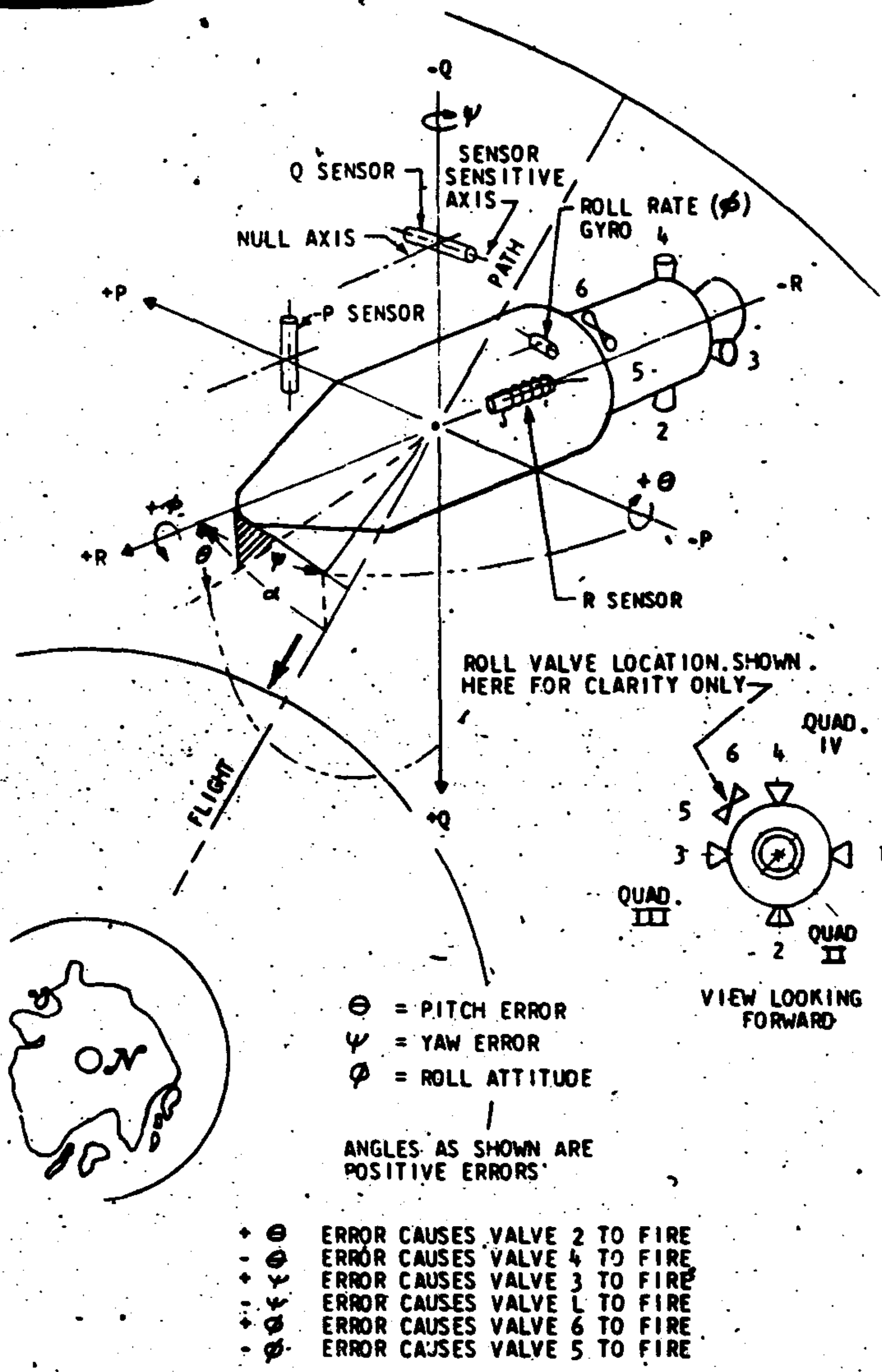


Figure B-18 Attitude Control Sign and Nomenclature Convention

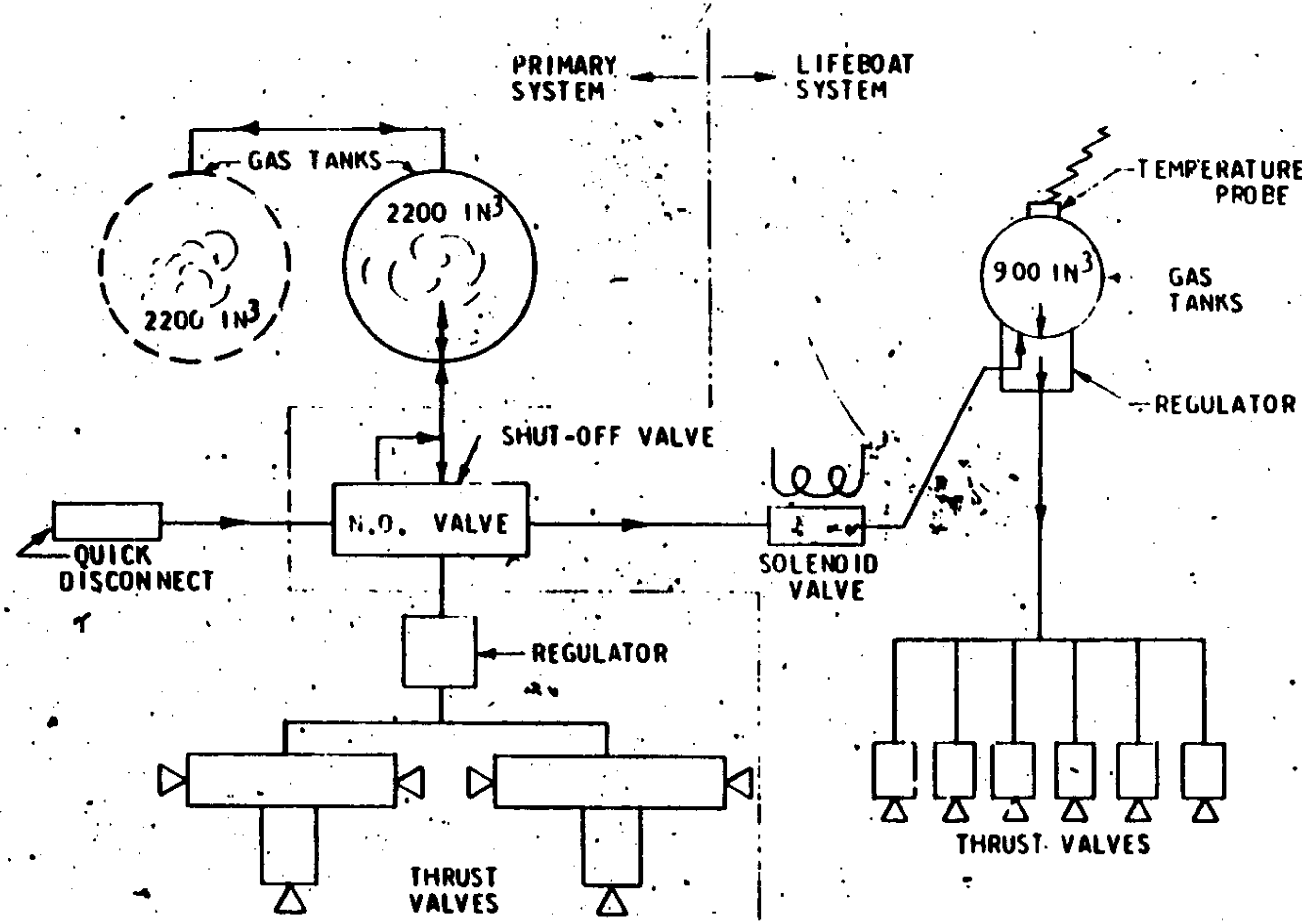


Figure B-17 Primary and Lifeboat Pneumatic Systems

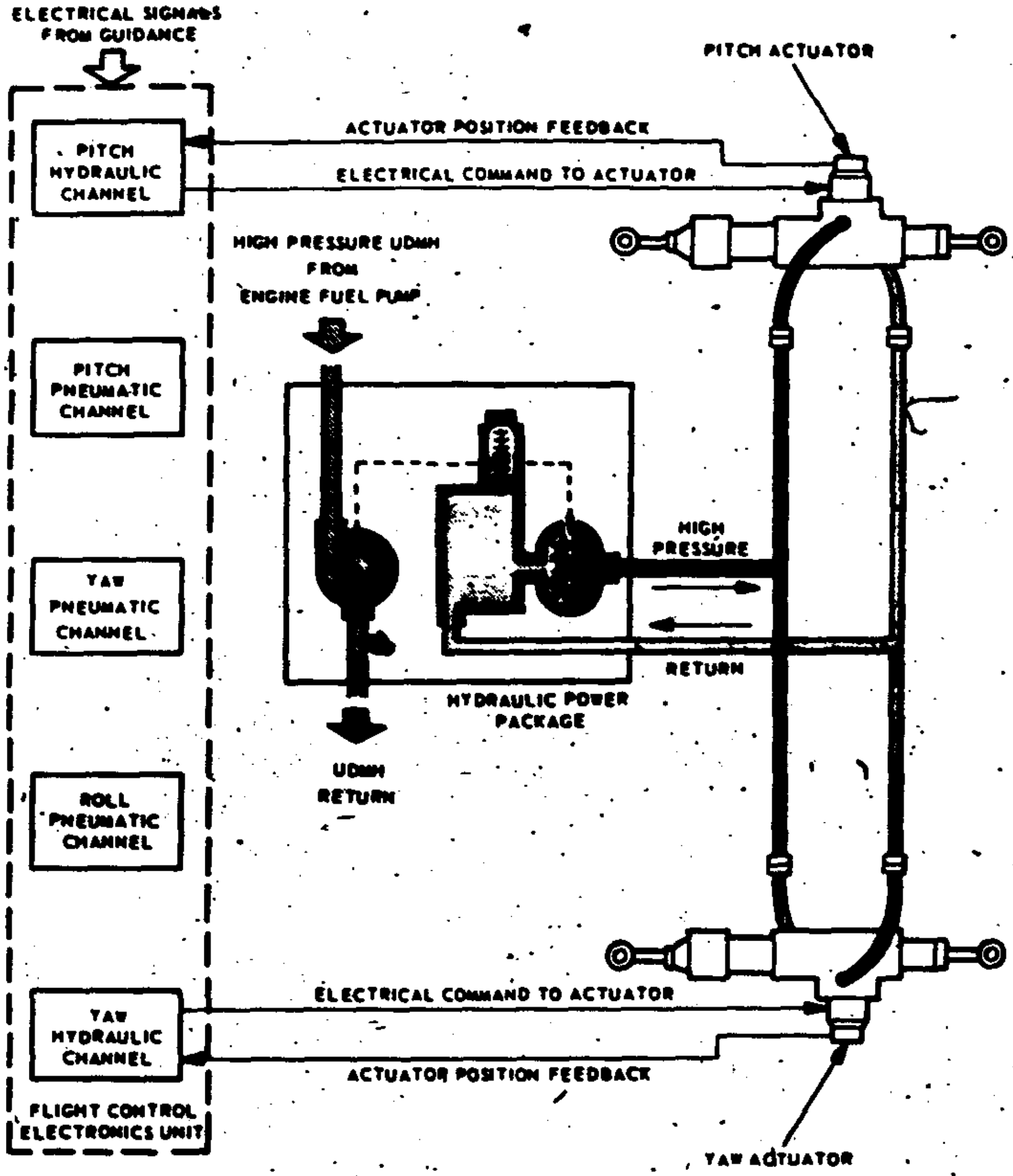


Figure B-18 Hydraulic Flight Control System of the guidance module, flight control electronics unit, sequence timer, payload and program-peculiar functions, telemetry, umbilical, and vehicle test points.

B-5.3 . Flight Programming Equipment (Ascent Sequence Timer)

Flight event programming necessary to accomplish the Agena/ascent phase of the mission is provided by the primary sequence timer.

The timer consists of 72 switches (10 amp resistive contact rating) arranged in 12 discrete switch banks consisting of six switches; and are subdivided into groups ranging from two to four switches each. With this arrangement, 24 separate events may be programmed. The majority of the switches are used by the Agena itself. Approximately one-third of the switches are brought to the flight control patch panel and utilized for variable mission functions.

The sequence timer furnishes the Agena with switch closures, +28VDC, or 28V return commands and pyrotechnic power to initiate pyrotechnic functions. The timer accuracy is a function of power supply frequency, accuracy, and running time.

B-5.4 Optional Guidance Equipment Kits

Optional kits which are applicable to the guidance and control system are described in the following paragraphs.

B-5.4.1 Flight Control Patch Panel Kit

This kit is required by this program to replace the basic vehicle test patch panel installed in the flight control J-box. Wiring of the patch panel is a using program responsibility. Installation of the programmed flight control patch panel provides program-peculiar guidance and control-signal distribution and power-control routing points, plus routing vehicle command functions.

B-5.4.2 Auxiliary Nitrogen Tank Kit

The auxiliary nitrogen tank kit is used to install a 2200 cubic inch capacity high-pressure sphere in the aft equipment support structure. The auxiliary tank was necessary to provide additional control gas due to the extended mission requirements. A temperature sensor is supplied for measuring gas temperature. When used in conjunction with an existing pressure transducer, it furnishes the capability for telemetering accurate information on the gas consumption.

With the flight requirements for a low-altitude (perigee) mission, the drag due to the atmosphere has increased considerably. To compensate for this, a drag make-up system (DMU) which consists of a maximum of twelve rockets and a nominal number of nine, are installed on each vehicle. (See Figure B-2) With the firing of each of these rockets, a change in the height of perigee and the angle of the argument of perigee results. This requires a restabilization of the vehicle and, of course, a quantity of control gas is used. To provide for the increased consumption of gas, a third (2200 cubic inch) auxiliary nitrogen sphere has been added. A temperature sensor and pressure transducer provide telemetry monitoring of the gas during flight.

B-5.4.3 BTL Adapter Kit

The BTL adapter kit is required to accommodate installation of the Bell Telephone Laboratory (BTL) command guidance system in the Agena D. The kit consists essentially of the BTL skin, UHF traveling wave slot antennas (ventral and dorsal), wire harnesses, BTL umbilical door, BTL control package, ventral and dorsal fairings, fairing covers, and necessary mounting hardware. The BTL-600 guidance canister which contains the integrated command receiver, transponder circuits, and associated equipment, are Government-Furnished Equipment (GFE) and not part of this kit.

During early stages of ascent, BTL commands are transmitted to the vehicle via the dorsal antenna. After pitchover, the commands are transmitted to the vehicle via the ventral antenna. In order to optimize the ascent trajectory for a low-angle pitch-over, it is necessary to optimize reception of the BTL commands. To minimize interference pattern between the two BTL antennas during the later stages of ascent, a controllable attenuator is installed in the wave guide of the BTL dorsal antenna. The attenuation is controlled by a BTL discrete command.

The Agena-installed BTL radio command system is used to provide the Agena with increased accuracy during ascent and injection into orbit. By controlling the vehicle into the desired orbit, this eliminates any requirement for a second burn to correct orbit anomaly. The BTL system also provides discrete commands in addition to the steering commands. This is in conjunction with the ascent timer of the Agena.

D

B-6.0 ELECTRICAL SUBSYSTEM

B-6.1 General

The electrical subsystem comprises two major categories of equipment - one providing unregulated and pyro power and its distribution, and the other providing destruct capability.

B-6.1.1 Electrical Power System

The electrical power system (EPS) furnishes power at the voltage levels and frequencies required by the associated vehicle subsystems and using program equipment for a time period consistent with the vehicle mission duration. The Agena power system is made up of power source components, power conversion components, and power control and distribution components. The power source components consist of primary batteries to supply the initial source of energy to the power equipment and other system components, as well as secondary batteries to supply power to the destruct system. The power conversion components consist of the Type XIIA, 400-Hz, 115VAC, three-phase inverter and the Type IXA and Type X ± 28V DC-DC converters. Internal vehicle power is controlled by the main power transfer switch, which is capable of transferring from AGE external power during test to internal vehicle power. Power control and distribution components consist of switches to transfer between power units, command or programmed switches, and wiring harnesses for distribution of electrical energy to the system components.

B-6.1.2 Destruct System Power

The basic Agena may be destroyed by means of the self-destruct system during the ascent phase, liftoff to just prior to booster/Agena separation, in the event that hazardous flight conditions occur. The destruct initiators are provided power by two Type VIA secondary batteries. These batteries provide a terminal voltage of 7.5 volts minimum with no load, and are normally installed in the Agena during the countdown on launch day.

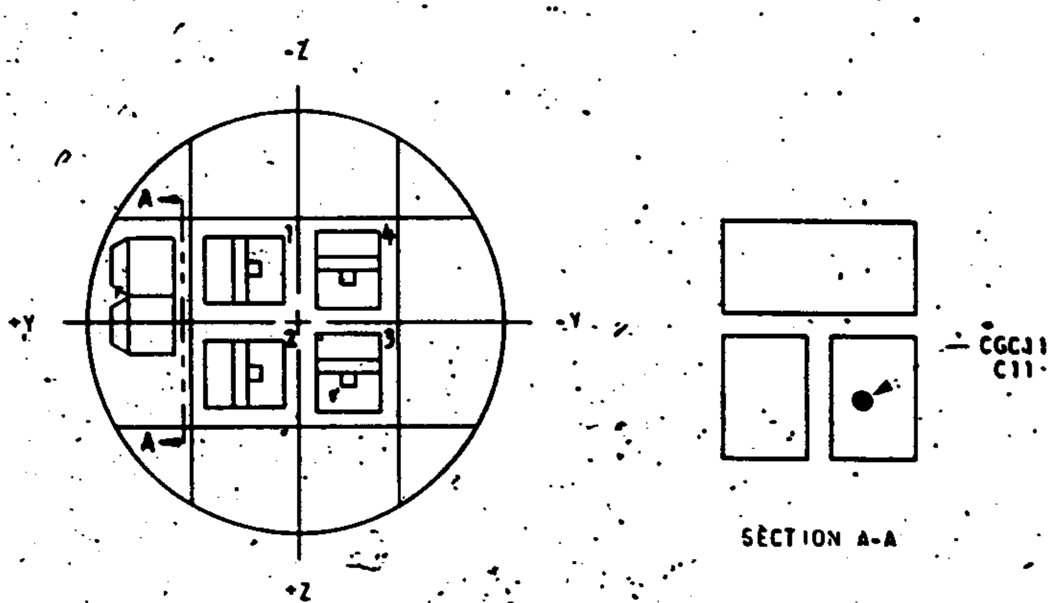
B-6.2 Basic Vehicle Electrical Hardware

The basic Agena electrical hardware makes up the basic power system and the electrical portion of the destruct system. Capabilities of these systems may be supplemented or altered by the addition of optional and peculiar hardware.

B-6.2.1 Basic Vehicle Power System

The main battery system of the standard Agena provides

Table B-1 Typical Battery Configuration



BATTERY LOCATION	BATT. TYPE	FLIGHT TEMP. MEAS.NO.	AGE TEMP. MEAS.NO.	BATT. REF. NO.	PLUG NO.	CURRENT SENSOR MEAS.NO.
QUAD.I AG-D UPPER	1H	C10	CGC10	1	AC7P1X	C289
QUAD.I & II AG-D LOWER	VI	C11	CGC11	FWD #2	C79P2X	C290
	VI			AFT #7	C79P3X	
QUAD.II	1H	C12	CGC12	3	1C5P1X	C291
QUAD.III	1H	C13	CGC13	4	2C8P1X	C292
QUAD.IV PYRO	1H	C14	CGC14	5	3C8P1X	C293
QUAD. I PYRO	1H	C15	CGC15?	6,	4C8P1X	C294

for a component input unregulated voltage ranging between 22.5 to 29.25 VDC. The amount of available electrical power depends upon the type and number of batteries selected by the using program. A typical installation showing the types of batteries and the quadrant in which they are installed is shown in Table B-1. The power distribution system is shown in Figures B-19 and B-20.

The secondary battery system provides power for the destruct systems. Two Type VIA secondary batteries provide the necessary power for the basic self-destruct system. They are installed in the booster adapter assembly.

Table B-2 lists the nominal battery power required during the period from Agena liftoff through engine burn; earth-orbit injection for a representative one-hour duration ascent mission.

Table B-2 Nominal Agena Power Requirements

SUBSYSTEM	PEAK WATTS	AVERAGE WATTS
B (PROPULSION)	500	6
D (GUIDANCE & CONTROL)	364	313
C & C (TELEMETRY)	129	116
SYSTEM LOSSES	108	95
TOTAL	1,101	530

B-6.2.2 Power Source Hardware

Primary batteries furnish the power required by the associated vehicle subsystem for the time periods consistent with the vehicle mission. Secondary batteries furnish the power required for the destruct system.

The primary batteries are not part of the basic Agena, but must be provided by the using program. Provisions are made, however, for installing Type 1C, Type 1D, Type 1H, or Type VI

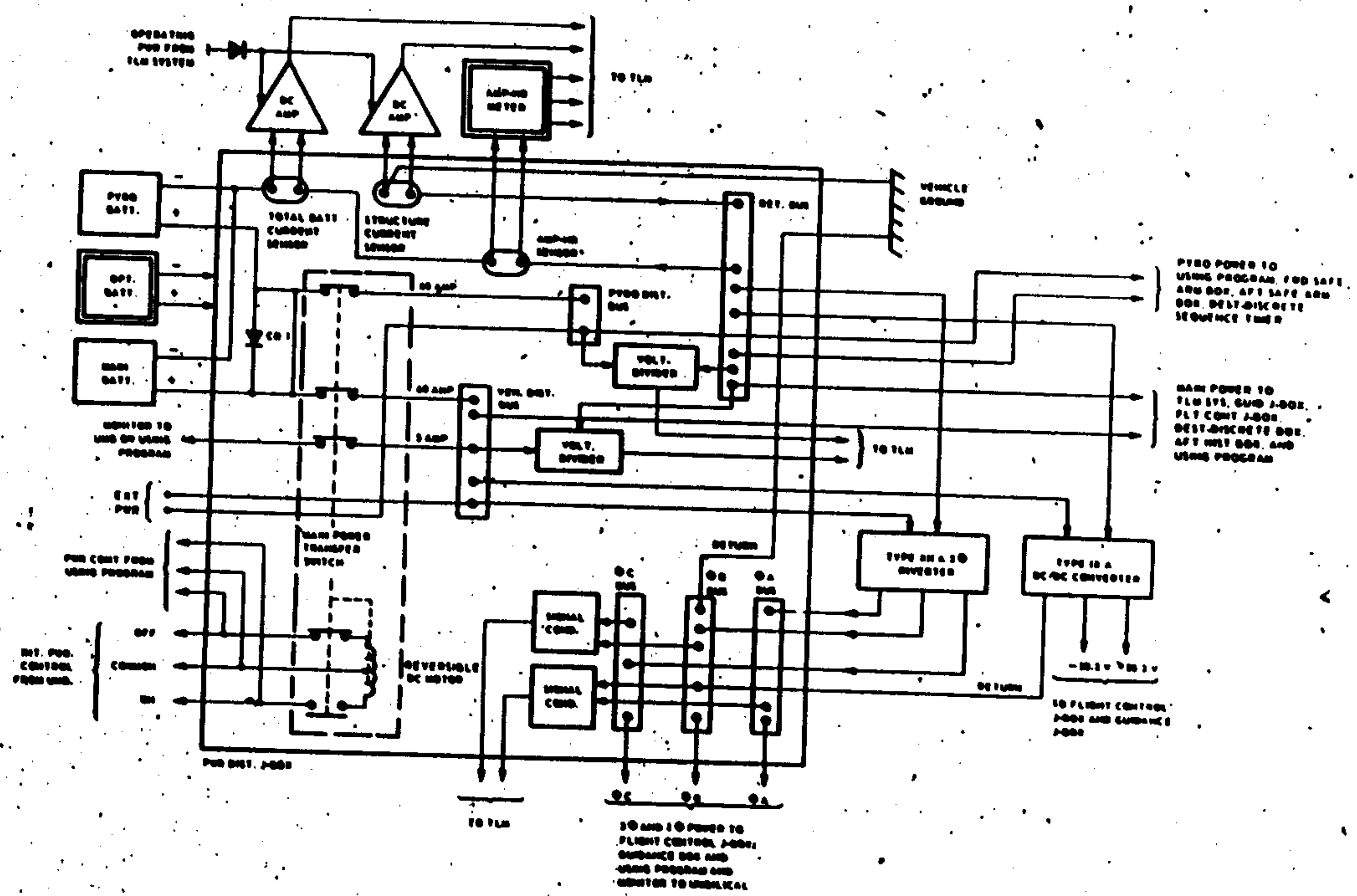


Figure B-19 Power Distribution System

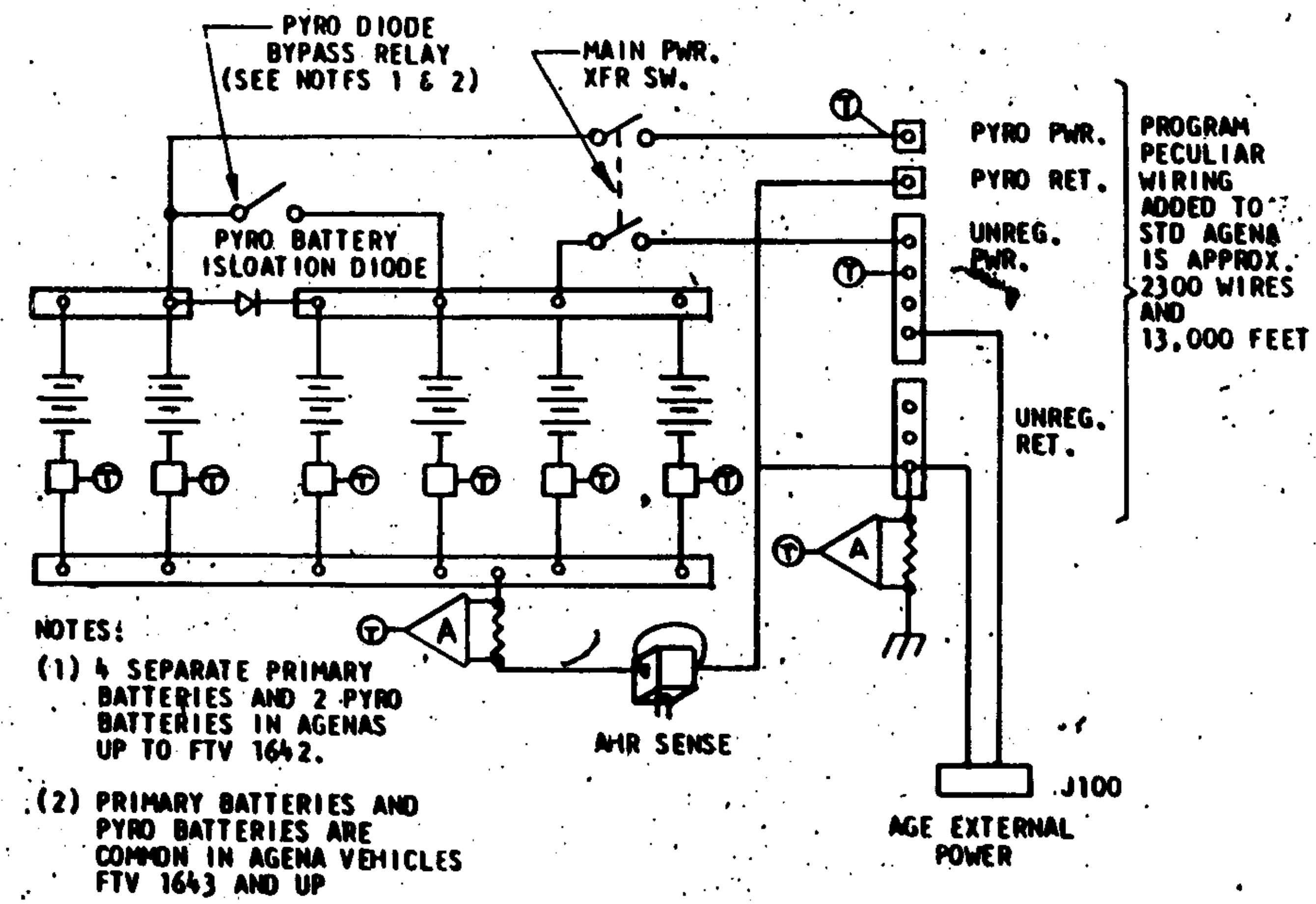


Figure B-20 Basic Power Distribution

primary batteries by utilizing available optional kits. The selection of the type and number of batteries used for each Agena mission is dictated by the power requirements of the using program. Battery parameters are shown in Table B-5.

A pair of Type VIA secondary batteries are used in the basic Agena self-destruct system.

B-6.2.3 Power Conversion Hardware

The Agena power conversion equipment consists of a Type XIIA three-phase inverter and Type IXA and Type X DC-DC converters. The inverter is mounted in the power module in the Agena forward section and the Type X converter on the guidance module. Though the inverter output is available at a connector on the power distribution box for program use, care must be exercised to avoid interference with the operation of the Agena Guidance and Control subsystem.

The inverter provides 115 VAC (rms), 400 Hz, three-phase power with Phase AB used as a source of single-phase power. The output is delta-connected with point B of Phase AB grounded external to the inverter. The input may range from 22 to 29.3 VDC. The load power factor should be maintained between the limits of 0.8 lagging to 0.95 leading on each phase. The maximum load on any single phase is 100 volt-amperes for phase AB and BC and 60 volt-amperes for phase CA.

The Type IX DC-DC converter is designed to provide a $\pm$ 28.3 VDC output with input voltage ranging from 22 to 29.25 VDC. The converter has an output capability of 60 watts (plus) and 20 watts (minus).

B-6.2.4 Power Distribution

The power distribution J-box is the functional center of the electrical power system. The box is the principal distribution point for unregulated dc power, pyrotechnical power, and single- and three-phase ac power.

The signal conditioners required for monitoring the vehicle electrical power system are located within or are attached to the J-box, except for the +28 VDC monitor which is in the guidance J-box. The external/internal power transfer switch is located in the power distribution J-box. Vehicle wiring and electrical connectors provide the interconnection between electrical components.

The transfer switch used to switch Agena power from external (AGE) power to internal power is a reversible, motor-actuated switch. Two of the three pole contacts are capable of handling a continuous 60 amperes resistive load, and the other contact 5 amperes. One of the 60-ampere contacts is used to switch pyrotechnic power to the pyro distribution bus, and the other switches the battery power to the main electrical vehicle bus. (See Figure B-19)

B-6.2.5 Destruct Discrete Box

The destruct discrete box consists of relays, fusistors, diodes, and electrical wiring. Four relays (latching type) are part of the self-destruct system. Their primary function is to enable/disable the destruct system. Five relays are used in the booster/Agena separation circuit, and one relay provides +28 volts to actuate the Uncage Gyro relays and Horizon Sensor Fairing Eject relays. The 28 V ground return for the relays energized by the booster-furnished power is isolated from the Agena ground return. Two relays are available for program use. Four fusistors with a nominal impedance of 1.8 ohms are used in the booster/Agena separation pyrotechnic circuits. The destruct/discrete box is located in the booster adapter.

B-6.2.6 Pyrotechnical Electrical Hardware

The basic pyrotechnic electrical hardware consists of an Internal/External Transfer switch, aft and forward Safe-Arm J-boxes, Safe and Arm connectors, and pyrotechnic wire harnesses. Except for the booster/Agena separation and horizon sensor fairing eject functions, the pyro signals are programmed by the guidance and control sequence timer. The timer also serves as a backup for the booster/Agena separation and horizon sensor fairing ejection functions which are commanded through the booster (BTL) discretes.

The pyro electrical power is applied to the primary pyro distribution bus (located within the power distribution box) whenever the transfer switch is in the internal power (battery) mode. The pyro +28 VDC power is distributed to the sequence timer, forward Safe-Arm box, aft Safe-Arm box, and to the Destruct/Discrete box.

The forward and aft Safe-Arm boxes contain relays and fusistors. A Safe-Arm receptacle is installed on each of the boxes which is mounted on the Agena in a manner that facilitates mating of the safe or arm connectors. The receptacles also provide access to the pyro circuits and are used for checking and verifying the system. This program requires that arm plugs be installed at Sunnyvale and never removed prior to launch. Future modifications will eliminate any requirement for arm plugs, and wiring will be straight through.

B-6.2.7 Basic Vehicle Destruct System

The basic Agena destruct system is a self-destruct system which provides destruct capability during the ascent phase, liftoff through just prior to booster/Agena separation. It consists of two Type VIA secondary batteries, a junction box, an initiator, two premature separation switches, and wiring harnesses. These items are installed in the booster adapter.

The system functions by firing a shaped charge that ruptures both the Agena oxidizer and fuel tanks. The resultant mixing of hypergolic propellant destroys the vehicle. The self-destruct system operates from batteries that are independent of the primary batteries of the vehicle.

The operation of the self-destruct system is initiated in one of two ways:

a. The Range Safety Officer initiates an RF (radio frequency) command signal to the booster command destruct system.

b. Initiation is mechanically switched by an untimely (premature) separation of the Agena from the booster vehicle.

B-6.3 Optional Electrical Hardware

Optional Agena electrical power system hardware includes the following: primary and secondary batteries, battery adapter kits, current monitoring equipment, and a command destruct kit used in lieu of the basic self-destruct system.

B-6.3.1 Power Source Options

Primary batteries are available to furnish power to the Agena and payload. Space provisions are provided on the aft equipment support structure, which may be used for the installation of additional batteries by the using program.

The primary batteries contain positive electrodes of zinc, and use potassium hydroxide as the electrolyte. They have high-energy ratings and are not rechargeable. The secondary batteries contain positive electrodes of nickel hydroxide, negative electrodes of cadmium hydroxide, and use potassium hydroxide as the electrolyte.

 [redacted]

B-6.4 Agena/J-3 Payload Electrical Interface

B-6.4.1 Electrical Connectors

The Agena/Payload electrical interface consists of six connectors, as shown in Tables B-3 and B-4. Connector AP1 is used primarily as a test-point connector during ground tests. It is used in flight for the yaw signal voltage and return to cross the interface. From the AP1 connector, this signal goes to the OSFG (orbital sine function generator) connector on the Agena side of the interface. Accelerometer data from the payload are also wired through AP1 to the Link IV Kit for the first four (4) J-3 development payloads.

Table B-3 Interface Connectors

CONN. NO.	CONNECTOR NAME	CONNECTOR TYPE (AGENA SIDE)
AP19X	AP AUXILIARY CONNECTOR	LS 8436 AR 2255 SW
AP20X	AP PYRO CONNECTOR	LS 8496 AR 1811 SS
AP21X	AP PYRO COMMAND CONNECTOR	LS 8496 AR 2221 SW
AP22X	AP POWER CONNECTOR	LS 8496 AR 2221 SS
AP23X	AP COMMAND CONNECTOR	LS 8496 AR 2255 SS
AP24X	AP TELEMETRY CONNECTOR	LS 8496 AR 2255 PS
AP1	AP VIBRATION MONITOR & TELEMETRY CONNECTOR	LS 8496 AR 2255 PW

Table B-4 Special-Purpose Connector

CONN. NO.	CONNECTOR NAME	CONNECTOR TYPE
DIP41	OSFG CONNECTOR	DTK 06-10-6 PW

NOTE: THE OSFG CONNECTOR CARRIES YAW VOLTAGE FROM THE API TEST CONNECTOR TO THE IRP ON THE AGENA SIDE OF THE INTERFACE. IT IS ADJACENT TO THE INTERFACE ON THE AGENA SIDE, BUT IS NOT USUALLY CONNECTED TO THE CIRCUITS IN THE TEST CONNECTOR CARRYING THE YAW VOLTAGE FROM THE ORBITAL SINE FUNCTION GENERATOR (OSFG) UNTIL THE J-3 PAYLOAD IS MATED TO THE AGENA FOR LAUNCH. IT IS AN AUXILIARY CIRCUIT, NOT DIRECTLY A PART OF THE INTERFACE.

B-6.4.2 Type and Source of Interface Power

B-6.4.2.1 Primary Power (See Figure B-17)

Primary unregulated power consists of groupings of Type 1-C, 1-D, 1-H, and Type VI batteries. Figure B-20 and Table B-5, below, describe the characteristics of each type battery.

Table B-5 Battery Parameters

BATTERY	CELLS	WEIGHT	NOMINAL NO LOAD VOLTAGE (1.8 V/CELL)	CAPACITY WATT/HRS. @ 24.3 V	@ 70 F AMP/HRS. @24.3 V	NOMINAL EFFICIENCY (WATT HRS/LB)
TYPE 1-C	16	117 LBS	28.8	11,950	491.8	102.0
TYPE 1-D	16	107 LBS	28.8	9,060	372.0	84.5
TYPE 1-H	16	124 LBS	28.8	12,925	531.6	105.0
TYPE VI	17	26 LBS	30.6	1,955	80.45	75.1

PERMISSIBLE VOLTAGE RANGE, PRIMARY UNREGULATED POWER BUS, AND PYRO POWER BUS AT SPECIFIED INTERFACES:

SOURCE	AGENA DISTRIBUTION INTERFACE	PAYLOAD/AGENA INTERFACE
PRIMARY	22.5 TO 29.25	22.0 TO 29.5
PYRO	22.0 TO 29.25	22.0 TO 29.5

B-6.4.2.2 Pyro Power

The pyro power source illustrated in Figure B-20, utilizes two of the same types of batteries (Types 1-C or 1-H) as are used for the primary power source on the main unregulated power bus for FTV's up through 1642. For FTV's 1643 and up, the separate pyro battery will be eliminated and all six batteries will supply both pyro and main power buses in common.

The permissible voltage limits at the interface under full pyro loads are described for two blocks of Agena vehicles in Table B-6, below.

Table B-6 Voltage Limits

FTV SERIES	SOURCE	PAYLOAD/AGENA INTERFACE VOLTAGE
BELOW FTV 1643	SEPARATE PYRO BATTERY	14.0 TO 29.5 VDC
FTV 1643 & UP	COMBINED PYRO & MAIN BATTERIES	14.0 TO 29.5 VDC

The Agenas used for J-1 and the early J-3 systems have a separate set of pyro batteries which are diode-isolated, but have the capability to be made common with the unregulated bus by command closure of a relay. Originally, the batteries were isolated to prevent transients on the unregulated power bus during pyro operation, and to isolate the pyro batteries from the main power bus in the event of a short circuit in the pyro subsystem. It also provides an index point to measure power consumption during orbital operations (Figure B-21).

In later J-3 systems, on FTV's 1643 and up, compatibility tests indicate that the diode may be safely eliminated, and all Agena batteries will be common to both the primary power bus and the pyro bus under the revised Agena design criteria.

B-6.4.2.3 Regulated +28 VDC and -28 VDC Power

The +28 VDC and -28 VDC (nominal) regulated power

[redacted]

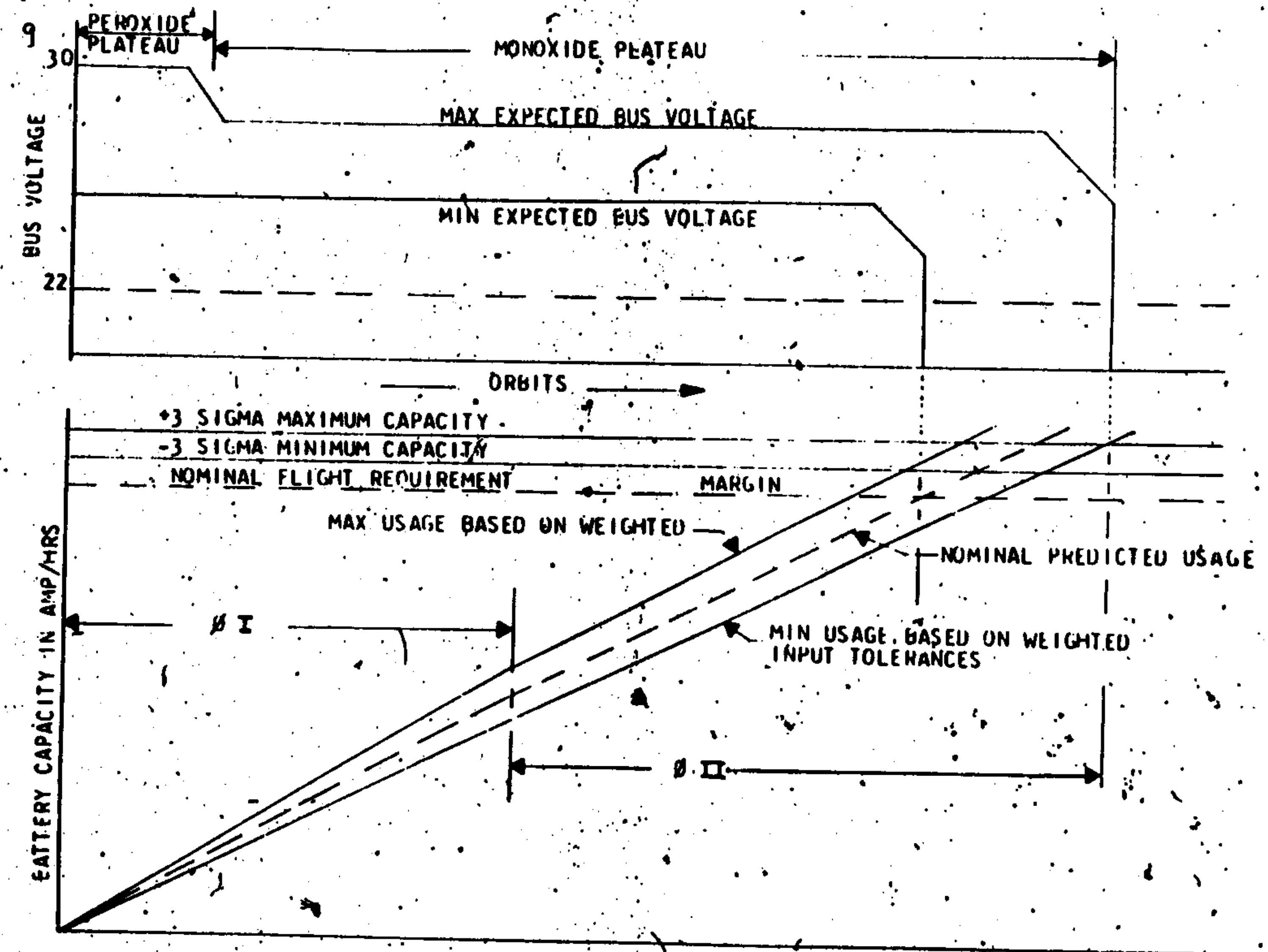


Figure B-21 Typical Flight Predict Curves

[redacted]

generated by the Agena Type X DC/DC converter is not used in J-3 payloads. J-3 systems convert unregulated primary battery power to regulated DC voltages internally where necessary.

B-6.4.2.4 115 VAC, 3-Phase, 400 Hz Power in J-3

The Agena Type XIIA inverter changes raw battery power (22 to 29.5 VDC) to 115V, 3-phase, 400 Hz alternating current. The vehicle distribution bus provides a steady-state voltage of 112.7 to 117.3 volts rms.

a. Phase AB (IRP gyro reference voltage) is routed to the J-3 payload system for use in the orbital sine function generator (OSFG), where it is conditioned and returned to the Agena. The amplitude of the returned signal controls the Agena yaw displacement.

b. Phase BC also crosses the J-3 interface for use in the CR instrument subsystem.

B-6.4.2.5 Power Supply Characteristics

Table B-7 below, describes the principal features of the Agena power supply requirements.

Table B-7 AC and Regulated DC Power Limitations

POWER SUPPLY	POWER CAPABILITY
TYPE X (+28 VDC)	350 WATTS - 12.3 AMPS
TYPE X (-28 VDC)	15 WATTS - 0.5 AMP
TYPE XII A	120 WATTS CONTINUOUS, 200 WATTS INTERMITTENT
Ø AB	100 WATTS - .87 AMP
Ø BC	100 WATTS - .87 AMP
Ø CA	60 WATTS - .52 AMP

Type XII A Performance Requirements

Waveform distortion:	5 percent maximum
Frequency variation:	399.92 to 400.08 Hz
Maximum envelope modulation:	.7V (peak-to-peak)

B-6.4.3 Load Characteristics of J-3

B-6.4.3.1 For power requirements, see Section M.

B-6.4.3.2 Load Impedance

A/P subsystem loads on the Agena unregulated DC bus are linear and generally noise-free. A/P subsystem loads on the Agena 3-phase, 115 VAC bus have power factors not less than 80 percent lagging, or more than 95 percent leading. No unsymmetrical half-wave loads are applied.

B-6.4.3.3 Spike Suppression

Diodes or similar devices to suppress spikes from collapsing magnetic fields are required wherever current flowing through an inductance is interrupted.

B-6.4.4 Cables and Harnesses

Cables and Harnesses in the Agena conform to specification LMSC 447969B.

B-6.4.5 Signal Circuits

Shielded A/P signal circuits that cross the Agena interface have the shield grounded on the Agena side. Shield ties must not be connected in a way that creates a ground loop. All vehicle interface shields are grounded to the case ground of the connector.

B-6.4.6 Circuit Groundpaths

The J-3 Payload system and all subsystems ground all power or signal returns to the Agena ground point on the Agena side of the interface, to avoid ground loops, electromagnetic interference, and electrolytic corrosion.

The bonding requirements for the payload system and internal subsystems are specified in [redacted]. RF by-pass devices are utilized to control electro-magnetic interference (EMI) where necessary.

B-6.5 Interface

The locations of interface electrical plugs are shown in Figure B-22.

B-7.0 COMMAND SUBSYSTEM

B-7.1 General

The communications and control system receives, decodes, and processes command signals when the Agena is within the acquisition range of a ground station. The command system also consists of a time-sequenced series of stored program commands (SPC's) from a prelaunch punched tape orbital timer (See Figure B-23).

B-7.2 J-3 Command Definition

B-7.2.1 Real Time Commands

The UHF command link now provides 39 real time commands (RTC's) to the Agena. In the near future, it will also provide secure commands by means of Type 9 decoders, thereby eliminating the requirement for the VHF link. It is also planned to utilize the UHF link to command the A/P Storage Register for stored program commanding. The link consists of a UHF receiver demodulator and a digital decoder in accordance with Figure B-23.

Operating details of the UHF Command System are beyond the scope of this document, except for external characteristics. However, to understand the interface with the proposed storage A/P Command Register, the logic system is briefly discussed.

a. The receiver input signal consists of a UHF carrier phase modulated with "0", "1", "S" (Set), and "R" (Repeat) message bits (see Figures B-24 and B-32).

b. The demodulator recovers these bits and presents them to the decoder, except for the "R" bit.

c. The Decoder Type 21 (Type 22 decoder 1648 and up)

[redacted]

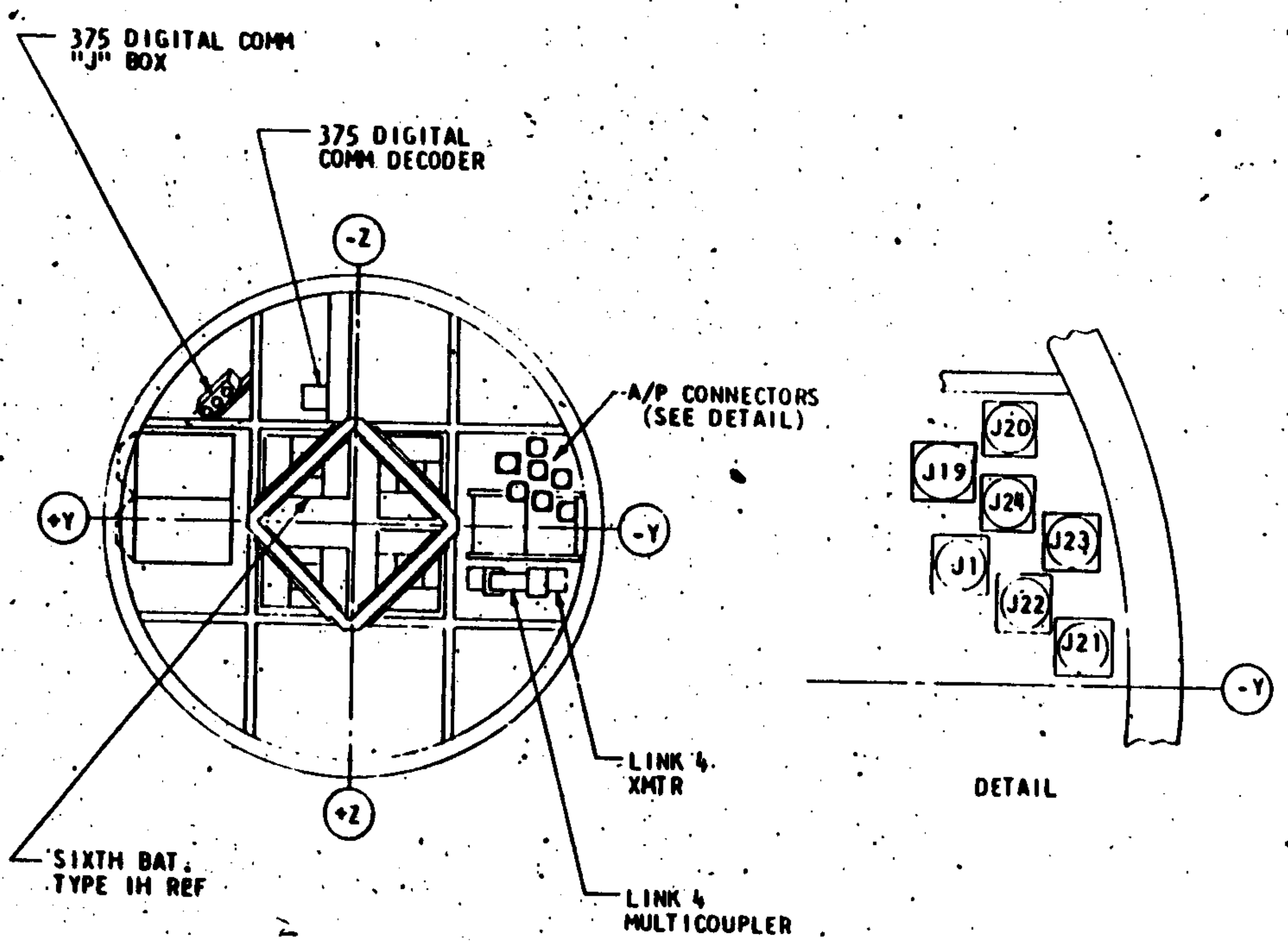


Figure B-22 Interface Electrical Connector Location

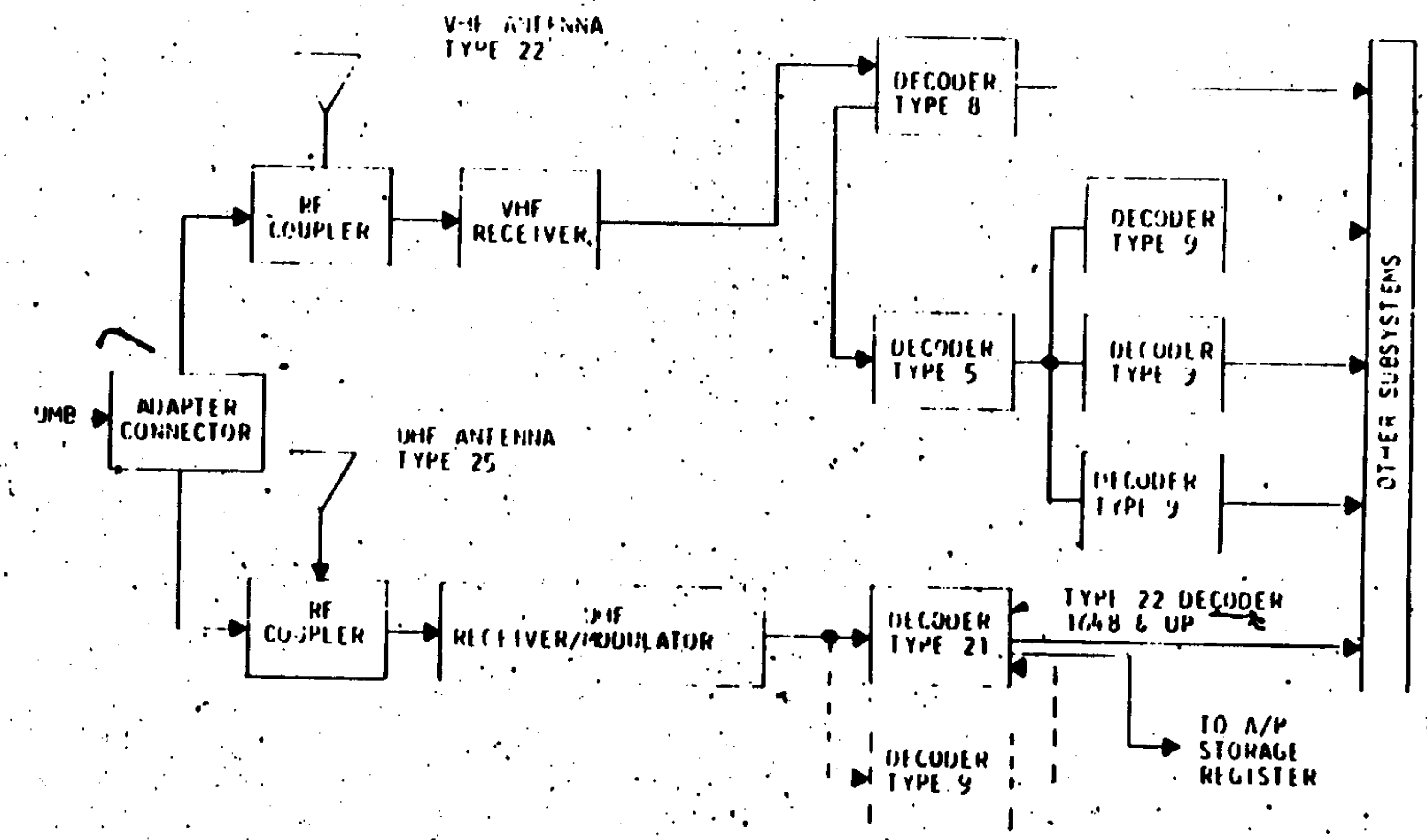


Figure B-23 VHF and UHF Command System

[redacted]

[redacted]

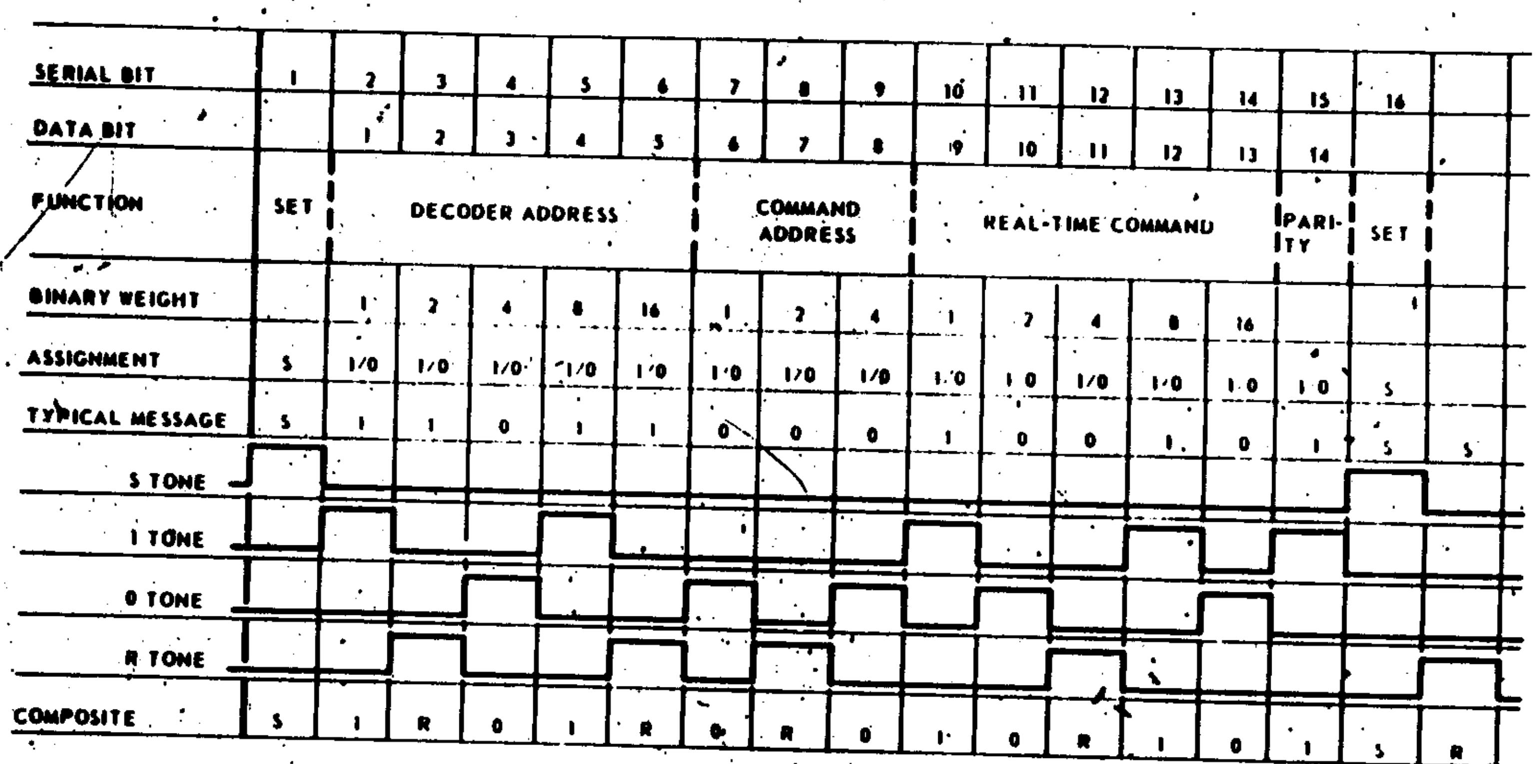


Figure B-24 Uncle Command Format (Ref. Fig. B-32) converts groups of message bits to one of the 39 output commands.

d. These output commands are amplified by a transistor driver which has the power capability for actuating two 500-ohm relay coils. All except special-purpose commands provided to the A/P interface are relay-isolated in the command relay box.

e. Relay contacts carrying current for equipment operation are rated for two amps.

f. Event duration is 350 ± 100 ms (Digital Write command is an exception, in which case it will be 5 ms).

g. Minimum time between successive commands is 1.15 seconds.

h. Uncle (UHF) Commands 111 through 125 back up UHF Analog commands (ANA) 1 through 15, respectively. Of these redundant Uncle commands, 116, 118 through 122, 124, and 125 cross the A/P interface. Several less critical A/P functions are commanded by Uncle 101, 103 through 107, and 109.

i. Uncle 102 will be Write command for storage register for FTV 1648 and up. The A/P command register will be incorporated in the production-phase J-3 systems in two steps. The schedule is as follows:

(1) Some of the UHF commands are energized with a switched unregulated voltage. For Agenas prior to FTV 1648, this has little significance, since this voltage is generated only when the UHF system is turned on.

(2) For FTV 1648 and up, the UHF system will be ON continuously to meet the Lifeboat subsystem command requirements presently met by the VHF ZEKE system. Most of the Unsecure commands will then be energized only when the vehicle is over a tracking station, to minimize the opportunity for unauthorized commanding. The demodulator will then supply message bits to several Type 9 decoders to generate the Secure commands presently supplied by the ZEKE system (see Figure B-27). In addition, the decoder Type 22

will supply message sequence to the A/P storage register. This decoder will then replace decoder Type 21 presently in use.

B-7.2.1.1 S-Band System

The S-Band (UHF) system provides 15 analog commands and several secure commands. It also has transponding capability to aid in ground tracking (see Figure B-25).

The UHF S-Band carrier is modulated by a pulse spacing technique. Information is recovered from the RF signal and applied to the decoder Type XIB and decoder Type XIIIA. The decoder Type XIB provides 15 analog commands. The decoder Type XIIIA converts incoming data to a form usable by the Type 9 decoders, which in turn provides secure (KIK-ZORRO) commands.

The S-Band System is turned ON at "acquisition" and OFF at "fade" by the orbital programmer, to reduce the opportunity for unauthorized commanding.

B-7.2.1.1.1 Analog Commands

The transmitted analog signal consists of three (3) pulses that modulate the carrier frequency at a defined pulse repetitive frequency (PRF). The first and third pulses are for interrogation and identification, while the center pulse is tone-modulated. There are a total of six (6) tones identified as A, B, C, D, E, and F. Any combination of two of the tones constitute a command (see Figure B-26 (a) and B-31).

The receiver/decoder Type XIB receives this signal, and by appropriate tone filters converts the tones to 15 analog commands.

The interrogation pulses trigger the Beacon transmitter which re-transmits a single pulse at some PRF signal for tracking purposes.

Analog commands 6, 8, 9, 10, 11, 12, 14 and 15 are supplied to the A/P interface. All UHF S Band commands are

[redacted]

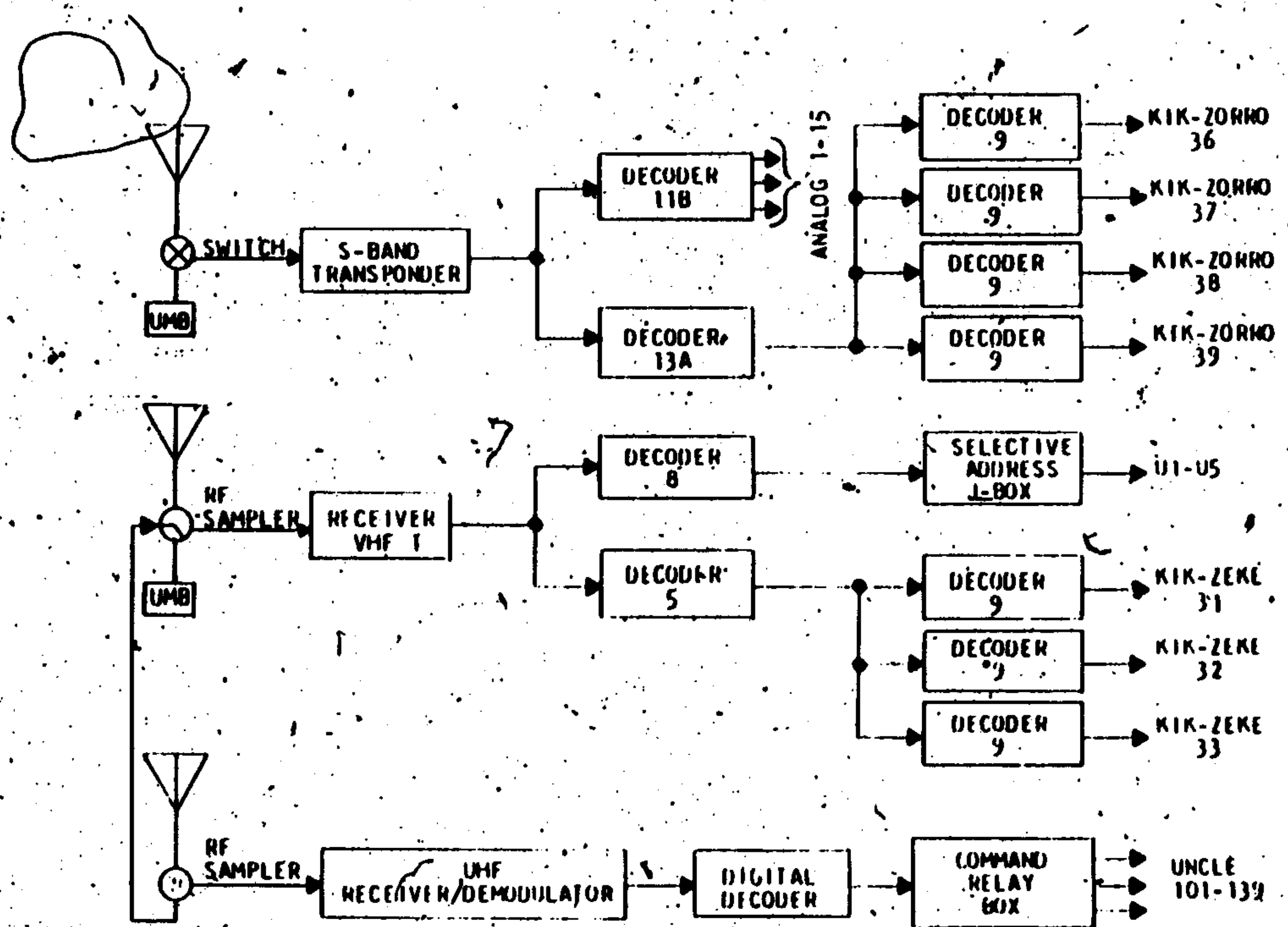


Figure B-25 Tracking and Command Links

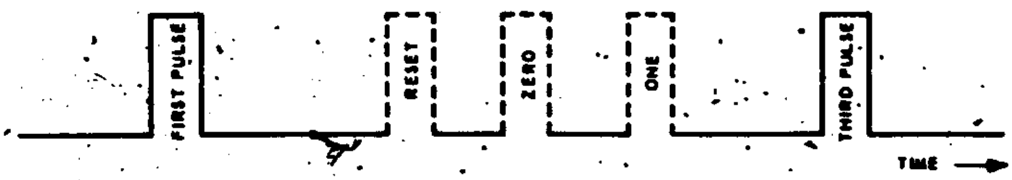


Figure B-26 (a) Center Pulse Position

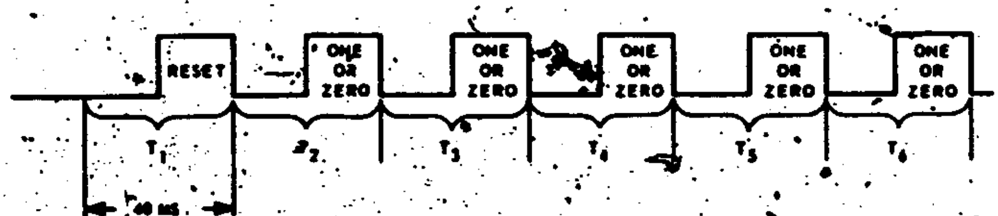


Figure B-26 (b) ZORRO Command Format

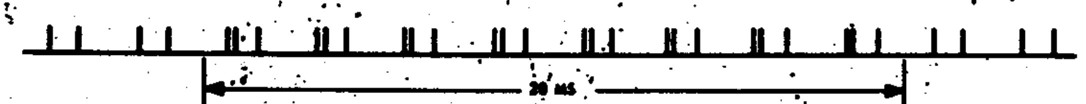


Figure B-26 (c) Center Pulse Characteristics at Radar Pulse Repetition Frequency of 410/second

Figure B-26 ZORRO Command Format (Ref. Fig. B-31)

[redacted]

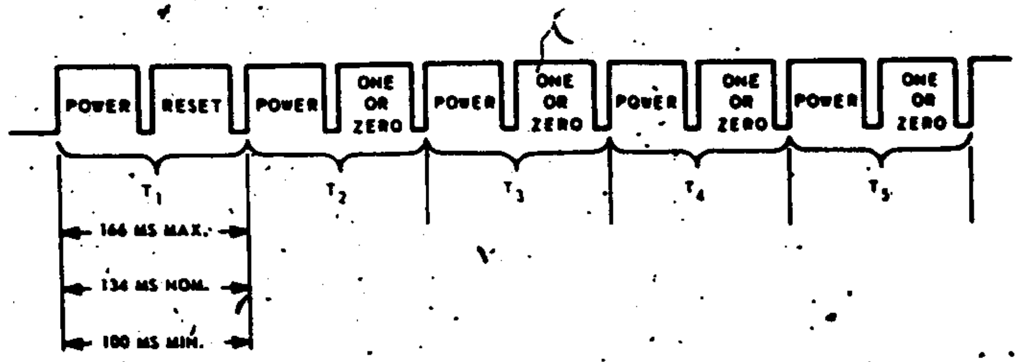


Figure B-27 (a) ZEKE Secure Command Format

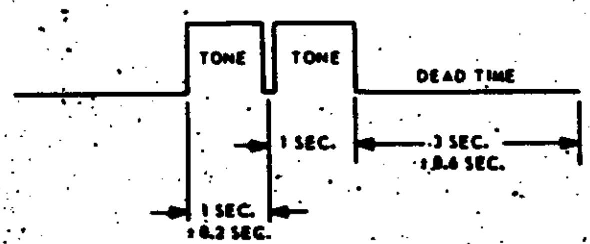


Figure B-27 (b) ZEKE Functional Command Format

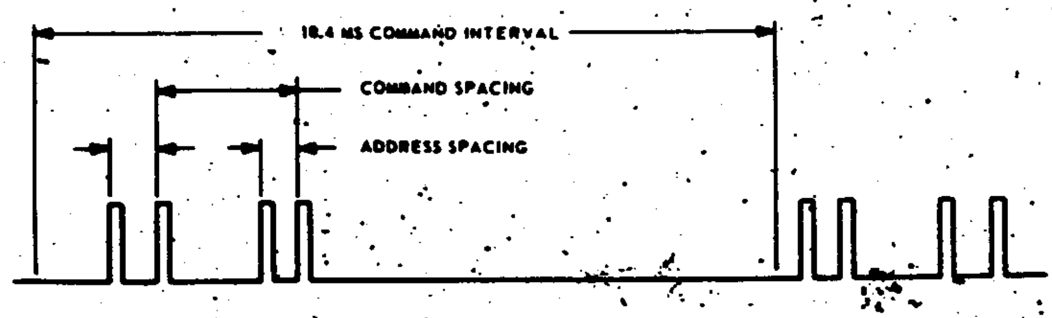


Figure B-27 (c) Radio Guidance Command Format

Figure B-27 ZEKE Command Format (Ref. Fig. B-30)

[redacted]

backed up by Uncle Commands.

The relay contacts have a 2A current capability. Command duration is 0.1 to 1.3 seconds with a minimum interval between successive commands of 0.7 seconds.

Four secure (KIK ZORRO) commands are provided by four Type 9 decoders. These decoders receive their inputs from the Decoder Type XIIIA (see Figure B-26 (b)).

The Decoder Type XIIIA receives pulse spacing information from the UHF receiver and converts it to a series of data bits consisting of zeros, ones, and resets. When a Secure message is sent, it is supplied to all four of the Type 9 Decoders in parallel. The Type 9 Decoders accept the message only if the message sequence corresponds to the code-plug connections for that specific decoder. The first bit must be a Reset command to clear the memory of the Type 9 Decoder. The subsequent 35 bits are zeros and ones. A sequence which does not correspond to the code plug wiring causes the Decoder to reject the command.

Of these four (4) secure commands, KIK-ZORRO 36 and 37 are used to enable the recovery sequences of SRV A and SRV B. KIK-ZORRO 38 and 39 are supplied to the A/P interface for early SRV A to SRV B transfer. They must be secure, since premature transmission would abort the mission (at least in part). KIK-ZORRO 38 and 39 are enabled shortly after injection by the Standard Ascent Timer. The actual commands when transmitted exist from the time they are sent until power is removed from the Type 9 Decoders at "fade." The command link is illustrated in Figure B-28.

B-7.2.2 Stored Program Commands

B-7.2.2.1 Signal Description

The Fairchild Type 8 orbital programmer provides the stored program commands. The commands are stored in the form of square holes punched in 35 mm width, 1.5 mil thick Mylar tape. The command duration is 12.5 ± 2.5 seconds.

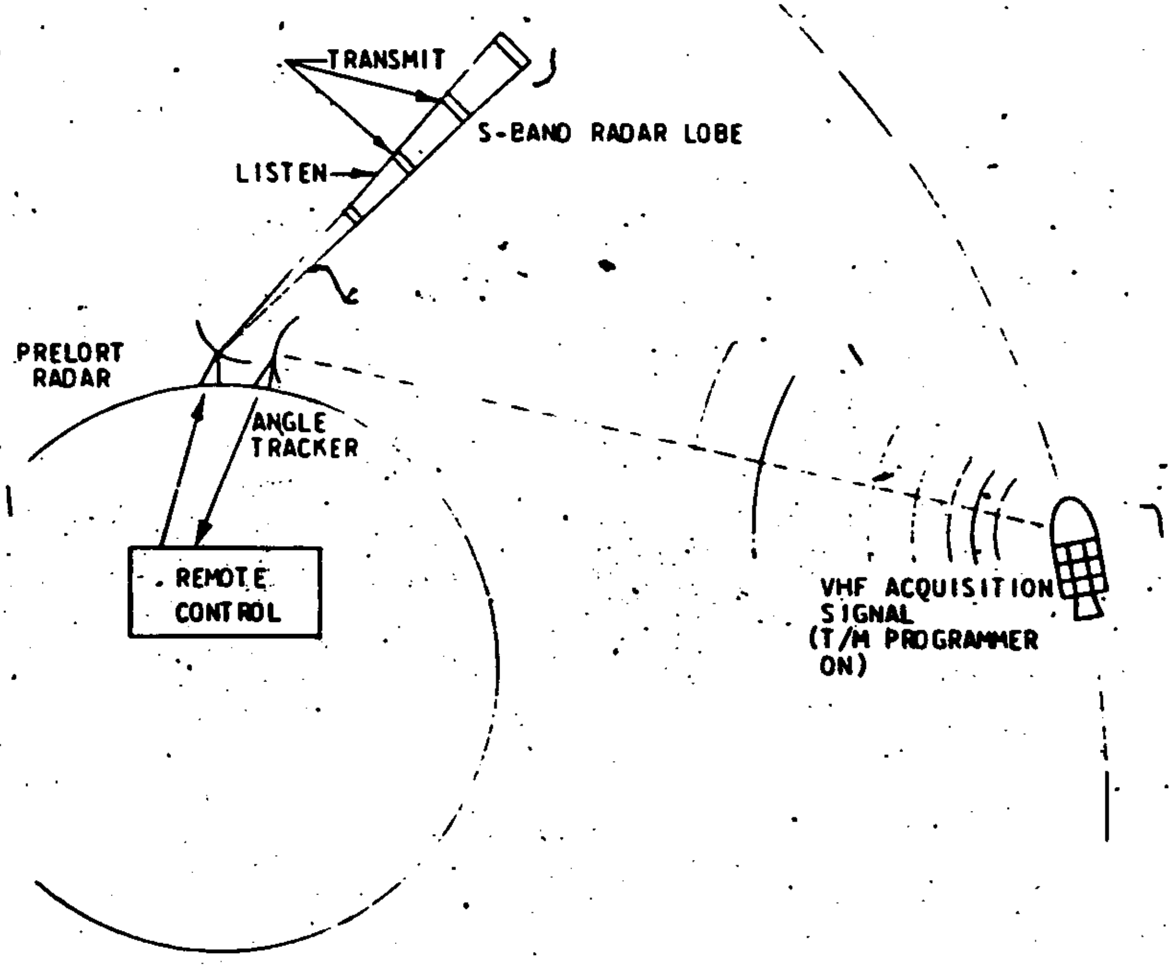


Figure B-28 Vehicle Acquisition

The tape speed and position must be synchronized with the orbital period to make the commands occur at the desired times. The commands take the form of a ground pulse (10 seconds nominal duration). Synchronization of the Fairchild Type 8 programmer is accomplished by SPC (Brush) and Analog Commands. See Figure B-2' Type VIII Programmer reset monitor events.

Approximately half of the Stored Program Commands (SPC's) generated in the orbital timer cross the interface from the Agena to be further processed by the J-3 Command Subsystem for control of the internal workings of the Payload System. The remaining SPC's are used for Agena functions. In later J-3 systems the command box will be replaced by a Digital Shift Register Command System. This system will store predetermined commands received from the UHF command link. These stored commands will be read out by shift commands from the orbital programmer brushes.

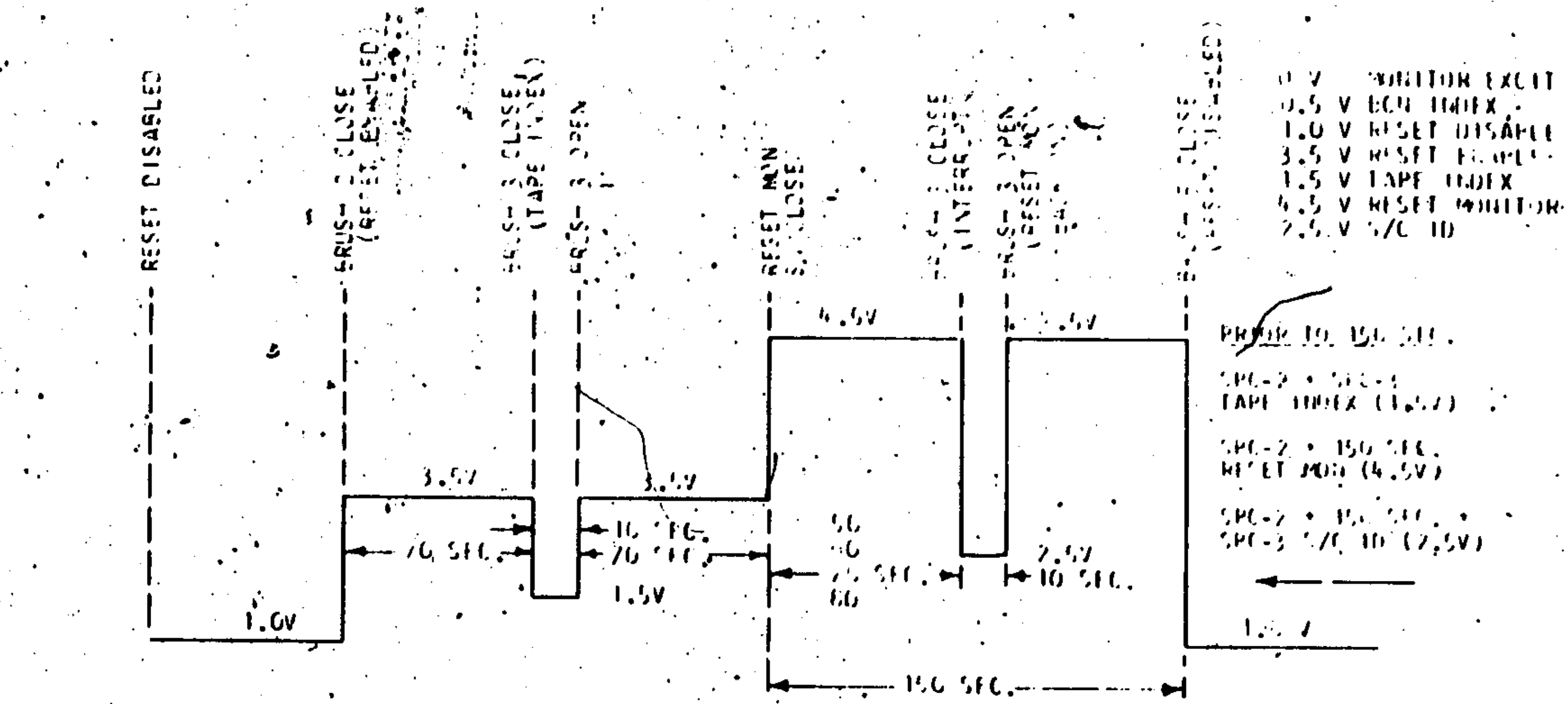
The Type 8 Orbital Programmer has four motor-driven, 35 mm Mylar film strips of 13 channels each, giving a total of 52 brush commands or command channels.

a. Normal speed is 9 inches per orbit for a nominal orbital interval of 90 minutes.

b. Each of the four tapes (running in parallel) is long enough to provide stored program commands for a period of 14 days, or approximately 230 orbits of 90 minutes each.

c. The vehicle command function list specifies each brush assignment. Each command takes the form of a relay contact to ground (operating external circuits through the relays). The source current capacity of each brush is 300 ma per command, with a one-ampere maximum limit for each set of 13 SPC brushes.

Each stored program command controls a latching relay having a nominal coil resistance of 600 ohms.



ANALOG-1 0-PCMR INC/DEC TOGGLE

ANALOG-2 0-PCMR 10 SEC. PERIOD ADJ.

ANALOG-3 0-PCMR RESET
(SPC -2 RESET ENABLE)
(SPC -5 RESET DISABLE)

ANALOG-7 0-PCMR 1 SEC. DECREASE

320 SEC. AUTO DISABLE AFTER RESET ENABLE

RESET FWD — 150 SEC. AFTER RESET ENABLE PROGRAM RESET

RESET BACK — 300 SEC. AFTER RESET ENABLE PROGRAM DISABLE

BRUSH 1 (LINK 1 ON & BEACON ON W/O 120 SEC.)

BRUSH 2 (RESET ENABLE) & (BEACON ON)

BRUSH 5 (RESET DISABLE)

BRUSH 3 (LINK 1 ON & AP T/M CONTROL ON)

BRUSH 4 (LINK 1 OFF, BEACON ...)

Figure B-29 Type VIII Programmer Reset Monitor Events

B-7.2.2.2 Use of SPC's

Reference: Command Function List for Vehicle Brush Assignments.

Reference: Electrical Interface, Command Definitions, and Telemetry Instrumentation Schedule for Payload Subsystem Assignments.

B-7.2.3 Recovery Sequence Signals

B-7.2.3.1 Recovery Timers

The recovery sequence commands (ARM, TRANSFER, DISCONNECT, and SEPARATE) are generated in either of two electronic timers, designated as follows:

a. The primary recovery timer, used for normal recovery sequences,

b. The Lifeboat timer, used as a backup timer to effect emergency recovery using one of the two Lifeboat commands, U1 or U2.

(1) Lifeboat command U1 is used when the primary Agena guidance system fails or the primary recovery timer will not start.

(2) Lifeboat command U2 is used when the attitude control of the primary guidance system is still operable, but the primary recovery timer fails to start after the SPC brush command has been given by the orbital programmer. The secure KIK-ZEKE command to start the L/B timer is also used if the UHF command system fails. (See Figure B-30 for the ZEKE Command System.)

B-7.2.3.1.1 Recovery Sequence Commands, Primary Recovery Timer

The normal recovery orbit is selected by transmitting either an analog command 4 for even-numbered recovery passes or analog command 5 for odd-numbered recovery passes. The orbital programmer tape is pre-punched to provide brush commands for the recovery sequence. Brushes 8 and 10 are used to start the recovery sequence for even-numbered recovery passes, and brushes 7 and 9 are used for odd-numbered recovery passes.

After transmitting either an analog command 4 or 5 for either an even or odd recovery, a KIK-ZORRO-36 or KIK-ZORRO-37 Secure command is transmitted one or two orbits prior to dump. The Secure command turns recovery timer power on in preparation for the recovery sequence one or two revolutions later (approximately 5400 seconds per revolution). The brush commands associated with the analog command selected start the recovery timer. The Agena pitches over to the recovery attitude, the SRV is ejected, and the Agena returned to normal flight attitude.

The timer and functions associated with the recovery sequence are shown in Table B-8. Also see Figures R-1, R-2, and R-4 The normal recovery sequence for each SRV is shown in Section R (Recovery). The sequence of commands to effect the recovery under Lifeboat emergency conditions is similar in most respects, but this is discussed more fully below.

B-7.2.3.1.2 Secure Commands

Random initiation of any recovery sequence command, or early A to B P/L bucket transfer, is prevented by use of the four Secure Commands, KIK-ZORRO 36, 37, 38 and 39. J-3 systems equipped with the Command Storage Register subsystem will have comparable Secure commands.

B-7.2.3.2 Recovery Signal Voltage Source

Recovery signal voltages are obtained from the Agena 28-VDC unregulated bus (battery bus) and are applied or removed by the switching functions of the electronic timers. Source current capacity is 2 amperes maximum. A description of the recovery

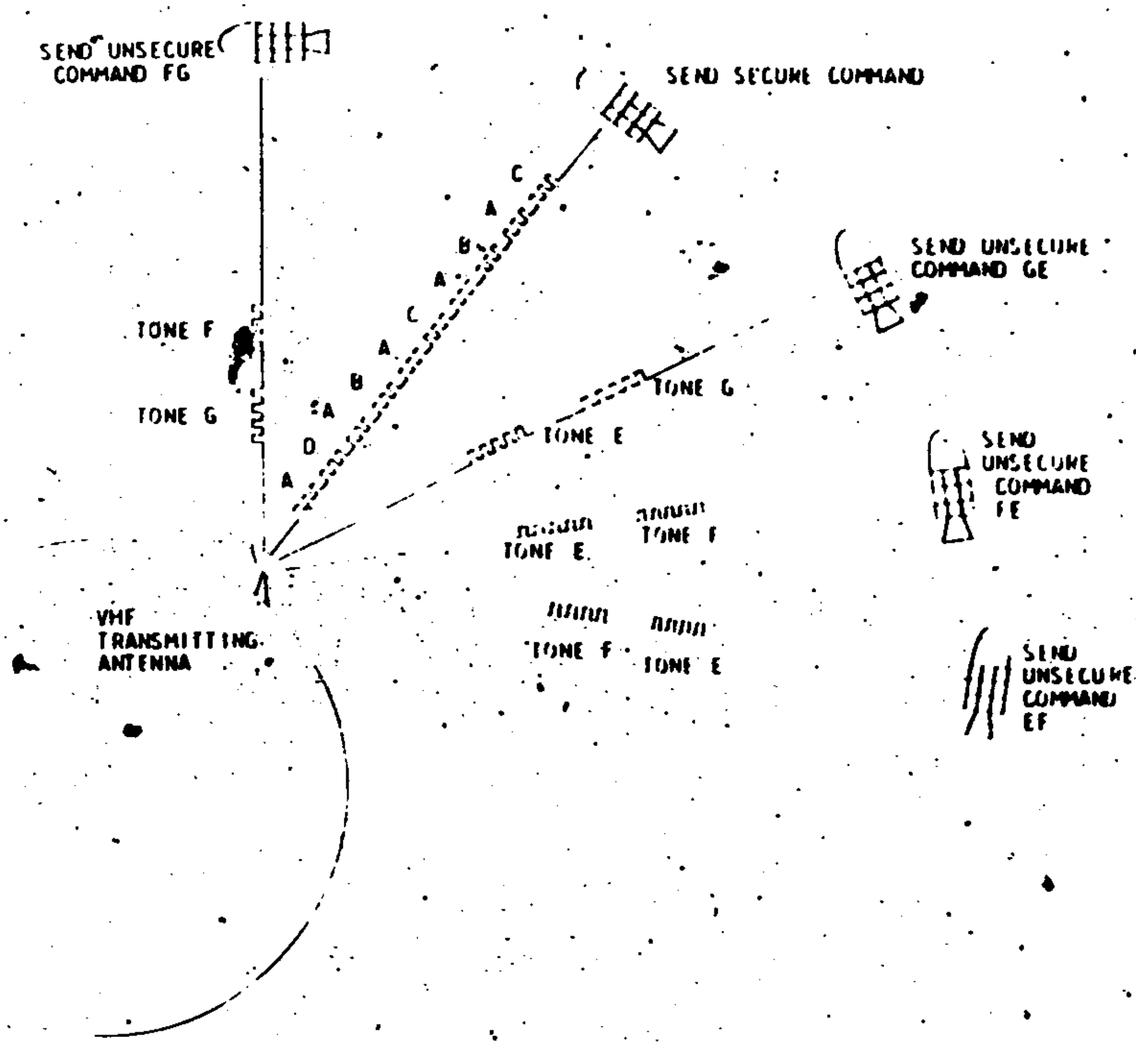


Figure B-30 VHF Pulse Techniques, ZEKE Command System
(Ref. Fig. B-27)

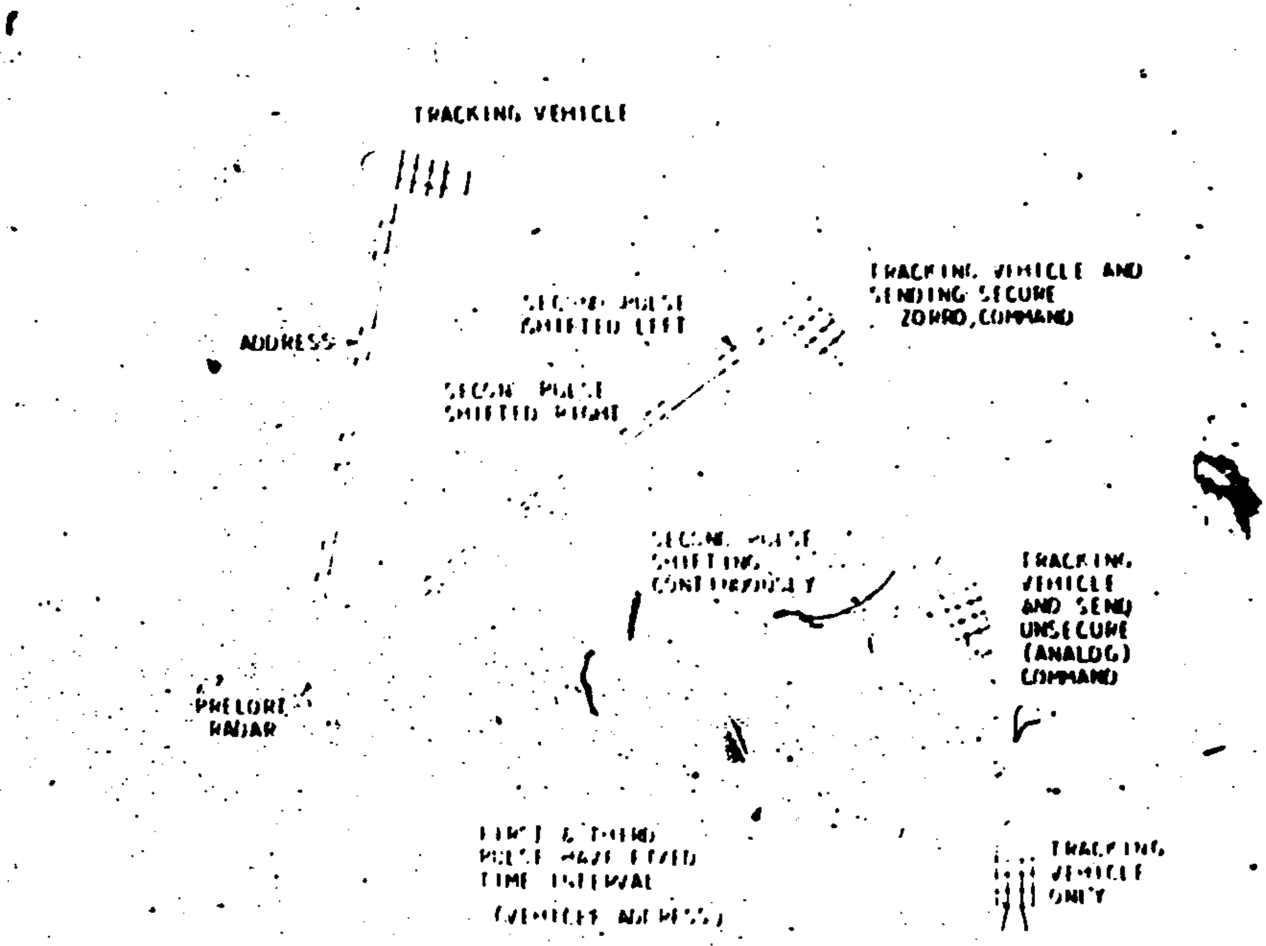


Figure B-31 Prelort Pulse Techniques, S-Band Command System

(Ref. Fig. B-26)

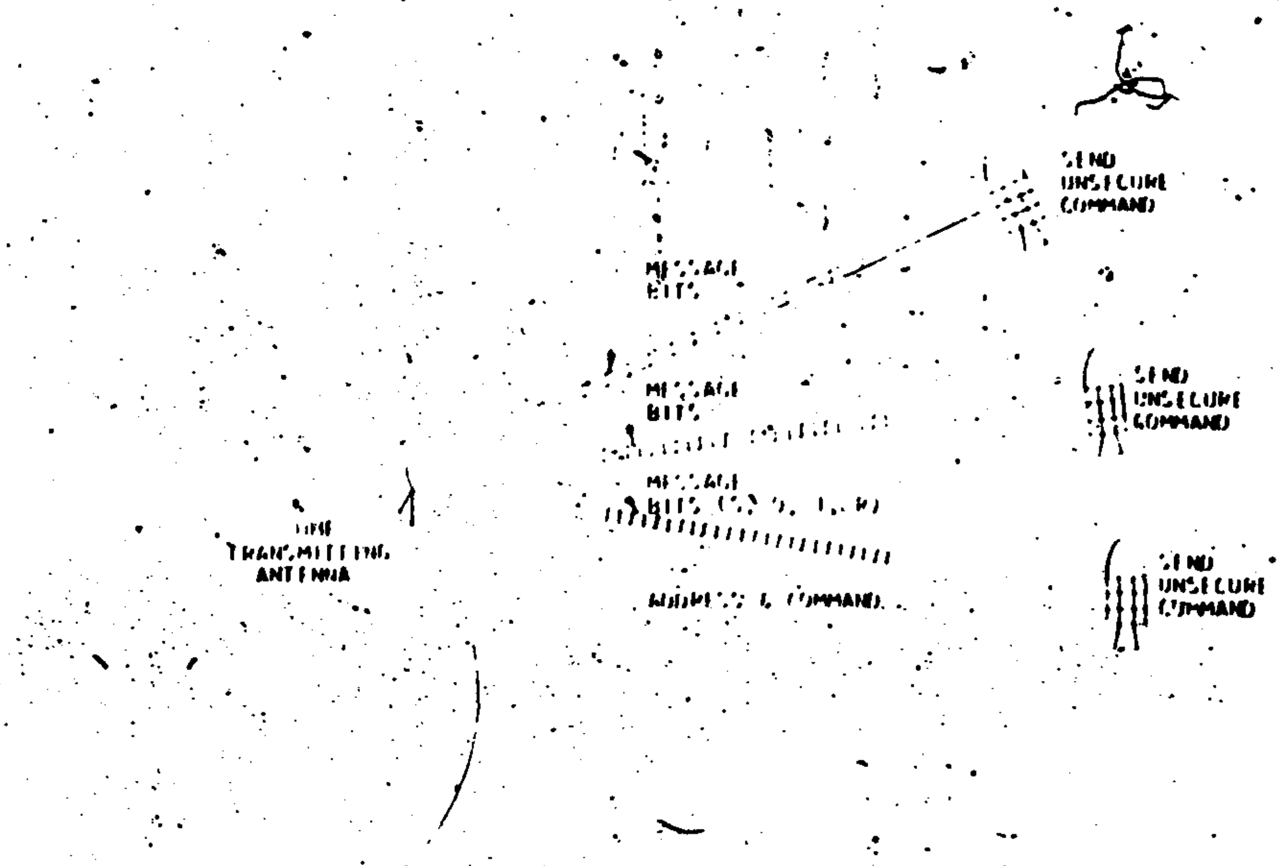


Figure B-32 UHF Pulse Techniques, UNCLE Command System
(Ref. Fig. B-24)

[redacted]

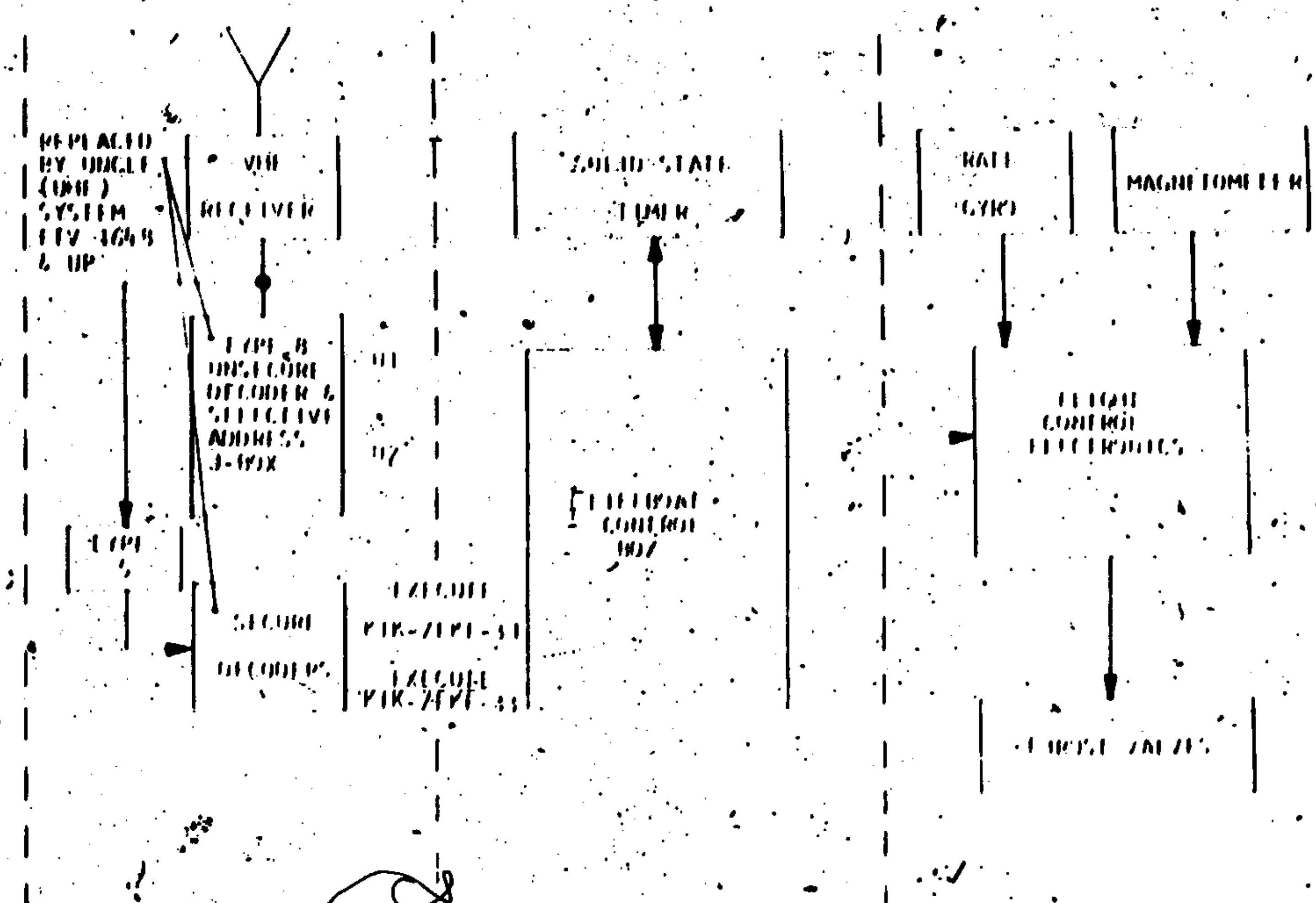


Figure II-33 Lifeboat System

TOP SECRET [redacted]

signals oriented to the J-3 Systems may be found in Section R (Recovery) for details.

B-7.2.3.3 Lifeboat Recovery Sequence

In the event the primary vehicle guidance system is disabled or the Recovery timer will not start on brush command, the Lifeboat system may be used to effect the recovery phase. Basically, the Lifeboat system is an independent backup mode of operation consisting of an RF Link, electronic timer, and attitude control system. Block diagrams of this system are shown in Figures B-33, B-34, and B-35.

Table B-8 Typical Sequence of Recovery Events

EVENT	TIME SECS.	FUNCTION
		START RECOVERY TIMER (BY ORBITAL PROGRAMMER EVENT .)
TO	0	APPLY POWER TO AP POWER RELAY & AP MODE COMMAND TO RP
T1	3	RESET MONITOR
		PNEU. TO HI-PRES., F/C TO ASCENT MODE, REMOVE H/S SIGNALS, STOP GYRO COMPASSING, SWITCH IRP GYRO T/M TO ASCENT MODE
	3	APPLY -120°/MIN. PITCH RATE & REMOVE -4°/MIN. PITCH RATE
T2	6	ARM SIGNAL
		REMOVE POWER FROM AP POWER RELAY
	6	DISABLE RECOVERY ENABLE RELAY

Table B-8 Continued

EVENT	TIME SECS.	FUNCTION
T3	8	REMOVE RECOVERY TIMER START POWER
T4	65	APPLY -4°/MIN. PITCH RATE & REMOVE -120°/MIN. PITCH RATE (PITCH OVER -120°)
T5	81	TRANSFER SIGNAL
T6	82	DISCONNECT SIGNAL
T7	83	SEPARATION SIGNAL
T8	87	APPLY +120°/MIN. PITCH RATE & REMOVE -4°/MIN. PITCH RATE
	87	ENABLE TRANSFER TO EXP. #2 BACKUP
T9	100	REMOVE AP POWER & AP MODE COMMAND TO RP - RESET AP RECOVERY ENABLE & APPLY DMU LOGIC POWER
	100	REMOVE PNEU. TO HI-PRES. POWER
	100	PNEU. TO LOW-PRES.
T10	110	TRANSFER TO EXPERIMENT 2
T11	145	APPLY -4°/MIN. PITCH RATE & REMOVE +120°/MIN. PITCH RATE (PITCH UP 120°)
	145	F/C TO ORBIT MODE, CONNECT H/S TO GYROS, START GYRO-COMPASSING, SWITCH IRP GYROS T/M TO ORBIT MODE & REMOVE PNEU. TO LOW PRES. POWER
T12	154	RESET RECOVERY TIMER
TA	600	REMOVE RECOVERY TIMER POWER & ARM ANALOG 4 & 5

B-7.2.3.4 Modes of Operation

At present, the Lifeboat system provides two modes of operation, designated as follows:

a. Mode U1, Lifeboat Next Orbit: (LBNO), used when the vehicle guidance system is inoperative.

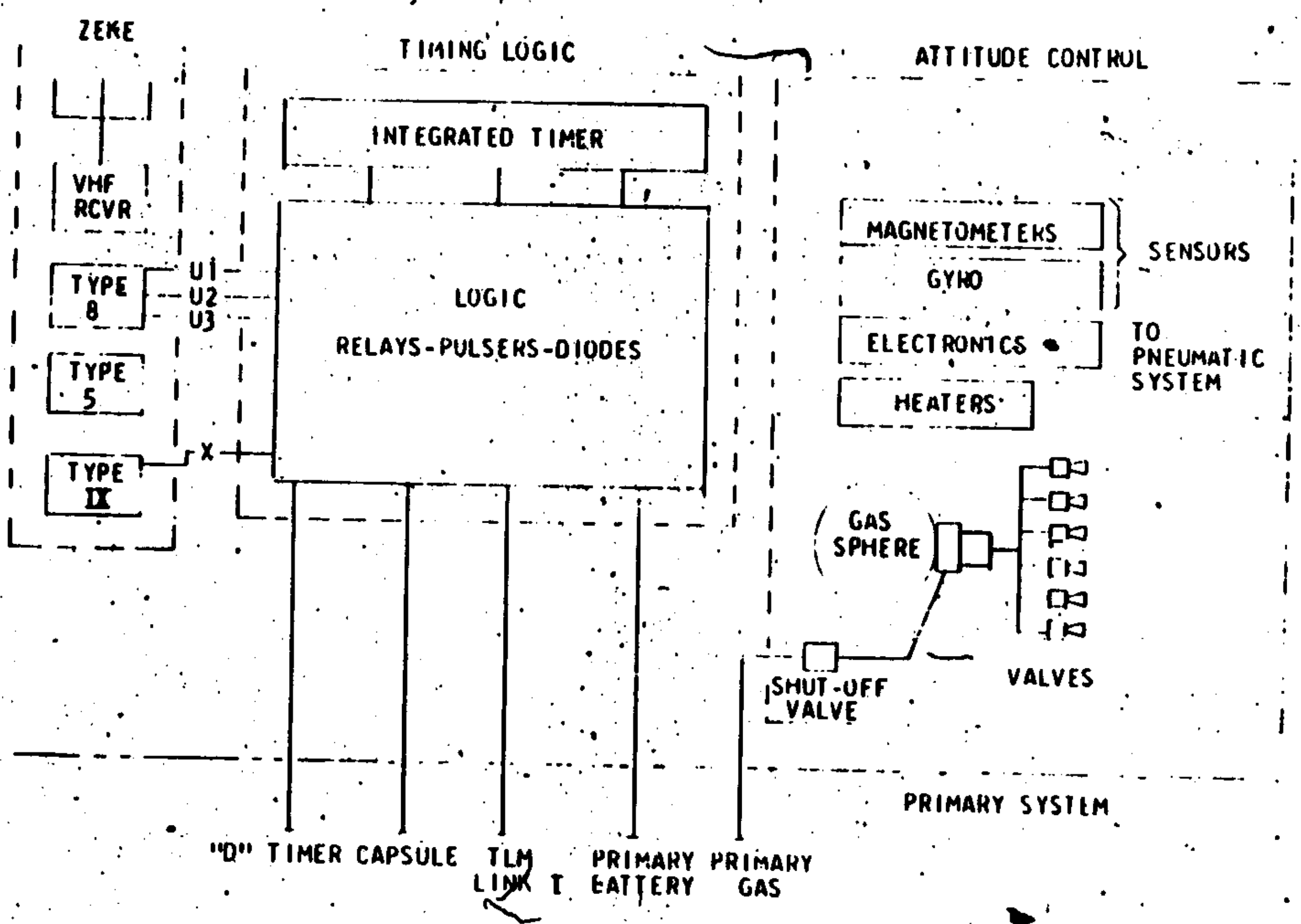


Figure B-34 Block Diagram of Lifeboat System

[redacted]

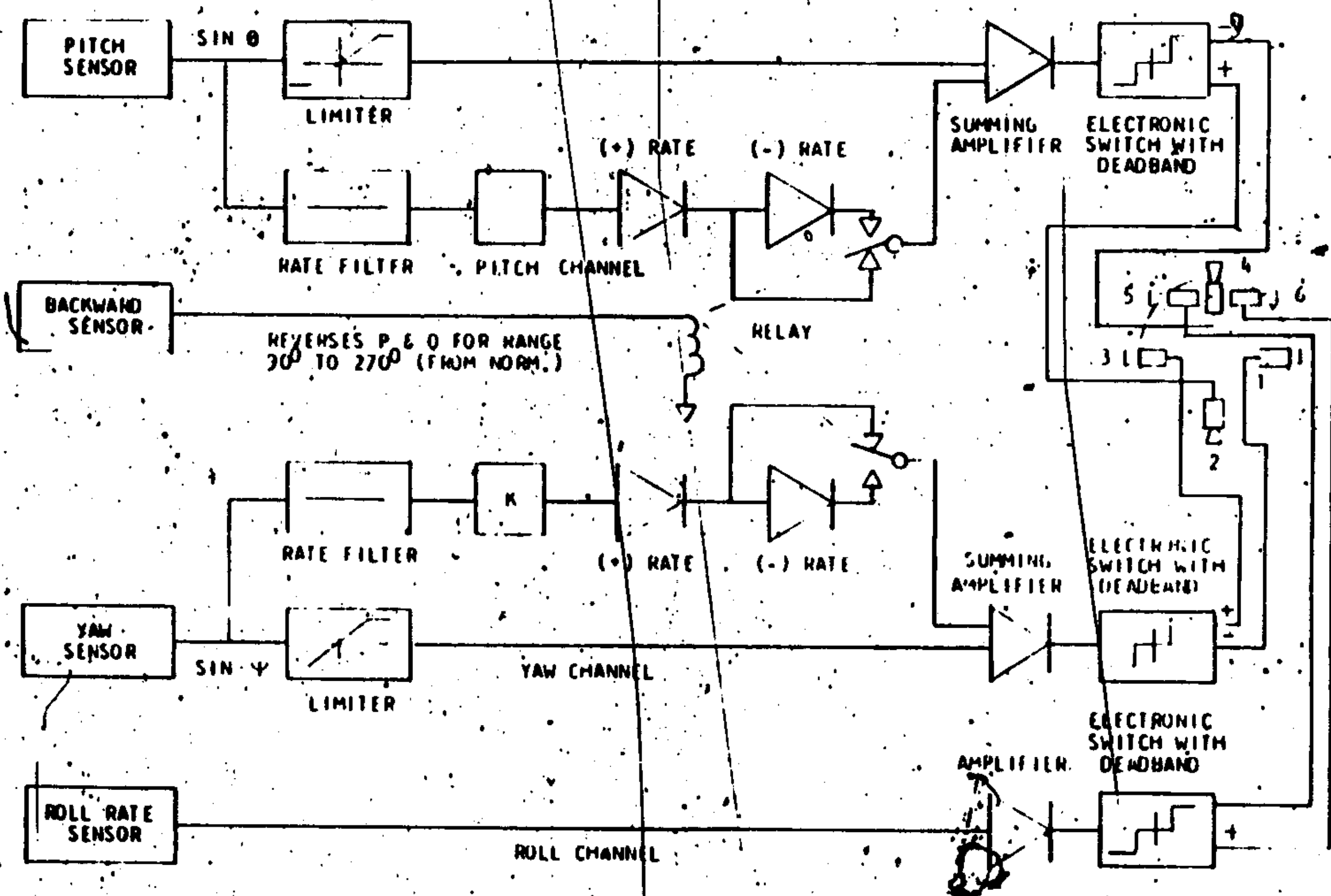


Figure B-35 Attitude Control System Block Diagram

b. Mode U2, Primary Next Orbit, (PNO) used when the recovery timer fails to start by the normal orbital programmer brush command. In this mode, the regular primary recovery timer is used to effect recovery, but gets its starting pulse from event T6 of the Lifeboat timer. The regular attitude control system remains operable, once the primary recovery timer is started, and remains under control of the Recovery Timer rather than using the Lifeboat emergency attitude control system to effect recovery.

Both modes are explained in greater detail below:

a. U1, or LBNO, is the mode used when the vehicle guidance system is inoperative. Mode selection is obtained by transmitting an assigned unsecure command pair (Address command and Mode command) to the ZEKE system, which turns Link I telemeter ON and prepares the L/B attitude control system for operation. At the appropriate time, a secure Lifeboat Command KIK-ZEKE 31 or 33 is transmitted which starts the Lifeboat timer. This timer provides switching signals to provide vehicle and payload orientation by means of magnatometers and thrust valve operation. It also provides recovery signals to the payload. The typical sequence of vehicle functions is as follows:

MODE SELECT

<u>U1 (Unsecure Command)</u>

Initiate A sequence

Link I ON

Rate Gyro ON

Regulator Heater ON

L/B Pneumatic OFF

<u>EXECUTE (Secure Command)</u>

Initiate B Sequence

Arm T1, T3 thru T9

Disable Unsecure Command

Table B-9 shows the sequence of recovery events in Mode U1.

[redacted]

Table B-9 Sequence of Events, Lifeboat Modes U1 and U2

EVENT	*TIME	FUNCTION --- U1 MODE	FUNCTION --- U2 MODE
T_0	0	LOCKOUT TIMER START DISABLE START COMMAND	LOCKOUT TIMER START DISABLE START COMMAND
T_1	25	AP RECOVERY ENABLE DMU DISABLE (TRANSFER TO EXP. 2 BACKUP)	AP RECOVERY ENABLE DMU DISABLE (TRANSFER TO EXP. 2 BACKUP)
T_2	30	REMOVE T_1 EVENT POWER	REMOVE T_1 EVENT POWER
T_3	5060	LINK I ON START A SEQUENCE	LINK I ON INITIATE A SEQUENCE
T_4	5355	PRIMARY PNEUMATICS OFF	NO EFFECT
T_5	5360	L/B PNEUMATIC ON PP T/M TO AP MODE	NO EFFECT
T_6	5380	ARM	START RECOVERY TIMER B SEQUENCE
T_7	5455	TRANSFER	NO EFFECT
T_8	5456	DISCONNECT	NO EFFECT
T_9	5457	SEPARATE	NO EFFECT
T_{10}	5545	LIFEBOAT RESET	LIFEBOAT RESET
T_{11}	5550	TRANSFER TO EXP. 2	REMOVE RECOVERY TIMER START SIGNAL
T_{12}	5560	TIMER RESET B	RESET B SEQUENCE
T_A	5680	LINK I OFF (T_3 & T_A)	LINK I OFF

*SECONDS

b. U2 or PNO is the Lifeboat mode used when the Recovery timer cannot be started by the orbital programmer brush command. Mode selection is again obtained by an assigned ZEKE Unsecure command pair; however, the Lifeboat Attitude Control system is not enabled during this mode of operation. Upon receipt of a Lifeboat Secure command, power is applied to the recovery timer and the Lifeboat timer starts. In this mode the Lifeboat timer only issues the A/P recovery enable, Telemeter Link I ON, and Recovery Timer start commands. All other Lifeboat functions are disabled in this mode, and the recovery sequence is obtained in the same manner as previously described for a normal recovery operation.

Typical sequence of vehicle functions are as follows:

MODE SELECT

U2 (Unsecure Command)

Link I ON

Reset B Sequence

(Rate Gyro OFF)

(Heaters OFF)

EXECUTE (ZEKE Secure Command)

Initiate B Sequence

Recovery Timer Power ON

ARM T1

Disable Unsecure Command

Table B-9 shows the sequence of recovery events under Lifeboat

B-7.2.4 Special-Purpose Commands

There is a group of five special-purpose commands which perform certain essential functions in both the Agena and the Payload section but are not considered as part of the regular command structure. Rather, they are considered part of the automatic functions necessary to the operation of the satellite vehicle. The five commands are listed below, and their functions are explained in Section Q (Satellite Recovery Vehicle).

a. Inflight Reset Signal

b. A/P Orbit Mode Signal

c. A/P Data Enable Command

d. A/P Recovery Enable

e. Link I Telemeter Signal

B-7.2.4.1 Inflight Reset Signal

The Inflight Reset signal has two functions:

(1) On the Agena side of the interface, it enables the Agena pneumatic attitude control subsystem, which controls the pitch and

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[redacted]

and yaw functions of the satellite. On the payload side of the interface, it resets two relays in the Pyro command box to initiate the pyro ejection of the right blowoff door. (S.N. 97 [illegible] C).

B-7.2.4.2 A/P Orbit Mode Signal

The Orbit Mode signal is sent by the closing of a switch (Event 9) in the Standard (ascent) timer, approximately 280 seconds after the timer is started. The time after liftoff for starting the standard timer varies somewhat with each mission according to mission requirements, (i.e., the timing is mission-peculiar), but for ground test purposes only a standard starting time of 215 seconds after liftoff has been arbitrarily selected. Thus, the A/P Orbit Mode signal normally occurs within a nominal time that is 215 seconds after liftoff to standard timer START, 280 seconds (nominal) after timer START to Event 9, A/P Orbit Mode signal.

The A/P Orbit Mode signal has two functions:

a. The primary function is to switch the 28 VDC unregulated power from the Ascent mode to the Orbital mode.

b. It also serves as a backup command to eject any remaining blowoff doors by sending another firing pulse to the pyro circuits that actuate the door ejections.

B-7.2.4.3 A/P Data Enable Command

The A/P Data Enable command is a 28 VDC unregulated signal provided at the payload interface when payload functions are to be recorded on the Agena vehicle tape recorder. It is normally disabled until a signal from the orbital programmer, the primary recovery timer, or the Lifeboat timer closes a relay to enable the circuit for A/P use. (

B-7.2.4.4 A/P Recovery Enable Command.

The A/P Recovery Enable command is a 28 VDC unregulated pulse which is developed by a special purpose [illegible] in the Agena vehicle. It is transmitted by either of the [illegible] Recovery Enable commands, KIK-ZOURO 36 or KIK-ZOURO 37, or by means of the Lifeboat Timer Event [illegible].

The pulse is transmitted to the interface and passed to the payload system.

KIK-ZOURO 36 or 37 are generally transmitted one [illegible] orbits before the recovery pass for normal SRV Recovery. For U1 or U2 Lifeboat modes, Lifeboat timer Event T1 will occur 25 seconds after execution of either KIK-ZEKE Secure Command 31 or 33 for both U1 (LBNO) and U2 (LBNO) Lifeboat Recovery mode.

B-7.2.4.5 Link I Telemeter Signal

The Link I T/M signal is a 28 VDC unregulated signal provided to the payload interface at any time the Agena vehicle Link I Telemeter is turned ON. Agena documentation refers to this signal as A/P T/M ON. The signal is initiated when one of a pair of orbital programmer brush commands (stored program commands) turns on the Link I vehicle telemeter. A different brush of a pair of SPC's turns the signal OFF when it turns off the Link I Vehicle Telemeter.

The purpose of the signal generated by the SPC's above is to turn on the payload system commutators and interrogate the payload System Clock (the DRCG, or Digital Recording Clock Generator). This is done periodically throughout the mission for time correlation between events controlled by orbital programmer and the systems time for vehicle ephemeris data. The exact time of the SPC's to turn the Link I T/M ON or OFF are mission-peculiar.

Link I T/M and payload system commutators may also be turned on by any of several real time commands as follows:

[redacted]

a. RTC's for selection of Lifeboat Unsecure modes 01 and 02 cause Link I telemeter and payload Commutators to operate for 600 seconds.

b. Execution of a Lifeboat Recovery sequence will operate the Telemeter Link as the Lifeboat timer times through the sequence.

c. One Secure VHF Real Time command (KIK-ZCKE-32) will operate the vehicle telemeter and payload commutators for a period of 420 seconds.

NOTE: The unsecure Lifeboat commands and KIK-ZCKE-32 may be used repetitively.

B-8 TELEMETRY SUBSYSTEM

B-8.1 General

The telemetry subsystem provides the means of collecting operational and functional data from the Agena/Payload systems and transmitting this information to the ground station in real time or as a recorded readout.

B-8.2 Telemeter Signals Across the Agena Interface

B-8.2.1 Telemeter Channel Requirements

B-8.2.1.1 Telemeter Link I

The Agena vehicle provides ascent and orbit telemeter channels as required by the payload system for inflight monitoring of payload system performance.

Telemeter Link I, Channels 5 and 13 are assigned to the payload for continuous use during ascent and orbit operations. Channels 6, 8, 9, 10, 11, and 18 are used for monitoring Agena vehicle parameters during the ascent phase. These channels are switched to payload data after the TLM-to-Orbit Mode signal by the standard ascent timer. On Channel 8 only, A/P data are switched out and the Lifeboat pneumatic gas valves are monitored during a U1 (LBNO) mode of operation.

T/M Signal Voltage and Signal Conditioning:

a. The vehicle telemeter voltage controlled oscillator (VCO) requires a signal voltage input of 0 to 5 VDC, referenced to the telemeter return.

b. VCO input impedance is 1 megohm ± 20 percent. Payload circuit impedance must not exceed 10 K-ohms when measured between the data point and telemeter signal return.

B-8.2.1.2 Telemeter Date Link II

Four Link II channels are also assigned to monitor the payload system. They are Link II channels 15, 16, 18 and F.

Channels 15 and 16 receive their payload system inputs from 5 rpm, 60-point commutators. The commutated data must meet the same VCO requirements as those described in paragraph B-8.2.1.1 for the Link I telemeter. Channels 18 and F are assigned to Tape Recorder functions.

B-8.2.1.3 Differences in Control, Link I, and Link II T/M

Link II Telemeter is not controlled in quite the same way as Link I telemeter. Link II is turned ON or OFF by brushes from the orbital programmer. (See the Current Command and Function List.) There is at present no real time command capability to operate the Link II telemeter system, as there is for Link I which can be operated either by RTC or SPC methods. Link II does not have a special monitor signal as does Link I.

B-8.2.1.4 Special-Purpose Monitors:

a. Payload/SRV Separation Monitor:

This monitor has the designation "A218".

b. Thrust Monitors:

The Agena vehicle gas valves (or thrust valves) provide individual signals to the payload interface whenever there is thrust valve activity. Each of the six thrust valve monitors has a nominal electrical pulse duration of 21 milliseconds. The basic gas pulse repetition rate is a function of the programmed pitch guidance rate. This is modified by the horizon sensor inputs for pitch, yaw, and roll to maintain attitude control. The thrust signals from each gas jet appear at the interface as corresponding electrical pulses. The signals at the interface are 28 VDC unregulated pulses, continuously applied until vehicle thruster activity, at which time the signal for that thrust nozzle is zero VDC during the pulse. These signals are conditioned for T/M data readout and fed into one of the two A/P digital data tape recorders in the SRV's. From there it is used (with DRCG time correlation) to monitor the effect of the Agena's attitude control equipment jet pulses on payload operation.

c. A/P-to-Agena Tape Recorder, Tracks 1 and 2.

The Agena vehicle provides two tape recorder tracks (1 and 2) for shared use between A/P and Research Payload data. During Tape Recorder Readout, Track 1 data is fed to Link II Telemeter channel 18, and Track 2 data is fed to Link II, Channel F. A/P data to be tape recorded and subsequently played out by Link II must meet the required electrical characteristics and should have a maximum pulse repetition rate of 24 pps.

Recording of A/P data on tape recorder Track 1 is dependent on the mission programming of Orbital Programmer Brush 21. During recovery operations, Track 1 is switched to A/P by the A/P Mode signal from recovery or Lifeboat timers. Recording of A/P data on tape recorder Track 2 is a function of the recovery sequence. This data recording is initiated by the A/P Mode signal provided by either the recovery or Lifeboat timers after receipt of the Recovery or Lifeboat mode command.

The A/P Mode T/M signal occurs at X+3 seconds (X = Start time) and is removed at X+100 seconds by the recovery timer. The

Lifeboat timer applies the signal at Event T5 (5360 seconds) and removes the signal at Event T10 (5545 seconds).

SECTION C

STRUCTURE - PAYLOAD VEHICLE (P/L V)

C-1.0 PURPOSE

The purpose of the P/L vehicle (P/L V) is to structurally support and house all necessary components in a light-tight environment during launch and on-orbit.

C-2.0 CHARACTERISTICS

The J-3 payload vehicle configuration is shown in Figure C-1. The primary structure is a 60-inch diameter instrument barrel, the aft end of which interfaces with the 60-inch diameter Agena, and the forward end with the 10-degree conic. A 15-degree fairing attaches the A SRV to the forward end of the conic to complete the payload vehicle structure. Magnesium thorium material was chosen because of its high strength-to-weight ratio over a wide temperature range, and for its excellent vibration damping properties. The overall length of the payload vehicle is 152-1/2 inches; the launch weight is approximately 1,800 lbs.

The J-3 structures house the following:

a. The CR panoramic stereo camera system
b. The DISIC camera system
c. Two SRV systems (which house the take-up cassettes)
d. Supporting subsystems which aid in the command, monitoring, and functioning of the above items.

C-2.1 Design Considerations

Surface coatings are applied to both the internal and

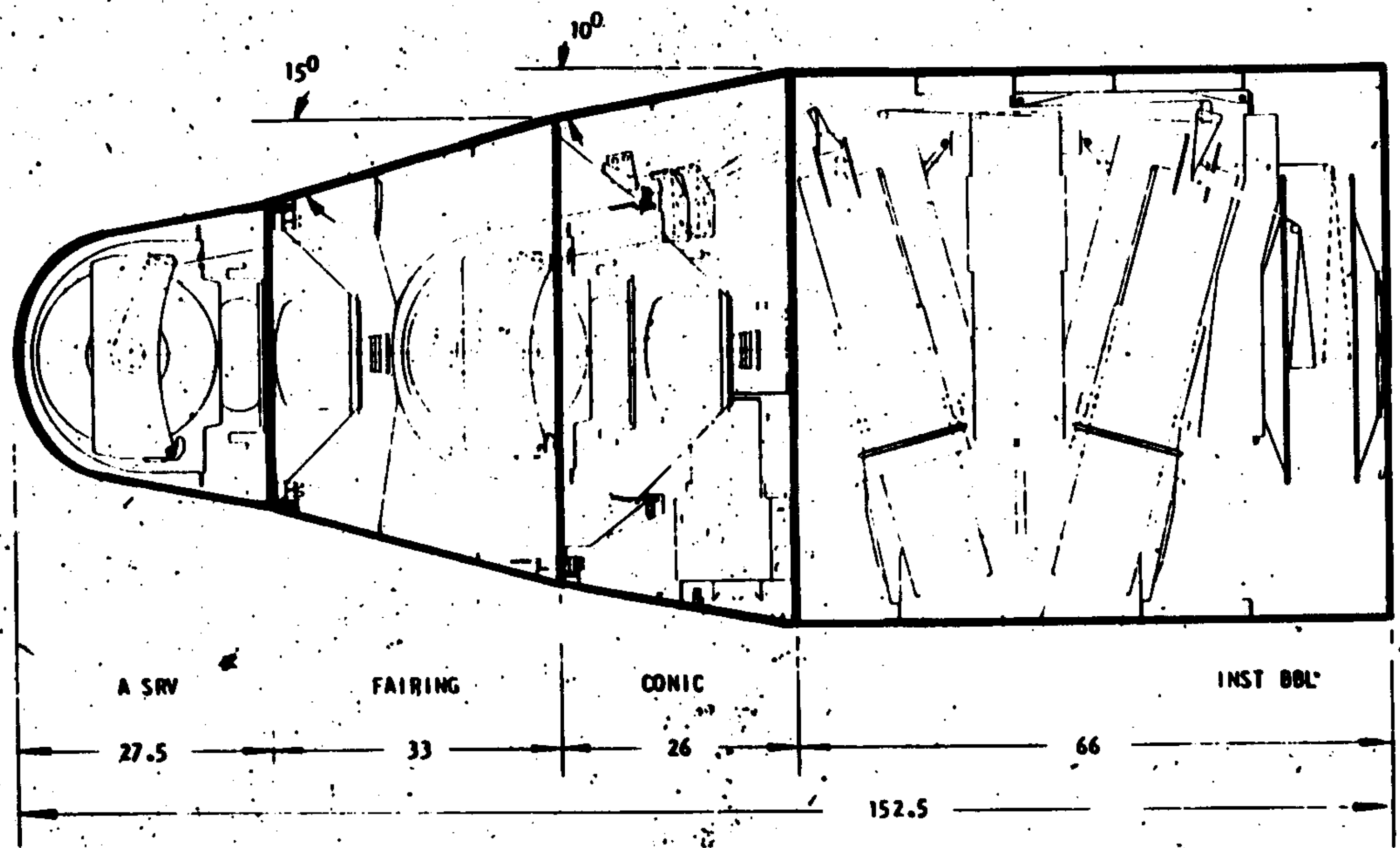

Figure C-1 Structural Dimensions - J-3

external surfaces of the major structures to control internal temperature on-orbit, as well as to prevent corrosion and to present an attractive surface.

Figure C-2 tabulates each of the major structures and lists important details concerning physical make-up (such as size, material, weight, doors, etc.) The "A" SRV is also an important structural component because its ablative shell forms the nose of the payload vehicle for streamlining and protection against ascent heating. See the SRV Section Q and Recovery Section R for SRV component descriptions and operations.

C-2.2 Doors in Payload Vehicle Structure

The locations of the access and blow-off doors are shown in Figure C-3. The construction of the main door is shown in Figure C-4.

C-2.2.1 Pyro Release Doors

The eight pyro-ejected doors are as follows:

a. One main door, pan instruments (two pin pullers)
b. One terrain door, DISIC (one door ejector)
c. Two stellar doors, DISIC (one door ejector each)
d. Four CR horizon doors (one door ejector each)

NOTE: Figures C-4 to C-7 show details of doors and ejection hardware (also refer to Section P Pyro Subsystem).

A seal around the periphery of the main door frame reduces venting during ascent, to prevent a large pressure differential across the main instrument boot.

PAYLOAD STRUCTURE		15° FAIRING	10° CONIC	BARREL
BASE DIMENSIONS AND RING ARRANGEMENT (RINGS NOT TO SCALE)		32.55; 50.56; 55.17	36.00; 50.56; 60.00	60.00; 61.00
OVERALL LENGTH 152.0 IN				
LIFTOFF WEIGHT 1772 LBS*				
SKIN THICKNESS		.090	.080	.071
MATERIAL	SKIN	HM21A-T8 MAG	HM21A-T8 MAG	HM21A-T8 MAG
	END RINGS	HM21A-T5 MAG	HM21A-T5 MAG	HM21A-T5 MAG
	MID RINGS	HM31A-T5 MAG	HM31A-T5 MAG	ZK60A-T5 MAG
RING TO SKIN FASTENING	END RINGS	RIVETED	WELDED	WELDED
	MID RINGS	RIVETED	RIVETED	RIVETED
WEIGHT LBS.	BASIC SV	38	56	83
	AFTER AP MOD	40	66	150
	COMPLETE	57 + 517 LBS (LESS FILM)	224 + 319 SRV (LESS FILM)	855
[illegible]	ACCESS	4	4	8
	OPTICAL	NONE	5 (3 TERRAIN, 2 STELLAR)	5 (1 PAN, 4 HO)
	THERMAL	THERMAL CURTAIN, THERMAL SHIELDING	THERMAL SHIELDING	PRESSURE DIAPHRAGM, THERMAL SHIELDING
COMPONENTS	FILM TRANSPORT	FORWARD ROLLER BOX	MAIN-INTERMEDIATE ROLLER ASSY, DISK SYSTEM (3 TERRAIN, 2 STELLAR)	CARRIAGE [illegible] SYSTEM (2 MAIN, 4 HORIZON [illegible]), SUPPLY CASSETTE
	STRUCTURAL MOUNTS	ELECTRICAL BOX MOUNT	ELECTRICAL BOX MOUNT, DISK EXIT MOUNTING MOUNT, DISK SUPPLY MOUNT, SRS INST MOUNT, PRESSURE MAKEUP MOUNT	SUPPLY CASSETTE MOUNT, ELECTRICAL BOX MOUNTS, PAN INST MOUNT
	ELECTRICAL, INSTR, INST OP [illegible]	T/M BOX	DISK CYCLE COUNTER, POWER BOX (FWD), TRANSFER J BOX, PYRO J BOX.	HF PROGRAMMER, EXPOSURE CONT., POWER BOX (AFT), [illegible], VACUUM GAGE, COMMAND BOX, HUMIDITY SENSOR, CLOCK, TELEMETRY J BOX (AFT), PYRO CURRENT MONITOR
	MECHANICAL	SRV SPINOFF PLUG & RETRACTOR, SRV PIN PULLERS & SPRINGS, FAIRING EJECTION SPRINGS, DISK CHUTES	FAIRING SPIN OFF PLUGS & RETRACTOR, SRV SPIN OFF PLUG & RETRACTOR, SRS PIN PULLER & SPRINGS, FAIRING PIN PULLERS, DISK DOOR EJECTOR, [illegible] SEAL ASSY, MANIFOLD SEAL ASSY, COIL & SIEVE ASSY, PRESSURE MAKE-UP	MAIN DOOR PIN PULLERS, HORIZON DOOR EJECTORS, N_2 VALVE

Figure C-2 Structural Summary

[redacted]

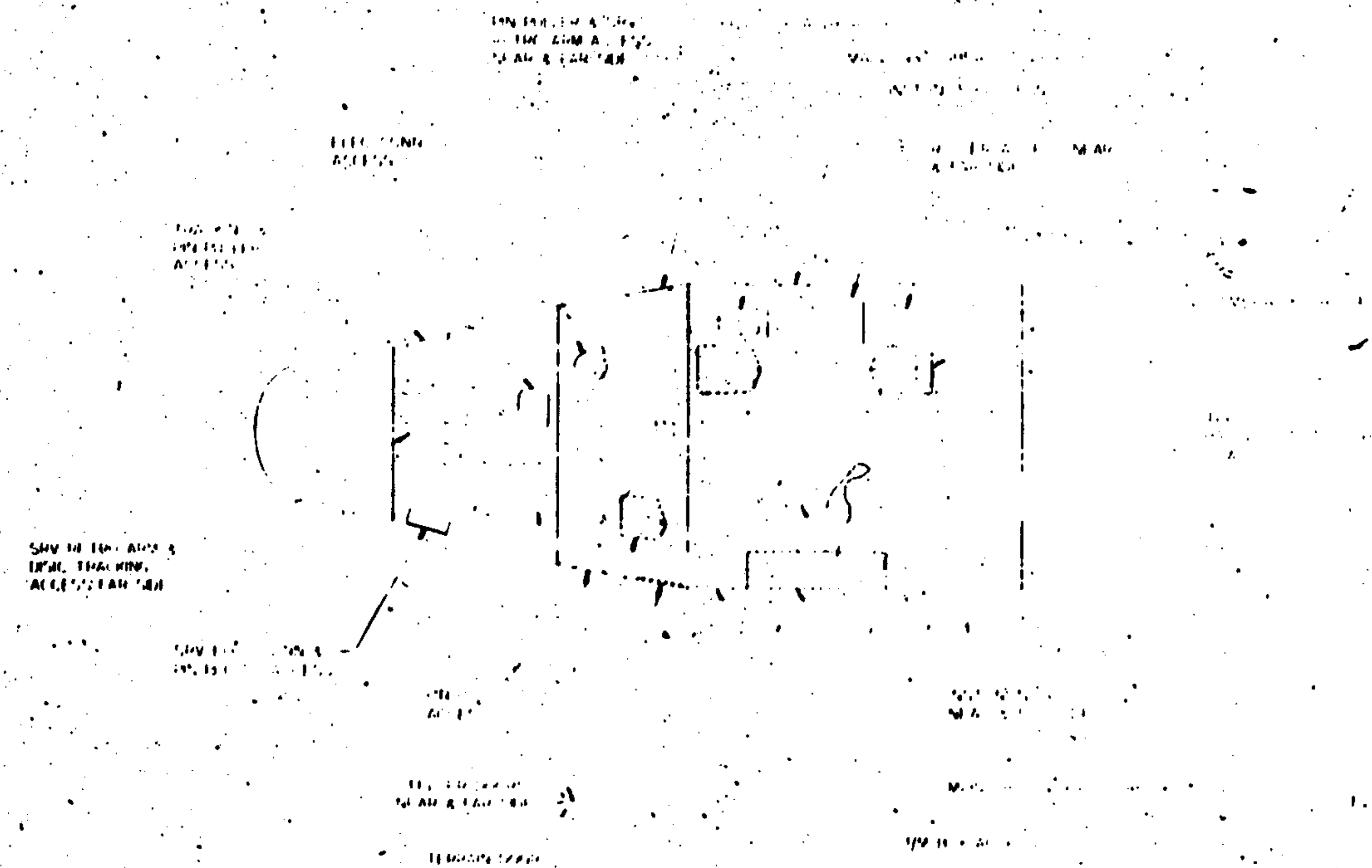

Figure C-3 Access and Blow-Off Doors

[redacted]

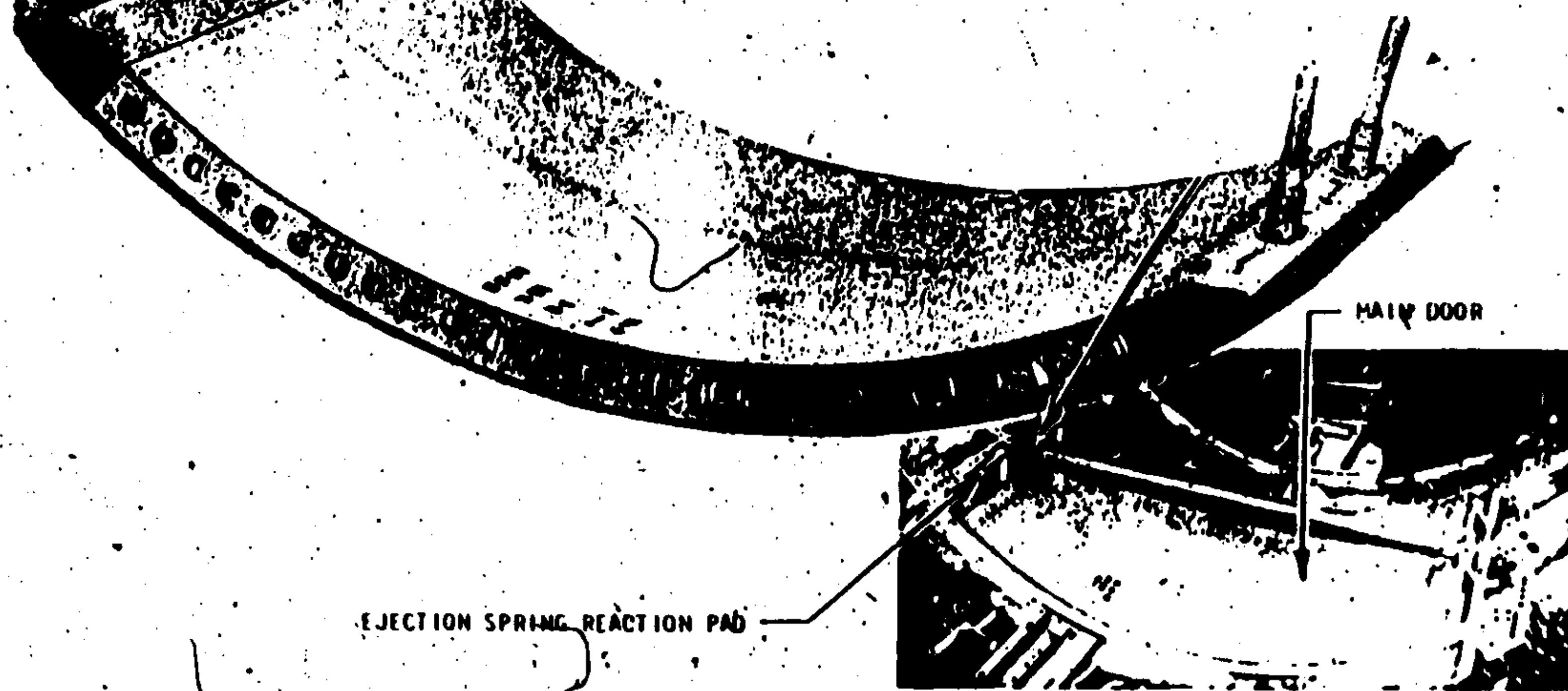

Figure C-4 Main Door

C-2.2.2 Small Blow-Off Doors

The construction of the small blow-off doors is shown in [redacted] Figure C-5. Doors in the barrel are honeycomb-reinforced and [redacted] designed to withstand burst pressure loads. Doors in the conic a[redacted] single-sheet construction and designed to withstand collapse-pres[redacted] sure loads. The doors are retained by two hook fittings at one e[redacted] and by a door ejector at the other end. At ejection, one end of th[redacted] door is kicked outboard by the door ejector and the door pivots fr[redacted] about the hook fittings. (See Section P.)

C-2.2.3 Pin Puller

The pin puller retracts a pin from a clevis and releases [redacted] the item being held. (Figure C-6 shows a picture and a sectional [redacted] drawing of the pin puller.) The pin puller uses two standard M-1[redacted] squibs (see Section P). An electrical signal detonates the squibs [redacted] which generates a hot gas to force the pin to retract. The force [redacted] from a single squib is sufficient to retract the pin. The pyro gas[redacted] are sealed within the device. Nine pin pullers are used in the J-[redacted] system at four locations as follows:

a. Two for the A SRV
b. Two for the B SRV
c. Three for the fairing
d. Two for the main CR instrument door

C-2.2.4 Door Ejector

The door ejector is a pyro-actuated retaining and ejectio[redacted] device. (Figure C-7 shows a picture and cross-section drawing [redacted] the door ejector.) The door ejector uses two standard M-11 squi[redacted] which are detonated by an electrical signal (refer to Section P). [redacted] force from a single squib is sufficient to extend the piston, shear [redacted] the pin, and eject the device being held. The pyro gases are seal[redacted]

[redacted]

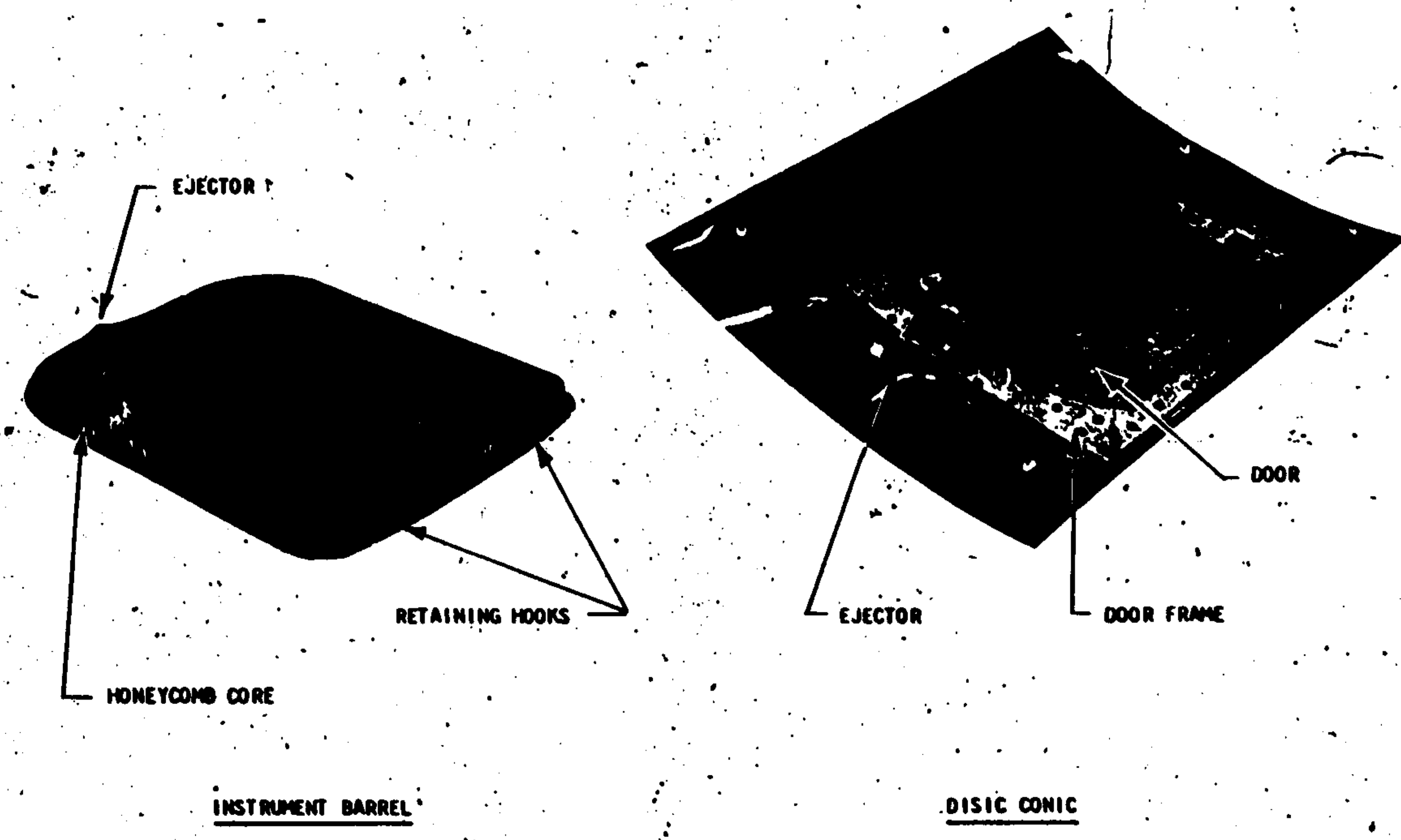

Figure C-5 Small Blow-Off Doors

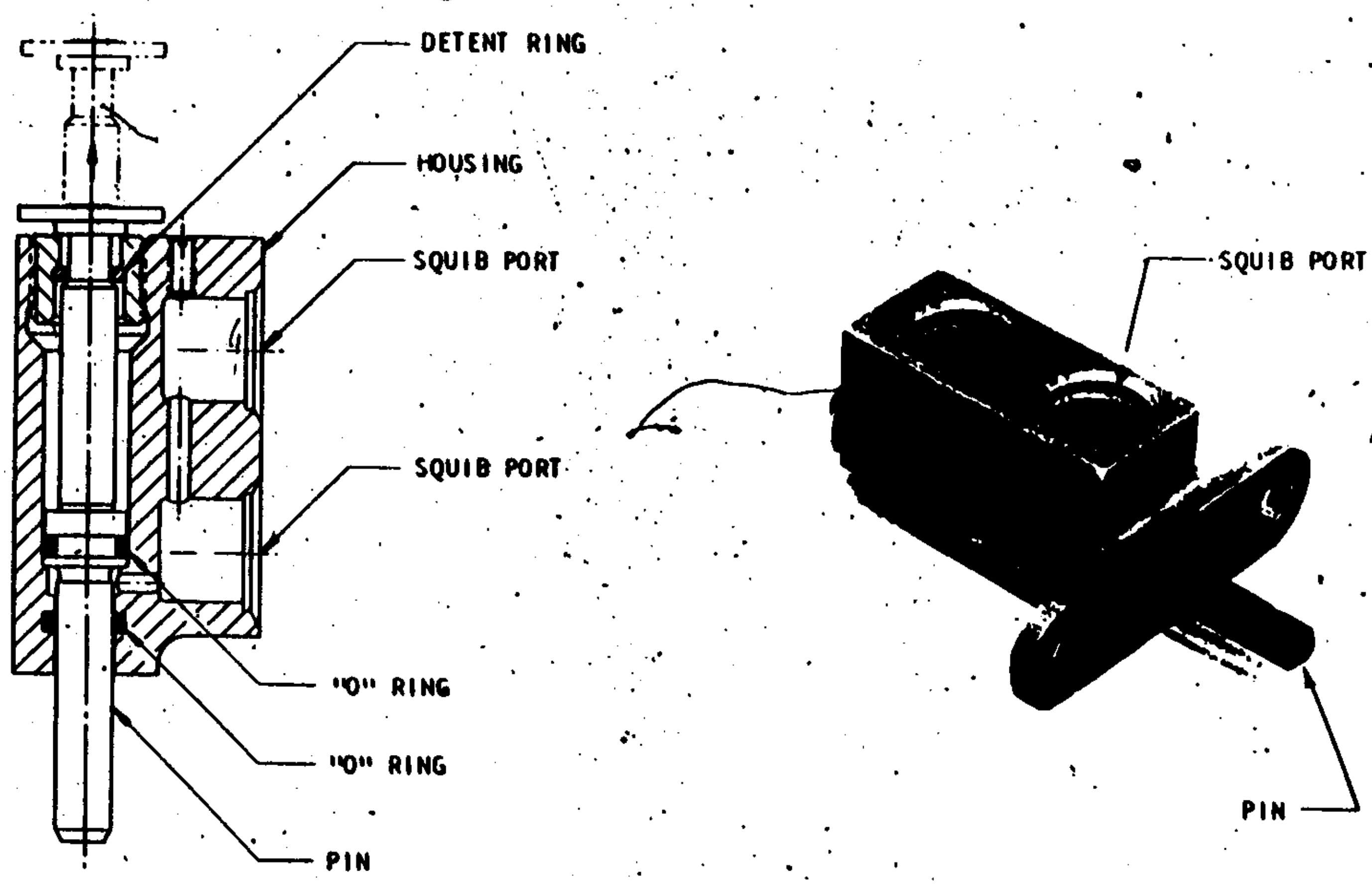

Figure C-6   Pin Puller - J-3

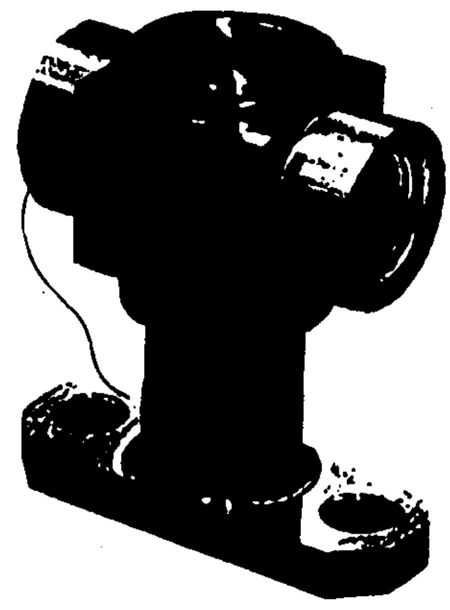

Figure C-7 Door Ejector - J-3

within the device. Door ejectors are used in the following seven places in the J-3 system:

a. Four for the horizon optics doors(one per door)

b. Two for the DISIC stellar doors (one per door)

c. One for the DISIC terrain door

C-2.2.5 Acess Doors

A total of sixteen access doors are provided for system test and flight readiness requirements. (The doors are located as shown in Figure C-3.) There are four doors in the fairing, four doors in the conic, and eight doors in the instrument barrel.

C-2.3 Venting Provisions

Location and description of the venting provisions are shown in Figure C-8. The pressure diaphragm valve opens at 0.3 psi differential pressure, and allows air to escape from the payload cavity into the Agena forward section during ascent. Horizon and stellar boot vents equalize the pressure between the boot cavities and the payload cavity, to reduce the pressure differential across the boots. The main boot area is vented through the main instrument labyrinth.

C-2.4 Light-Tightness

The payload vehicle structure provides a light-tight enclosure for the camera system. The DISIC film path is fully chuted as a back-up light seal, due to the greater sensitivity of the stellar films. No chutes are required for the CR instrument film paths.

C-2.4.1 Light Sealing Provisions

Light-sealing provisions are shown in Figure C-9. An interface lip provides a light seal between the payload vehicle structures. The joints around all openings are sealed with various

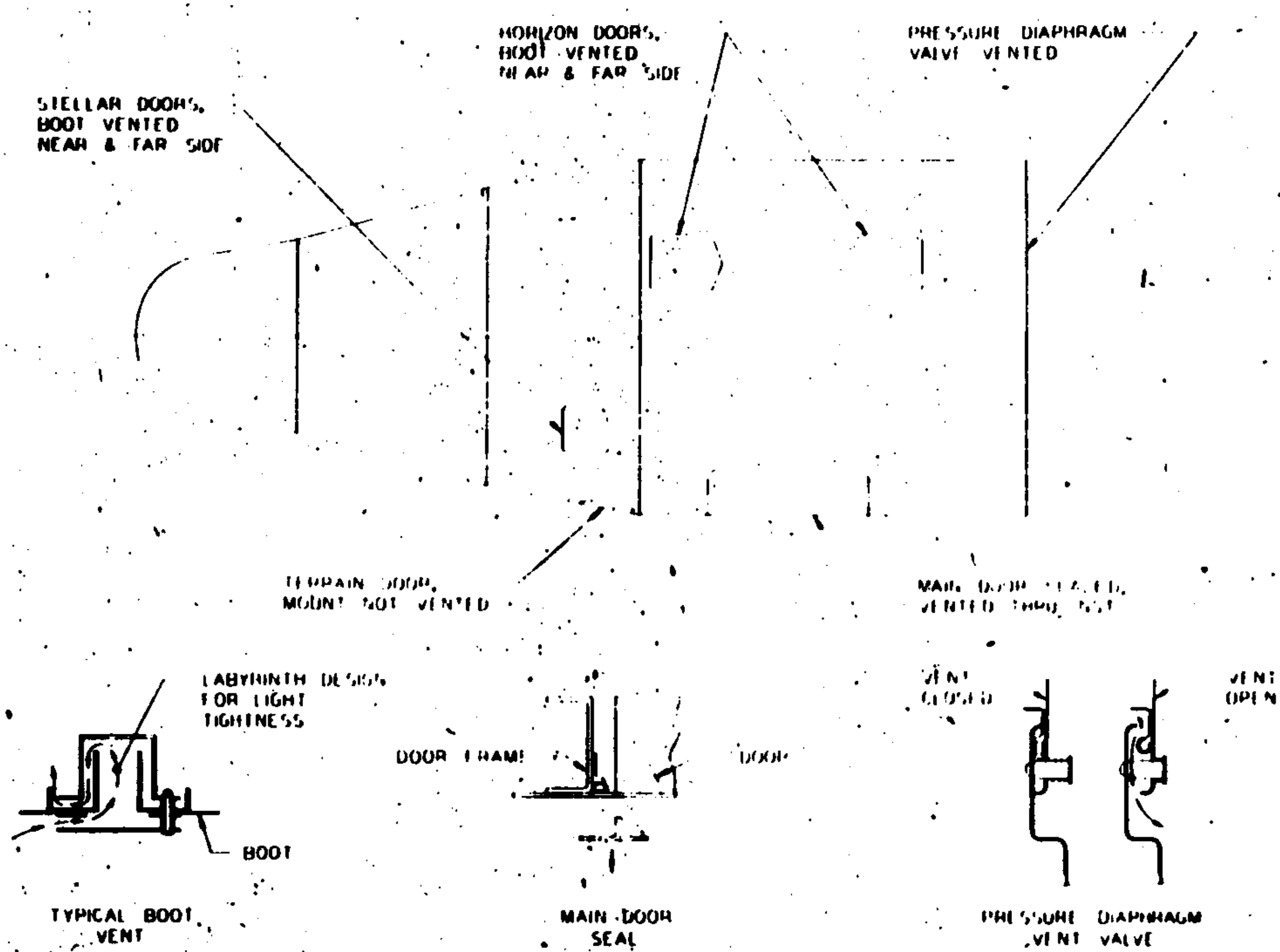

Figure C-8 Venting Provisions

[redacted]

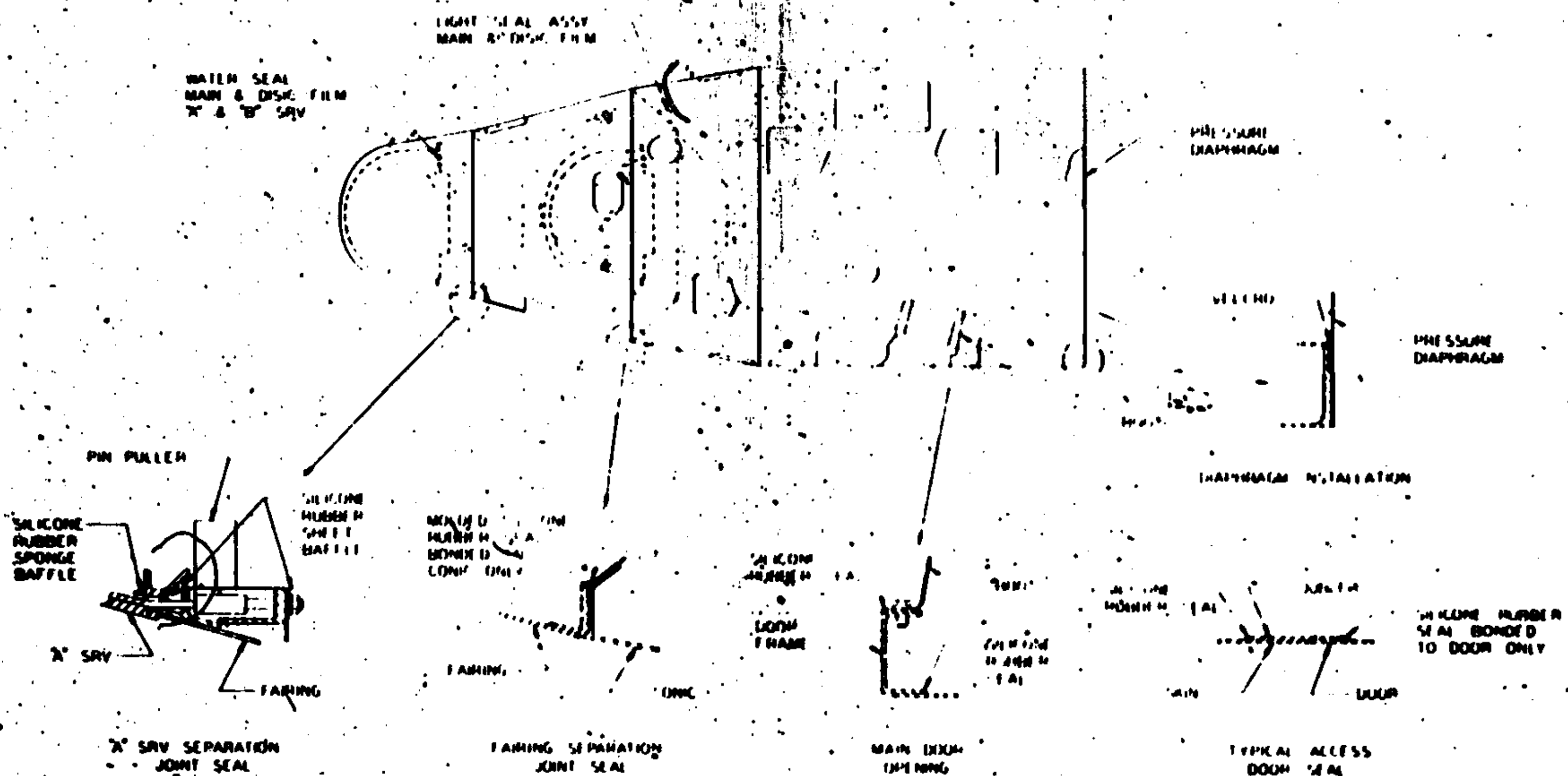

Figure C-9 Light Sealing Provisions

forms of silicone rubber. The pressure diaphragm uses a labyrinth valve in its center and a Velcro seal around the periphery.

Optical door openings are fully booted. Labyrinth-type air vents are provided in each boot except the DISIC terrain boot and main instrument boot. Two pyro-actuated trap-door payload seals close off the film slots in the support cone for the B SRV to maintain a light-tight enclosure after separation of the A SRV. Two pyro-actuated water seals in the cover of each recovery capsule close off the film slots at the time of SRV separation.

C-2.4.2 Light-Leak Testing Provisions

Figure C-10 shows the light-leak testing provisons provided in the J-3 payload system structure. Four photometer ports are provided for light-leak testing. These ports are sealed with light-tight plugs when the photometers are removed at the conclusion of the light-leak tests. See Sections T and V.

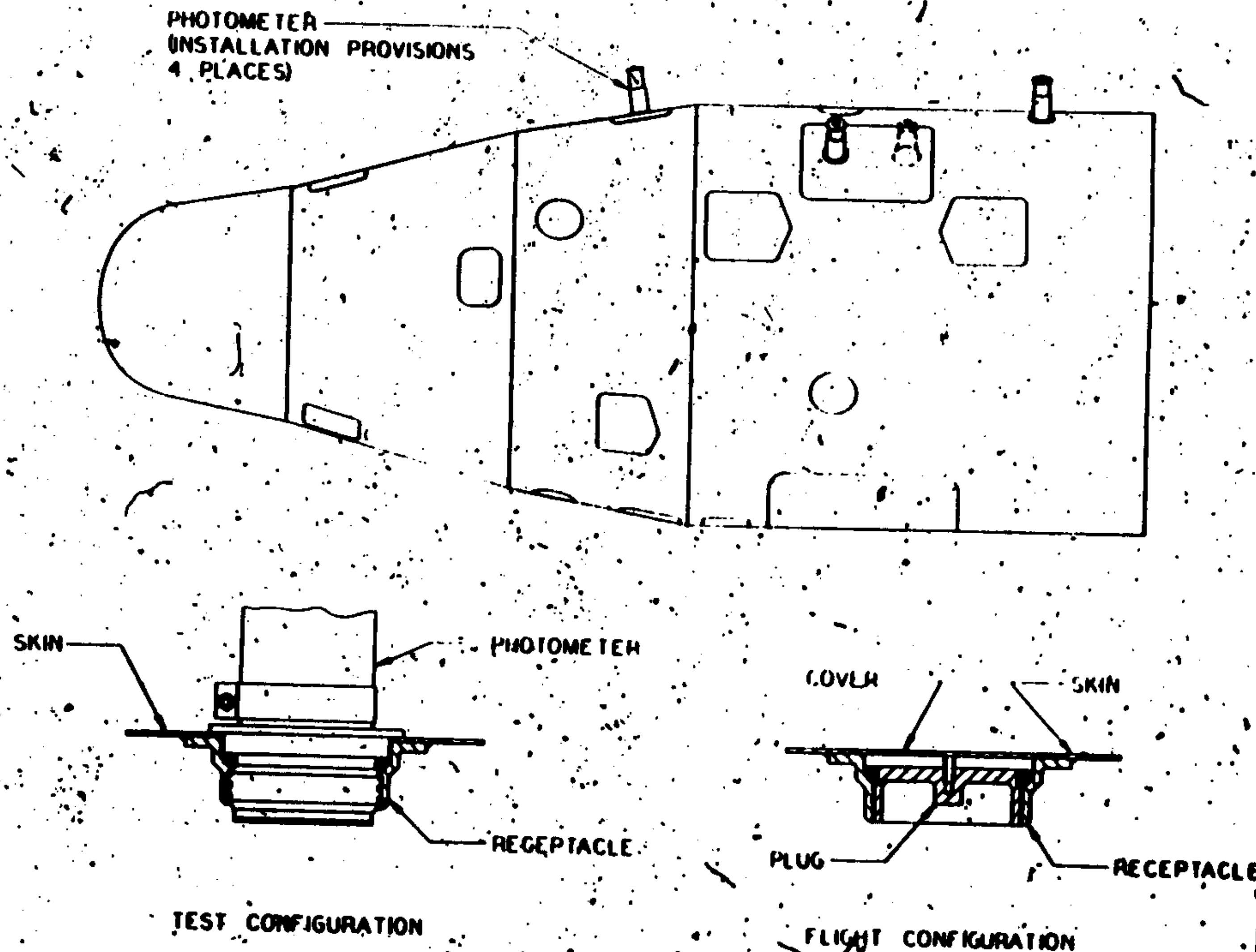

Figure C-10 Light-Leak Test Provisions

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SECTION D

THERMAL CONTROL SUBSYSTEM

D-1.0 PURPOSE

The purpose of the thermal control subsystem is to maintain required internal temperature in the J-3 system. Passive techniques and methods are used to maintain the temperatures of specific components as required.

D-2.0 CHARACTERISTICS

D-2.1 Thermal Control Analysis

Orbit and ascent thermodynamic studies have been made to determine the thermal environment to which the J-3 system may be exposed, and to control the payload temperatures within specified limits for all phases of the flight. The analytical techniques, which involve the use of the IBM 7094 and Univac 1108 digital computers, should predict temperatures within ± 10 degrees of the actual flight data.

D-2.2 J-3 Orbital Temperature Requirements

The temperature limits for J-3 components are presented in Table D-1.

Table D-1 J-3 Orbital Temperature Requirements

- CR INSTRUMENT -- 70 ± 30°F
  - LENS CELL -- 70 ± 10°F (SYSTEM GOAL)
- DISIC INSTRUMENT -- 70 ± 30°F
  - ELECTRICAL BOXES -- 0 - 125°F
- MECHANICAL COMPONENTS -- 0 - 125°F

Table D-1 , Continued

- PAYLOAD STRUCTURE OVER ALL -- MAINTAIN INSTR. 70 ± 30°F
- SRV VEHICLE:
  - PAN TAKEUP -- 40 - 100°F
  - DISIC TAKEUP -- 40 - 100°F
  - RECOVERY BATTERY AT ACTIVATION -- 60° F MIN.
  - TM BATTERY AT ACTIVATION -- 20°F MIN.

D-3.0 GENERAL DESCRIPTION

D-3.1 Passive Thermal Control Systems

D-3.1.1 Early J-3 Systems

Early J-3 systems CR-1 through CR-5 will use the passive features shown in Figures D-1 and D-2. The structure is gold-plated inside and outside. The exterior of the structure is then painted with a silicone elastomer to place white paint stripes on the gold background in the +Y and -Y quadrants, and solid black paint completely covering the +Z and -Z quadrants. An aluminum foil thermal shield is clipped to the interior of the structure. The aft end of the payload vehicle is thermally controlled by the aluminum pressure diaphragm. An aluminized thermal curtain in the fairing covers the opening exposed by A SRV separation.

D-3.1.2 Later J-3's

J-3 systems CR-6 and up will use the no-gold passive thermal control surface shown in Figure D-3. The advantages of this type of thermal control are as follows:

a. More consistent thermal optical properties for closer control of on-orbit temperature.

b. Elimination of corrosion, which has been a consistent problem with the gold surfaces.

c. Reduction of manufacturing costs.

[redacted]

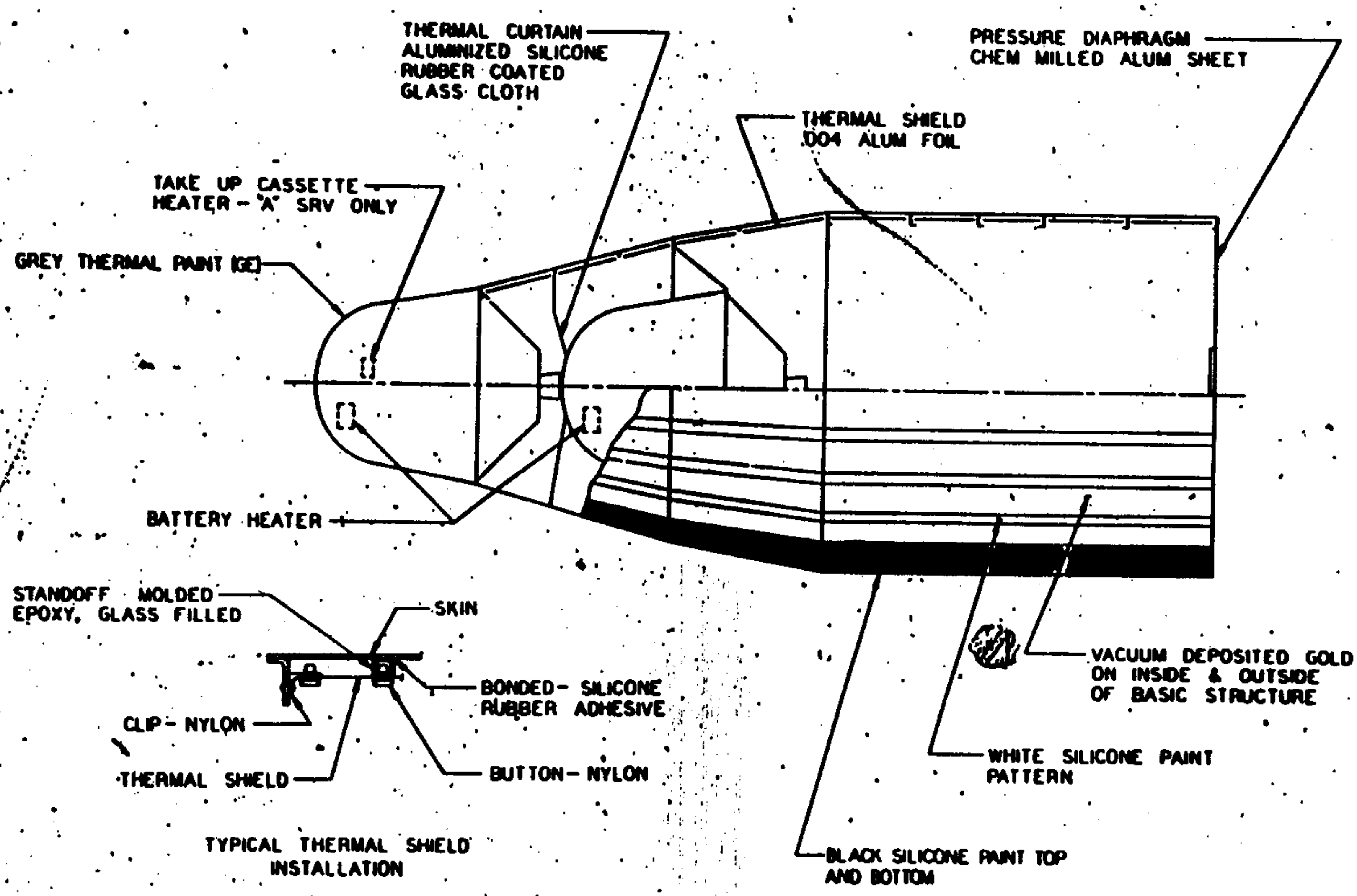


Figure D-1 J-3 System Thermal Control - CR-1 through CR-5

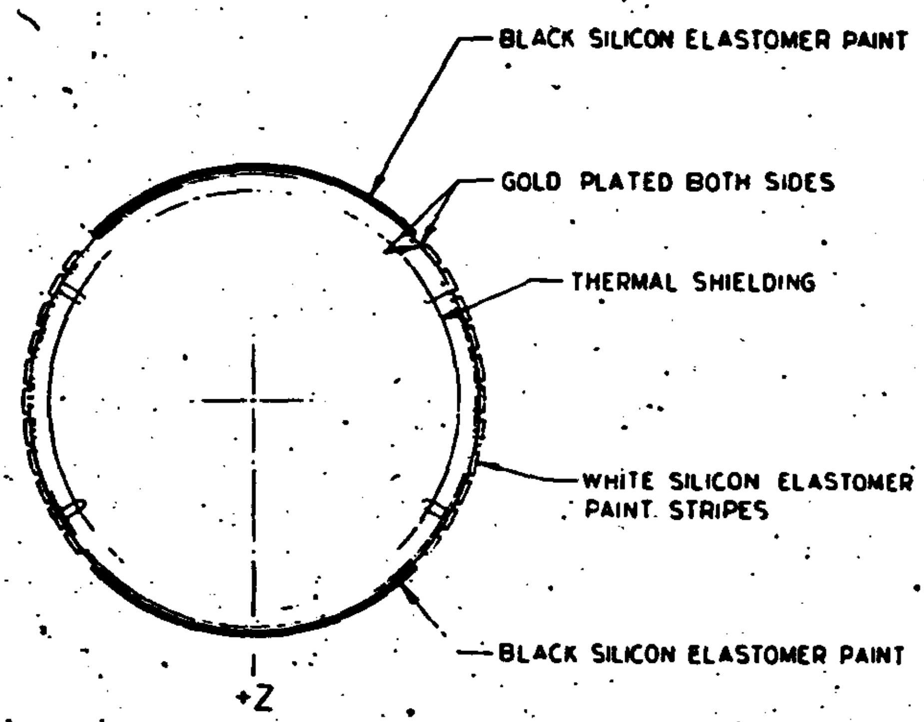


Figure D-2 J-3 System Thermal Control System CR-1 through CR-5

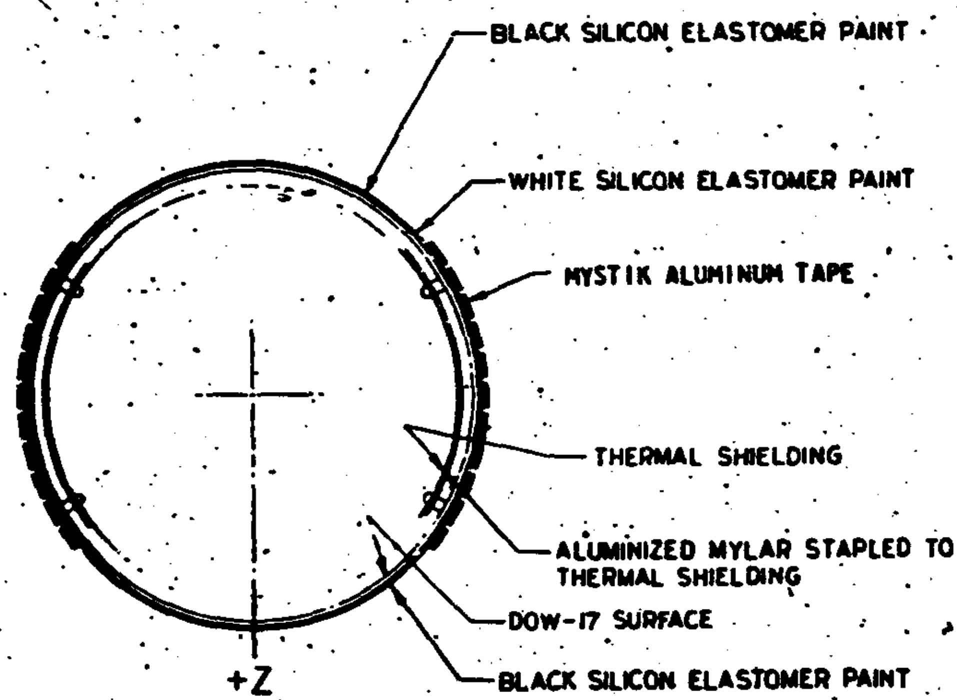


Figure D-3 J-3 No-Gold Paint Pattern, CR-6 and Up

The exterior surface consists of 50 percent black silicone paint, 10 percent white silicone paint, and 40 percent Mystik aluminum tape. The interior of the structure has a Dow-17 finish. The absence of gold is compensated for by two additional layers of aluminized Mylar superinsulation stapled to the thermal shielding.

D-3.2 <u>Active Thermal Control</u>

Active thermal control features used include a thermostatically controlled cassette heater in the A SRV only, and recovery battery heaters in both the A and the B SRV's which actuate one orbit before SRV separation to assure the required voltage in the recovery battery. The operating details concerning the heaters are covered in detail in Section L, Command.

D-4.0 THERMAL ANALYSIS

D-4.1 <u>Maximum Predicted J-3 Ascent Temperatures</u>

The maximum predicted ascent temperatures for the payload vehicle are plotted in Figure D-4. This plot shows the maximum predicted temperature to occur at the forward end of the fairing, and to be in excess of 600^{o}F.

The time after liftoff that the maximum predicted ascent temperature occurs is plotted in Figure D-5. This figure shows the maximum fairing temperature to occur about 230 seconds after liftoff.

D-4.2 <u>Typical Temperature Variations for One Orbit</u>

Figure D-6 shows the typical temperature variation during one orbit of a J-1 flight. The J-3 system temperature variation is similar, because the thermal environment and the mechanical and electrical systems are thermally similar.

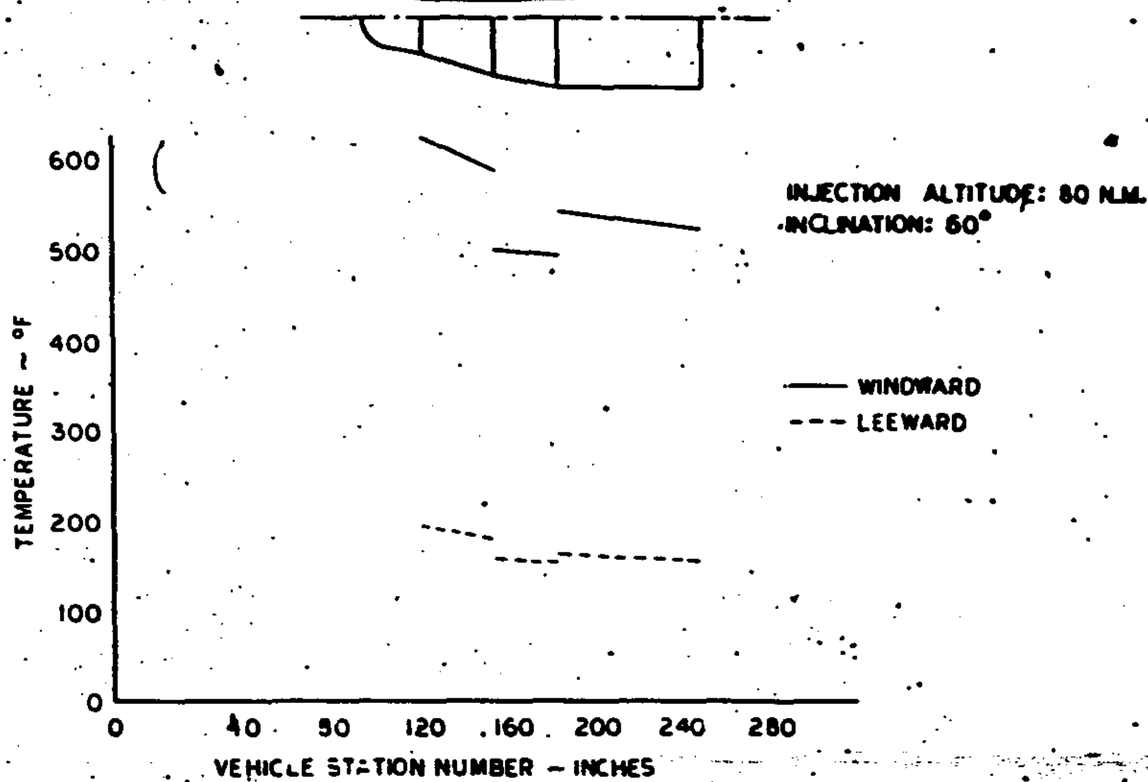


Figure D-4 Maximum Predicted Ascent Temperatures vs. Station

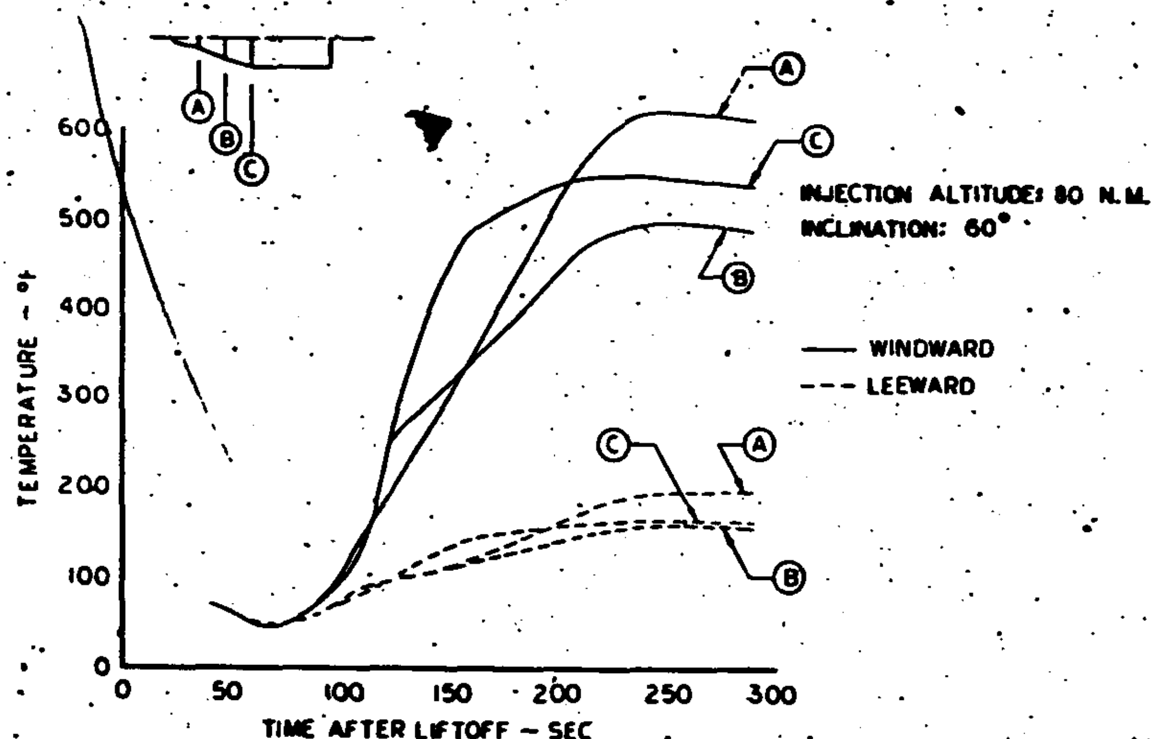


Figure D-5 Maximum Predicted Ascent Temperatures vs. Time

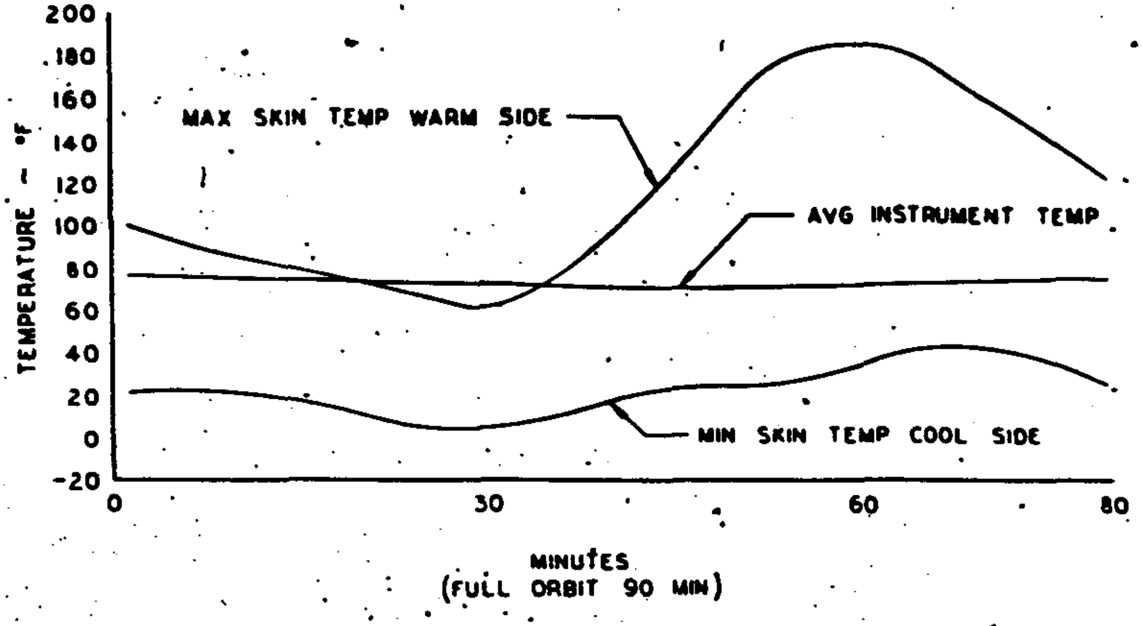


Figure D-6 Typical Thermal Variations for One Orbit (From J1 System J38)

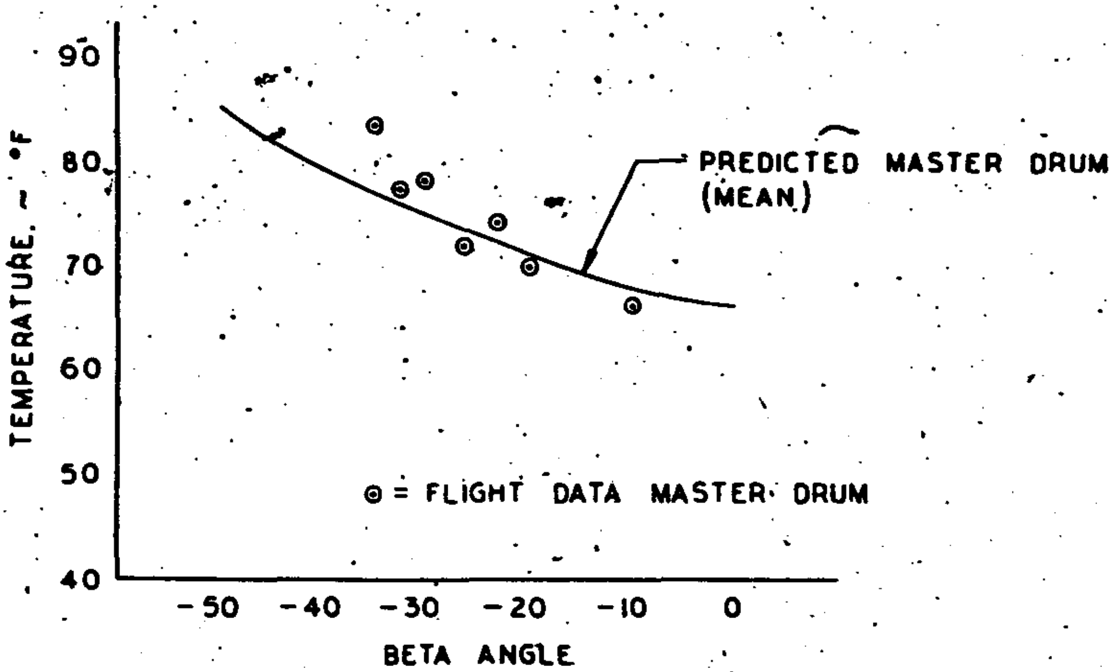


Figure D-7 Temperature Variations for a Typical Mission

D-4.3 Temperature Variation with Mission Life

Figure D-7 shows the temperature variation of one component (the master drum) over a particular J-1 14-day mission where the Beta angle varied from -35 to -10 degrees. Both the predicted and the actual flight data points are plotted for comparison. The J-3 system behavior is similar to this plot, since the orbit conditions are comparable.

D-5.0 MANUFACTURING CONSIDERATIONS

D-5.1 Paint Pattern

A standard thermal paint pattern is applied to the exterior of the payload vehicle during manufacture. See Section T.

At R-8, the orbital conditions to which the vehicle will be subjected are known and the thermal requirements are re-evaluated. If a modification of the standard paint pattern is required, this is done by adding white silicone rubber or Mystik aluminum pressure-sensitive tape.

The different absorptivity-to-emissivity ratios (of radiant thermal energy) of these two tapes are such that applications of the white silicone would induce higher energy transmission from the system and reduce temperatures. Conversely, the metallic tape would retard energy transmissions and elevate system temperature.

[redacted]

SECTION E

INTERFACE - ELECTRICAL AND MECHANICAL

E-1.0 PURPOSE

The purpose of J-3 interface is to define the diverse systems, subsystems, and components utilized in J-3, with the objective of mating the electrical and mechanical interface into a functional unit. The integration of such mutual interfaces is reached through technical agreements of understanding among the various associates.

E-2.0 SUMMARY DATA

The following figures illustrate the electrical and mechanical interfaces: Figure B-6, Agena Inboard Profile; Figure E-1, J-3 P/LV Inboard Profile; Figure E-2, Electrical Equipment Installation; and Figure E-3, Interconnection Diagram.

E-3.0 ELECTRICAL INTERFACE WITH AGENA AND ASSOCIATES

E-3.1 <u>Agena Interface - T3-5-023</u>

E-3.1.1 Pyrotechnic system - T3-6-041

a. Two plugs at Payload Agena interface.

(1) Pyro power connector - provides all pyro power, shield tie points, pyro returns, and the continuity loop.

(2) Pyro signal connector - provides all recovery signals, door eject signals, A to B Transfer signals, and a continuity loop.

b. Pyro J-Box

(1) Located in the conic section

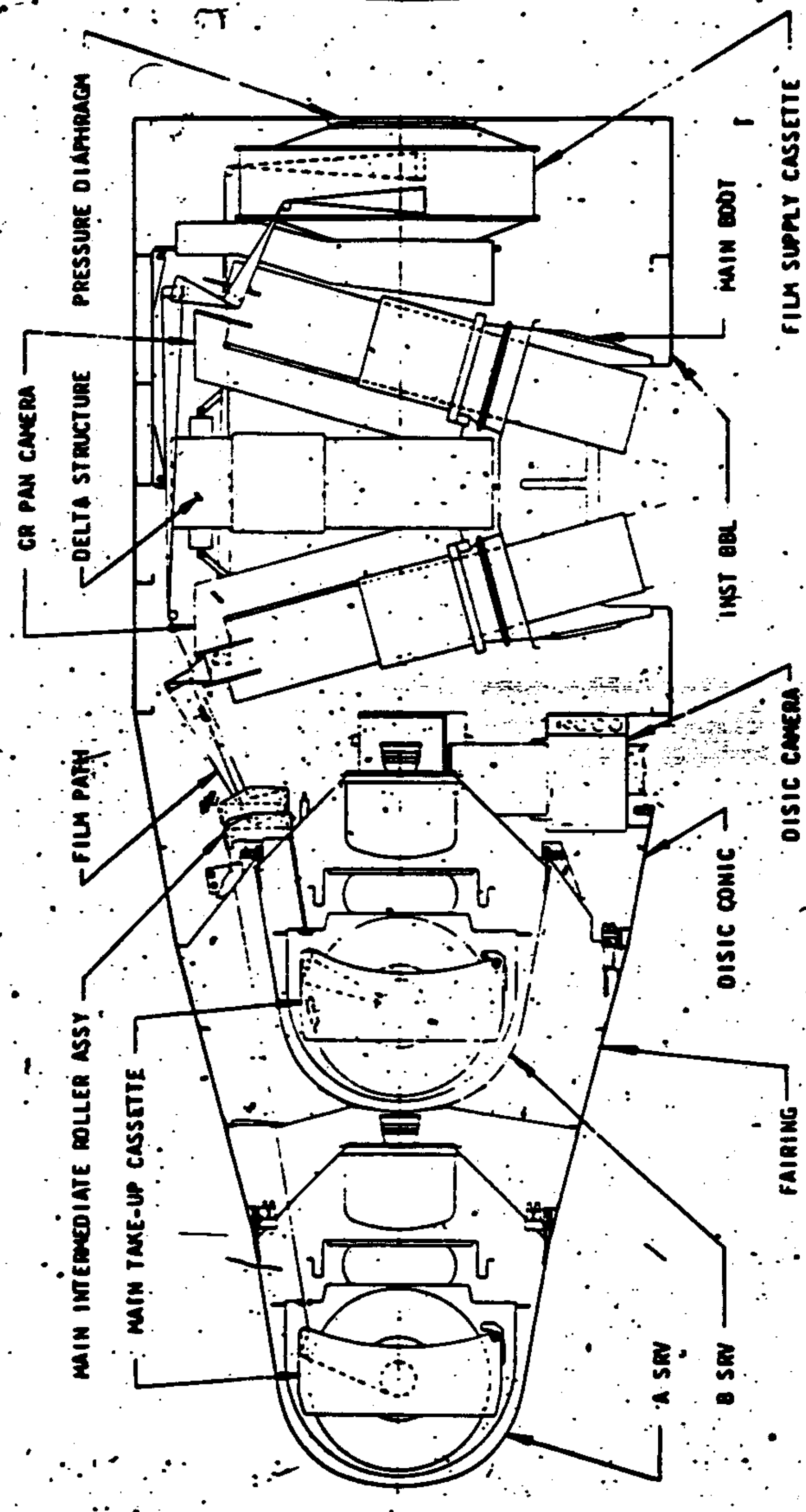


Figure E-1 J-3 P/LV Inboard Profile

C ~~TOP SECRET~~ [redacted]

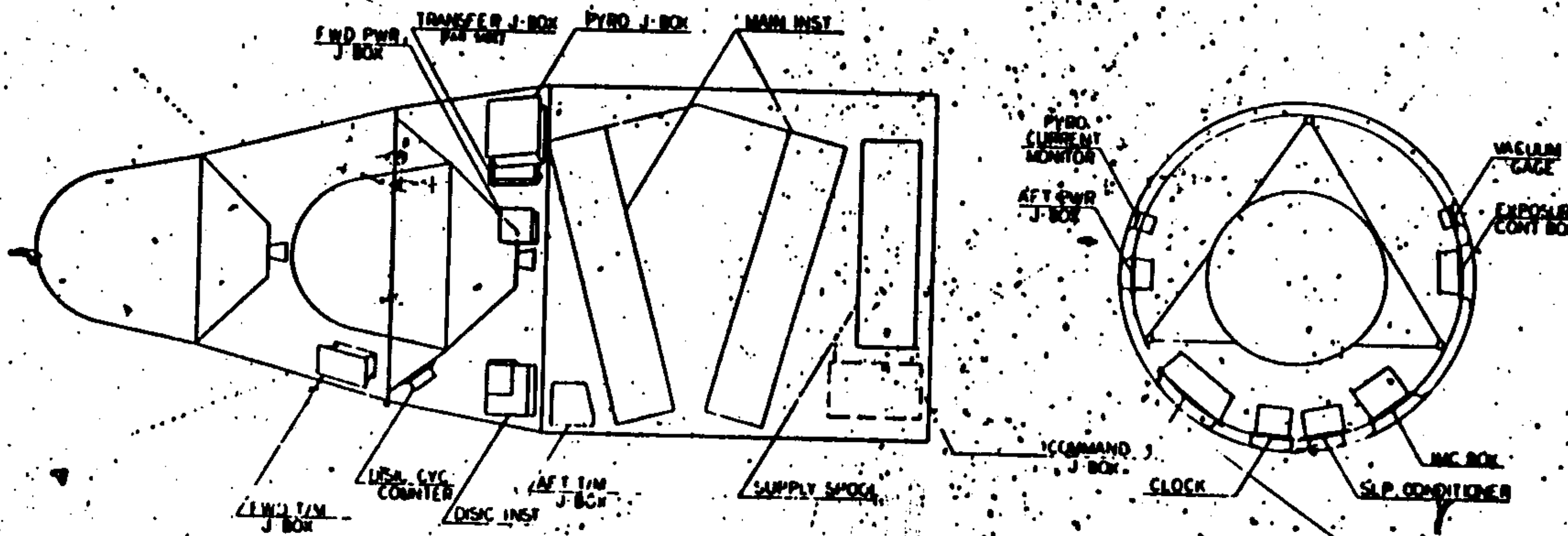


Figure E-2 Equipment Installation - Profile

[redacted]

C ~~TOP SECRET~~ [redacted]

[redacted]

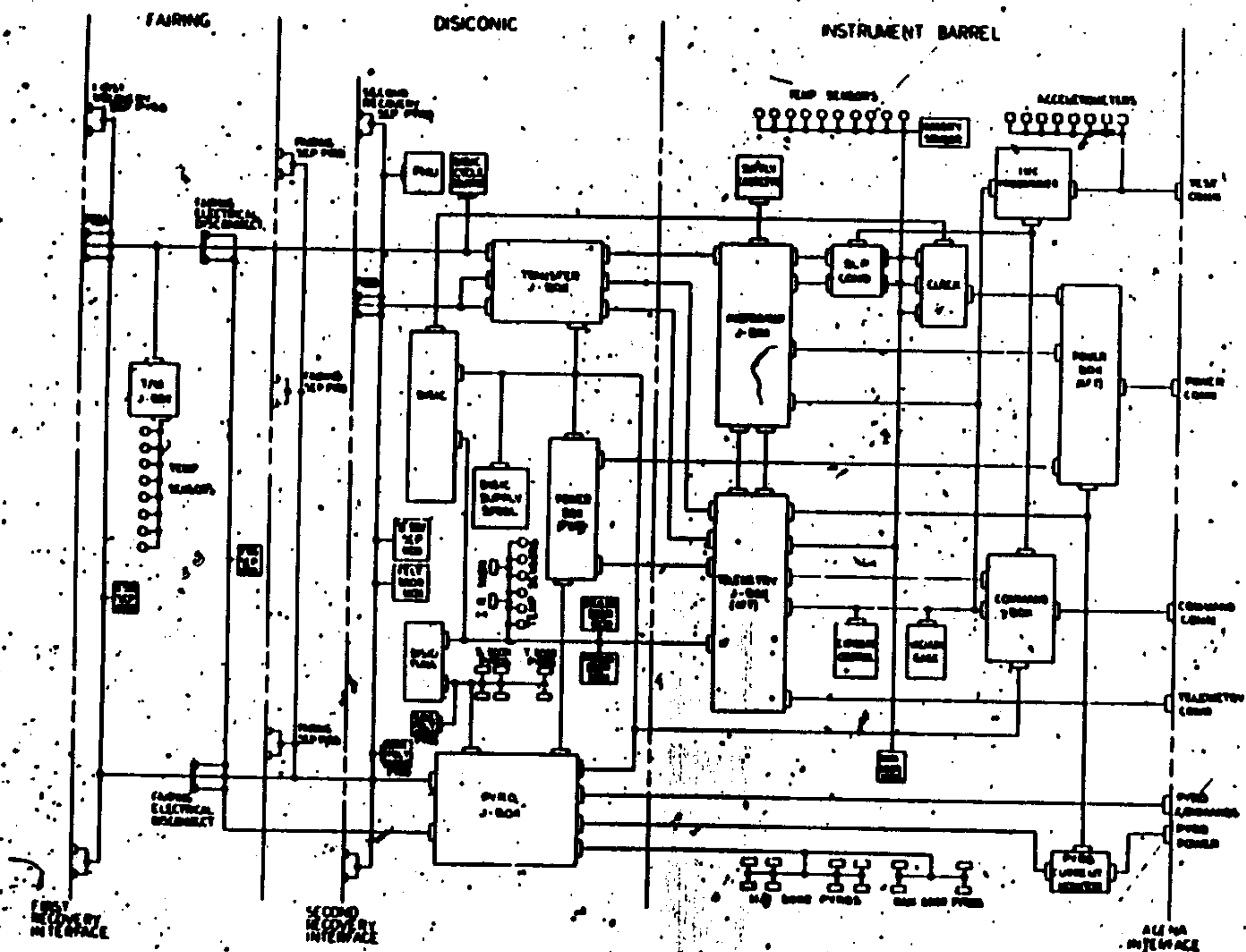


Figure E-3 Interconnection Diagram

(2) Ejects all port covers during ascent coast phase.

(3) Transfers A mission to B mission for both CR and DISIC payloads while in orbit.

(4) Effects separation of the A SRV, the fairing, and the B SRV from the A/P payload.

(5) Disconnects the electrical interface connectors between these subsystems.

(6) Provides signals to the SRV pyrotechnic devices to initiate the de-orbit phase of the recovery modes.

E-3.1.2 Power system - T3-6-033

a. One plug at Payload Agena interface.

(1) Power connector - provides all primary power for payload, with the exception of pyro power. +24 VDC unregulated and return; 115 V, 400 Hz, ∅ A; 115 V, 400 Hz, ∅ C; 115 V, 400 Hz, ∅ B Ret; and an AC shield tie point.

b. Power J-Boxes (forward and aft)

(1) Two power J-boxes - the aft box is located in the aft end of the instrument barrel. The forward box is located in the conic section.

(2) All payload electrical power, except for some back-up devices and recoverable payloads, is supplied from the central power system located in the Agena.

(3) All regulated power, and voltages other than 24 VDC unregulated or 115 VAC, 400 Hz, is generated or conditioned by the subsystem units.

(4) Power distribution is such that each subsystem

unit receives power from the main power bus.

E-3.1.3 Command System

a. Two plugs at Payload Agena interface

(1) Command connector - provides all UNCLE commands from the Agena UHF command link, ANA commands from the Agena S-Band beacon, the stored program commands from the Agena H-timer, the payload to Agena tape recorder track 1 and track 2, and a tape recorder shield return.

(2) Command connector - a second command connector is added on CR-6 and up, to provide for the additional commands required for the new command system.

b. Command box - T3-6-042

(1) Located in the aft instrument barrel.

(2) Provides a program of instrument operations.

(3) Provides a selection of the programmed instrument operations.

(4) Selects either, both, or neither instrument.

(5) Provides emergency instrument operate mode.

(6) Provides DISIC instrument operation control.

(7) Provides SRV A to B transfer commands.

(8) Provides command signal distribution for exposure control, yaw function, and FMC function.

c. Transfer box

(1) Located in the conic section.

(2) Provides distribution points and relays for A to B Transfer functions.

d. Slope programmer (image motion compensation subsystem) - T3-6-030

(1) Located in the aft instrument barrel

(2) Provides an eccentricity function generator and an oblateness function generator which, when summed, generates a forward motion compensation function to control the CR instruments cycle and nodding rates.

(3) Provides cross track motion compensation in the form of a yaw error signal to the Agena guidance system.

e. Switch programmer (exposure control subsystem) - T3-6-054

(1) Located in the aft instrument barrel.

(2) Provides control of four exposure positions and a fail-safe position for the CR instruments.

(3) Provides one exposure change for DISIC.

(4) Sequences through exposure changes from night-to-day and day-to-night positions.

(5) Provides RTC control of timing system to compensate for launch window uncertainties and/or delays.

E-3.1.4 Instrumentation system

a. One plug at Payload Agena Interface

(1) Telemetry connector - provides all monitors to the Agena telemetry system, the multiplexed signals, commutator wiper signals, payload umbilical commands and monitors, relay reset, T/M signal return, T/M shield tie, and Link I T/M on signal.

b. Aft T/M box - T3-6-029

(1) Located in the forward end of the instrument barrel.

(2) Provides operational data and diagnostic measurements thru six continuous channels and four commutated channels.

(3) Contains the associated components necessary to operate the recoverable tape recorder.

(4) Contains the patching and multiplexing of T/M monitor signals.

(5) Contains power supplies for T/M system.

(6) Provides T/M control.

c. Fwd T/M box

(1) Located in fairing.

(2) Contains multiplexing and temp sensor power distribution for measurements located in fairing.

d. DISIC cycle counter

(1) Located in the conic section.

(2) Counts the operation of the DISIC cam switch and establishes monitoring voltages for readout of cycle count over T/M.

e. Current monitors

(1) Pyro current monitor located in aft end of instrument barrel.

(2) 24 V unregulated current monitor located in aft power box.

f. SLP Conditioner

(1) ~~Located in the aft end of the instrument barrel.~~

(2) Conditions and sequences clock parallel binary time word to SLP data heads in the CR instruments.

(3) Provides 30 bit index, time word, complement of time word, and parity utilizing three columns of data head for each instrument.

(4) Has capability for two distinct variable column drive durations to provide proper dot intensity for various film ASA speeds.

(5) Utilizes solid-state micrologic-integrated circuits for gating and sequencing.

g. Tape recorder system

(1) Tape recorder located in each SRV; A/D multiplexer and electronic commutator located in aft T/M box.

(2) Records data from two main sources - (1) the output of an A/D multiplexer that contains the Agena thrust monitor data, serial time word from the clock, and two electronic commutator outputs, and (2) the output of two pulse stretchers driven by clock sync outputs activated by the main instruments center of format pulses.

(3) The digital clock sync is time-based from the A/D converter, and a 10 KC pulse is recorded on both channels.

E-3.2 Associate Interface

E-3.2.1 Constant rotator system - T3-5-019

a. Thirteen plugs at CR-A/P interface.

(1) Command connector - contains all CR operate commands from the command system, slope programmer, and switch programmer.

(2) Power connector - contains the 24 V unregulated 115 VAC, 400 cps power, and returns to the CR instrument.

(3) T/M connector (#1) - contains all T/M monitors and excitation voltages for CR #1 instrument.

(4) T/M connector (#2) - contains all T/M monitors and excitation voltages for CR #2 instrument.

(5) Take-up control connector - contains voltages and returns and commands to the take-up from the CR instrument system.

(6) Data connector (#1) - contains the clock parallel binary time word from the SLP conditioner to the SLP data head in the CR #1 instrument.

(7) Data connector (#2) - contains the clock parallel binary time word from the SLP conditioner to the SLP data head in the CR #2 instrument.

(8) Take-up connector (A SRV) contains the control voltages, heater power, T/M excitation, and TM monitors to the CR instrument system from the A SRV.

(9) Take-up connector (B SRV) - contains the control voltages, heater power, T/M excitation, and T/M monitors to the CR instrument system from the B SRV.

(10) Supply spool connector - contains controls, and
(11) power, and T/M to the supply spool cassette from the CR instrument system.

(12) Intermediate roller monitor #1 connector - contains excitation and monitor information from the IR to the CR instrument system.

(13) Intermediate roller monitor #2 connector - contains excitation and monitor information from the IR to the CR instrument system.

E-3.2.2 DISIC system

a. Six plugs at the DISIC-A/P interface.

(1) Power and command connector - contains the operating, mode, capping, cassette motor excitation, and brake release commands; and 24 VDC unregulated.

(2) T/M connector - contains the DISIC operating and position monitors and temp sensors.

(3) Data connector - contains the time word from the clock to the DISIC.

(4) Supply cassette connector - contains power, brake release command, and switch closure for continuity loop.

(5) Take-up cassette A connector - contains T/M monitors and excitation to and from the A SRV.

(6) Take-up cassette B connector - contains T/M monitors and excitation to and from the B SRV.

E-4.0 MECHANICAL INTERFACE WITH AGENA AND ASSOCIATES

The principle mechanical interfaces are the mating surfaces of the J-3 payload with the Agena, the payload structure sections, the separation modules, the major assembly mounts, and the ground handling equipment attachment points. All major assembly and mating operations must be performed in accordance with approved procedures. For interface mechanical details, reference may be made to the following drawings:

[redacted] N/C Station 0.0 to 86.0
N/C Station 86.0 Aft
SRV Cover, T/U/G/S Roller and parachute

[redacted] SRV General

[redacted] Supply, Cassette, DISIC
Instrument Mount, DISIC
Stellar Baffle, DISIC
Exit Housing & Tuna, DISIC
S/C, Exit, T/U, and IR Roller, Main

[redacted] Main Door Boot
Main Instrument, Main Electrical Connections, Location

[redacted] Interface-Installation of Main Duct
Interface - Payload/Vehicle (Mech.)

SECTION F

CR INSTRUMENT SUBSYSTEM

F-1.0 PURPOSE

The purpose of the CR instrument subsystem is to provide, from a resonnaissance satellite, high-resolution stereoscopic photography having reconnaissance, cartographic, and geodetic evaluation capabilities.

F-2.0 CHARACTERISTICS

Table F-1 summarizes the CR instrument parameters to allow ready access to facts that describe the system physically and operationally.

Table F-1 Summary of Physical Features and Operational Parameters

PHYSICAL FEATURES	
CONFIGURATION:	30-DEGREE CONVERGENT STEREO PANORAMIC CAMERAS
LENSES:	24-INCH FOCAL LENGTH, PETZVAL DESIGN
FILM CAPACITY:	16,000 FEET OF 70 MM, 3.0 MIL POLYESTER-BASE FILM PER CAMERA
	24,000 FEET OF 70 MM, 2.0 MIL UTB POLYESTER-BASE FILM PER CAMERA
FILM SIZE (ONE FRAME):	31.632 X 2.754 INCHES
USABLE FORMAT:	29.323 X 2.147 INCHES
POWER	1,620 WATT-HOURS (24 VDC UNREGULATED AT 2.5 RADIANS PER SECOND

Table F-1 Cont.

WEIGHTS:	
SUBSYSTEM (EMPTY)	437 POUNDS
SUBSYSTEM (FULL)	
3.0 MIL FILM	598.6 POUNDS
2.0 MIL FILM (UTB)	591.2 POUNDS
TAKE-UP CASSETTE (EMPTY)	23 POUNDS
SUPPLY CASSETTE AND STRUCTURE	75 POUNDS
CYCLE PERIOD:	1.5 TO 4.2 SECONDS PER CYCLE
EXPOSURE TIME:	VARIABLE
OVERLAP:	FIXED - 7.6 PERCENT
FILTER:	VARIABLE (2 POSITION, 2 FILTER TYPES)
OPERATIONAL PARAMETERS	
V/H RANGE:	0.0525 TO 0.021 RADIANS PER SECOND
ALTITUDE:	80 TO 200 NAUTICAL MILES
CROSS-TRACK COVERAGE PER FRAME:	116 TO 290 NAUTICAL MILES
ALONG-TRACK COVERAGE PER FRAME:	7.73 TO 19.33 NAUTICAL MILES
TOTAL ALONG-TRACK COVERAGE AT 80 NAUTICAL MILES ALTITUDE:	
3.0 MIL FILM	41,167 NAUTICAL MILES
2.0 MIL FILM	61,750 NAUTICAL MILES
TOTAL OPERATING TIME AT 80 NAUTICAL MILES ALTITUDE:	
3.0 MIL FILM	169 MINUTES
2.0 MIL FILM	254 MINUTES

F-2.1 Location

The general locations of the major components of the CR instrument subsystem are shown in Figure F-1.

F-3.0 SYSTEM DESCRIPTION

A summary of the basic physical features and operational parameters is provided in Table F-1. Figure F-2 shows the

[redacted]

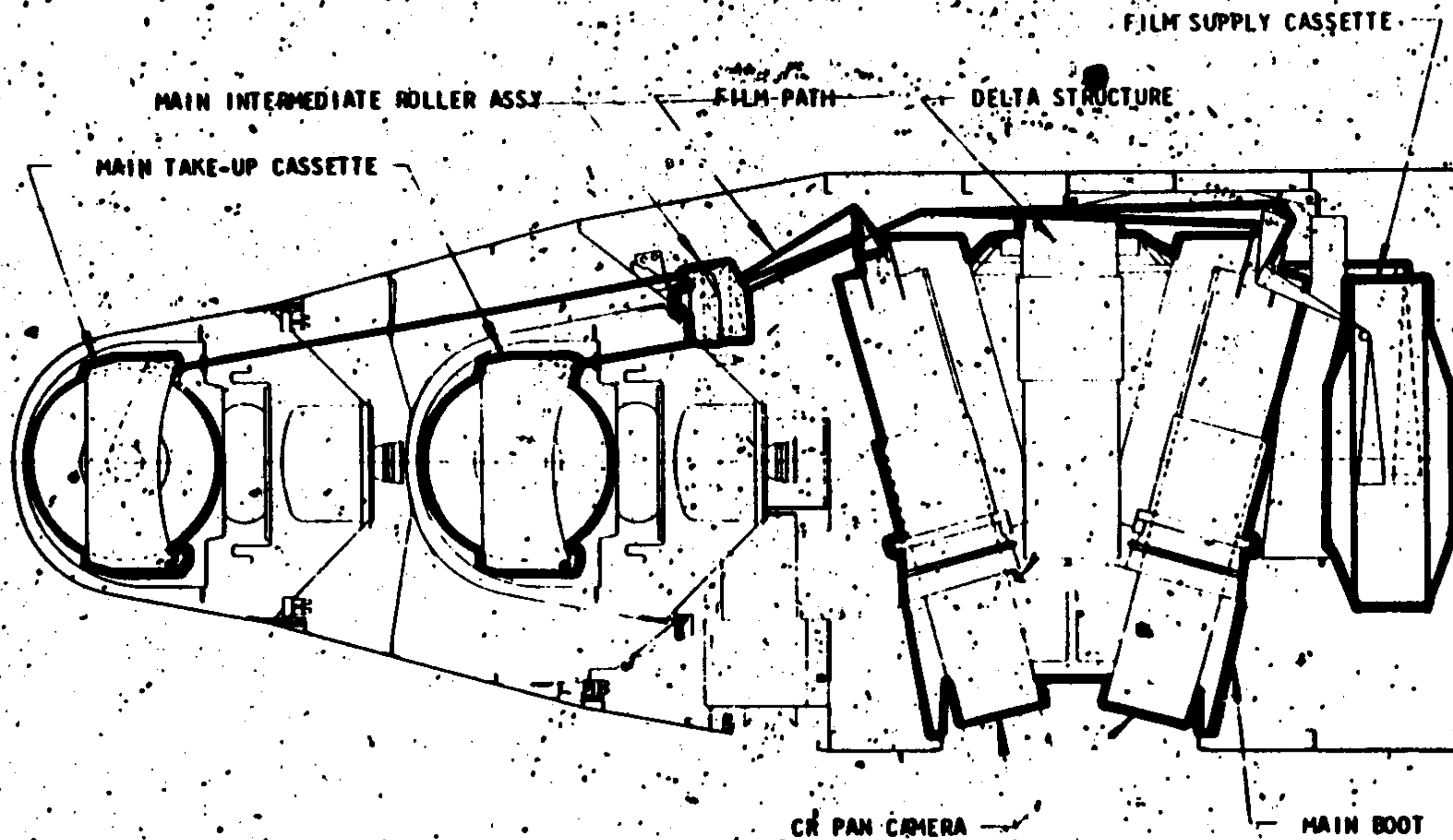


Figure F-1 Major Components of CR Subsystem

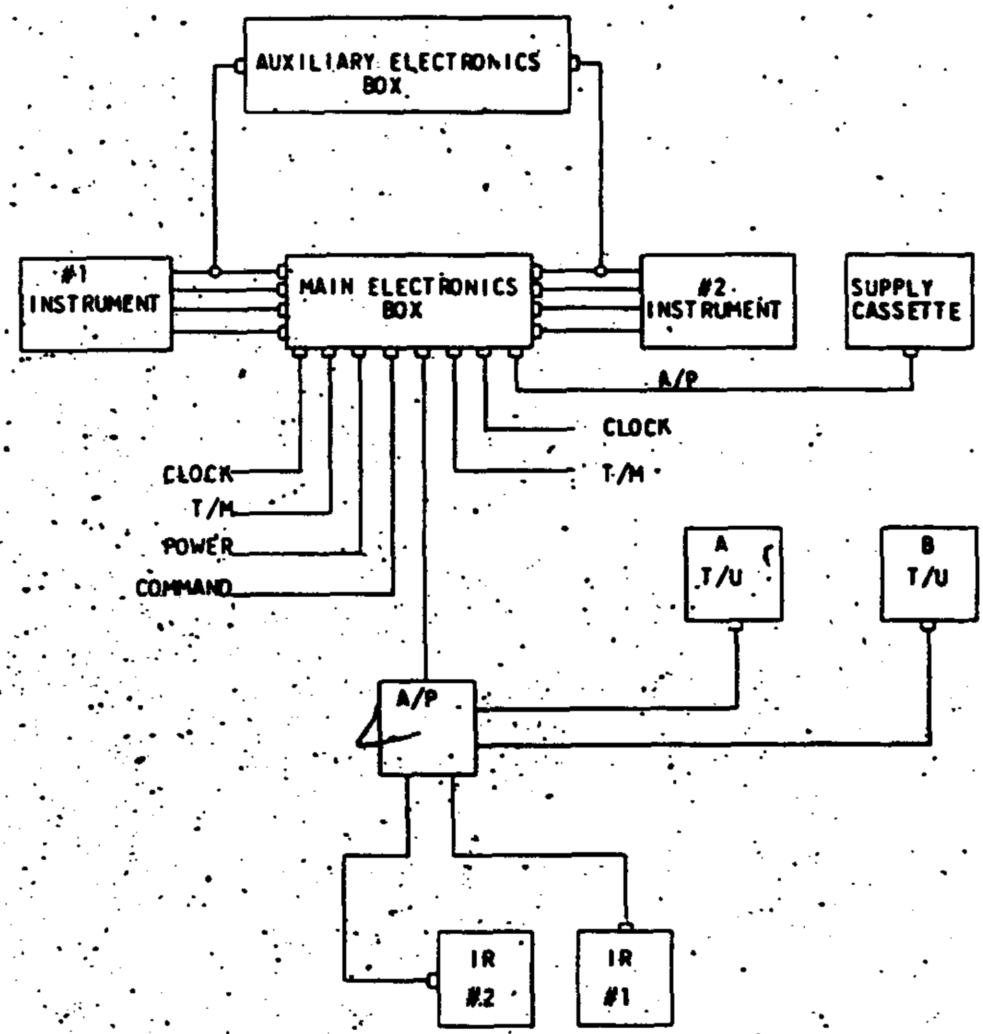


Figure F-2 A/P-to-CR Block Diagram

electrical block diagram. The complete CR system payload consists of the following:

a. Two similar, 24-inch focal length, f/3.5 panoramic cameras, each having two integrated 55 millimeter focal length, f/6.3 horizon optics.

b. One auxiliary structure (supports both panoramic cameras and the electronics packages to form the so-called camera module)

c. One supply cassette

d. Main supply structure

e. Two take-up cassettes

f. One intermediate roller assembly.

The panoramic cameras are positioned on the auxiliary structure in a V-configuration to provide a 30-degree stereo angle. The auxiliary structure is three-point mounted to the vehicle so that the even serial-numbered camera is located forward and views toward the rear (aft-looking), and the odd serial-numbered camera is located aft and views forward (forward-looking). The auxiliary structure also provides the mounting surface for the system electronic packages. The supply cassette, which contains the total film supply for both cameras, is located aft of the camera module. The supply cassette is fastened to a support structure, which is, in turn, three-point mounted to the vehicle. Take-up A, located in recovery vehicle RV-1, and take-up B, located in RV-2, each take up half of the film of each camera. The intermediate roller assembly is attached to the vehicle between take-up B and the camera module.

The system is basically designed to use 2.5 mil base, 3.0 mil thick, 70-millimeter, EK 3404 film. The supply cassette contains two 28-inch diameter spools, each capable of storing 16,300 feet of 3.0 mil film or 24,450 feet of 2.0 mil (UTB) film. Each of the two take-up A spools is capable of storing 8,200 feet of 3.0 mil and 12,300 feet of 2.0 mil (UTB) film. Each take-up B spool is capable of

8,100 feet of 3.0 mil and 12,150 feet of 2.0 mil (UTB) film. The system total film capacity, therefore, is limited by take-up B to 32,600 feet of 3.0 mil film or 48,900 feet of 2.0 mil (UTB) film.

F-3.1 Electrical Characteristics

The power requirements of the CR Subsystem are 24 VDC, unregulated, and 115 VAC at 400 cps. Unregulated 24 VDC power is utilized for general service in the camera, supply control, and take-up control. The 115 VAC, 400 cps power is utilized in the camera to develop regulated direct current power. Plus and minus low voltages are developed for the camera drive servo, the exposure control circuits, and various direct current voltages for assorted lamp requirements.

The power supply returns are carefully segregated within the system to provide isolation between the 115 VAC, 400 cps return and the 24 VDC unregulated return. Also, isolation is provided between power returns and all shielding and bonding arrangements. In addition, regulated DC power returns are joined to the unregulated DC return in only one point (drive servo). This is required to maintain proper referencing of the V/h programmer signal to the tachometer feedback signal.

F-3.2 Telemetry

The subsystem contains several component temperature and operation monitors which provide telemetry data during operation. In addition to the telemetry, monitor points which can be checked during ground testing are provided. A detail description of T/M monitors is shown in para. 5.0.

F-3.3 Camera Module

The camera module shown in Figure F-3 consists of the two panoramic cameras and system electronics boxes which mount to the

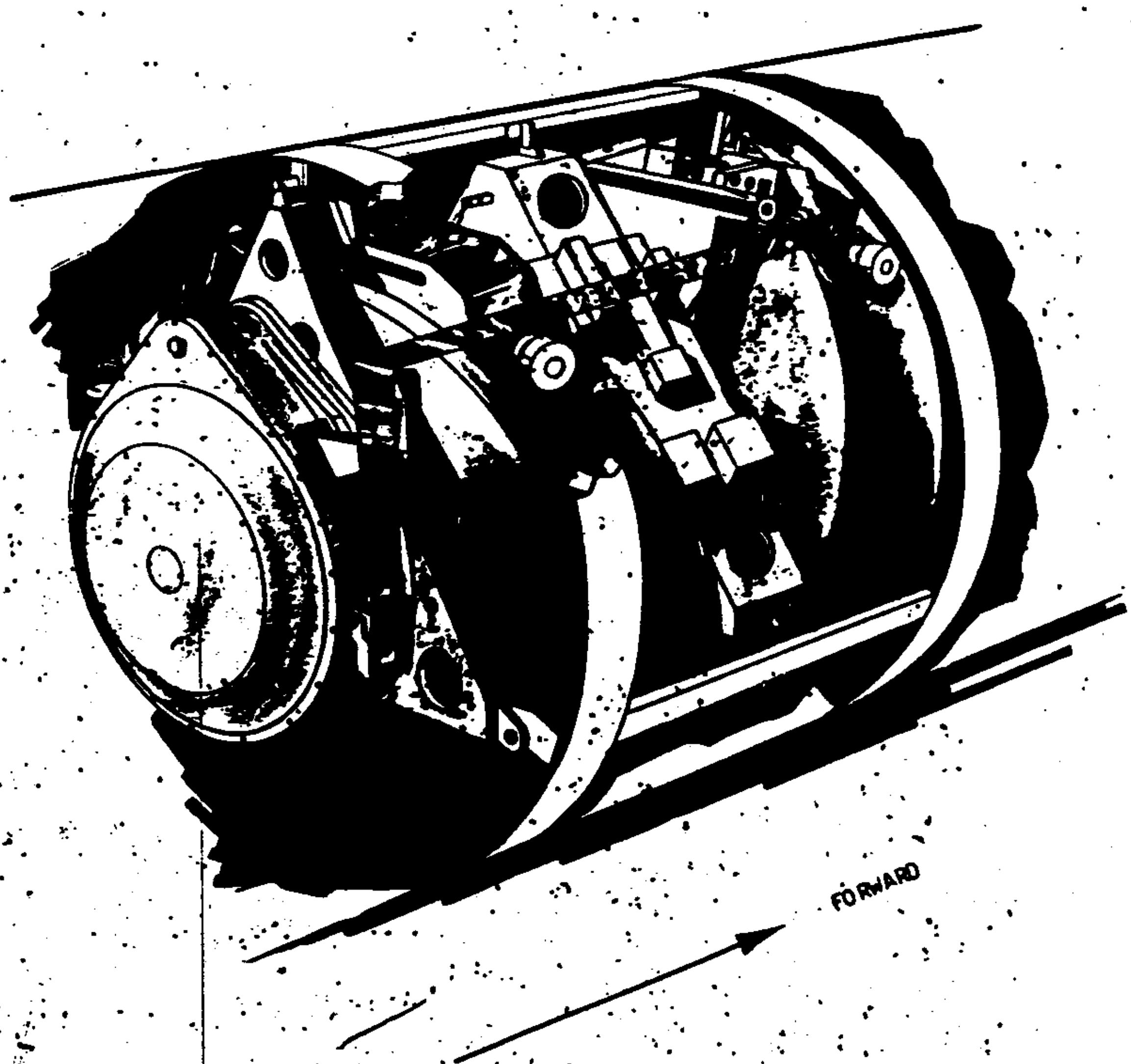


Figure F-3 CR Camera Module

auxiliary (delta) structure. The main electronics box contains the control package, the interface package, the data signal conditioner, and the 400 cps power supply. The auxiliary electronics box contains the main servo and the panoramic geometry electronics circuits.

F-3.4 Camera Description

The panoramic cameras are independent and similar, but are not interchangeable. Each camera consists of a machined frame upon which most of the camera components are mounted. Because some camera components are attached to the auxiliary structure, the structure must be considered as an integral part of the panoramic camera.

The primary components of the panoramic camera are: (a) drive system, (b) lens, (c) scan head assembly, (d) drum, (e) film transport mechanisms, (f) FMC mechanism, (g) panoramic geometry system, and (h) the horizon optics. The actions of these components are related and time through a system of belts and pulleys and special-function gear packages, all of which are driven from a single camera drive motor.

The 24-inch focal-length lens is a Petzval design consisting of five elements mounted within a cast magnesium cell. A sixth element, the field flattener, and an exposure/filter device are mounted on the end of a titanium tail cone which is, in turn, secured to the lens cell at the nodal point.

The scan head assembly, which contains the slit width (see Section H) and filter change device and focal plane rollers, is mounted on the end of the lens cone. This device consists of a bidirectional, four-position slit width changer and a two-position filter changer. A slit width failsafe mode or nominal slit width position is also provided. The slit blades are driven by a servo motor and a dual potentiometer. The filter is driven by a stepper motor and a dual potentiometer. During the exposure portion of the scan, the focal plane rollers lift the film from the guide rails into the exact focal plane.

In order to prevent light from entering the vehicle compartment through the vehicle/camera interface, a drum rotates with the lens within a network of nonrotating light shields. The drum is light-tight, except for the clear aperture and and a smaller opening for the scan head and access cover. Two formed pieces of sheet metal, which are attached to the drum around the periphery, rotate inside a fixed labyrinth preventing light from entering alongside the drum. The inside diameter of the light shields is slightly larger than the diameter of the drum, and the shields encompass the drum over a sufficient portion of the circumference to prevent light from passing around the drum.

The drum assembly also serves as a thermal shield for the lens when the camera is inoperative. Furthermore, a series of rollers, located around the circumference of the drum and placed parallel to the lens rotation axis, revolve with the drum just beneath the film guide rails to prevent film from being pulled through the rails. These rollers do not contact the film under normal operation.

The camera film transport system comprises an input metering roller which is geared through a 99/101 percent clutch to provide continuous input metering at a nominal rate. Film guide rails guide the film over the 70 degree format, and film clamps located at either side of the format are actuated during exposure. A frame metering roller pulls one frame of exposed film out of the format area during the nonexposure portion of the cycle. A shuttle mechanism stores extra loops of film arising from continuous film input and output and intermittent frame metering. The shuttle also is used to control the 99/101 percent clutch. Figure F-4 illustrates the film transport system. Film

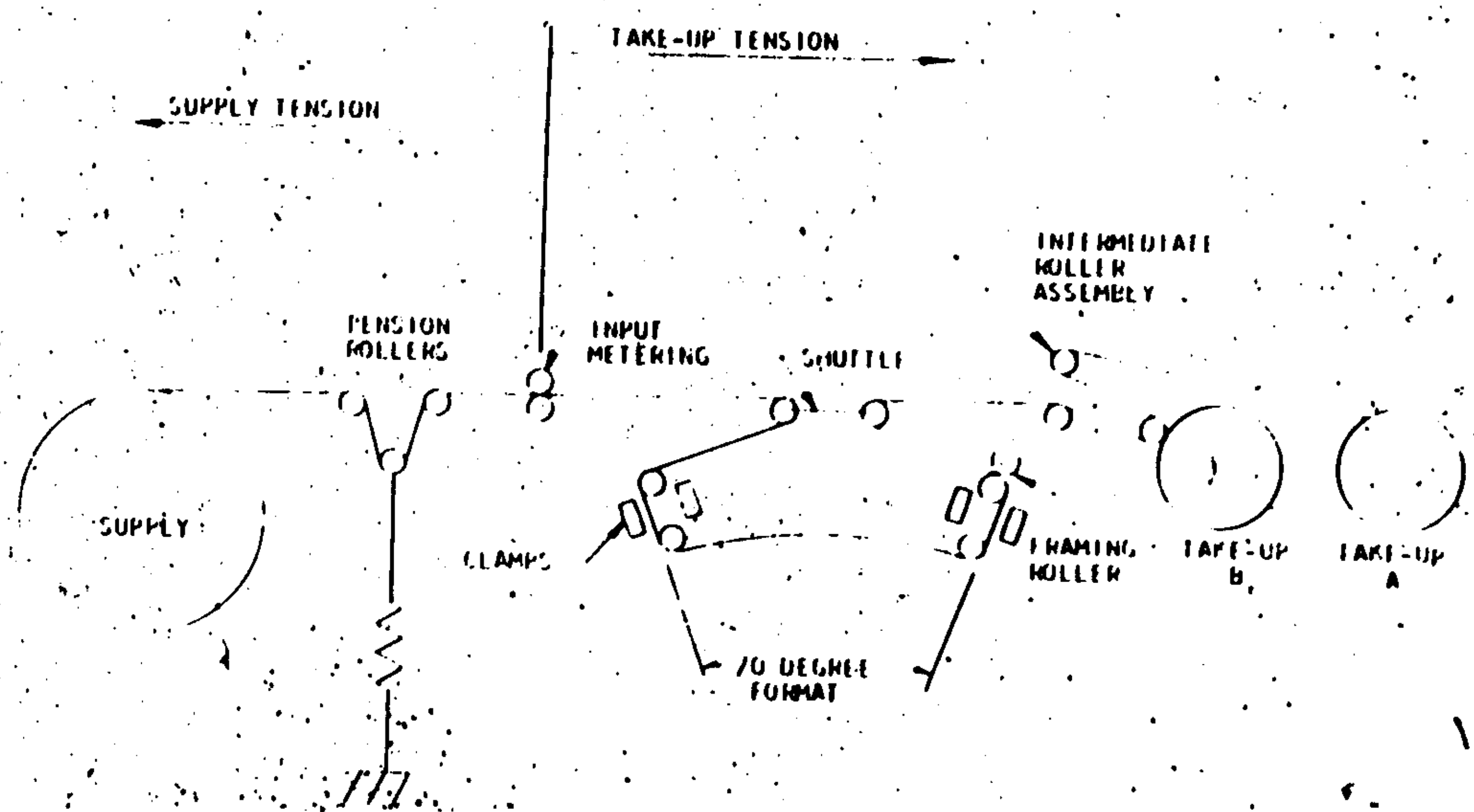


Figure F-4 Film Transport System Schematic threading is illustrated in Figure F-[illegible].

Each camera contains an FMC (forward motion compensation) mechanism. The FMC mechanism is comprised of a cam, which is driven by the camera drive motor, and a four bar linkage which is driven by the cam. The linkage is fixed at one point such that the action of the cam against the linkage causes the cameras to rock about the vehicle pitch axis.

The panoramic geometry subsystem contains the equipment which is required to record a sufficient amount of data on each panoramic frame to enable a calibration of the panoramic cameras. The elements of the panoramic geometry subsystem include the following:

a. Holes in the film guide rails which are spaced about one degree apart, angularly, and two incandescent lamps which are mounted on the scan head of the lens and are exposed through the rail holes.

b. A subsystem consisting of an accurate optical encoder, electronic circuits, xenon flash tube, two sections of optical fiber bundles, a rotating optical coupling, and a lens all of which combine to expose dots on the film to represent the roll angle of the camera.

c. An accurate pulse generator which triggers a neon tube and exposes timing marks on the film to permit the determination of the time difference between the exposure of two different points of the format.

d. Two lights mounted on the scan head, which provide the locus of the scan head as it traverses the format.

Each panoramic camera contains two horizon camera assemblies that allow the photointerpreter to quickly determine the pitch and roll attitude of the panoramic camera during exposure. The horizon camera consists of a 55 millimeter, f/6.3 lens, a

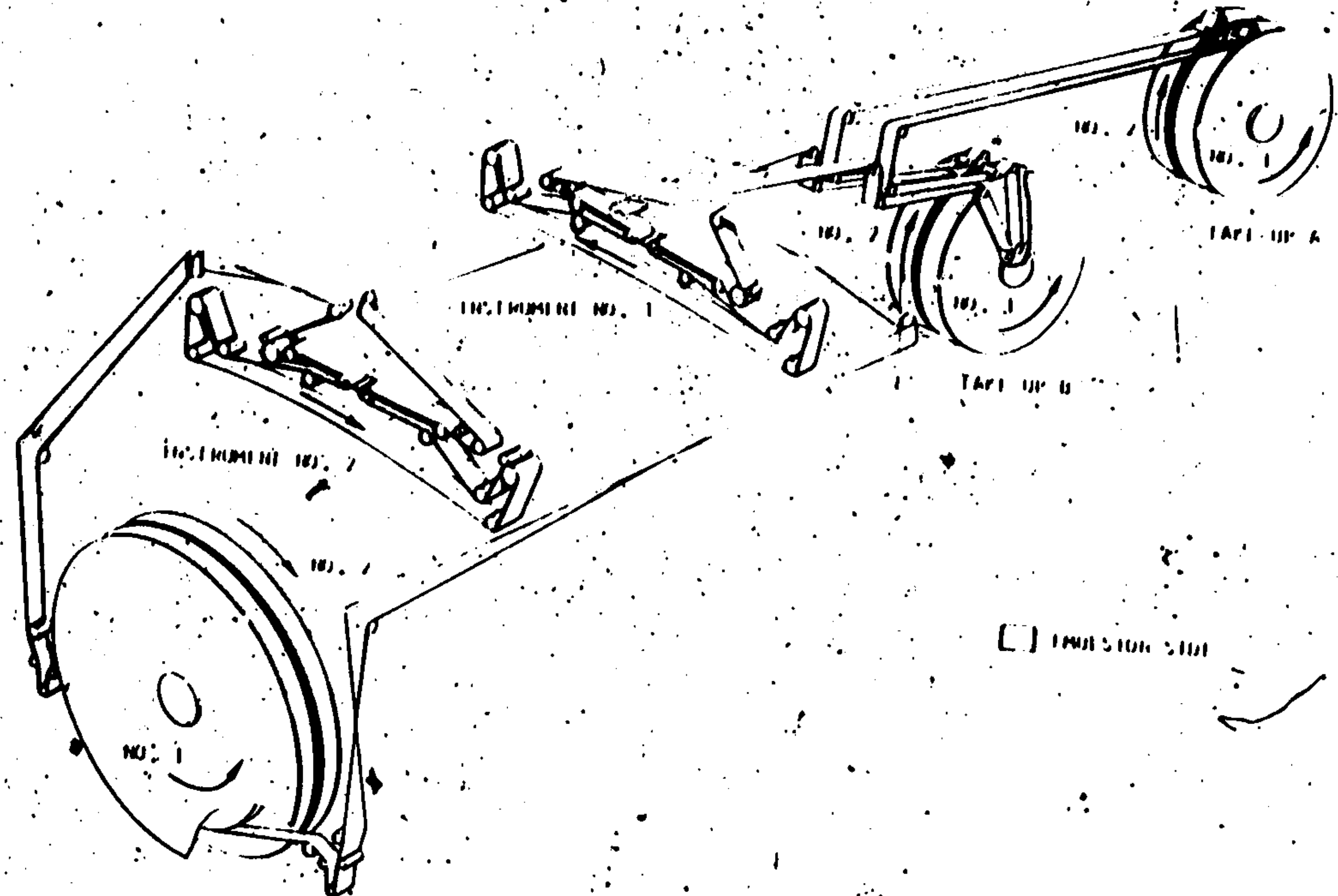


Figure F-5 Film Threading Diagram

between the lens leaf shutter, a shutter trip solenoid, a filter change mechanism, and an assembly housing. The horizon camera assemblies are mounted on each end of the film transport bridge. This facilitates the sharing of a common film supply and path with the panoramic cameras. The optical axes of the horizon lenses are nominally, but not exactly, coplanar with the optical axis of the panoramic camera.

The horizon camera housing provides a support structure for the lens, shutter mechanism, lens cone, lens hood, and filter change mechanism. The filter change mechanism, mounted in front of the lens, consists of a sliding filter on a track, a drive motor, and connecting linkage. An attenuating filter may be slid in front of the lens when faster film than the basic 3404 is used.

F-3.4 Supply and Structure

The supply cassette, which remains integral with its support structure after final assembly, contains the supply spools for both panoramic cameras, a torque motor for each spool, a radius sensor arm which controls the output of each torque motor, a set of tension rollers for each spool, and brakes for each spool.

The triangular-shaped support structure is a riveted, magnesium skin construction with machined fittings. It has a support ring centrally located to which the rear cover of the supply cassette is mounted.

The supply cassette is composed of three individual magnesium castings; these are two end covers and one center section which are machined and lightened by chemical milling. The cassette assembly is light-tight, except in the area of the tension rollers located on each side of the center section where the film exits from the cassette. They can be temporarily sealed to prevent light leaks during testing.

Tension is provided by torque motor output to a gear attached to one of the two flanges of each supply spool. Internal brakes on each torque motor prevent rotation of spools when the power is OFF.

F-3.6 Take-up Cassette

The take-up cassettes consist of a structure, spools, spindle, sensor arm, and component boards and cable. An additional assembly, the roller carriage, is used in take-up B.

The structure consists of two magnesium honeycomb side plates which are aligned, bonded, and secured to two shear plates. Mounted on this structure are the cable, component board, resistor plates, transistors, RFI covers, heaters, and thermostat.

The spools are of lightweight magnesium construction. The B take-up spool has a larger core diameter which results from having three hub rollers and a set of wrap-around plates installed.

The spindle assemblies consist of a three-piece magnesium housing into which are assembled two torque motors, the necessary drive gearing, and two antibackup systems for the A take-up (or two brakes for the B take-up). The antibackup unit consists of a ratchet wheel coupled to the motor shaft through a one-way clutch, a pawl, suitable linkage, and a release solenoid. The brake used in the B spindles is keyed to the motor shaft and is released electrically.

The sensor arm assembly consists of a magnesium frame into which are assembled two potentiometers, antibacklash gearing, and a spring-loaded sensor arm and puck assembly.

The roller carriage assembly, contained only on B takeups, consists of two magnesium side plates into which are mounted the input and output rollers, deflection roller, roller shafts, and film guard.

F-3.7 Structures

The CR camera consists of four basic structural sections. The lens and drum assembly has been discussed.

The film transport or shuttle assembly consists basically of a pair of magnesium-faced honeycomb cone plates spaced to accommodate the film rails, input metering assembly, framing assembly, shuttle, and grid rollers. The horizon optics are also supported at either end of the shuttle assembly.

Both the lens and drum assembly and the shuttle assembly are supported by an anchor-shaped magnesium main structure. This structure forms the backbone of an individual camera, and in addition to supporting the two noted assemblies, also carries the main drive assembly, the image motion compensation (IMC) mechanism, control switch complex, and various pulleys, counters, etc.. The main structure is milled from a solid billet of magnesium to achieve the maximum physical characteristics of the material. Each end of the lower cross of the anchor carries a shaft. These shafts are in line with each other, and form the nod axis of the camera when mounted in bearing blocks carried on the auxiliary (delta) structure.

The auxiliary structure is an integral part of, but shared by, each panoramic camera of the stereo pair. This aircraft-type sheet metal structure carries the bearing blocks for the nod axes of both panoramic structures, and also provides the fixed tie points for the rocking links of the FMC mechanisms. Additionally, it carries all electronic packages needed for the operation of both cameras. The auxiliary structure interfaces with the vehicle at three points to minimize the effect of any vehicle distortions on the camera.

F-3.8 Light Seal Assembly

The functions of the payload seal assembly are as follows:

a. Provide a light-tight seal over the film slot through the B SRV support cone during the B mission (see Figure F-6).

b. Provide a drag on the tail end of the main film being taken into the B-SRV during the cut-and-wrap operation (A to B transfer).

This device has been known as the "felt seal" on previous programs. It is a trap door-type of device which is dimple-motor actuated and torsion-spring powered. A special black velvet material covers the door and door frame, which provides a light seal with the door in the closed position. The seal assembly is used in two places on the B SRV support cone, one place to pass the main instrument film, and the second place to pass the DISIC film.

F-3.9 Main SRV Waterseal

The functions of the main waterseal are as follows:

a. Cut the main film at point of entry into the capsule prior to recovery.

b. Provide a light-tight capsule seal.

c. Provide a water-tight capsule seal so the capsule does not leak and sink prematurely if it goes into the water during recovery.

The cutting blade is released by actuation of the dimple motor. A cocked tension spring provides the power to close the blade. The tension spring also applies a tilting moment to the blade. This moment and the force from two compression springs provide a continuous cutting pressure on the blade as it travels. The blade is supported at three points as it moves, which enables it to float and conform to irregularities in the cutting surfaces. The blade is self-sharpening; one edge is soft aluminum, the other hard-anodized. The compression springs also provide a force against the soft-rubber gasket when the blade seats in the home position (see Figure Q-14).

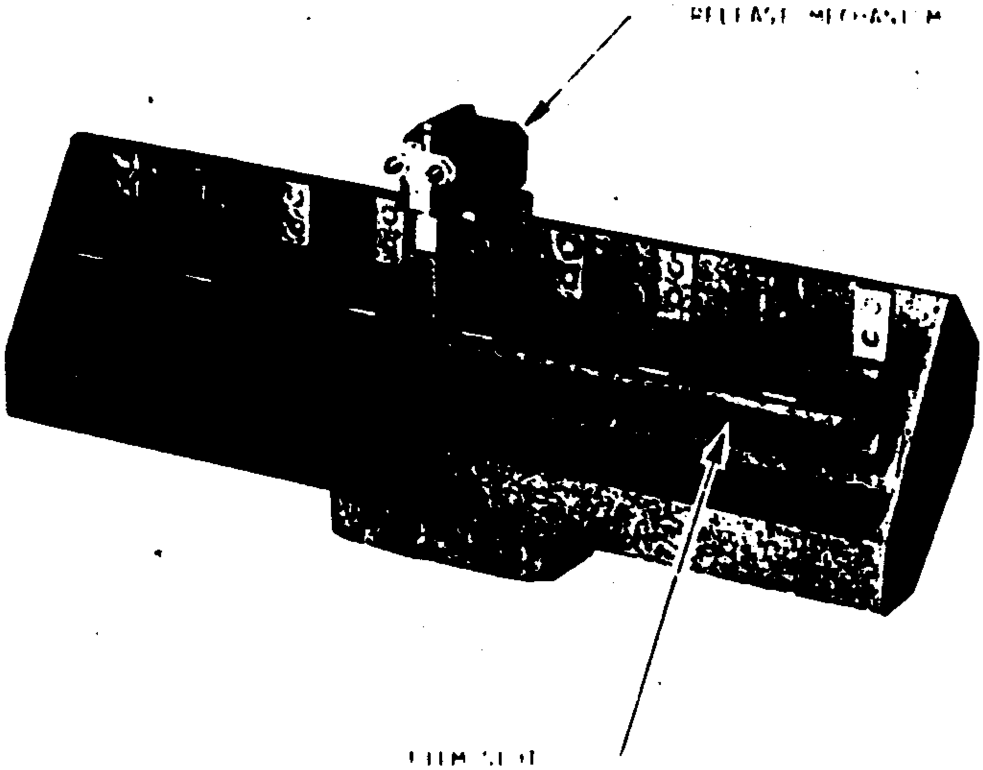


Figure F-6. Light Seal Assembly

F-3.10 General Principles of Operation

F-3.10.1 Inputs and Commands

The CR subsystem receives its power from the Agena vehicle, and its command signals from the LMSC control package via the vehicle interface harness which interfaces with the CR subsystem main electronics box. Inputs to the main electronics box interface are as follows:

a. Power
   (1) Plus 24 VDC unregulated
   (2) 115 VAC, 400 Hz

b. Control commands
   (1) Relay Reset (Launch Mode)
   (2) Orbit (standby) mode
   (3) Operate
   (4) V/h
   (5) A to B transfer

c. Other commands
   (1) Exposure slit position
   (2) Interrogate
   (3) Exposure failsafe
   (4) Film change

All commands and signals required to operate the components internal to the CR system (supply, cameras, and take-ups) are generated (basically) from the CR main and auxiliary electronics boxes.

F-3.10.2 Camera System Concept

The CR camera system has a lens which images information onto the film, a means for storing the film prior to exposure, a method of moving the exposed film from the exposure area (format), and a storage system for receiving the exposed film. Unlike most cameras, however, the CR camera has supply and take-up systems which are physically separated from the camera proper. In the case of the supply cassette, this separation is made to allow location of the spools at a position in the vehicle where there is room to carry large amounts of film and yet have good access for loading. The take-up, on the other hand, has been divided into two parts, since the available area in the recovery section is not sufficient to accommodate all of the film on one set of recovery spools. The dual take-ups also allow early recovery of the first half of the exposed film of both cameras.

Another camera requirement, a light-tight box, is in this case provided by the vehicle in order to save the weight that would otherwise be necessary if the camera were completely self-contained.

F-3.10.3 Modes of Operation

A camera system which is utilized in a satellite is subjected to a wide variation of environments which affect the original design and also the manner of operation. Phases of system operation are: powered flight (Launch mode), orbital flight without operation (Standby mode), orbital flight with operation (Operate mode), and A to B transfer.

F-3.10.3.1 Launch

During launch, the camera system is subjected to a variety of simultaneous stresses arising from acceleration, random mechanical vibrations, pulsating shock, and acoustical loading. Concurrently, there is likely to be, due to structural deflections, a considerable motion of one part of the camera system relative to another, particularly between comparatively widely spaced items such as the supply cassette, camera proper, and take-ups. As the film connects these components, damage could be incurred if the film became too taut, or if the film lifted from the rollers (causing subsequent mistracking) due to slack. To prevent these failures, the film transport system is programmed during launch such that a low-level tension is maintained throughout the film path.

This condition is accomplished by energizing the take-up spools at less than full power and de-activating the antibackup device in take-up A. The camera remains inoperative during this period of time. The supply torque motor supplies film tension from the supply spool up to the camera input metering roller by pulling backwards. The torque motor in take-up A supplies film tension from the input metering roller through the camera and forward to the take-up A film spool. The second take-up (take-up B) is held stationary by a brake, and the film is simply routed around an idler roller in a hub on the way to take-up A. In this condition, therefore, there is an allowance for relative movement between the basic system components without an occurrence of either excessively high or low tensions.

At separation, the doors which cover the camera [illegible] ports are blown off, exposing a portion of the camera to the external environment. In order to prevent undue thermal disturbance of the lens elements, the lenses are stored in an approximate horizontal position (along the vehicle axis). Following injection into orbit, the camera system enters the phase of non-operational flight.

F 3.10.3.2 Stand-by

In general, all power is removed from the camera system in the Stand-by mode. In this power-off condition, brakes restrain any motion of the supply spools or spools in take-up B. A ratchet type antibackup device in take-up A is also operative. The cyclic rate (V/h) and exposure command can be applied to the CR system at any time; however, the camera system does not react until an Operate command is received.

F-3.10.3.3 Operate

At receipt of an Operate signal, brakes on the supply spools and on the A take-up spools are energized (released). The brake on the B take-up remains ON. The action of the B take-up will be discussed later. Power is simultaneously fed to the supply and take-up torque motors, which then provide operational film tension through the system.

At this time, an electrical ground connection (which existed from the input to the camera drive servo) is removed and replaced with the V/h voltage. This V/h voltage provides a control to the camera drive servo motor which in turn brings the camera up to a cycle speed which is directly proportional to the V/h voltage. The torque motor is the only drive source in the camera, and the energy necessary for the other camera functions (such as the film transport) are derived from this source by the use of gears, pulleys, and timing belts.

To terminate operation, the Operate command is removed from the interface. The electrical circuitry is such that no internal camera action takes place until the completion of a camera cycle. At this time, the system is programmed down from the operational speed to a creep velocity. This creep velocity is maintained until the lens is brought into the storage position, at which time power to the camera is removed. The supply and take-up motors remain energized for an additional three seconds to maintain system tension. After this three second delay, the system is fully shut down and is in the stand by mode.

F-3.10.3.4 A to B Transfer

When the photographic operation has reached the point where the A take-up spools are full, it is necessary to initiate the action which brings take-up B into operation. This operation, called the A to B Transfer, takes place during some convenient nonoperational period of the orbit. The A to B transfer sequence is illustrated in Figure F-10.

A real time command actuates a mechanical cutter which is located close to the A take-up. The film is cut, leaving a loose ribbon of film (about eight feet long) between the cutter and the idler rollers in the hubs of the take-up B spools. The camera then receives a 30-second command signal from the LMSC Command Subsystem, which starts the sequence of the A to B transfer. A V/h signal calling for a low cycle rate is applied to the CR interface, but the camera does not react at this time. During the first five seconds of the 30-second command, the take-up B spool torque motor is energized at less than full power, thereby producing reduced film tension to wrap and cinch the slack film onto the take-up B spools. At the end of the five-second period, the supply and take-up B spool torque motors are energized, causing the cameras to operate at the commanded low cycle rate for 25 seconds. This cycle rate is such that a minimum of four camera cycles are completed in the 25-second period. At the end of the 30-second period, the A to B Transfer command and the internal Camera Operate signal are de-energized, the CR system completes a normal (ramp-down) stop, and the camera is once again in a standby mode.

F-3.10.3.5 Film Change Detector (FCD)

It is often necessary to use more than one type of film in the panoramic cameras during flight. Since the photographic parameters differ for each type of film, compensation for these variations is required to the optical system for each film change. The FCD performs this compensation automatically. The FCD senses the film change through infrared (IR) transmission variations in a series of five IR permeable windows which preceed the new film splice. The signals which initiate the optical compensation are generated as the film, with the windows, passes between an IR source located on one side of the film and an IR detector on the other.

The IR source consists of a photo-luminescent diode with filter and optics to direct the beam through the film. The detector is a germanium phototransistor which senses the difference in IR transmission characteristics and generates a series of five pulses. These pulses are shaped and amplified to drive a stepping motor which, rotating 180° (36° each pulse), will have automatically changed the scan head filter. A potentiometer associated with the filter initiates a sequence of other compensations. These include an AO (auxiliary optics) filter change and intensity changes of the SLP data block and data lamps of the guide rails, serial number, H/O (horizon optics) fiducial, and pan geometry readout. These intensity changes are accomplished by the use of preset potentiometers which control lamp current and the selection of load resistors for a timing lamp circuitry.

F.3.10.3.6 Fail Safe

To prevent spurious film changeover, as may be generated by a film splice (the detector cannot differentiate between splice tape and a window mark), a second detector is used to sense splices and thus prevent false changeover. In addition, the desired filter may be selected by a series of five RTC commands (Mode 103 and Mode 104), in the event of failure of the electronics in the FCD. A telemeter commutator point is used to ascertain whether the normal or alternate filter is in use for each camera.

F.3.0 SEQUENCE OF EVENTS

For the various modes of operation, Figures F-7 through F-11 illustrate the sequence of events as described herein.

[redacted]

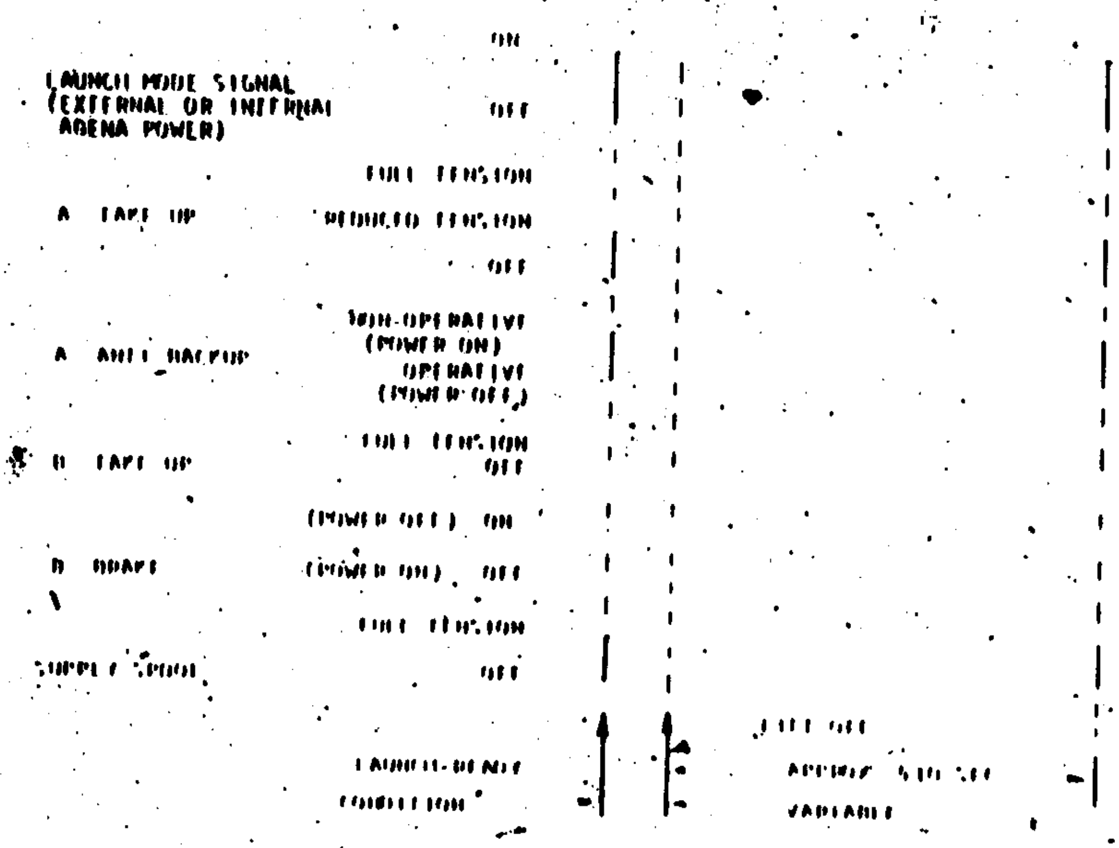


Figure F-7. Launch Mode Sequence

[redacted]

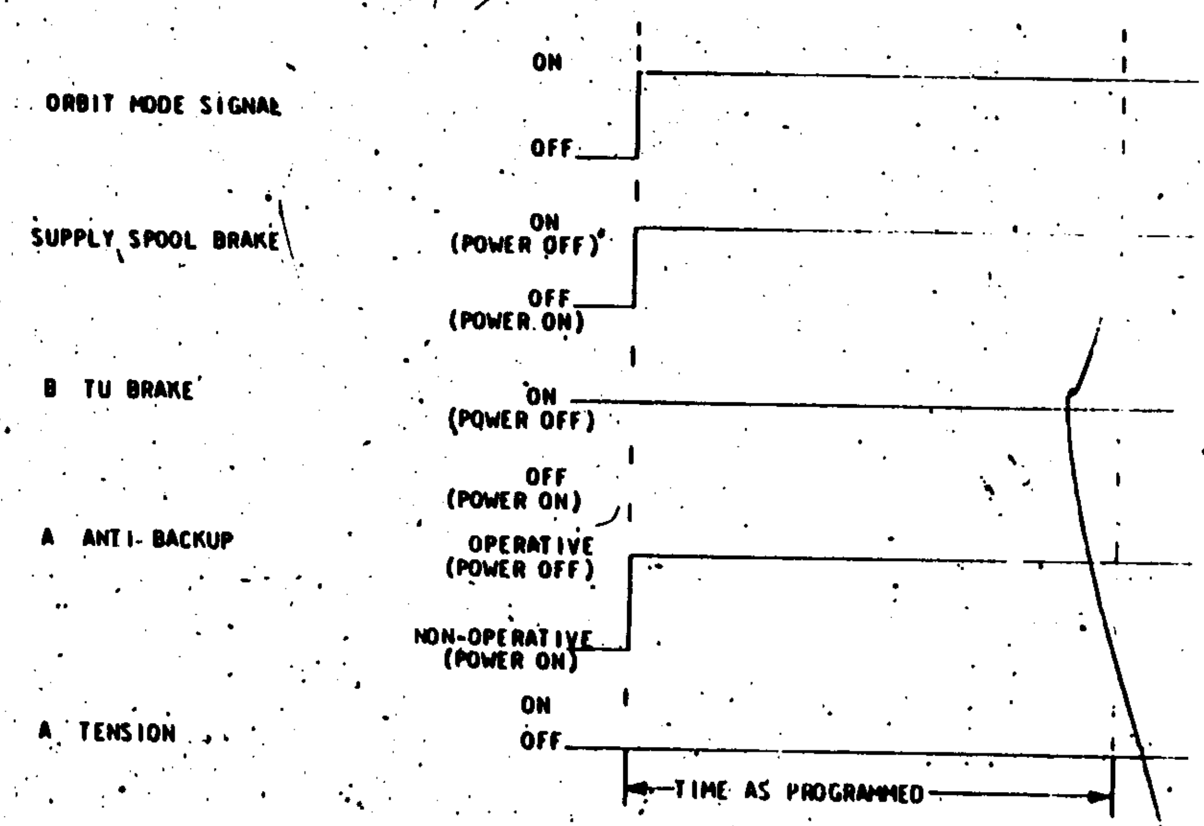


Figure F-8 Stand-By (Orbit) Mode Sequence

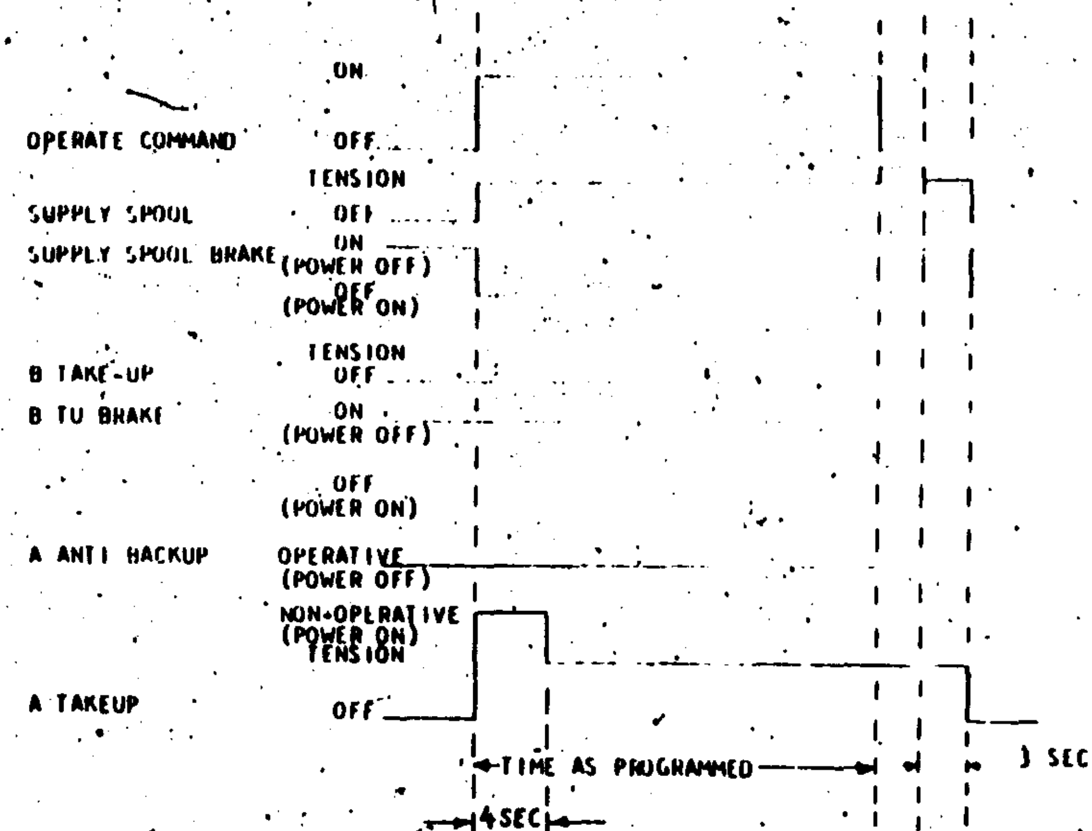


Figure F-9 "A" Operate Mode

[redacted]

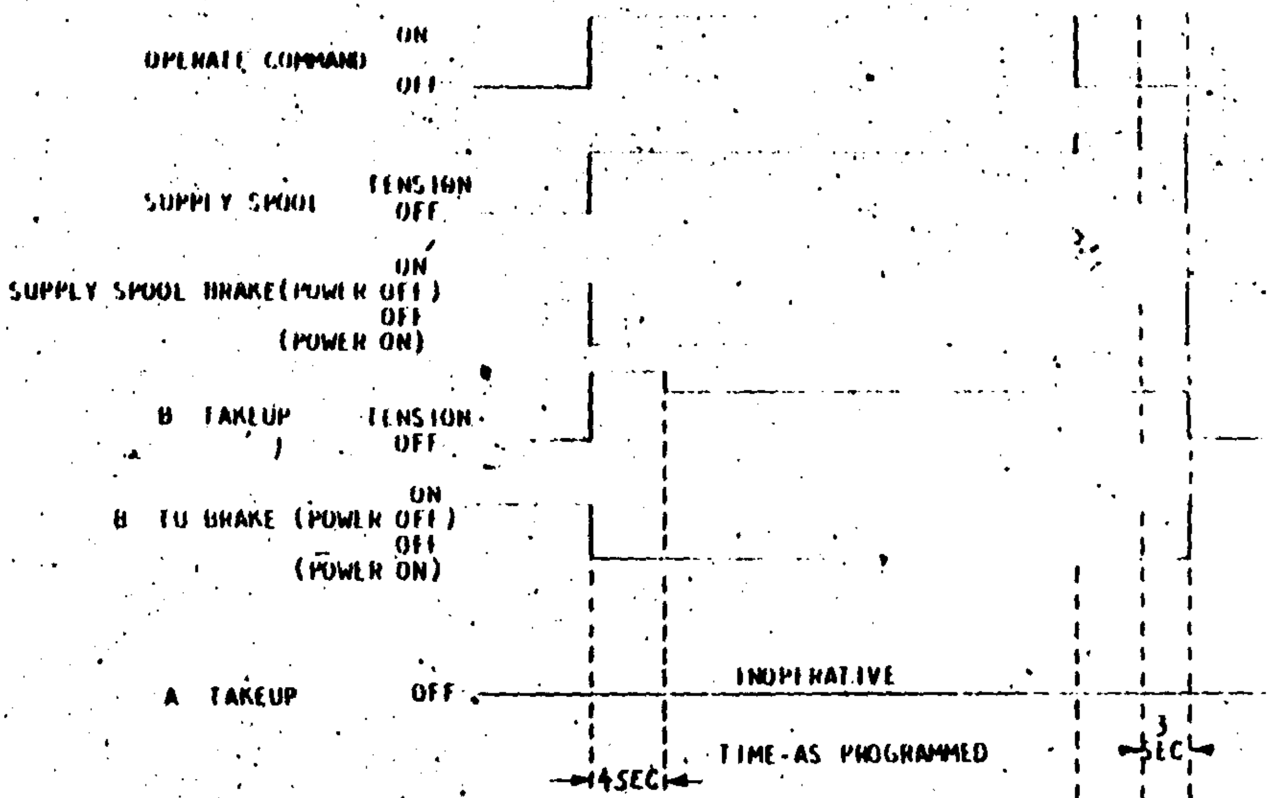


Figure F-11 "B" Operate Mode

F-5.0 MONITORS

Various monitors are required to evaluate the performance of the CR Instrument subsystem. Table F-2 defines the items that are incorporated on the subsystem. For specific T/M points or pins, refer to Section II and [illegible] Requirement Specification T/M.

Table F-2 CR Instrument Monitors

DESIGNATION OF VEH. OR P/L FUNCTION	INSTRUMENT FUNCTION	TRANSDUCER TYPE	LOCATION
UMB. MON. NO.6	PAD TEMP MONITOR	SILICON CHIP RESISTANCE	DELTA STRUCTURE
COMMUTATOR I RING B LK I CH 11	TEMP SENSORS (8) INSTRUMENT NO. 1	"	LENS CELL LENS CONE REAR RAIL RT. AUX OPTICS DRIVE MTR. FRONT RAIL DRUM SUPPORT HI EFF. AMPLIFIER
COMMUTATOR I RING B LK I CH 11	TEMP SENSORS (8) INSTRUMENT NO. 2	"	LENS CELL LENS CONE REAR RAIL RT. AUX. OPTICS DRIVE MTR FRONT RAIL SUPPLY CASS. DELTA STRUCTURE
COMMUTATOR I RING A LK I CH 13 PLUS	PAN FILM DOOR (LIGHT SEAL)	SWITCH	LIGHT SEAL
	PAN #1 T/U DIAMETER	POT	T/U #1 (A)
COMMUTATOR II RING A LK II CH 16	PAN #2 T/U DIAMETER	POT	T/U #2 (B)
	PAN NO. 1 CYCLE COUNTER (4 POINTS)	ELEC. DIGITAL READOUT	INSTR. NO. 1
	PAN NO. 2 CYCLE COUNTER (4 POINTS)	ELEC. DIGITAL READOUT	INSTR. NO. 2

[redacted]

Table F-2 Continued

DESIGNATION OF VEH. OR P/L FUNCTION	INSTRUMENT FUNCTION	TRANSDUCER TYPE	LOCATION
COMMUTATOR II RING A (K II CH 16	PAN NO. 1 SLIT WIDTH POSITION	POT	INSTR. NO. 1
	PAN NO. 2 SLIT WIDTH POSITION	POT	INSTR. NO. 2
	PAN NO. 1 FILTER POSITION	POT.	INSTR. NO. 1
	PAN NO. 1 & NO. 2 FILM CNG. DETECTOR	POT.	INSTR. NO. 1 & NO. 2
COMMUTATOR II RING B (K II CH 15	"A" WATER SEAL	SWITCH	"A" WATER SEAL (CAPSULE COVER)
	"B" WATER SEAL	SWITCH	"B" WATER SEAL (CAPSULE COVER)
	PAN NO. 1 INPUT ROLLER ROTATION	POT.	INSTR. NO. 1
	PAN NO. 2 INPUT ROLLER ROTATION	POT.	INSTR. NO. 2
	PAN NO. 1 FRAME METER ROLLER ROTATION	POT.	INSTR. NO. 1
	PAN NO. 2 FRAME METER ROLLER ROTATION	POT.	INSTR. NO. 2
	PAN NO. 1 T/U VOLTAGE A & B (CR 5 & UP)	POT.	T/U NO. 1 & T/U NO. 2 (A & B)
	PAN NO. 2 T/U VOLTAGE A & B	POT.	T/U NO. 1 & T/U NO. 2 (A & B)
	PAN NO. 2 H/O PLATEN POSITION	SWITCH	H/O
	PAN NO. 1 DRIVE MTR. VOLTAGE - A	INSOLATION AMPLIFIER	INSTR. NO. 1
	PAN NO. 2 DRIVE MTR. VOLTAGE - A	ISOLATION AMPLIFIER	INSTR. NO. 2
	PAN NO. 1 H/O PLATEN POSITION	SWITCH	H/O

[redacted]

Table F-2 Continued.

DESIGNATION OF VHM. OR P/L FUNCTION	INSTRUMENT FUNCTION	TRANSDUCER TYPE	LOCATION
COMMUTATOR II RING B LK II CH 15	PAN NO. 2 DRIVE MTR. VOLTAGE - B	ISOLATION AMPLIFIER	INSTR. NO. 2
	PAN NO. 1 DRIVE MTR. VOLTAGE - B	ISOLATION AMPLIFIER	INSTR. NO. 1
	PAN NO. 1 TACH. FEEDBACK VOLTAGE	ISOLATION AMPLIFIER	INSTR. NO. 1
	PAN NO. 2 TACH FEEDBACK VOLTAGE	ISOLATION AMPLIFIER	INSTR. NO. 2
	PAN NO. 2 OPERATE VOLTAGE	ISOLATION AMPLIFIER	
	PAN NO. 1 OPERATE VOLTAGE	ISOLATION AMPLIFIER	
	PAN NO. 1 SUPPLY MOTOR VOLTAGE	ISOLATION AMPLIFIER	
	PAN NO. 2 SUPPLY MOTOR VOLTAGE	ISOLATION AMPLIFIER	
	PAN NO. 2 IR ROTATION	POT.	INTERMEDIATE ROLLER ASSY
	PAN NO. 1 IR ROTATION	POT.	INTERMEDIATE ROLLER ASSY
	PAN NO. 1 H/O PLATEN & SHUTTER COMMANDS	ISOLATION AMPLIFIER	
	PAN NO. 1 & 2 LAUNCH MODE	RELAY	
	PAN NO. 2 H/O PLATEN & SHUTTER COMMANDS	ISOLATION AMPLIFIERS	
APS (NO. 1 INSTR.) LINK I CH 5	LENS ASSY ANGULAR POSITION (NO. 1 & 2)	POT.	
	LENS ASSY ANGULAR POSITION (NO. 1 & 2)	POT.	
	39/101 CLUTCH COMMAND (NO. 1 & 2)	ISOLATION AMPLIFIER	
APS (NO. 1 INSTR) LINK I CH 5	CENTER OF FORMAT COMMAND (NO. 1 & 2)	ISOLATION AMPLIFIER	
	AUX. OPTICS PLATEN COMMAND (NO. 1 & 2)	ISOLATION AMPLIFIER	
	AUX. OPTIC PLATEN COMMAND (NO. 1 & 2)	ISOLATION AMPLIFIER	

F 6.0 REFERENCE DOCUMENTS

1232-HOS-COR-67-310	Description and Operations Manual, J-3 Panoramic Camera System
J-3-5-019	Electrical Interface Specification for the J-3 Constant Rotator System
J-3-7-004	Requirement Specification, J-3 Telemetry Instrumentation
J-3-7-023	Tracking, T/M, Commands, Power, and Pyro Interface Spec for A/P Payload and Program [redacted] gena Orbital Vehicle

SECTION G

IMAGE MOTION COMPENSATION SUBSYSTEM

G-1.0 PURPOSE

The purpose of the image motion compensation subsystem is to provide a controllable means of compensation for those factors which cause motion in the image plane of the satellite cameras during exposure. The image being stationery will result in a high-resolution photograph with a minimum of smear.

G-2.0 CHARACTERISTICS

G-2.1 Physical Description

The components for the image motion (IMC) subsystem are housed in the slope programmer. This box measures 17 x 9 x 6 inches, and weighs about 14 pounds.

G-2.2 Location

The IMC subsystem slope programmer is located near the aft end of the instrument barrel between the +Z and +Y axes (see Figure E-2).

G-2.3 Elements of IMC

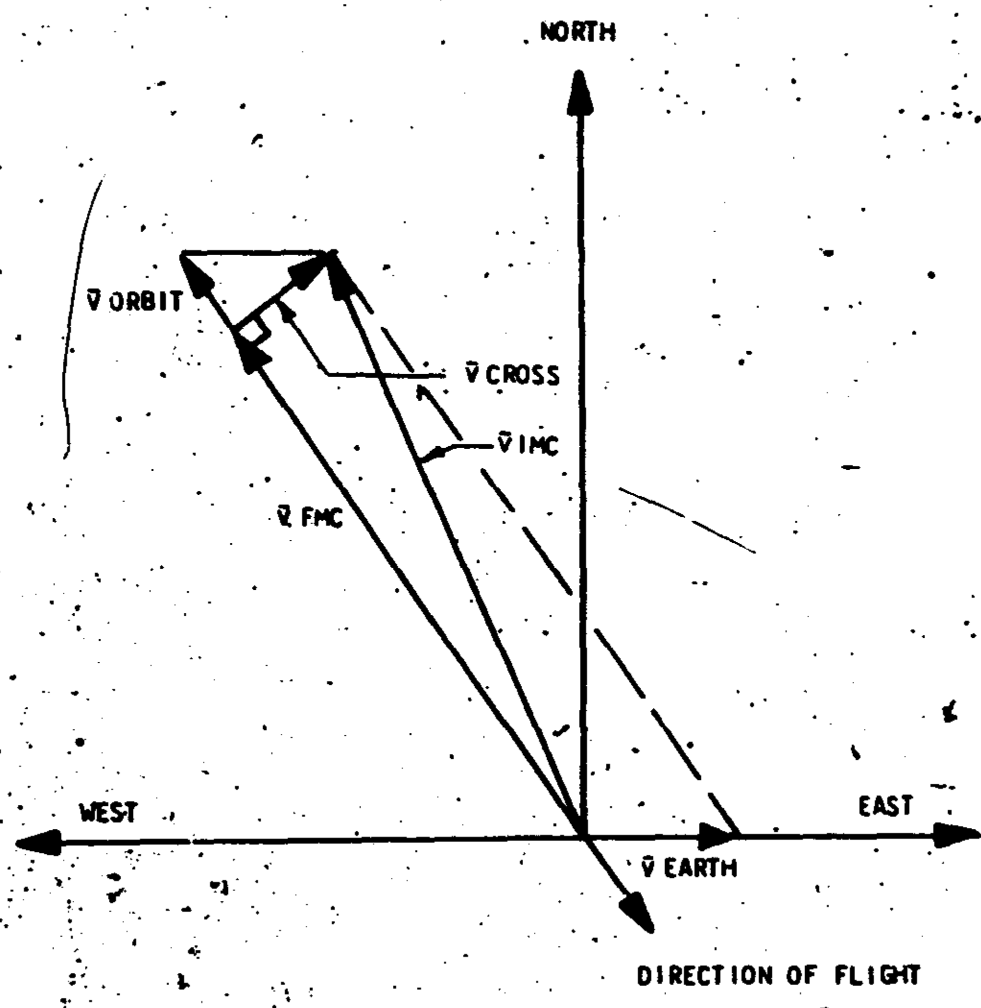
G-2.3.1 Attempting to photograph a moving target with a stationary camera will invariably result in a distributed displacement of the image, called smear. If the camera is moved at the same relative angular velocity as the moving target, the smear is less. The highest quality photograph will result when both the relative angular velocity and direction of the camera movement exactly matches that of the moving target. Both these compensations cause the image on the film emulsion to be stationary during the time of exposure; and a high-resolution photograph results. In photography from a satellite, the relative angular velocity through which the cameras must move is related to the ratio of $\frac{\text{velocity of the satellite}}{\text{height above the target}}$ (V/h), and determines the required forward motion compensation (FMC) necessary to render the target stationary.

In a nominal orbit for the J-3 system, the relative velocity of targets beneath the CR camera move (at the equator) at approximately 4.7 statute miles per second.

The alignment of the camera to the apparent direction in which the target appears to move is called yaw compensation, and this eliminates the cross-track component. When both the FMC and yaw compensation are present, a high-quality photograph, because of image motion compensation (IMC), results. The slope programmer is an IMC generator. It generates the two compensatory signals, FMC and yaw compensation. See Figure G-1.

G-2.3.2 The FMC signal is related to the V/h, and would be a fixed voltage if both the velocity of the target and height above it were fixed. Such is not the case with a satellite camera, unless the orbit was exactly equatorial, the orbit circular, and the earth spherical. As most orbits are both polar and eccentric, together with the earth being an oblate sphere, the FMC signal combines these deviations from the steady-state signal by summing the eccentricity and oblateness functions into a single signal resembling a cosine wave. The thus modified FMC output voltage excites the CR camera system, causing its lens to rotate about the optical nodal point at a rate dictated by the FMC. In addition to rotating, the lens cell moves perpendicularly to the axis of rotation (nods) so that the terrain image is stationary by keeping the cameras pointed at the target during the instant of exposure.

A framing camera such as the DISIC does not require IMC



$\bar{V}$ EARTH - EARTH ROTATION VELOCITY VECTOR REFERRED TO THE SATELLITE

$\bar{V}$ ORBIT - FORWARD GROUND TRACK VELOCITY REFERRED TO THE SATELLITE

$\bar{V}$ IMC - IMAGE MOTION VELOCITY REFERRED TO THE SATELLITE — ($\bar{V}$EARTH + $\bar{V}$ ORBIT)

$\bar{V}$ CROSS - CROSS TRACK VELOCITY COMPONENT OF $\bar{V}$IMC (YAW COMPENSATION)

$\bar{V}$ FMC - FORWARD MOTION COMPONENT OF $\bar{V}$IMC (FORWARD MOTION COMPENSATION)

Figure G-1 IMC Vector Diagram

compensation, since shutter speeds are so rapid that, for all practical purposes, the terrain image is stationary. The shutter speed is 1/500 or 1/250 second, in contrast to period of rotation of the CR camera of 1.6 to 4.0 seconds per cycle. See Sections F and I.

G-2.3.3 The CR camera drum assembly, which contains the lens cell, rotates at a speed which is proportional to the FMC signal generated by the slope programmer. The FMC signal feeds into the high-efficiency amplifier portion of the CR servo subsystem, wherein it determines the pulse duty cycle of an astable multivibrator. The pulses (8K HZ) switch two sets of drive motor transistors (forward and reverse) ON and OFF for the durations determined by the pulse train duty cycle. A feedback voltage, from a tachometer in the drive motor train, is summed with the FMC signal such that when the feedback signal is equal in amplitude to the FMC signal, the pulse duty cycle is 50 percent and the drive motor speed is constant.

G-2.3.4 The accuracy of the FMC is based on the preciseness of knowledge of the satellite velocity, the height of the cameras above the target, and the satellite inclination angle. As variations of the planned orbital parameters occur, some slope programmer FMC signal levels, amplitude, and start times (phase) are correctable in flight to allow for a continuous match of this apparent velocity and target height to the cameras.

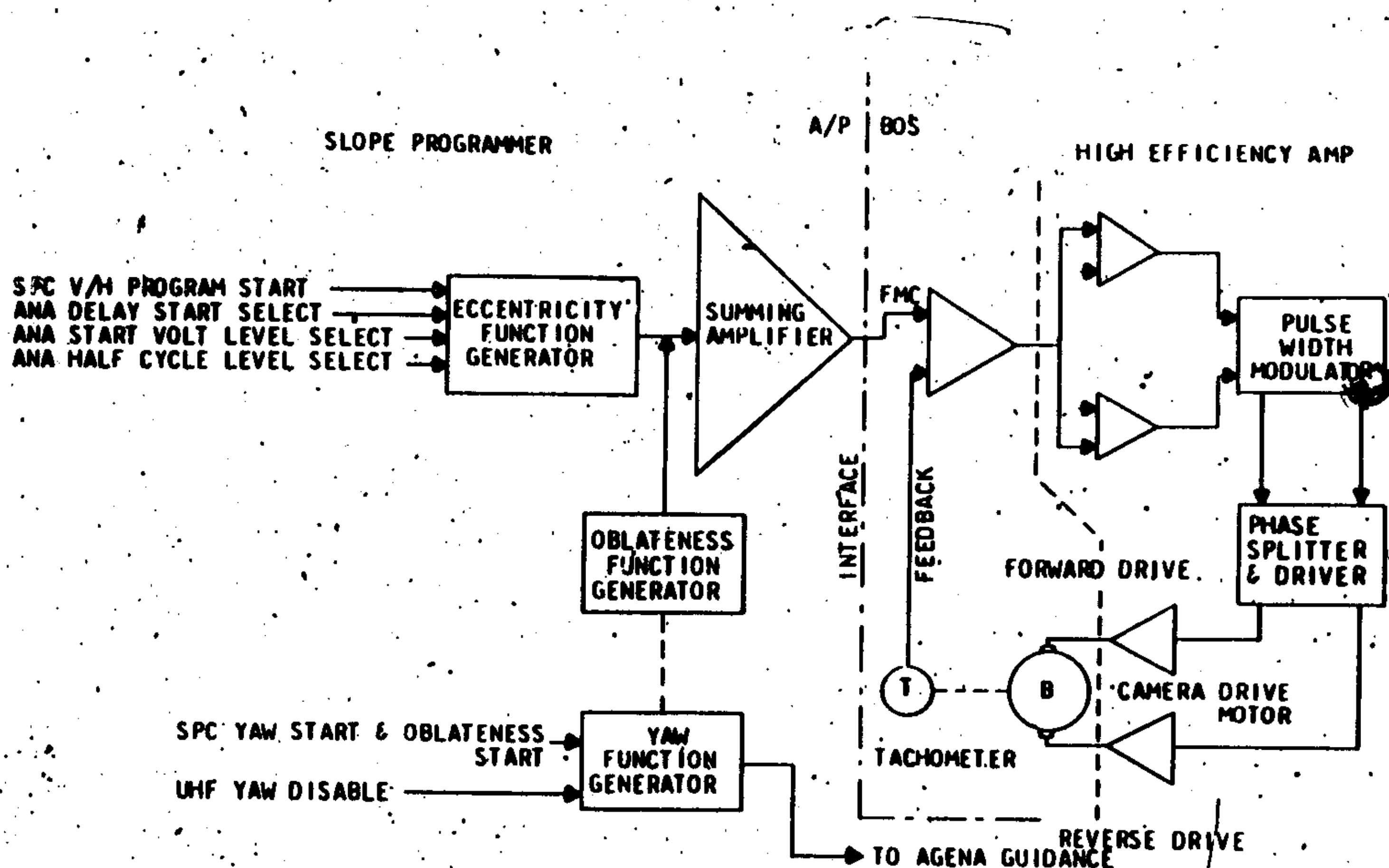
G-2.3.5 The yaw compensation signal negates the target cross-track error which is caused by earth rotation. This is accomplished by orienting the entire Agena so that the axis of camera rotation is perpendicular to the resultant of the satellite travel direction and the earth rotation vectors (the direction of nod is the same as the apparent target motion). This signal, a suppresed carrier voltage, is presented to the Agena guidance system (see Section B) as an error signal which causes Agena orientation. The amplitude and phase of the yaw correction signal is dependent on the injection angle and instantaneous longitude of the Agena. As both these quantities are predictable and known, no in-flight yaw adjustment is required. A two-state command (yaw compensation ON or OFF) can be controlled by a real time command.

G-3.0 DESCRIPTION

The following simplified block diagram (Figure G-2) shows the slope programmer and its integration into the payload system. Only the main function blocks are shown.

The block diagram shows that the FMC generator and yaw correction generator are separate, each having an individual electrical output (although a mechanical linkage does exist between the two). The mechanical linkage consists of a common drive motor for the yaw programmer and oblateness function generator portion of the FMC. Both the yaw correction and the oblateness functions are related and dependent on the satellite period and inclination angle. As the inclination angle is an orbital parameter precisely achieved, the only adjustable parameter to both these functions is time. Each must be started at the proper time, so that the outputs coincide with the effects to compensate; namely, oblateness and earth cross-track error. This is accomplished by brush 14, which occurs precisely at the same time during each orbit.

The number of command functions related to the eccentricity generator portion of the FMC are greater, as height above target and satellite velocity are not exactly predictable prior to launch, so that prelaunch settings of the eccentricity generator must be updated (in-flight) as soon as these parameters become known.



NOTE: THE SIMPLIFIED BLOCK DIAGRAM SHOWS THE RELATIONSHIP OF THE SLOPE PROGRAMMER TO THE CAMERA DRIVE SYSTEM. THE FORWARD AND REVERSE DRIVE AMPLIFIERS PULSE DRIVE MOTOR (B) AT A DUTY CYCLE DETERMINED BY THE MODULATOR. WHEN FEEDBACK VOLTAGE FROM THE TACHOMETER(T) IS EQUAL TO FMC VOLTAGE FROM THE SLOPE PROGRAMMER, THE SPEED IS CONSTANT AND THE CYCLE RATES ARE EQUAL TO THOSE LISTED IN PARAGRAPH C-2.1.

Figure G-2 Block Diagram - Simplified Camera Drive System

G-3.1 Eccentricity Generator

The eccentricity generator is the basic V/h function generator. It consists of a cosine function potentiometer driven by a motor and a voltage source. The speed of rotation is such that the instantaneous voltage developed at the wiper of the potentiometer is equal to the V/h. The following block diagram (Figure G-3) shows the constituents and relationships of the eccentricity function generator.

G-3.2 Program Timer

The program timer is a device to delay the start of the eccentricity function generator, to obtain a match between orbital parameters and the function being generated. It consists of a stable oscillator with a fundamental frequency of 0.04 cycles per second, which corresponds to a period of 25 seconds per pulse. Three flip-flops contained within the timer permit division by two for a time increment of 50 seconds per pulse, or by four for a total of 200 seconds per pulse. External leads permit the selection of one of the time increments prior to launch at day R-6, by means of a rotary switch.

The pulses of the increment selected are fed into a transistor/resistor logic (TRL) register, consisting of eight flip-flops arranged as a frequency divider and permitting a maximum division by 20. The eight "set" inputs to the time register are connected to a diode matrix which fans out to 20 leads (binary to decimal converter), any one of which may be selected. When one is selected, the division in the register will be by the number of the lead selected. Thus, division by any integer between one and twenty is possible by the selection of one of twenty leads. This makes it possible to select a delay from 25 seconds to 4000 seconds, depending on the time increment and interval selected. The following correspondence holds:

Increment	Interval (20 steps) Min.	Max.
25 sec.	25 sec.	400 sec.
50 sec.	50 sec.	800 sec.
200 sec.	200 sec.	4000 sec.

The program timer is started by SPC, Brush 27. The application of the brush closure performs two functions: it starts the oscillator and maintains a bias on the selected diode matrix interval. At time-out of the timer, power is applied to the step servo drive system by means of a relay. The relay will remain energized until de-energized by a switch closure in the cam switch.

G-3.3 Delay Start Time Selector

The selection of the interval can be made, or up-dated from prelaunch settings, by ANA V/h Delay Start Select during flight. The application of each ANA V/h Delay Start Select impulse causes a stepper motor to step, rotating a rotary switch 18 degrees. Each of the 20 steps corresponds to an input of the diode matrix and to a time increment. A similar 20-position switch (commutator) is in quinary code for telemetry identification of the selected interval.

G-3.4 Step Servo Drive

The step servo drive system consists of a step servo motor, a controller, and a gear head. Its function is to provide the motive power for the eccentricity function potentiometer. The servo drive system is started by the output relay of the program timer, it applying +24 volts unregulated to the controller.

G-3.5 Controller

The controller consists of two variable-frequency oscillators, necessary logic, and power amplifiers to drive the step servo motor. The oscillators are stable and relatively insensitive to temperature and voltage variations. The two oscillators, each used for a different mode of eccentricity function operation, are variable in pulse repetition rate and determine the stepping rate of the step servo motor. Mode 1 is the normal operating mode, generating a frequency such that the period of one complete revolution of the eccentricity function potentiometer may be fixed between 2400 seconds and 4800 seconds. Mode 2 is the slewing mode (fast return), and the rate may be adjusted between 240 and 480 seconds.

Given the period, the frequency or repetition rate may be calculated from the following equation:

$$\frac{74914.16}{X} = Y$$

Where X is the period in seconds and Y is the repetition rate in pulses per second. The formula is equally applicable to determine the periods of either Mode 1 or Mode 2 operation. The following nomograph (Figure G-4) shows this relationship.

A repeatable cam and switch mechanism connected to the step servo drive system will change the pulse generator pulse repetition rate from Mode 1 to Mode 2, speeding up the step servo motor until the cam detents the step servo motor and function potentiometer to "home," or starting position. Although the eccentricity function generator stops after having made one complete cycle, a long delay start time may make the function period exceed the orbit period. The change from Mode 1 to Mode 2 is performed by SPC, V/h Homing Reset-Oblateness Start-Yaw Programmer Start. The longest time to slew from any position is 8.0 minutes.

Logic circuits within the controller alternately apply power pulses to the step servo motor, causing it to increment one step for each pulse applied. Pulse power is applied to various sets of stator coils in the step servo motor, incrementally causing the rotor to rotate.

[redacted]

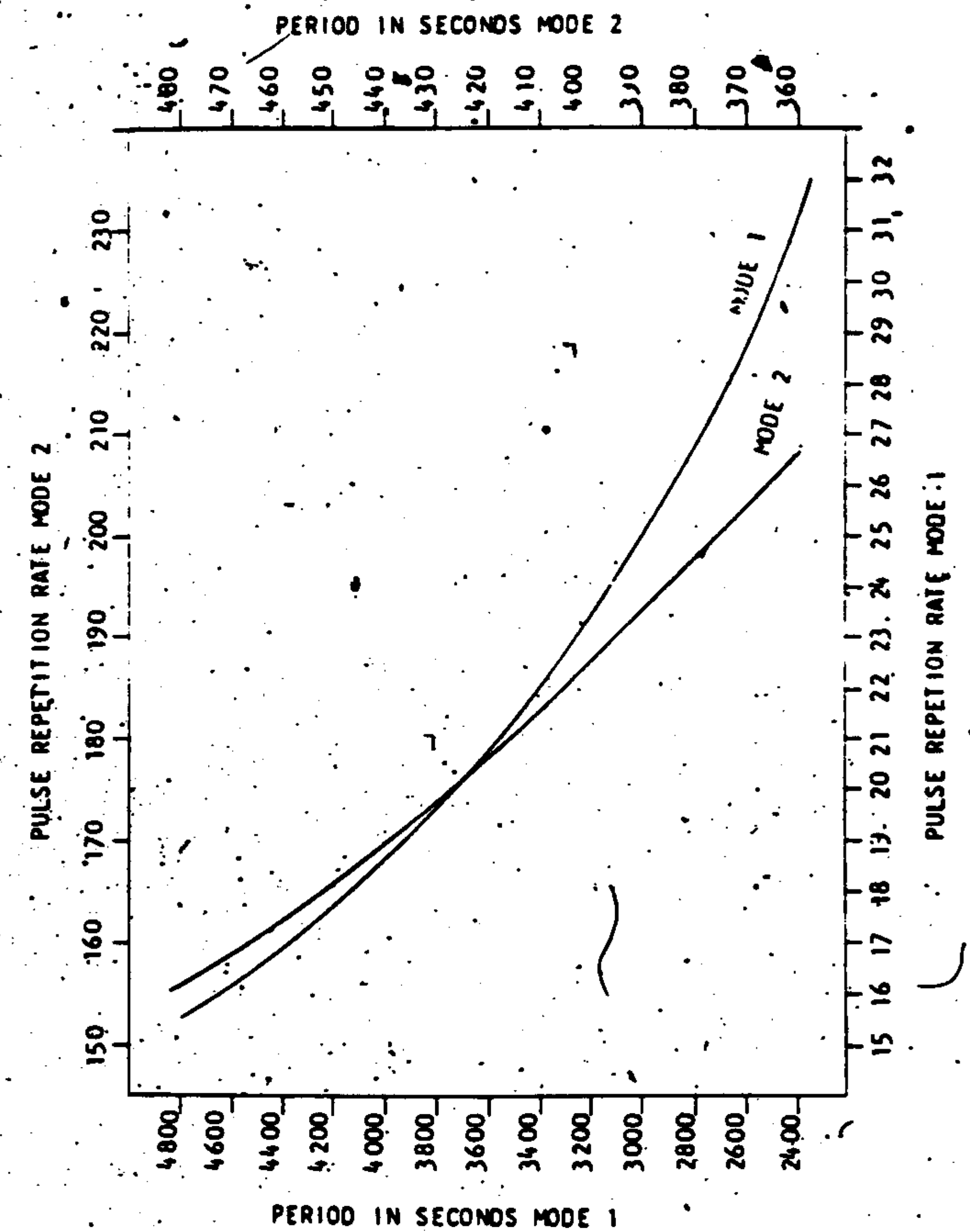


Figure G-4 Pulse Repetition Rate vs. Period

C ~~TOP SECRET~~ [redacted]

[redacted]

G-3.6 Step Servo Motor-Gearhead

The step servo motor is a permanent magnet rotor motor. The stator consists of four pairs of coils which are energized consecutively in pairs. Energizing a pair of adjacent coils causes the rotor to assume a position between the two, hence making it step 45 degrees for each pulse applied. The motor has no detent action, nor is any required, as the motor is directly coupled to a gearhead having a stepdown ratio of 9364.27:1. In turn, the gearhead is coupled to the eccentricity function potentiometer, causing it to rotate approximately 0.005 degrees for each pulse from the controller in Mode 1.

G-3.7 Eccentricity Function Potentiometer

The eccentricity function potentiometer is a precision potentiometer which generates a cosine function conforming to a close tolerance required to maintain an overall accuracy of $\pm$ 1 percent FMC. The potentiometer is excited by two voltages, each at a different top, to determine the E max (half-cycle) and E min (start) of the output function. The value of the function potentiometer is as high as one can practically be made, to minimize the loading effects caused by the two function exciting voltages (start and half-cycle).

G-3.8 Start and Half-Cycle Selector

Both the start and half-cycle voltage inputs to the eccentricity function potentiometer are adjustable on-orbit. Two real time commands, ANA V/h Start Level Select and V/h Half-Cycle Level Select, are provided for this purpose. The two circuits, the Start and Half-Cycle Selectors, are identical. Each consists of a stepper motor which is geared to precision linear potentiometers with wipers which provide the exciting voltages to the eccentricity function potentiometer. The Start and Half-Cycle potentiometers are excited by voltage sources which are adjustable such that the voltages across each potentiometer will be within the range of 1.34 to 3.75 VDC. Each ANA V/h Start Level Select or V/h Half-Cycle Level Select causes the respective stepper motor to advance 18 degrees, incrementing the Half-Cycle and Start function potentiometer excitation by 60 to 80 mv. See Tables G-1 and G-2.

G-3.9 Eccentricity Function Amplifier

The wiper of the eccentricity function potentiometer is the basic V/h voltage describing a spherical earth, and must be modified to account for earth oblateness if FMC is to result. The output of the eccentricity function potentiometer is fed into an amplifier having unity gain, and serves as a buffer to minimize the effects of loading on the function potentiometer that the oblateness function circuits (which follow) might impose.

Table G-1. Start Voltage Level

	START VOLTAGE LEVEL		CYCLE RATE	T/M VOLTS	
	POSITION	NOM. VOLT (± 1%)	SEC./CYCLE	FIVES	UNITS
LOWER	1	1.340	4.63	1	1
LIMIT	2	1.467	4.24	1	2
USE	3	1.594	3.91	1	3
	4	1.721	3.62	1	4
	5	1.848	3.38	1	5
	6	1.995	3.14	2	1
	7	2.102	2.97	2	2
	8	2.229	2.86	2	3
	9	2.356	2.65	2	4
	10	2.483	2.51	2	5
	11	2.610	2.38	3	1
	12	2.737	2.28	3	2
	13	2.864	2.17	3	3
	14	2.931	2.08	3	4
	15	3.118	2.00	3	5
	16	3.245	1.96	4	1
	17	3.372	1.82	4	2
	18	3.499	1.78	4	3
	19	3.626	1.72	4	4
	20	3.753	1.66	4	5

Table G-2 Half-Cycle Level

HALF-CYCLE LEVEL		T/M VOLTS	
POSITION	NOM. VOLT (± 1%)	FIVES	UNITS
1	2.000	1	1
2	2.092	1	2
3	2.184	1	3
4	2.276	1	4
5	2.368	1	5
6	2.460	2	1
7	2.552	2	2
8	2.644	2	3
9	2.736	2	4
10	2.828	2	5
11	2.921	3	1
12	3.013	3	2
13	3.105	3	3
14	3.197	3	4
15	3.289	3	5
16	3.381	4	1
17	3.473	4	2
18	3.563	4	3
19	3.657	4	4
20	3.749	4	5

G-3.10 Oblateness Function Generator

The output of the eccentricity function amplifier is modulated by the oblateness function generator. The oblateness function generator consists of a cosine function potentiometer with a wiper arm mechanically coupled to a motor gearhead and an additional gear pass such that it makes one complete revolution in 43-3/4 seconds. The output of the eccentricity function excites the oblateness function potentiometer in series with an adjustable rheostat, so that the level of modulating signal is adjustable prior to launch. The output of the oblateness function generator is the wiper of the oblateness function potentiometer, and it feeds into an operational amplifier having unity gain to offset loading. A simplified diagram is shown in (Figure G-5).

The FMC generator consists of the summing of both the output of the eccentricity function generator and the oblateness function generator. The summing is performed by a precision resistor network and an operational amplifier, such that $E_{FMC} = E_{EC} + E_{OBL}$

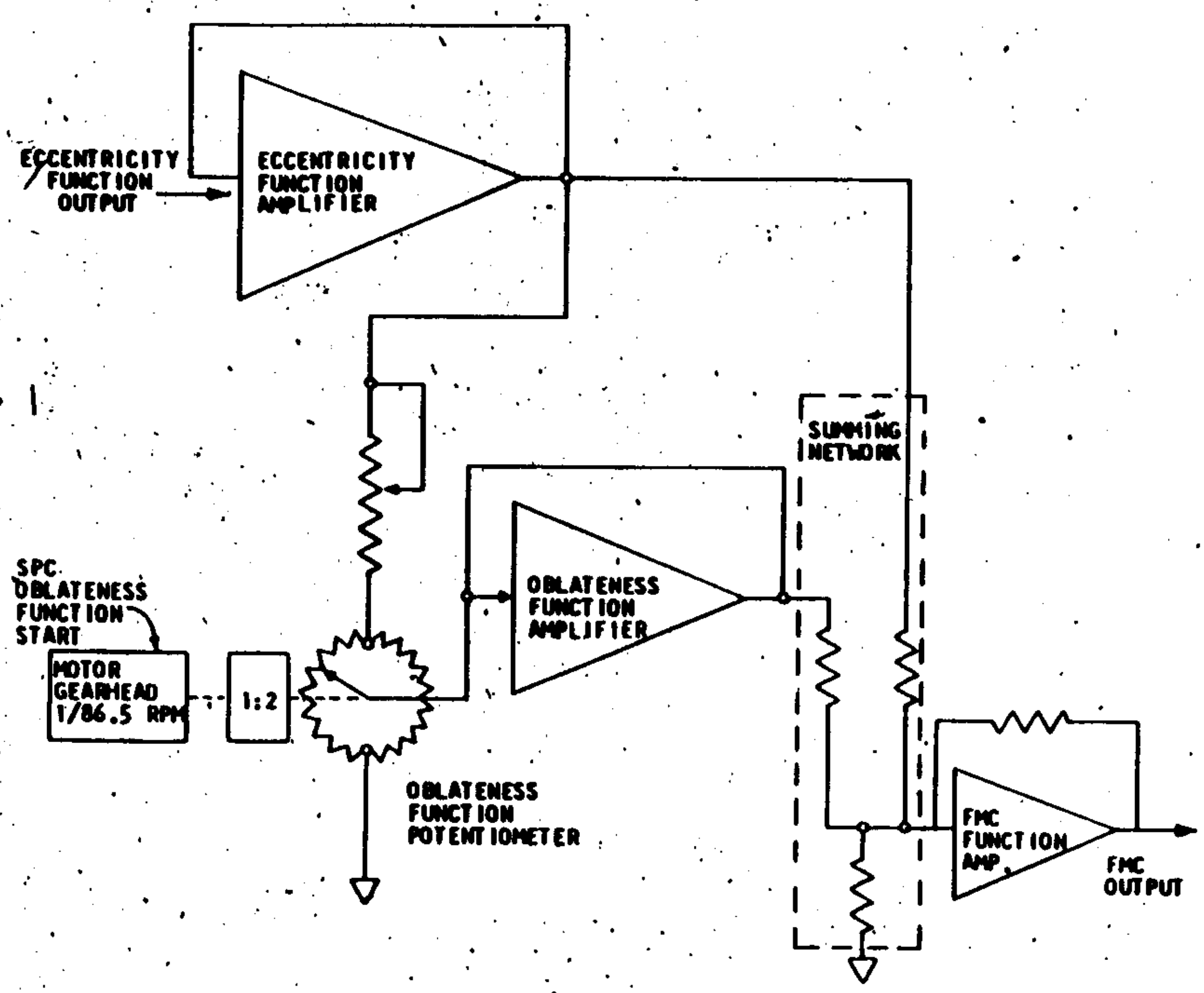


Figure G-5 Oblateness Generator

G-3.11 Yaw Function Generator

The yaw function generator consists of a motor-driven resolver. The motor gearhead drive is the same one used in the oblateness function generator, with the exception of the additional gear pass. It makes one revolution in 87-1/2 minutes. The resolver is excited by 400 Hz, and the output is 400 Hz voltage which amplitude is a function of the shaft angle. The resolver is essentially a fixed-ratio transformer with fixed input and variable coupling. It is driven through a gearhead having a ratio of 1:696,000, by a hysteresis synchronous motor having a fixed speed of 8000 rpm.

The yaw function generator is started by SPC V/h Homing Reset-Oblateness Start-Yaw Programmer Start, and continues until it times-out by a precision cam switch. This assures that it will start at a predetermined position each time. It should be noted that the period of the yaw function programmer is less than the shortest orbital period (88 minutes). A provision to enable or disable the yaw function by real time command UHF Yaw Programmer Enable/Disable has been provided. This circuit is a flip-flop in which one state enables the yaw function generator and the other disables it and short-circuits its output, thus reducing the incidence of noise being fed into the Agena guidance.

A block diagram (Figure G-6) showing the various components which comprise the yaw function generator is shown below:

G-4.0 T/M MONITORS, IMC SUBSYSTEM

Telemetry monitors have been provided for diagnostic, status, and command verification of the IMC subsystem. All of the T/M data appear on commutated channels in flight, but may be monitored continuously during ground test with the exception of the V/h Eccentricity Start command, V/h Eccentricity Operate, V/h

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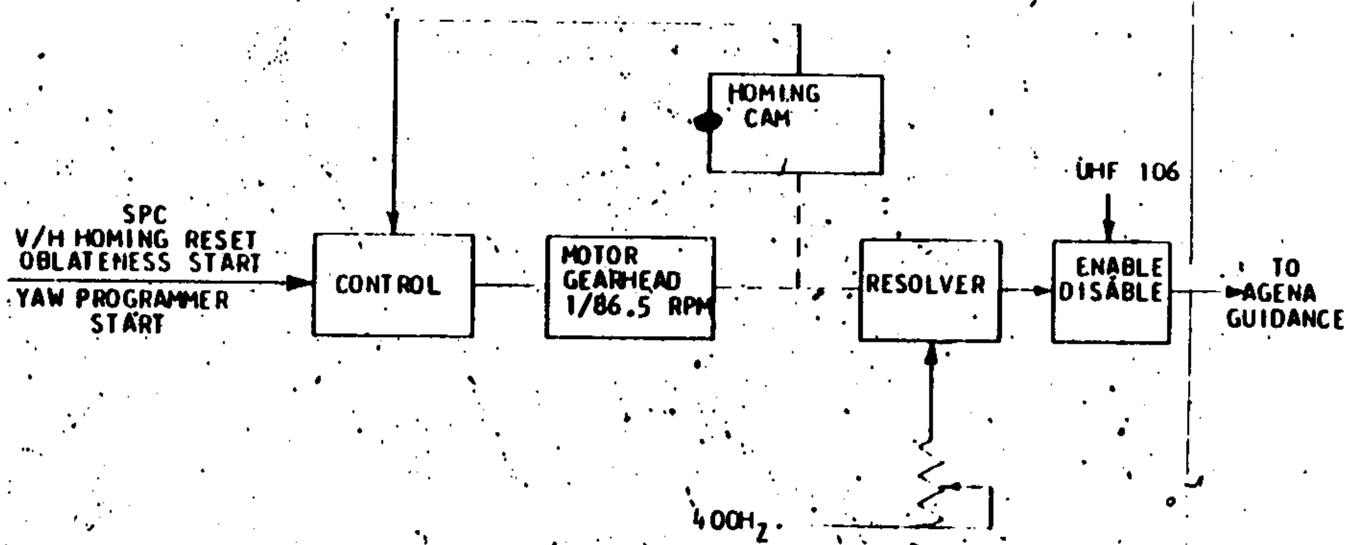

Figure G-6 Block Diagram of Yaw Function Generator

Operate, and V/h Programmer Temperature Sensor.

The T/M monitors, the commutator positions, and DC voltage assignments with the corresponding RTC (where applicable) are as follows:

Commutator I, Ring A, Link 1 Channel 13

Commutator II, Ring A, Link 2 Channel 16

Function	RTC	Voltage Level
V/h Start Level Selector - Fives	ANA 11	1, 2, 3, 4
V/h Start Level Selector - Units	ANA 11	1, 2, 3, 4, 5,
V/h Half-Cycle Selector - Fives	ANA 12	1, 2, 3, 4,
V/h Half-Cycle Selector - Units	ANA 12	1, 2, 3, 4, 5,
V/h Delay Start Selector - Fives	ANA 15	1, 2, 3, 4,
V/h Delay Start Selector - Units	ANA 16	1, 2, 3, 4, 5,
Yaw and Oblateness Operate	---	1.5, 2.5, 3.5, 4.5
Yaw Program Enable/Disable	UHF 106	1, 2

Commutator II, Ring B, Link 2 Channel 15

Function	Voltage Level
Yaw and Oblateness General Position	0 - 5
Yaw Resolver Output	0 - 5
Eccentricity Function Position	1.5, 2.5, 3.5, 4.5
V/h Eccentricity Start Command & Operate Relay	1.5, 2.5, 3.5, 4.5
FMC Function Output	0 - 5

Commutator I, Ring B, Link 1 Channel 11

Function	Voltage Level
V/h Programmer T/S #1	0 - 5

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SECTION H

EXPOSURE CONTROL SUBSYSTEM

H-1.0 PURPOSE

The purpose of the exposure control subsystem is to provide a controllable means of adjusting the exposure in the CR and DISIC cameras to be compatible with in-flight changes in film type (filter change), and with changes in target illumination as the satellite passes from night to day or day to night.

H-2.0 CHARACTERISTICS

H-2.1 Major Assemblies

The exposure control subsystem consists of the following:

a. The switch programmer

b. The two slit width control mechanisms in the two CR instruments

c. The two filter control mechanisms in the two CR instruments

d. The two exposure control mechanisms in the DISIC

H-2.2 Size, Weight, and Location

The switch programmer is housed in a package approximately 6 x 9 x 12 inches. It weighs 10 pounds, and it is located just above the +Y axis at the aft end of the instrument barrel, as shown in Figures E-2 and M-3. The slit width control mechanism in each CR instrument is located in the scan head assembly of that instrument. See Figures H-1 and H-2. The dual-position clutch to change shutter speeds in the DISIC is linked to the shutter control mechanism of the DISIC.

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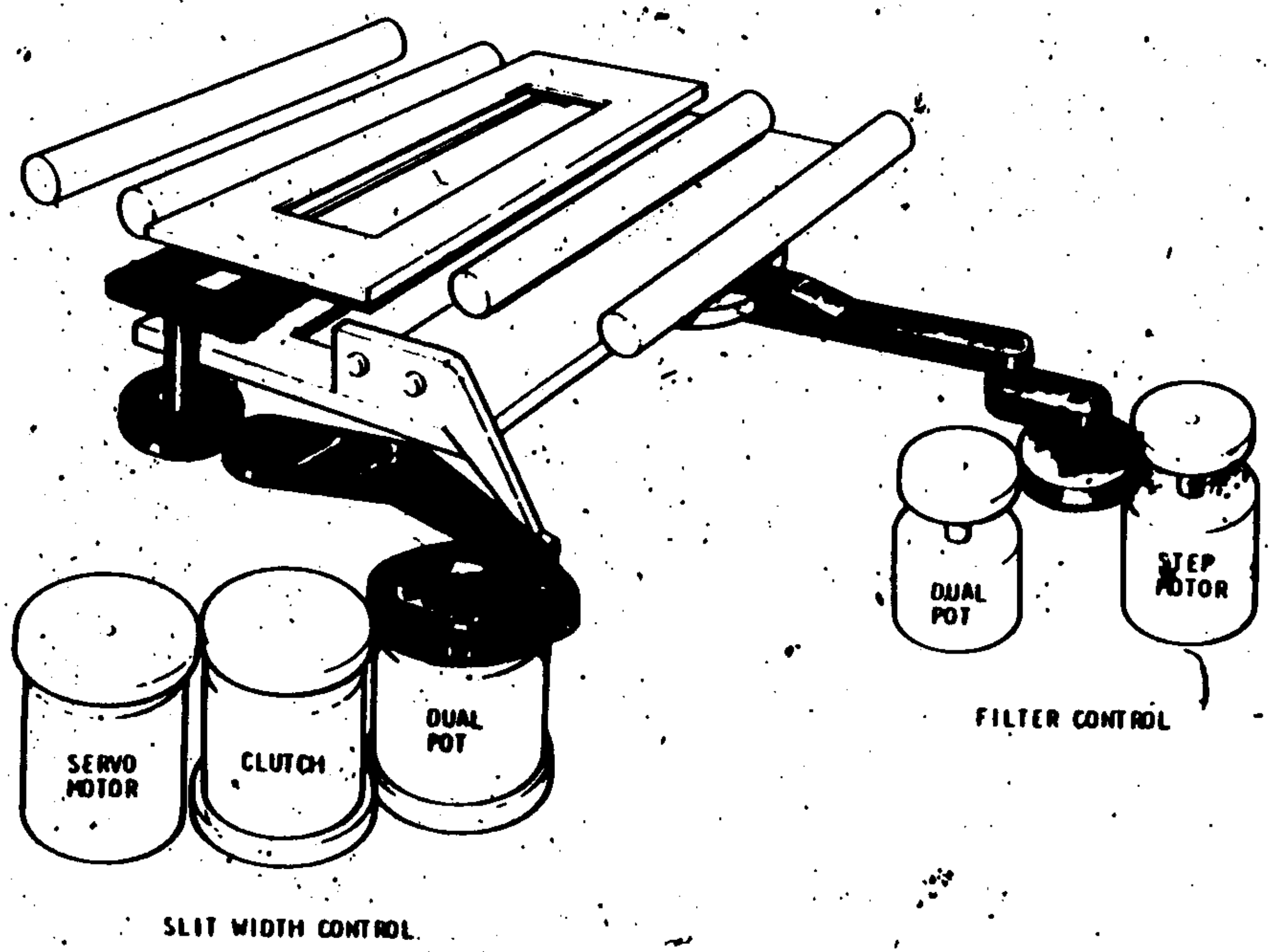

Figure H-1   Slit Width Control Assembly in Scan Head

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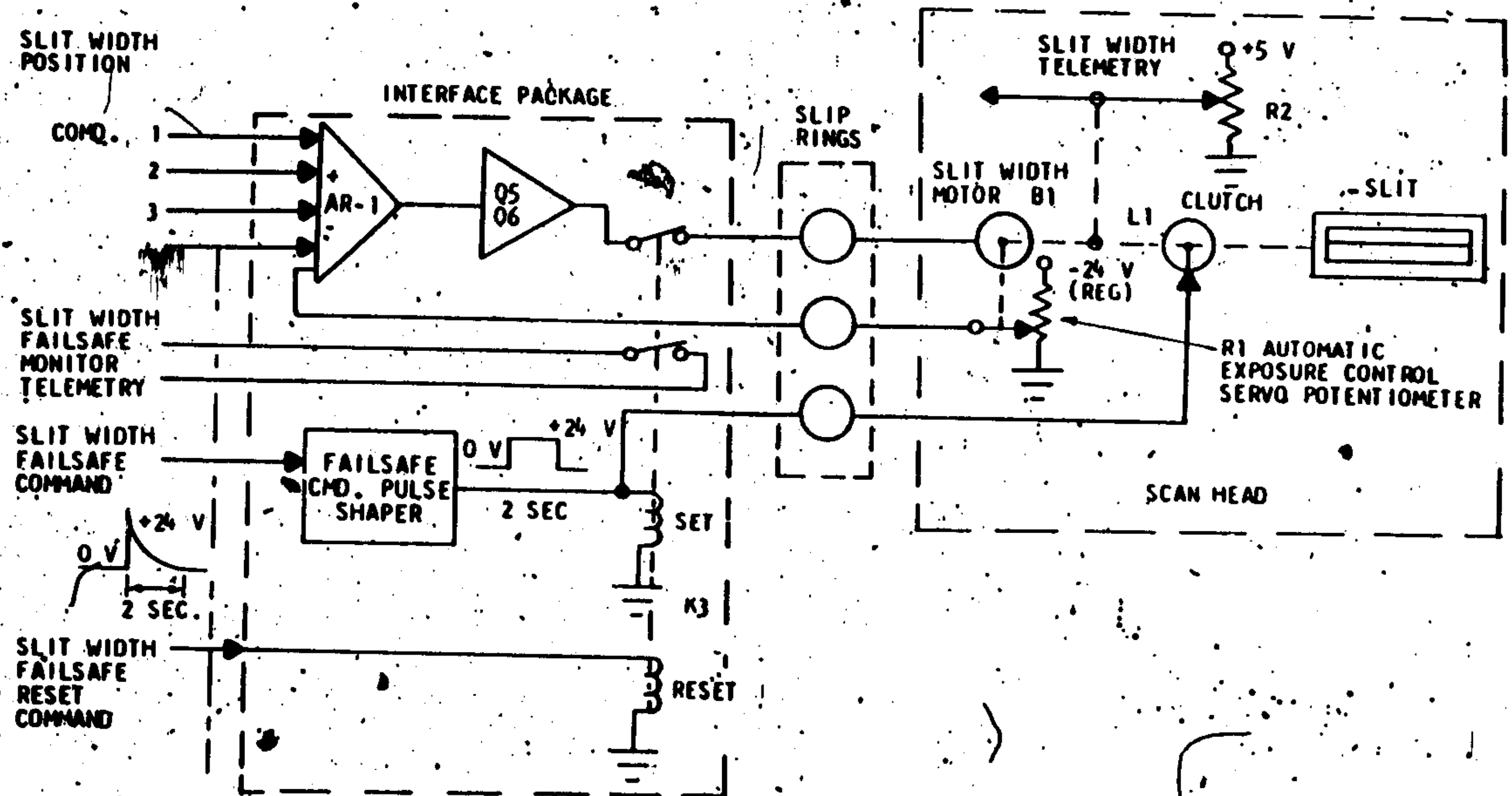

Figure II-2 Exposure Control Schematic - CR Instrument Part

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H-3.0 SUBSYSTEM OPERATION

H-3.1 General

H-3.1.1 Command Options

The exposure control subsystem provides in-flight selection of the following: (See Table H-1):

a. Four (4) selectable discrete slit widths to control the exposure of the CR instruments, plus a "failsafe" slit width. See Section F.

b. Two (2) exposures, 1/250 and 1/500 second, for the DISIC index camera. See Section I.

The switch programmer has two modes of operation: Timing sequence mode, and the real time command control mode. In the timing sequence mode, the switch programmer controls the CR instrument and DISIC exposure in time sequence (night-to-day and day-to-night exposure sequence), which is variable within limits by a real time command, exposure control delay, to compensate for launch time, orbital parameters, etc. The timing sequences are started with stored program commands, exposure control night-to-day and exposure control day-to-night.

In the real time control mode, UHF 101 (in conjunction with a stepper switch) overrides the timing sequence and places both CR instruments in any one of four selected CR instrument slit widths or in the fail-safe slit width. In addition, either one of the CR instruments can be placed in fail-safe slit width while the other instrument operates through the timing sequence mode or in any one of four fixed slit widths. A fail-safe reset capability is provided to get the system out of fail-safe slit width position. An additional real time command (UHF 102) places both CR instruments directly into fail-safe slit width.

Table H-1 Summary of Commands and Monitors

I. STORED PROGRAM COMMAND CAPABILITY

A. NIGHT-TO-DAY EXPOSURE SEQUENCE START
B. DAY-TO-NIGHT EXPOSURE SEQUENCE START
C. POWER OFF TIMERS

II. REAL TIME COMMAND CAPABILITY

A. REAL TIME CONTROL OF CR SLIT WIDTH
B. CR INSTRUMENT FAIL-SAFE COMMAND
C. TIMING DELAY CONTROL FOR TIMER NO. 1
D. FILTER CHANGE
E. UMB. RELAY RESET (UMBILICAL COMMAND TO PLACE DISIC IN 1/500 SECOND EXPOSURE. CR INSTRUMENT IN SLIT WIDTH POSITION NO. 1 FOR LAUNCH.)

III. TELEMETRY MONITORS

A. SWITCH PROGRAMMER

1. SLIT WIDTH COMMAND MONITOR

SLIT WIDTH COMMAND MONITOR	T/M VOLTAGE
SLIT WIDTH CONTROL #1	1.5V
SLIT WIDTH CONTROL #2	2.5V
SLIT WIDTH CONTROL #3	3.5V
SLIT WIDTH CONTROL #4	4.5V

2. REAL TIME CONTROL STEPPER SWITCH MONITOR

STEPPER SWITCH POSITION	TELEMETRY VOLTAGE (2 COMMUTATOR POINTS)	
1	1V	1V
2	1V	2V
3	1V	3V
4	1V	4V
5	1V	5V
6	2V	1V
7	2V	2V
8	2V	3V
9	2V	4V
10	2V	5V
11	3V	1V

3. TIMER #1 TIME DELAY MONITOR

TIMER POSITION	TELEMETRY VOLTAGE (2 COMMUTATOR POINTS)	
1	1V	1V
2	1V	2V
3	1V	3V
4	1V	4V
5	1V	5V
6	2V	1V
7	2V	2V
8	2V	3V
9	2V	4V
10	2V	5V
11	3V	1V
12	3V	2V
13	3V	3V
14	3V	4V
15	3V	5V
16	4V	1V
17	4V	2V
18	4V	3V
19	4V	4V
20	4V	5V

Table H-1 Continued

B. CR INSTRUMENT

1. FAIL-SAFE/FAIL-SAFE RESET MONITORS

FAIL-SAFE RESET	1V
FAIL-SAFE:	2V

2. SLIT WIDTH POSITION POTENTIOMETER 1 TO 5V

C. DISIC

	MODE 1 (SLAVE)	MODE 2 (INDEPENDENT)
1/250	1.4V	2.4V
1/500	1.7V	3.3V

H-3.1.2 Method of Control, CR Instruments

The switch programmer interfaces with the CR instrument exposure control system, which is a DC closed-loop servo system. The switch programmer controls the reference signal to the servo system. For the fail-safe slit width, the switch programmer provides the command to disable the servo system and place the system into the fail-safe slit width through an electromechanical clutch. The Fail-Safe Reset signal from the switch programmer enables the servo system, which then can control the slit width position. Interchangeable cams, installed in the CR scan head during mission preparation, permit selection of four discrete slit widths before each flight, plus a fifth fail-safe position to which the slit blades move automatically when the slit width control mechanism is disengaged. The fail-safe reset feature enables either CR camera to operate in the fail-safe mode while the other is in timed sequence mode.

H-3.1.3 DISIC Control

The DISIC exposure control mechanism is an electromechanical clutch, operated to select either the 1/250 second or 1/500 second exposure.

H-3.2 Operation in Timed Sequence Mode

H-3.2.1 Night-to-Day Exposure Sequence

In the night-to-day sequence, the CR slit width changes in time sequence from S4 to S3 to S2 to S1, as shown in Figure H-3. Figure H-4 shows the simplified functional block diagram for the night-to-day exposure sequence.

The night-to-day sequence is initiated with SPC Exposure Control Night-to-Day, which starts Timer #1. After Timer #1 times out, the command to slit width #3 is enabled and Timers #2 and #3 are started. After Timer #2 times out, the DISIC exposure is enabled for 1/500 second exposure position. After Timer #3 times out, the command to slit width #2 is enabled and Timer #4 is started. After Timer #4 times out, command to slit width #1 is enabled. This completes the night-to-day sequence, and SPC Exposure Control Power OFF removes power from the timer. The switch programmer is designed such that only one of the four (4) CR instrument slit width control outputs is enabled at any one time. When one slit width control is enabled, the other three are automatically disabled. Also, since the control power to the slit width mechanism is from the Instrument Operate command, the slit width mechanism for the DISIC and the CR instrument operates only when the instrument is operated.

As discussed above, the timers of the switch programmer control the timing between slit width change. Figures H-3 and H-5 show Δt_1, Δt_2, Δt_3, and Δt_4.

Δt_1 has a range of either 10 to 200 seconds in 10-second increments, or 20 to 400 seconds in 20-second increments. Either one can be selected prior to flight only. In flight, Exposure Control Delay is used to select the exact time of Δt_1. That is, one of 20 positions in 10-second or 20-second increments.

Δt_2, Δt_3, and Δt_4 all have a range of 20 to 400 seconds

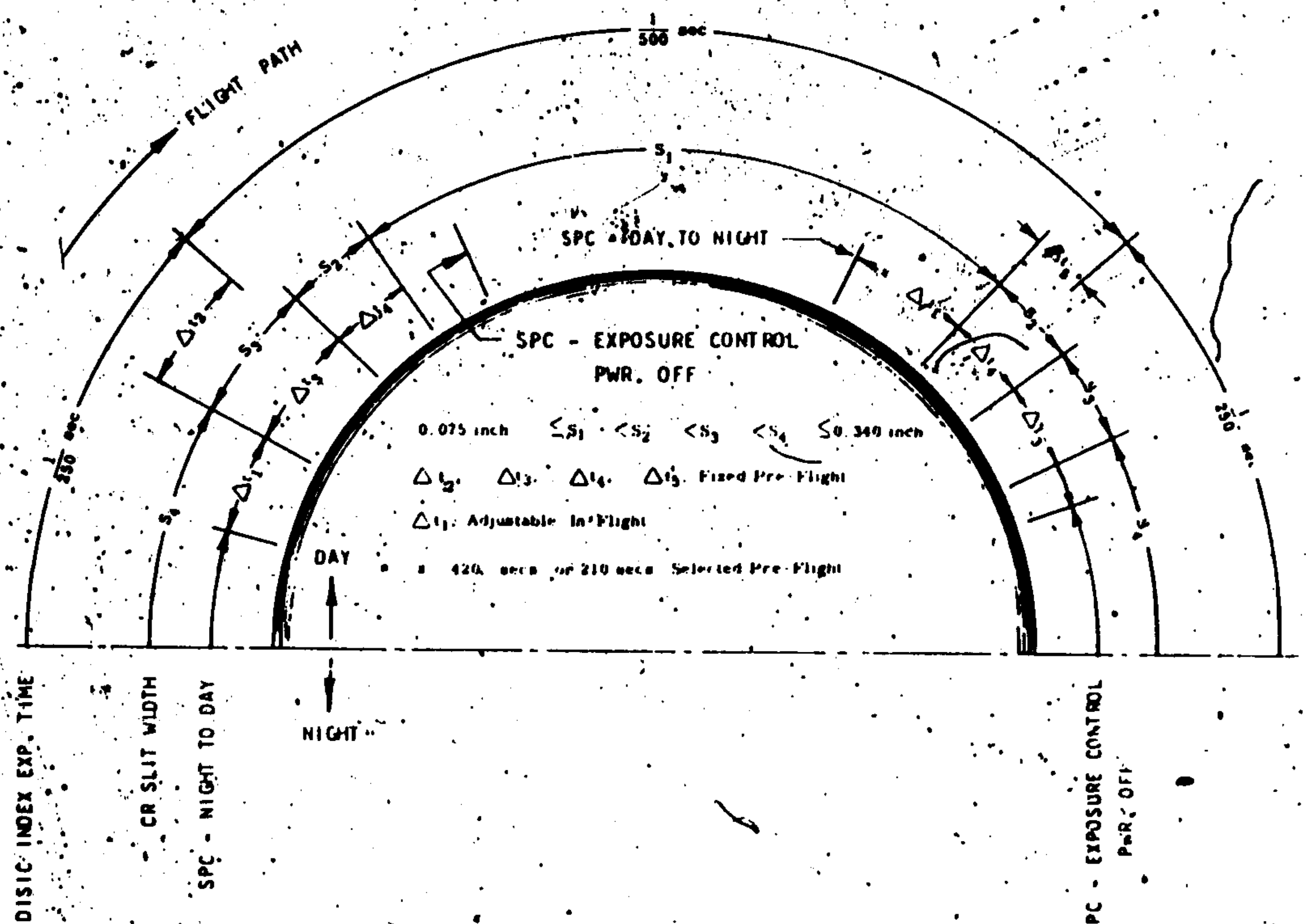

Figure H-3 Exposure Changing Sequence

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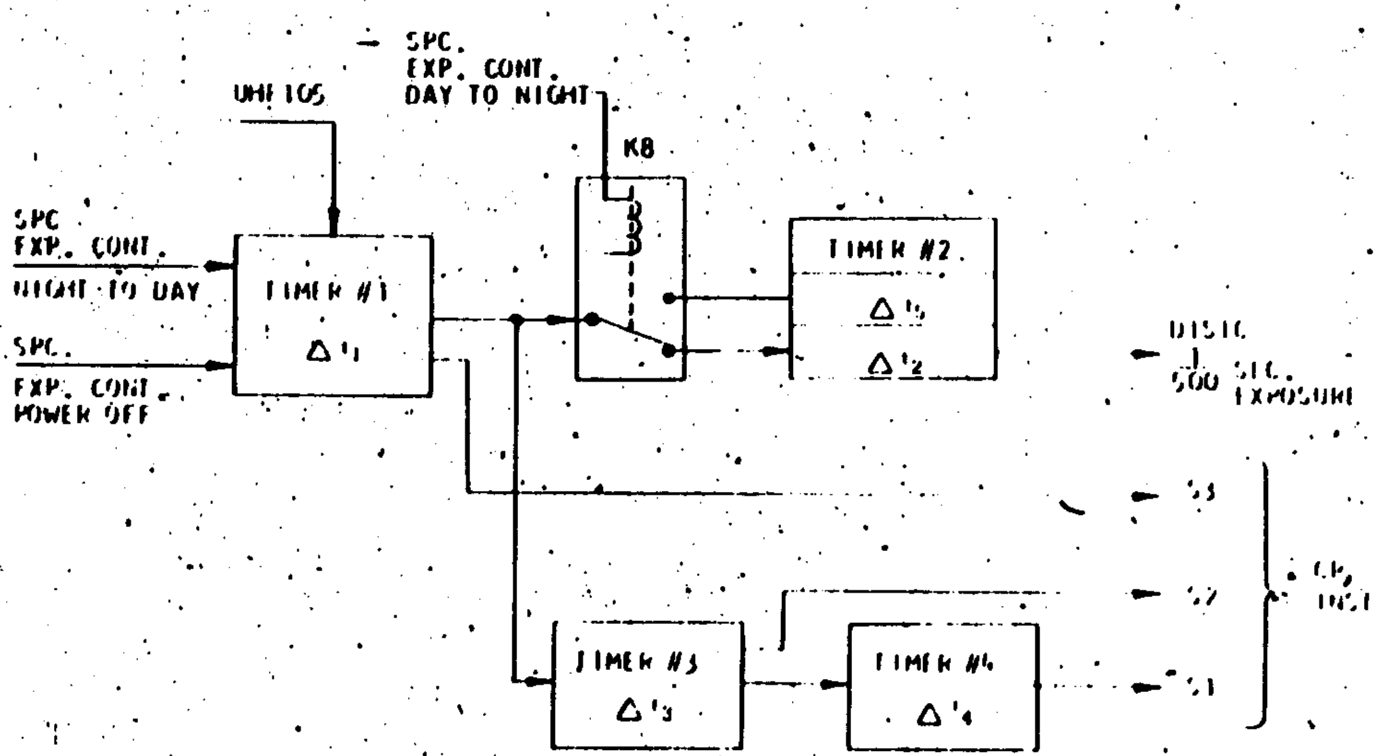

Figure H-4 Night-to-Day Exposure - Timing Sequence in 20-second increments. Each can be independently set prior to flight only.

H-3.2.2 Day-to-Night Exposure Sequence

The day-to-night sequence is initiated with SPC Exposure Control Day to Night, which starts Timer #1. Although the same timers used in the night-to-day sequence are again used in the day-to-night sequence, the delay times of Timers #1 and #2 may be different, and the sequence of the use of Timers 3 and 4 are reversed. After Timer #1 times out, the command to slit width #2 is enabled and Timers #2 and 4 are started. After Timer #2 times out, the DISIC exposure is enabled for 1/250 seconds. After Timer #4 times out, the command to slit width #3 is enabled and Timer #3 is started. After Timer #3 times out, command to slit width #4 is enabled. This completes the night-to-day sequence, and SPC Exposure Control Power OFF removes power from the timer. See Figures H-5 and H-6.

The time delay of Timer #1 will be either $210 - \Delta t_1$ or $420 - \Delta t_2$, depending upon whether Δt_1 was selected to be 10 to 200 seconds in 10-second increments or 20 to 400 seconds in 20-second increments. $210 - \Delta t_1$ corresponds with the 10 to 200 second range, and $420 - \Delta t_2$ corresponds with the 20 to 400 second range. Exposure Control Delay is used to select the exact time. Δt_5 has a range of 20 to 400 seconds in 20-second increments and is set prior to flight. Δt_3 and Δt_4 are the same as in the night-to-day sequence.

H-3.3 Operation in Real Time Command Mode

In order to provide operational flexibility, circuits are provided to override the timed sequence control. In the real time control mode, the switch programmer has the capability

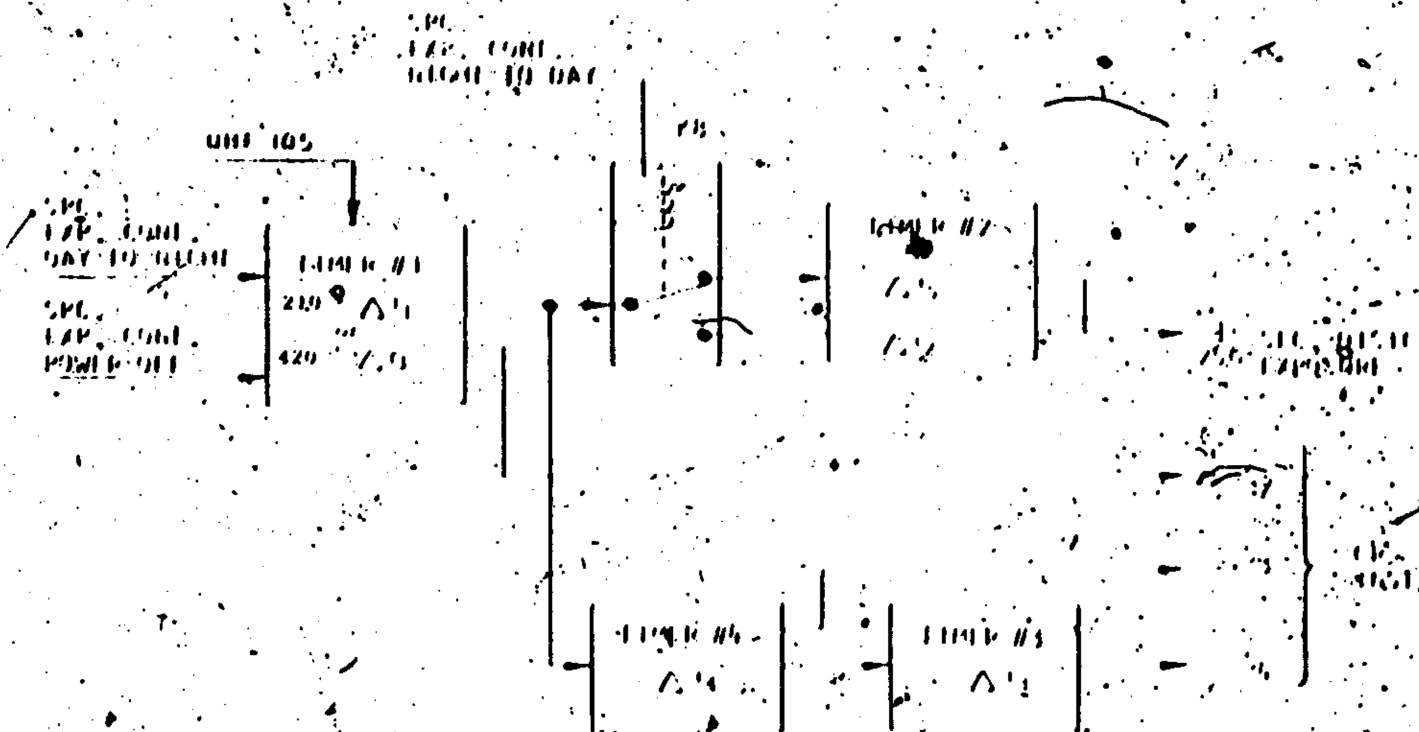

Figure II-5 Day-to-Night Exposure - Timing Sequence

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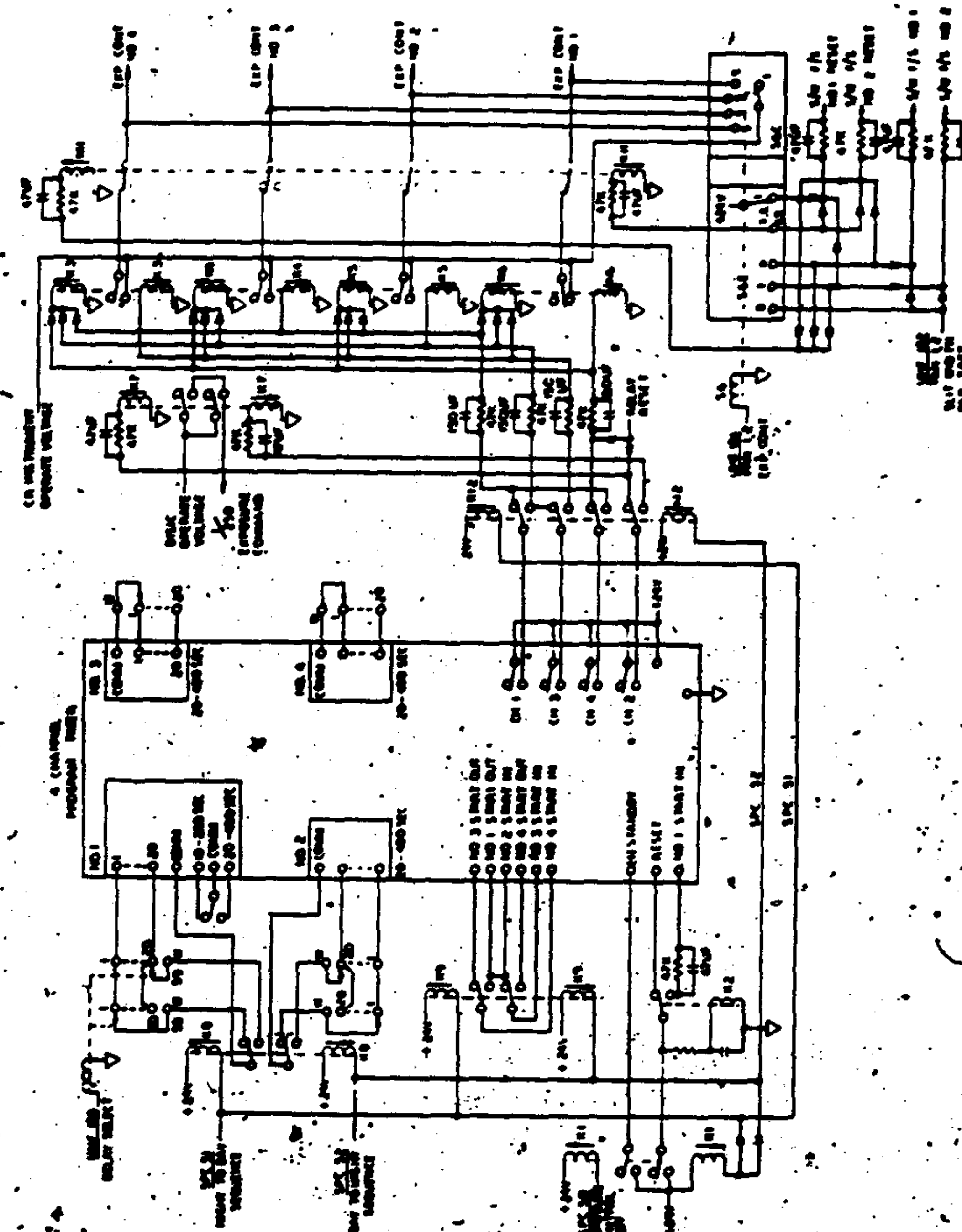

Figure H-6 Exposure Control Simplified Schematic of overriding the timing sequence and placing both CR instruments into any one of the four slit widths or into the fail-safe slit width. In addition, either instrument can be placed into Fail-Safe Reset and the other instrument can be operated through the timing sequence or in one of the four fixed slit widths.

H-3.3.1 Operation in CR Scan Head Assembly

The scan head assembly, which contains the slit width device, the filter change device, and the focal plane rollers, is mounted on the end of the lens cone. The device consists of a bidirectional, four-position slit width changer. A two-position filter changer is part of the same mechanism.

A cam driven by a servo motor provides the means for varying the slit width. The servo motor takes its command from a signal from the switch programmer. The switch programmer has a capability of providing four reference voltages. The normal exposure control is accomplished by using four slit width positions. The slit blades are driven by a servo motor which is clutched to a dual potentiometer. The filter changer is driven by a stepper motor and a dual potentiometer.

An additional position, called fail-safe mode, is obtained by sending a real time command which opens a clutch between the servo motor and the slit mechanism to allow a spring to pull the slit to a nominal width.

There are physical limitations, due to the location of the slit mechanism, to both the maximum slit width and the minimum slit width. The maximum available slit is 0.340 inch, while the minimum slit is 0.134 inch.

H-3.3.1.1 Filter Change Consideration

The J-3 camera is capable of handling several different basic film materials in combinations of two at a time. In order to keep the slit widths the same for different films, exposure is compensated by different filters.

There are two methods available for activating the filter change. One is by real-time command from the ground, and the other is by the CR instrument automatic splice detector (CR-3 and up).

H-3.4 Launch Condition

Prior to launch, the relay reset command on the umbilical places the DISIC exposure into a 1/500 second exposure and the CR instrument into slit width position #1.

H-3.5 Telemetry Monitors

Telemetry monitors are provided in the switch programmer, in the CR instrument, and in the DISIC exposure control assemblies for testing and inflight monitor purposes.

Each output relay for slit width command to the CR instruments is monitored. The real time control stepper switch is monitored. The status of the real time command (Exposure Control Delay) control of Timer #1 is monitored to determine the actual time delay programmed. In addition the scan head filter, whether normal or alternate is telemetered from both instruments.

The CR instruments have monitors to determine the fail-safe or fail-safe reset status, and have a potentiometer monitor to determine the actual slit width position. The DISIC has monitors to determine whether the clutch is energized for 1/250 second exposure and de-energized for the 1/500 second exposure. With the use of the combined monitors, the status of the complete exposure control system can be monitored during flight.

The functions monitored by T/M are shown in Figure H-7.

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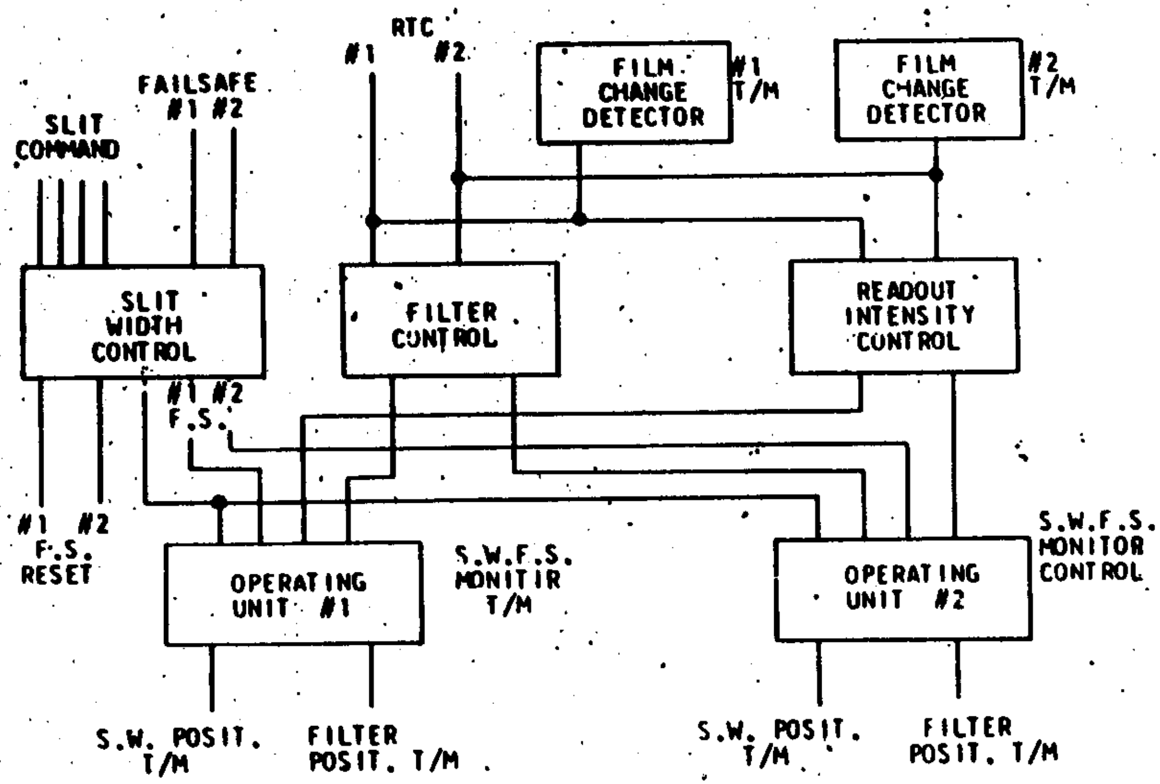

Figure H-7 —Exposure and Readout Control - Block Diagram

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SECTION I

DUAL IMPROVED STELLAR INDEX CAMERA SUBSYSTEM

I-1.0 PURPOSE

The purpose of the dual improved stellar index (DISIC) camera subsystem is to provide exposed film for use in precision geodetics and cartography, and also for use in conjunction with the main CR cameras to aid in establishing vehicle attitude and precise location of reconnaissance points of interest.

I-2.0 SUMMARY OF CHARACTERISTICS

Tables I-1 through I-4 are self-explanatory. Figure I-1 provides a functional schematic for pictorial definition. Figures V-4 and V-5 provide format descriptions.

Table I-1 Physical System Characteristics

PARAMETER	TERRAIN CAMERA	STELLAR CAMERA
LENS	3-INCH IKOGON	3-INCH IKOTAR
APERTURE	F/4.5	F/2.8
FILM FORMAT	4.5 INCHES BY 4.5 INCHES	1.25 DIA WITH FLATS
ANGULAR COVERAGE	74 BY 74 DEGREES	23 - 1/2 DEGREES
LENS DISTORTION	30 MICRONS (R) 5 MICRONS (T)	15 MICRONS (R) 5 MICRONS (T)
FILM FLATTENING	BY GLASS PLATE	BY GLASS PLATE
RESEAU	2.5 MM SPACING 10 MICRONS MAX.WIDTH	2.5 MM SPACING 10 MICRONS MAX.WIDTH
RESEAU ILLUMINATION	NATURAL	ARTIFICIAL
NATURAL FIDUCIALS	1 SET OF FOUR	1 SET OF FOUR
SHUTTER TYPE	ROTARY	ROTARY
SELECTIVE EXPOSURE TIME	1/250 SECOND 1/500 SECOND	1.5 SECONDS

Table I-1 Continued

PARAMETER	TERRAIN CAMERA	STELLAR CAMERA
CYCLE PERIOD	9.375, 12.50, 15.675 AND 18.75 SECONDS (LAST TWO NOT ON CR-1 THRU CR-6)	3.125 SECONDS (MODE I) SAME AS TERRAIN (MODE II)
DUAL STELLAR OPERATION	--------	SIMULTANEOUS, OR BY SELECTION
KNEE ANGLE	100 DEGREES	100 DEGREES
DATA RECORDING	TIME AND SERIAL NO.	TIME AND SERIAL NO.
FILM TYPE (NORMAL)	3400	3401
WIDTH	5 INCH	35 MM
TOTAL CAPACITY	2000 FEET	2000 FEET
METERED LENGTH	5 INCHES	3 INCHES

Table I-2 DISIC Subsystem Weight

(1)	DISIC INSTRUMENT (INCLUDING FILM CHUTES AND BAFFLES)	50 LBS.
(2)	SUPPLY CASSETTE	12 LBS.
(3)	TAKE-UP CASSETTES (TWO)	13 LBS.
(4)	FILM (MAX.)	25 LBS.
(5)	FILM EXIT HOUSING	4 LBS.
	TOTAL	104 LBS.

Table I-3 Power

INDEX CYCLING RATE	APPROX. TOTAL POWER	CURRENT TOTAL AVG AMPS
9.375 SEC. SLAVE	72 WATTS	3.00 (24 VDC)
9.375 SEC. INDEPENDENT	66 WATTS	2.75 (24 VDC)

NOTE:

(1) THE ABOVE TABULATION GIVES THE PREDICTED AVERAGE POWER CONSUMPTION FOR THE CAMERA SUBSYSTEM COMPONENTS ALONG WITH THE TOTAL CURRENT AND POWER. ONE OF TWO TERRAIN CYCLING PERIODS (9.375 SEC. OR 12.500 SEC/CYCLE) CAN BE SELECTED PRIOR TO FLIGHT. THE NUMBERS IN THE TABLE ABOVE ARE BASED ON CYCLING PERIOD OF 9.375 SEC. THIS PERIOD IS EXPECTED TO BE USED FOR MOST FLIGHTS, AND POWER CONSUMPTION AT THE 12.500 SEC. PERIOD WILL BE WITHIN 10 PERCENT OF THOSE SHOWN FOR 9.375 SEC.

(2) POWER OF APPROXIMATELY 850 WATT-HOURS IS REQUIRED FOR THE DISIC SUBSYSTEM DURING FLIGHT, BASED ON 14 DAYS OF ACTIVE MISSION LIFE WITH 2000 FEET OF INDEX AND STELLAR FILM. MISSION PROGRAMMING OF THE DISIC FOR THE INDEPENDENT AND SLAVE MODES MAY REQUIRE LESS THAN 2000 FEET OF FILM WITH A CORRESPONDING REDUCTION IN THE POWER REQUIREMENTS.

Table I-4 DISIC System Monitors and Channel Assignments

MONITOR	READOUT REQUIREMENTS COMMUTATED	READOUT REQUIREMENTS CONTINUOUS
(1) MOTOR VOLTAGE	T & F	T
(2) MODE COMMAND	T & F	
(3) OPERATE COMMAND	T & F	
(4) 1 RPC CAM SWITCH POSITION	T & F	T
(5) TERRAIN EXPOSURE SETTING	T & F	
(6) TERRAIN SHUTTER OPENING		T & F
(7) TERRAIN METERING CLUTCH COMMAND	T & F	T
(8) TERRAIN CAPPING COMMAND	T & F	T
(9) TERRAIN PLATEN POSITION	T & F	T
(10) TERRAIN FILM IDLER ROTATION		T & F

Table I-4 Continued

MONITOR	READOUT REQUIREMENTS COMMUTATED	READOUT REQUIREMENTS CONTINUOUS
(11) LEFT STELLAR CAPPING COMMAND	T & F	T
(12) RIGHT STELLAR CAPPING COMMAND	T & F	T
(13) LEFT STELLAR PLATEN POSITION	T & F	T
(14) RIGHT STELLAR PLATEN POSITION	T & F	T
(15) STELLAR FILM IDLER ROTATION		T & F
(16) TEMP SENSOR NO. 1 (TERRAIN SHUTTER)	T & F	
(17) TEMP SENSOR NO. 2 (TERRAIN PLATEN)	T & F	

*T = TEST
*F = FLIGHT

NOTE: MONITORS 6, 10, AND 15 ARE MONITORED ON ONE CHANNEL TO PROVIDE CONTINUOUS DATA DURING CAMERA OPERATION OVER SELECTED GROUND STATIONS.

CHANNEL-LINK

8_1	TERRAIN IDLER, TERRAIN SHUTTER & STELLAR IDLER, DISIC CUT & SPLICE.
11_1	TEMPERATURE MEASUREMENTS (TIME SHARED WITH PAN #1 INPUT IDLER) 0.4 RPS X 60-POINT COMMUTATOR RING IB.
13_1	OPERATIONAL CONTROL 0.4 RPS X 60-POINT COMMUTATOR RING IA
15_2	DIAGNOSTIC MEASUREMENTS 5.0 RPS X 60-POINT COMMUTATOR RING IIB
18_1	CLOCK SERIAL WORD (TIME SHARED WITH PAN #2 INPUT IDLER).
16_2	REDUNDANT OPERATIONAL CONTROL 5.0 RPS X 60-POINT COMMUTATOR RING IIA.

NOTE: (1) LINK 1 CHANNEL 5 AND 13 ARE REQUIRED ON ASCENT AND ORBIT. ALL OTHER CHANNELS ARE REQUIRED ON ORBIT ONLY.

(2) FOR COMMUTATOR POINT ASSIGNMENT, SEE T3-7-004, J-3 TM INSTRUMENTATION.

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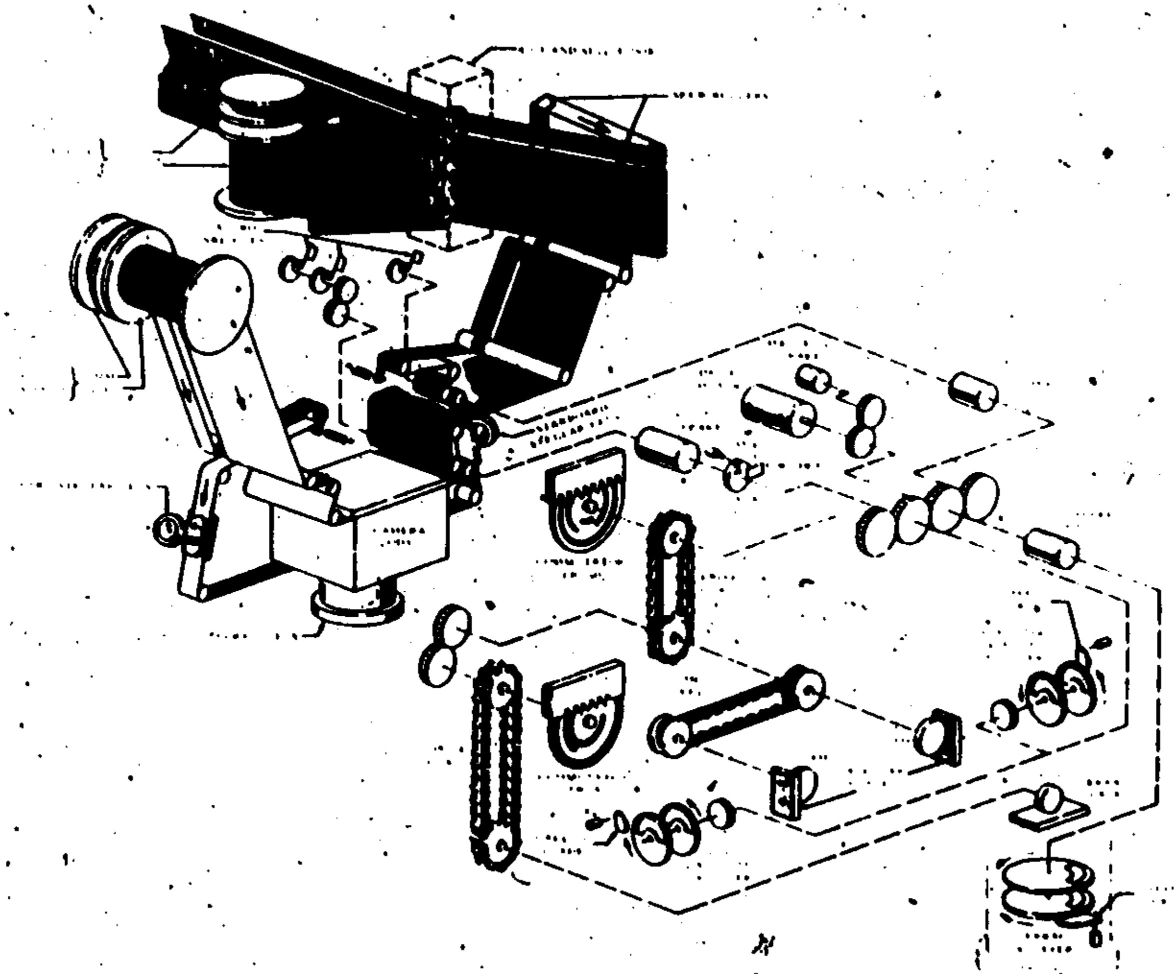

Figure I-1 Functional Schematic and Film Threading Diagram

I-3.0 DISIC SUBSYSTEM

The DISIC subsystem is located in the DISICONIC, as shown in Figure I-2. The major components of the DISIC system are the camera body, the supply cassette, two take-up cassettes, exit housing, cut and splice mechanism, fairing roller box, and film chutes.

The body assembly contains a terrain mapping frame camera utilizing 5-inch film and a 3-inch f/4.5 Ikogen lens, and two stellar frame cameras utilizing 35 mm film and 3-inch f/3.8 Ikotar lenses. The optical axes of the three lenses are precisely and accurately oriented with respect to each other in order to provide proper calibration between terrain and stellar photographs. Each of the lens assemblies consists of a lens cone, a glass focal plane plate containing a reseau grid pattern, and a between-the-lens rotary shutter.

The rotary shutters consist of two counter-rotating discs and a capping blade. The capping blade is controlled and operated by a rotary solenoid, the electrical circuitry of which contains both a stellar solar sensor and a Close command relay. The Close command relays, when energized by programmed Close commands (U107) or by the solar sensors, inhibit the respective capping solenoids. Programmed Close commands have precedence over solar sensors if both are activated at the same time.

The terrain shutter gear train contains a two-speed clutch which is normally in the 1/500 sec. position and can be commanded to the 1/250 sec. position.

The 35 mm and 5-inch film are threaded through the system (see Figure I-1) from the supply cassette through the DISIC body, exit housing, and cut and splice mechanism to the take-up cassette. Both films are pulled from the supply cassette by the metering rollers in the body assembly, and film tension is maintained by the drag clutches in the supply cassette. After each

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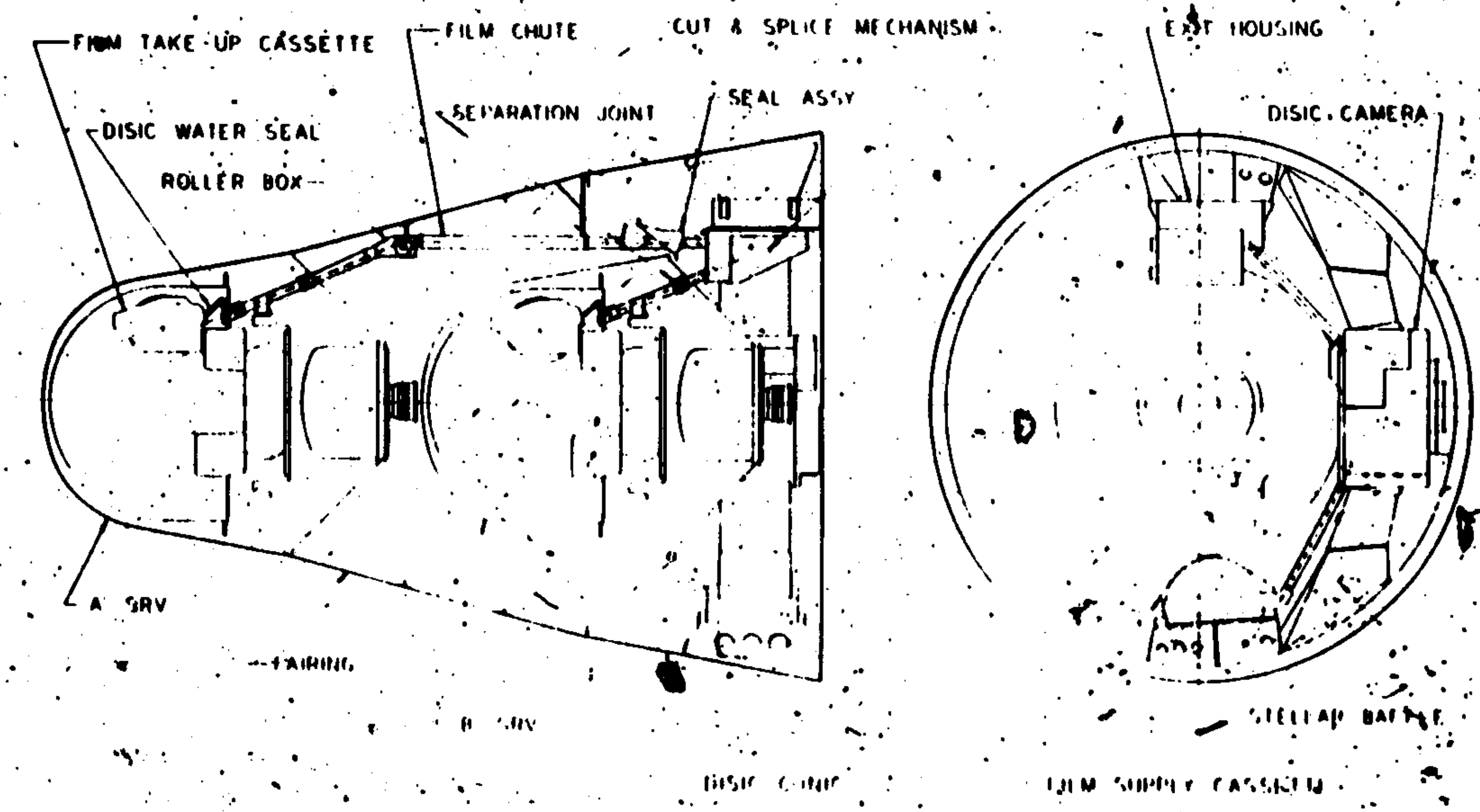

Figure I-2 DISIC Subsystem

exposure, film is transported from the body assembly to the take-up cassettes by the take-up torque motor drives which maintain constant film tension.

I-3.1 Supply Cassette

The supply cassette consists of a light-tight frame and cover assembly, a detachable spool supply assembly with independent spool spindles and drag clutches, and a spool spindle lock and reset mechanism which is solenoid-actuated for launch mode operation. When fully loaded, the supply cassette contains both 5-inch and 35 mm film spools of 2000 ft. capacity.

I-3.2 Cut and Splice Mechanism

The cut and splice mechanism (as shown in Figure I-3) is mounted to the DISIC exit housing, and accomplishes the cutting and splicing of the 5-inch and 35 mm payload (P/L) to effect the transfer from the A to the B take-up cassette. The assembly consists of a series of guide rollers and two cutting blade mechanisms which are released by a pyrotechnic device. The second cutting blade is a back-up cutter for the B water seal.

I-3.3 T/U Units

The T/U assembly contains both the 35 mm and 5-inch take-up spools, each having a 1000-foot capacity. The take-up spools are assembled on a common shaft which is supported from an aluminum honeycomb open-ended box configuration. Mounted on the honeycomb side plates are the spool torque motors (one per spool), solenoid-actuated antibackup gear mechanisms, film footage indicators, film guide rollers, and torque motor circuitry. To unload the cassette, the antibackup solenoid is actuated and the P/L is off-spooled using an off-spooling fixture.

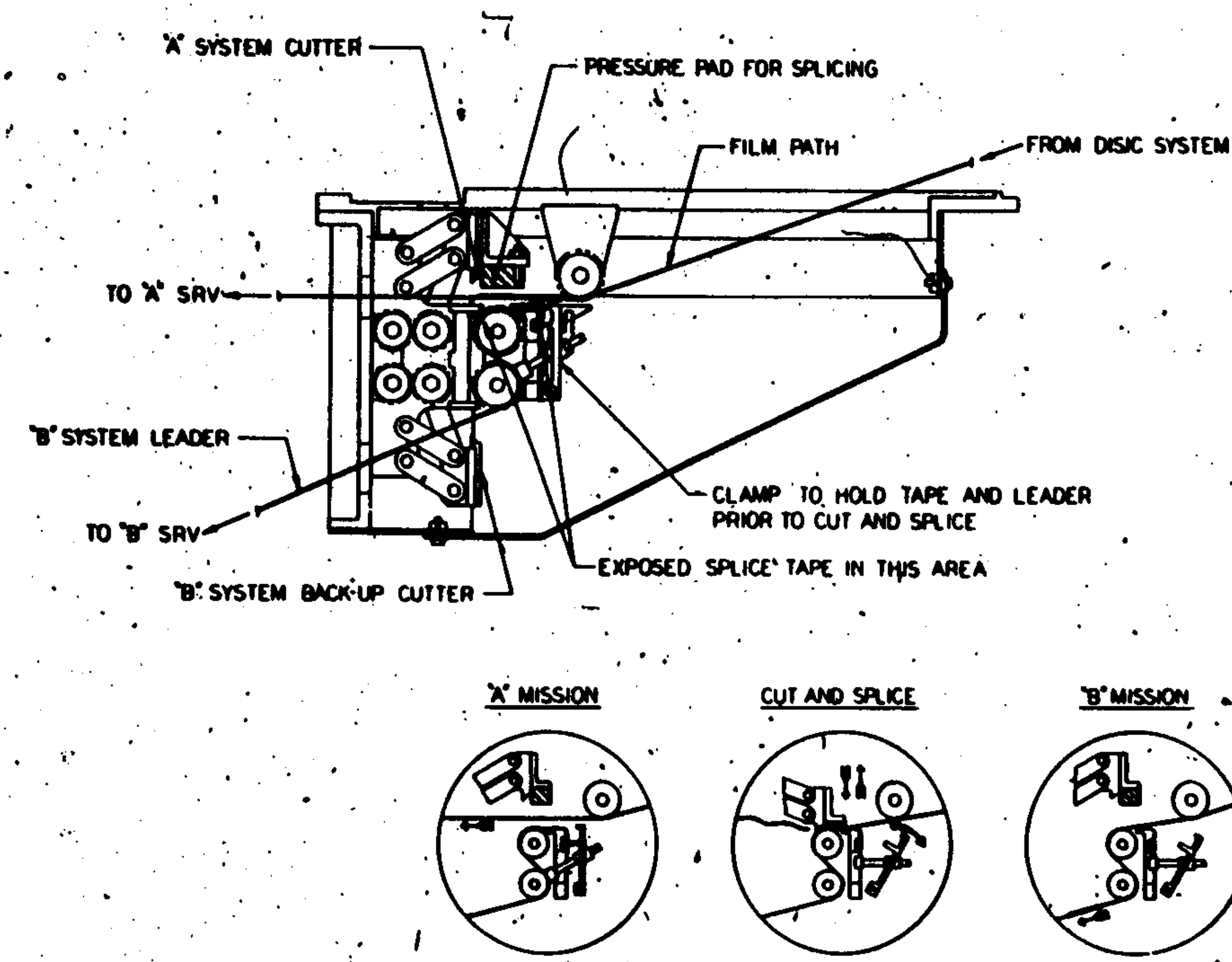

Figure I-3 Cut and Splice Mechanism (C/S)

I-3.4 Water Seal

A water seal is mounted on each SRV cover assembly to provide a light-and-water-tight closure for the SRV. The assembly is also capable of cutting film and is used as a backup cutter for the A SRV. The primary cutter is the cut and splice mechanism.

I-3.5 Binary Time Recording Generator (Clock)

The time generator, located in the main instrument barrel, is a triple parallel output clock generator capable of generating time words for 6.2 days prior to recycle. The third parallel output is for time recording on the DISIC films. Each parallel output, and serial output, is triggered by an interrogate pulse from an independent source, and can be accepted in any sequence with no relative timing restrictions. The maximum interrogate pulse rate for the parallel output is 0.5 seconds. The maximum interrogate pulse rate for the serial output is 2.00 seconds. These rates are continuously variable up to infinite time between interrogates.

I-3.5.1 Binary Time Recording

The parallel output of the clock is recorded adjacent to the format on the terrain frame and adjacent to the port stellar format on the simultaneous stellar pair. A time word is recorded for each terrain exposure and for each simultaneous stellar pair (this is true whether the DISIC is operating in slave or independent mode). The parallel time recording indicates the center of exposure, accurate to ± 0.005 second for the stellar frame and ± 0.001 second for the terrain frame.

The time data are recorded on the film with a solid-state silicon light pulser array. (The position of the arrays is shown in

Figures V-4 and V-5.) Each array contains six columns of 32 bits each at a spacing of 55 bits per inch. One of the columns of 30 bits covering an area of 0.544 inch by 0.009 inch is used for the 29 bits of time information and the index bits. Two additional columns, rows 31 and 32 only, are used for a start-of-pass mark.

I-4.0 OPERATIONAL DESCRIPTION

I-4.1 Operating Modes

The DISIC has two modes of operation, slave and independent (N.Y. modes 1 and 2). When the DISIC is operating in the slave mode, it is operated in conjunction with the pan instruments. In this mode it has a preflight-selected, fixed-cycle period for the terrain camera of 9.25 or 12.50 seconds, and a fixed 3.125 second cycle period for the stellar cameras. In the independent mode, the DISIC operates independent of the pan instruments as a mapping camera, and both the terrain and stellar cameras have identical cycle periods of 9.25 or 12.50 seconds.

In the slave mode, the Operate command is derived from the programmed pan Instrument Operate command, and for independent operation from the real time command ANA 14/U124 and Brush 48 and 49, ON and OFF commands. The DISIC may be disabled by RTC U107. The purpose of this capability is to disable the DISIC in the event of a failure or if the take-up cassette is filled prior to completion of pan instrument mission.

The intermix system used for the pan instruments also controls the DISIC in the slave mode. When the DISIC is operating independently and receives a Slave command, the slave command will prevail until it is removed. When the slave command is removed, the DISIC reverts to the independent mode if the independent Operate command still exists. Absence of the independent command will cause the system to stop.

I-4.2 Transfer and Recovery

During the A mission, the film take-up may be transferred to the B SRV at any selected time by RTC KZ 39. Transfer of the DISIC prior to transfer of the main instruments would only be used in the event that the DISIC T/U was filled prior to the main T/U's, due to extensive mapping operations, or in the event that the DISIC A T/U failed. Monitoring of the film footage potentiometers, predicted consumptions or programming, and total running time are used to preclude overfill of the T/U's. The DISIC subsystem may also be disabled by RTC for a portion of the mission if required. The transfer sequence and times would be the same for Lifeboat recovery, normal recovery, or early A to B transfer.

I-4.2.1 DISIC Transfer Sequence ("A" Mission)

Signal	Source	Time-Sec.	DISIC "A" Mission Event
RTC KZ39 or ARM		T = 0	(1) Actuate cut and splice
			(2) Apply T/U voltage to A cassette
			(3) Transfer control to B cassette
			(4) Enable dynamic T/M
	Time delay	T = 30	(5) Apply power to B T/U through dropping resistors
	Time delay	T = 35	(6) Remove power from A T/U
			(7) Remove power from B T/U
			(8) Remove T/M enable
	Transfer	T = 75	(9) Close light seal
			(10) Close A SRV water seal

I-4.2.2 DISIC Transfer Sequence ("B" Mission)

Signal	Source	Time-Sec.	DISIC "B" Mission Event
	ARM	T = 0	(11) Actuate backup cutter in Cut and Splice Mechanism
	Transfer	T = 75	(12) Actuate B SRV water seal

[redacted]

I-4.3 Stored Program Commands, Type 9 Timer

I-4.3.1 Track Assignments

DISIC/J System Dynamic T/M Enable - Brush #17

DISIC Independent ON - Brush #48

DISIC Independent OFF - Brush #49

Exposure Control - Brush #51 and #52, and #50.

I-4.3.2 IMC Requirements

No provision has been incorporated in the DISIC subsystem for image motion compensation.

I-4.3.3 Time Pads/Autocycle

The DISIC subsystem will complete a cycle when an OFF command is received. The next Start command begins the camera operation on the next frame, and since the camera has a start-up time requirement, the first frame will not have the exact programmed exposure and will be overexposed.

Slave mode operation will produce a terrain frame within one full cycle period (e.g., 9.375 sec) of the start of the J system panoramic operation. Successive cycles will follow to within one full cycle period of the end of panoramic operation. As J-3 system operations are greater than ten panoramic camera cycles (20 sec minimum) in duration, at least 18 stellar frames (nine frame pairs) and three index frames will accompany each panoramic operation when both stellar units are enabled, or nine stellar frames and three terrain frames when only one stellar unit is enabled.

Independent mode operation will be programmed to allow for full terrain coverage of the independent mission requirements. To allow for start up and/or shutdown characteristics and overlap requirements, appropriate time pads will be allowed for the ON and OFF commands.

I-4.3.4 Duty Cycle

The DISIC subsystem is rated for 45 minutes/orbit, allowing operation for as much as full daylight coverage every pass. Due to expected mission requirements, the maximum expected duty cycle is 25 minutes/orbit.

I-4.4 Real Time Commands

RTC # - KZ 39

First initiation starts transfer sequence.

RTC - U107

Selects Port or Starboard or both stellar units, or disables the DISIC.

ANA 14/U124 - DISIC Mode Select

Selects Independent or Slave mode

I-4.5 Launch Window Limitations

The thermal requirements of the DISIC subsystem impose no limitations upon the launch window.

Direct solar flare into the stellar field is generally eliminated by the correct positioning of the stellar baffles. Additional DISIC features provide a sun sensor in each stellar camera to cap the affected shutter or RTC to cap one of the stellar cameras.

I-5.0 PRIMARY/BACK-UP INSTRUMENTATION

The panoramic system is considered primary, and certain instrumentation was taken through the interface for monitoring on Link II. These data points are redundant and are defined as primary data points. They provide an emergency mode of operation for the J-3 system in the event of a Link I transmitter failure.

The DISIC system is considered a secondary system; therefore, no primary (redundant) instrumentation is provided for readout on Link II. However, certain monitors have priority and are backed up on Link I to provide redundancy in the event of a failure of one of the two VCO's used by the payload system.

These monitors are as follows:

a. DISIC Mode Select-ANA 14/U124 (Slave or Independent)

b. Cut and Splice Mechanism Status

c. DISIC Control Selector U107-Port, Starboard, Both, OFF

d. Terrain Cycle Counter

I-5.1 Film Footage Monitor Accuracy

A film footage monitor is provided for stellar and index take-up cassettes for monitoring film consumption. These monitors are "puck arm" actuated potentiometers which provide an output voltage to indicate the take-up cassette diameter or footage. The potentiometer resistance change of the film footage monitor in the region of greatest interest, maximum cassette diameter, is approximately 12 ohms per 15 feet of film. This corresponds to a voltage change of approximately 0.04 volts and a diameter change of 0.04 inches. This provides sufficient accuracy to determine film consumption and efficiently utilize and distribute the film supply between the A and B missions.

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SECTION J

TIMING AND DATA RECORDING SUBSYSTEM

J-1.0. PURPOSE

The purpose of the timing and data recording subsystem is to generate a system time and to mark each film frame with a digital time word together with other operational data. Also, to provide system time words to the digital instrumentation subsystem (tape recorder).

J-2.0 CHARACTERISTICS

The physical and operational characteristics of the Timing and Data Recording (TDR) subsystem are summarized in Table J-1, below. The clock and the Silicon Light Pulse (SLP) data conditioner are both physically located in the aft end of the main instrument barrel between the +Z and the +Y axis, as shown in Figure E-2. Data heads are located in each CR instrument and also the DISIC instrument, to expose the film as shown in Figures V-3, 4 and 5.

Table J-1. Characteristics of TDR

ITEM	PARAMETER	
	CLOCK	SLP DATA CONDITIONER
HEIGHT	5.75 IN.	5 IN.
WIDTH	7 IN.	8 IN.
DEPTH	10 IN.	14 IN.
WEIGHT	11 LB.	9.5 LB.
POWER CONSUMPTION	7.7 WATTS	5.5 WATTS
VOLTS	24.0 VDC UNREG.	24.0 VDC UNREG.
SIGNAL OUTPUT	200 PPS.	

J-3.0 SYSTEM DESCRIPTION

The J-3 Timing and Data Recording subsystem consists of an F-type Digital Recording Clock Generator, a Silicon Light Pulser Data Conditioner, and Silicon Light Pulser Data Heads located in both CR cameras and in the DISIC Stellar and Terrain Cameras.

The clock furnishes a parallel 29-bit time word directly to DISIC when requested by a No. 3 Interrogate pulse. The No. 3 parallel word generated by the clock is compatible with the silicon light pulser data heads. The No. 1 and/or No. 2 parallel time words are provided to the silicon light pulser data conditioner upon the receipt of the No. 1 and/or No. 2 Interrogate pulses. (See Section I.)

The SLP data conditioner conditions the No. 1 and No. 2 parallel time words which were originally designed to drive incandescent data block lamps to make them compatible with the requirements of the CR Instrument SLP data heads (See Section F)). In addition, the SLP data conditioner contains circuitry necessary for the generation of an index column to be recorded with each data word. (An index column is required to align the readout sensors of the automatic reader with the recorded data.) The SLP data conditioner also contains logic which generates the time word complement and a parity bit, to allow error checking to be performed on the data by the automatic readout equipment.

The clock also provides an accurate 200 pps signal to both CR cameras, which is used to generate a timing mark in the format to aid in mensuration. The pan cameras also use the 200 pps signal to synchronize the center-of-format switch closure, so as to generate a synchronized clock Interrogate pulse. Synchronizing the clock Interrogate pulse removes a source of ambiguity in locating the position in the format corresponding to the time recorded in the data block. This is accomplished by smearing the format 200 pps timing mark that was used to synchronize the center-of-format switch closure in order to create the clock interrogate pulse.

The data recorded on DISIC and panoramic material with the SLP data heads consist of dots nominally eight mils in diameter at the 50 percent density level and spaced on 18 mil centers. The peak dot density must be at least 0.3 greater than the interdot density. The SLP data heads are positioned so as to record the columns parallel to the edge of the panoramic material and perpendicular to the edge of the stellar and terrain DISIC material (see Figures 1, 4, and 5). The panoramic data blocks expose the material on the emulsion side, while DISIC exposes the material through the backing.

J-3.1 Digital Recording Clock Generator, Description

J-3.1.1 General

The F-type Digital Recording Clock Generator, frequently referred to as the DRCG or Clock, is an all-silicon semiconductor electronic device designed to provide a high-precision vehicle time system and a useful time base for other payload functions. The functional outputs of the clock comprise time word outputs provided in two forms: a serial one-wire output and three parallel twenty-nine-line outputs (all four outputs are completely independent) and a timing pulse train at 200 pulses per second. The clock contains monitoring circuits which form and supply output signals to telemetry modulators to enable the determination of the clock operating conditions.

The clock furnishes the binary time word output on demand by the insertion of an interrogate pulse. Time word outputs may be requested via four separate channels by inserting interrogate pulses in any order on the four interrogate lines. Thus, the clock furnishes four distinct and independent time word outputs. The time word output represents the next integral millisecond following the receipt of an interrogate pulse. Therefore, up to one millisecond can elapse due to the synchronizing of the asynchronous interrogate pulse inputs with the internal 1 Kpps clock time base pulse train. Interrogate pulse inputs may be inserted simultaneously on all four channels with the four interrogate pulses in synchronism with one another or asynchronous with one another.

The 200 pulse per second timing pulse train is furnished continuously by the clock. This signal is obtained through division of the basic oscillator frequency within the clock. It is thus synchronous with the one millisecond resolution bits of the time word.

J-3.2 Description of Outputs

J-3.2.1 Parallel Outputs

The time word outputs, which result from interrogate pulse inputs, contain a natural binary twenty-nine digit number. The resolution is one millisecond; thus, the unambiguous total count represents about 6.2 days.

The clock furnishes three parallel, twenty-nine line word outputs. These are, respectively, No. 1 Parallel Time Word Output, which is furnished via No. 1 Connector when an interrogate pulse is applied to No. 1 Interrogate Input; No. 2 Parallel Time Word Output, which is furnished via No. 2 Connector when an interrogate pulse is applied to No. 2 Interrogate Input; and No. 3 Parallel Time Word Output, which is furnished via No. 3 Connector when an interrogate pulse is applied to No. 3 Interrogate Input. In addition, two parallel power outputs consisting of power gates drive lines, referred to as No. 1 Lamp Return (Parallel Channel No. 1) and No. 2 Lamp Return (Parallel Channel No. 2), are generated following a Parallel Interrogate Input on Parallel Channel No. 1 or No. 2. Also, a parallel power output (Parallel Channel No. 3) consisting of column drive lines, referred to as Array A Return and Array B Return, is generated following a Parallel Input Request on Parallel Channel No. 3. Refer to Figure J-1.

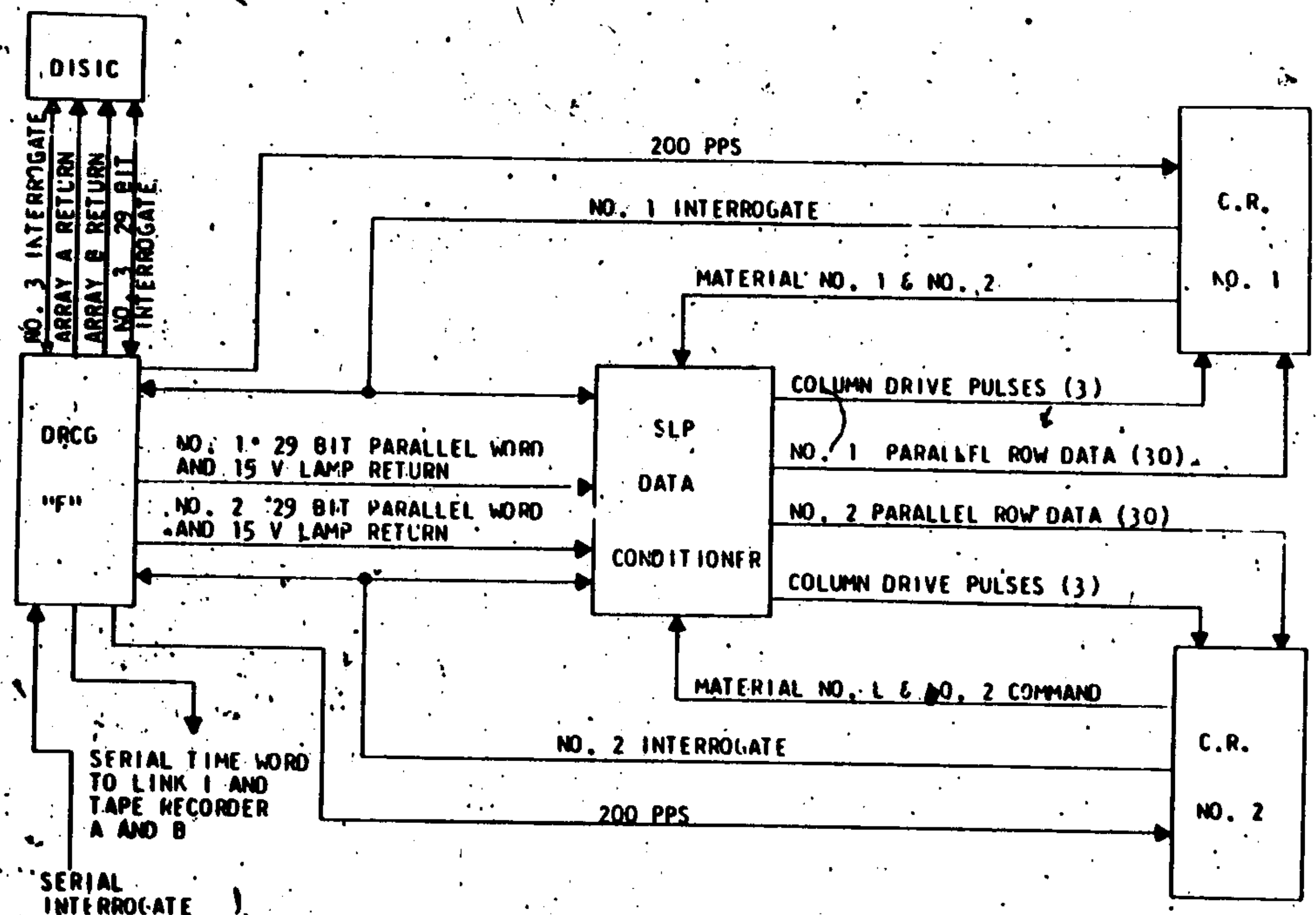

Figure J-1. Data Recording Subsystem Block Diagram

Each Parallel Time Word Output consists of a group of 29 controlled output points which are available on No. 1, No. 2, and No. 3 connectors. The parallel power outputs of Parallel Channel No. 1 and Parallel Channel No. 2 are provided as pulses of plus 15 volts, and with an adjustable pulse width of 60 to 120 milliseconds. Approximately one millisecond after the initiation of the power pulses, the controlled output gates receive a control signal permitting the flow of current through the circuits representing the bits of the time word. In this way, the controlled data points are maintained ON for the duration of the parallel power pulse. The No. 1 and No. 2 parallel power outputs are regulated for line variation and load variation; that is, the 15-volt level is maintained with a 22 to 29 volt change of input voltage and with a parallel output load change of 150 ohms to 5 ohms. The load variation range results from the variation in the number of "ones" in the time word (all "ones" represent maximum load and all "zeros" represent minimum load). The No. 1 and No. 2 parallel outputs were originally designed to accommodate incandescent lamp loads requiring regulated voltage drive; however, the J-3 system uses SLP data blocks requiring constant current drive. In addition, an index column, time complement, and parity are required by the J-3 system. These requirements are met by providing the No. 1 and No. 2 parallel outputs and power pulses to the SLP data conditioner for current source conversion and complement and parity generation.

The parallel output of Parallel Channel No. 3 is provided as sequential dual power pulses (Array Returns) capable of driving two sets of 29 resistive loads sequentially. Array A Return can be adjusted from 10 to 40 milliseconds, and Array B Return can be adjusted from 60 to 180 milliseconds. Each resistive load can draw a maximum of 50 milliamperes, with a load regulation of ± 1 ma over the range of unregulated voltage (21.5 to 29.5 volts) and the load range of all binary "zeros" to all binary "ones." Approximately one millisecond after the initiation of the power pulse, the controlled output gates receive the control signal permitting the flow of current through the circuits representing the bits of the time word. In this way, regulated current pulses are provided to the row inputs of the DISIC SLP data heads.

J-3.2.2 Serial Output

The Serial Time Word output of the clock is a single-line output. This output is initiated by application of a pulse to the Serial Request input.

Each serial word consists of a freeze pulse followed by an amplitude-controlled pulse train flowing at a rate of 20 pulses per second. The purpose of the freeze pulse is to mark the time instant designated by the time word itself. The leading edge of the freeze pulse may be thought of as a timing mark, where the time word serves as a post-date of the instant marked by the leading edge of the freeze pulse. The amplitude of the freeze pulse is 4 ± 0.5 VDC with a pulse width of 50 milliseconds. The first pulse of 29 bit trains occurs 100 milliseconds after the leading edge of the freeze pulse. The pulses consist of those representing binary "ones" and those representing binary "zeros." The binary "one" is represented by a pulse of [illegible] ± 0.5 VDC amplitude and a pulse width of 25 milliseconds. A binary "zero" is represented by a pulse of 1.5 volts DC ± 0.25 volts amplitude and 25 milliseconds in pulse width. The repetition rate within the 29 bit word is 20 pulses per second. Thus, the over-all duration of a serial word is approximately 1.55 seconds.

The serial time word output may be used for correlating the vehicle time system set up by the clock with external time systems or with tracking system time.

J-3.2.3 Telemetry and Time Base Outputs

a. The 200 pulse per second output is a negative-going pulse train of 10 volts amplitude. The rise time of the pulses is less than 2 microseconds. Measured at the half amplitude point, the pulse width is 75 microseconds.

b. The clock presents scaled telemeter output voltages to indicate the presence or absence of internal voltages or signals.

(1) A continuous DC level of 4 volts indicates presence of the + 24 volt dc power supply voltage.

(2) A continuous DC level of 4 volts indicates the presence of the + 3 VDC power supply voltage.

(3) A temperature sensor provides a voltage output falling between + 4.5 VDC and 1 VDC.

c. Output signals synchronous with Time Word Input Requests are available and enable the gating of external counting equipment.

d. The 1000 pps pulse train derived from the oscillator is available at the test connector.

J-3.3 Silicon Light Pulser (SLP) Data Conditioner

J-3.3.1 General Description

The SLP Data Conditioner is required to furnish a constant current into the row inputs of the SLP data heads during data recording. The intensity of the light output from each SLP light source data bit is directly proportional to the current. Also, the current is adjustable to allow selection of the proper current-time relationship, in order to adequately expose emulsions with widely differing speeds. To prevent damage to the SLP data head due to excess power dissipation, the row current must be limited in accordance with an inverse relationship with time duration.

The SLP data conditioner provides two sets of three sequential column drive outputs, each consisting of a low-impedance switch to + 24 volts unregulated. The duration of each column drive is adjustable in order to provide exposure control on a column basis in conjunction with the row current. The SLP data head bits are arranged in a true matrix form, and in order to time share the common row inputs and current regulators the column drive pulses are generated sequentially. Each column drive circuit is capable of carrying the total current supplied by all of the row current regulators simultaneously.

The column drive pulses are generated synchronously with a sequential set of pulses called the Data Select pulses. These pulses are required to enable the data assigned to a particular column, in synchronism with the associated column drive pulse. A matrix of transfer gates is provided to accomplish the data selection in conjunction with the data select pulses.

The three data selections which are accomplished and the columns to which they are assigned are as follows:

a. Column 1 - 30 bit index

b. Column 2 - time word and parity bit

c. Column 3 - complement time word and parity bit

The index column consists of 30 bits in all binary "one" configuration (all light sources in the column are ON). This column is generated each time the time word is requested, and is recorded in the first column position along the edge of the film. The index column is necessary to index and position the readout sensors in the automatic data readout equipment, over the recorded data.

The time word is recorded in the second column of each SLP data block, and requires 29 bits plus a 30th parity bit for the time determination. Each time data bit received from the clock is in the form of a ground provided through a silicon-controller rectifier (SCR). A common + 15 volt pulse is furnished by the clock to provide power to the bank of lamps used in the J-3 system. The SLP data conditioner converts these signals into the required constant current row pulses (see Figures J-1 and J-2).

The complement time word is generated by inverting each bit of the time word, and is recorded in the third column of each SLP data block using 29 data bits and a 30th parity bit.

The time word is checked for parity and the 30th parity of the time word and the time word complement is used to establish an odd parity condition. Odd parity is a situation in which the total number of binary "ones" in each of the parallel time words and complement time words is always odd. This is accomplished by checking the parity of each time word and adding a binary "one" to the 30th parity bit if the total number of "one" data bits is even. If the total number of "one" data bits in the time word is odd, then the 30th parity bit will remain a binary "zero."

Each independent SLP output sequence is initiated by the associated CR camera Interrogate pulse. The Interrogate pulses are asynchronous and independent, and result in the associated parallel time word being generated by the DRCG.

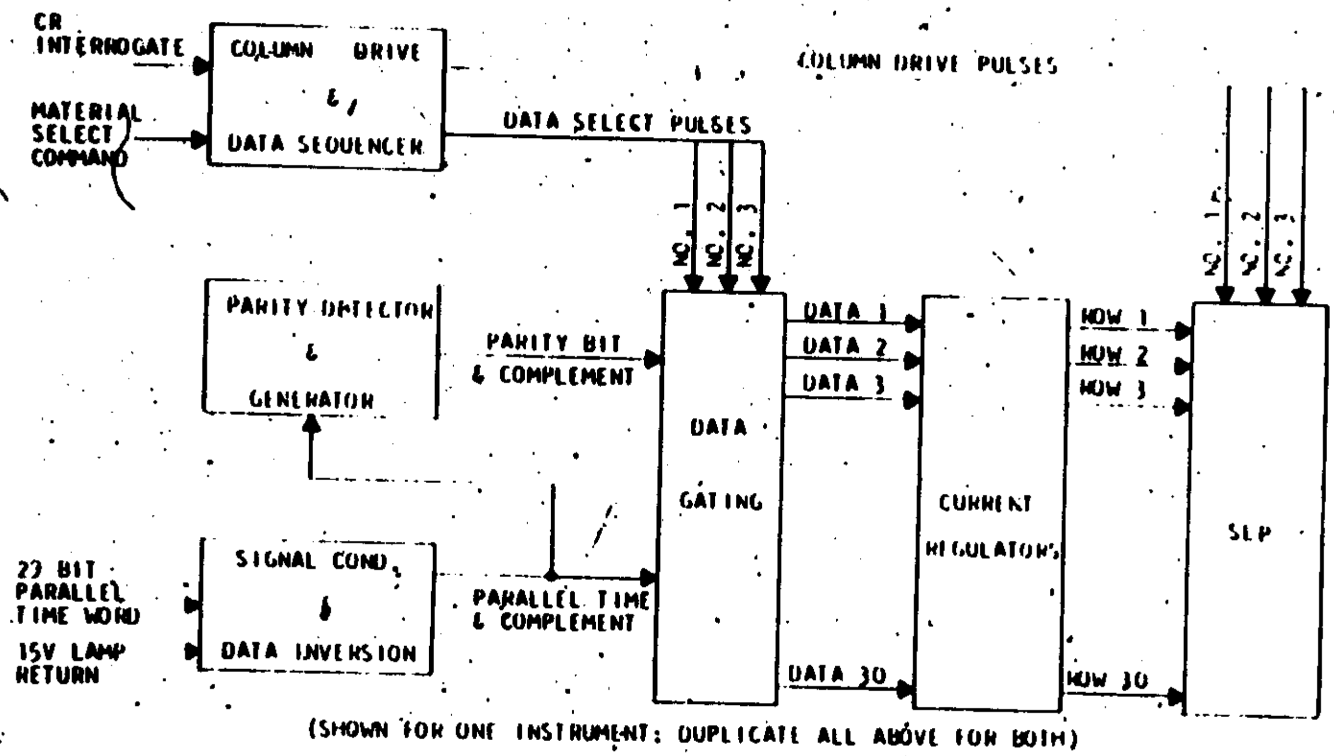

Figure J-2 SLP Data Conditioner Block Diagram

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SECTION K

PRESSURE MAKE-UP UNIT (PMU)

K-1.0 PURPOSE

The purpose of the pressure make-up unit (PMU) is to inhibit electrostatic discharge (corona) and the resulting film marking by increasing the payload vehicle internal pressure to a more desirable level.

K-2.0 CHARACTERISTICS

The physical and operational characteristics of the PMU System are tabulated in Table K-1. A schematic diagram of the system is shown in Figure K-2. A drawing of the PMU Assembly is shown in Figure K-3, and Figure K-4 shows the installation of the PMU system in the payload vehicle.

K-3.0 DESIGN CONSIDERATIONS

K-3.1 Electrostatic discharges which emit radiation cause marking and fogging of the photographic film. In camera systems, a static potential is created by moving contact of the film and rollers. When a certain "critical charge" is achieved, a corona discharge is effected by ionization of the surrounding gases. The critical charge is primarily a function of the environmental composition and pressure. In general, the lighter molecules and the lower pressures tend to reduce the potential necessary to discharge. External on-orbit pressures range from 1×10^{-4} to 1×10^{-5} microns; internal payload vehicle pressures range from 1 to 10 microns because of outgassing from the film and other components. Altitude testing has shown that J-3 system corona can be inhibited by increasing the payload vehicle internal pressure. The normal system film, Type 3404, exhibits marking below 10 microns and also from 20 to 45 microns pressure. For this reason, the payload vehicle internal pressure is required to be increased above 50 microns by the PMU system.

The severity of the corona marking, which usually originates at the metering rollers, is also related to film type, sensitivity, etc. It has been demonstrated that complete frames, including all data recording, can be obliterated on SO 340 while no marking is evident on SO 3404 in the same system and under identical conditions. Some films (in nonsystems tests) have marked from 1 to 100 microns or more. If these films are ever flown in the J-3 system, additional measures may be needed to suppress corona.

K-3.2 Operational Requirements

Payload internal pressure: 50 microns minimum

Turn on: CR Instrument ON command

Time for pressure build-up: 3 seconds maximum

Shut off: CR Instrument OFF command

Life: CR-1 through CR-4--230 minutes and 220 operations; CR-5 and up - 336 minutes and 320 operations

K-3.3 System Design

Curve "B" in Figure K-1 shows the desirable payload internal vehicle pressure versus time for the J-3 System. Curve A, of the same figure, shows the pressure build-up a single orifice PMU System would require in order to bring the pressure up to the required 50 microns in 3 seconds. The area under the curves represents gas consumption for a typical CR Camera Operate cycle. The excess area of curve A over curve B represents

C TOP SECRET [redacted]

[redacted]

wasted gas. In order to duplicate curve B, and minimize gas consumption, a two-orifice discharge system was designed. A large orifice discharges gas for approximately 3 seconds after the CR Camera Operate signal to provide a fast vehicle pressure build-up. A small orifice also begins discharging gas (at a rate equal to the vehicle leakage) with the CR Camera Operate command, and continues to do so until the CR Camera OFF signal.

The PMU System consists of a 231 in.^{3} titanium pressure vessel (two 231 in.^{3} pressure vessels on CR-5 and up) containing dry nitrogen at 3200 psi (initial fill pressure), a pressure regulator set at 15 psi, two solenoid-actuated valves, two orifices of different size, and control and instrumentation electronics.

K-4.0 PMU FUNCTIONS

K-4.1 Functions of Components

At CR Instrument Operate, solenoid valve #1 opens, permitting gas from the pressure vessel to be reduced in pressure by the regulator, and solenoid valve #2 opens, the reduced pressure gas discharges through both the sustaining orifice #1 and the fast build-up orifice #2. Solenoid valve #2 is held open for approximately three seconds (2.15 on CR-3 and up) by a time-delay relay to provide the required fast build-up of the vehicle internal pressure. At three seconds, valve #2 is closed and the vehicle internal pressure is maintained by gas flow through orifice #1 throughout the entire CR Instrument Operate period.

K-4.2 Command and Control

The CR Instrument Operate Signal is the only command required to operate the PMU System. It is a 24V unregulated signal which function is to close a relay to supply power to the system. This signal can be disabled by real-time command (UNCLE 110) on systems CR-3 and up.

Table K-1 PMU Characteristics

PHYSICAL CHARACTERISTICS

ITEM	1 RESERVOIR CR-1 THRU CR-4	2 RESERVOIRS CR-5 AND UP
SIZE	11 X 12 X 8 INCHES	11 X 20 X 8 INCHES
EMPTY WEIGHT	11.1 LBS.	18.4 LBS.
DRY N_2 GAS @ 3200 PSIG	2.3 LBS.	4.6 LBS.
LOADED WEIGHT	13.4 LBS.	23.0 LBS.
RESERVOIR:		
MATERIAL	FORGED AND WELDED TITANIUM ALLOY	
CAPACITY	231 CU. INCHES	
BURST	9000 PSIG	
PROOF	6000 PSIG	
WORKING MAX.	3600 PSIG (3200 PSIG USED) @ 70° F	
REGULATOR	SOURCE PSIG TO 15 PSIG	
FILTER	20 MICRON	
VALVES (2)	24 VDC SOLENOID-TYPE.	
ORIFICES (2)	ONE SURGE ORIFICE-.040 DIA. ONE SUSTAINING ORIFICE-.020 DIA.	
ELECTRICAL INPUT	24 VDC UNREGULATED	
FUSE	4.0 AMP FUSE	
T/M MONITOR 1	RESERVOIR PRESSURE 0 TO 5 V	
T/M MONITOR 2	RESERVOIR TEMPERATURE 0 TO 5 V	
T/M MONITOR 3	REGULATED PRESSURE (SWITCH 1.5-2.5 V)	
T/M POWER INPUT	5 VDC FROM T/M SUPPLY	

OPERATIONAL CHARACTERISTICS

OPERATE COMMAND	24 VDC UNREGULATED SIGNAL (SIMULTANEOUS WITH CR INSTRUMENT OPERATE)
TIME LIMIT TO PRESSURIZE CR FILMPATHS	3 SECONDS MAX. (COINCIDES WITH 3 SECONDS MAX. FOR CR CAMERAS TO REACH OPERATE SPEED)
PRESSURE REQUIRED	50 MICRONS, MINIMUM

[redacted]

Table K-1 Continued

ITEM	1 RESERVOIR CR-1 THRU CR-4	2 RESERVOIRS CR-5 AND UP
PMU/CAMERA OPERATE MODE SELECTION:		
(1) BOTH CAM.SYS. ON (CR MONO 1, MONO 2, OR STEREO; DISIC MODE 1)	PMU ON (COMMAND SUPPLIED BY CR INST. OPERATE)	
(2) CR ONLY ON (DISIC OFF OR DISABLED)	PMU ON (COMMAND SUPPLIED BY CR INST. OPERATE)	
(3) DISIC ONLY ON (DISIC INDEPENDENT, MODE 2)	PMU OFF (NO VOLTAGE FROM CR INST. PMU DISABLED)	
(4) ALL INST. OFF (STANDBY, QUIESCENT)	PMU OFF (NO VOLTAGE FROM CR INST.)	

K-4.3 Power Requirements

The power required to operate the PMU System is controlled by the CR Instrument Operate Command. This power is fused to prevent failure of the PMU from affecting the CR instrument. At power on the following functions occur:

a. Solenoid valve #1 opens

b. Solenoid valve #2 opens for approximately 3 seconds:

o Start time-out of the three-second time delay relay.

K-4.4 On-Orbit Life Pressure Requirements

The PMU functional life on-orbit is based on a fill pressure of 3200 psia, and a launch pressure of 2880 psia or greater.

K-4.5 Monitors

The following T/M monitors are provided for diagnostic, status, and command verification of the PMU system:

a. Bottle pressure

[redacted]

b. Bottle temperature

c. Regulated pressure by an on-off switch

These outputs are commutated, and are transmitted redundantly over T/M Links 1 and 2. For the exact commutator points and channel assignments consult the T/M instrumentation list for each particular J-3 Payload System. The T/M signals are further discussed in the T/M Instrumentation section of this manual, according to type of transducer and voltage outputs to the T/M transmitter interface.

K-5.0 SAFETY CONSIDERATIONS

As in any high-pressure system, extreme care and caution should be exercised when working with or near the PMU. Adequate test and safety margins have been provided for all high-pressure fittings and parts; nevertheless, accidental nicking or shock to the various components should be avoided.

The filling of the pressure vessel should be performed only by persons competent to do so, and in accordance with the appropriate procedures in the areas designated for that purpose.

The temperature of the pressure vessel should be monitored during filling or whenever there is an appreciable increase in ambient temperature.

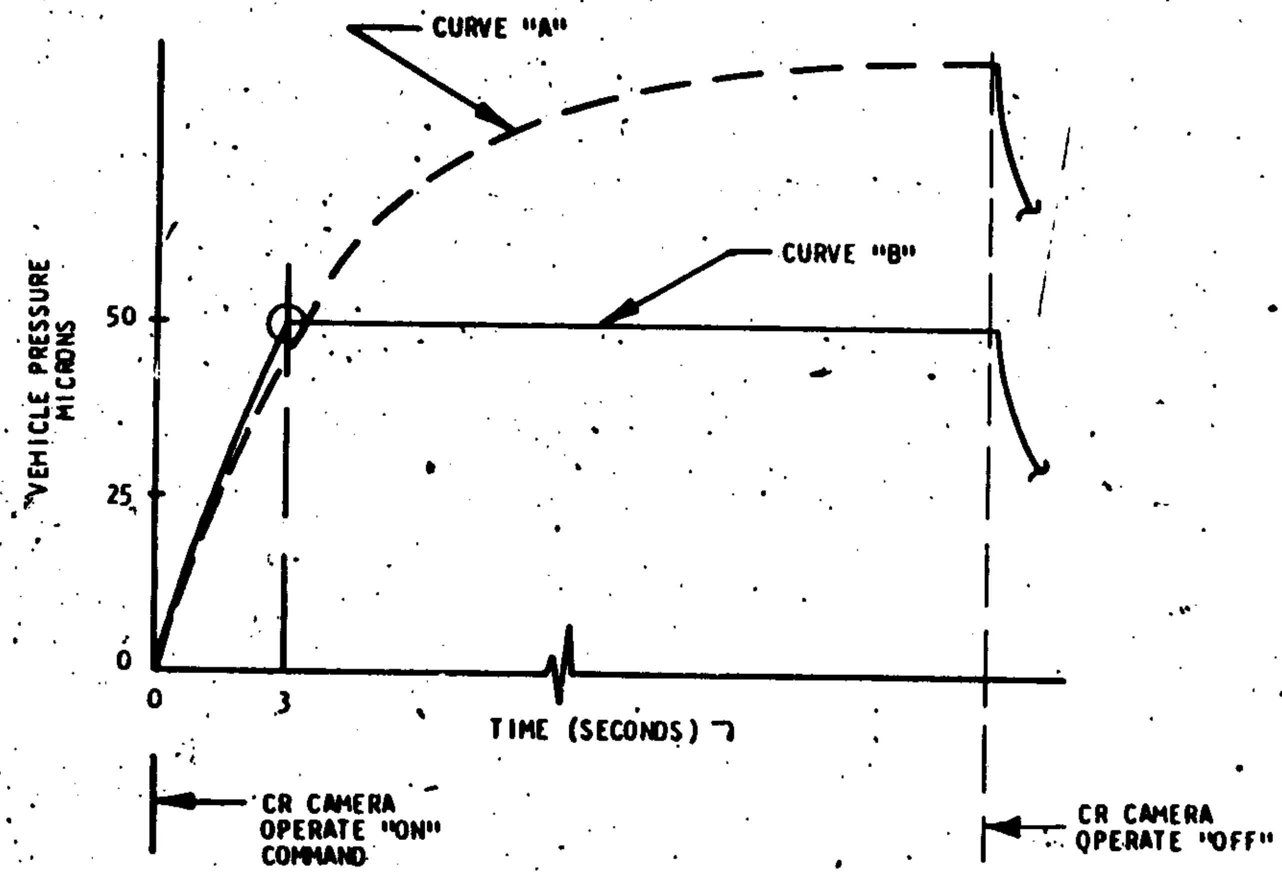

Figure K-1 PMU System - Design Requirements for Pressure Build-Up vs. Time

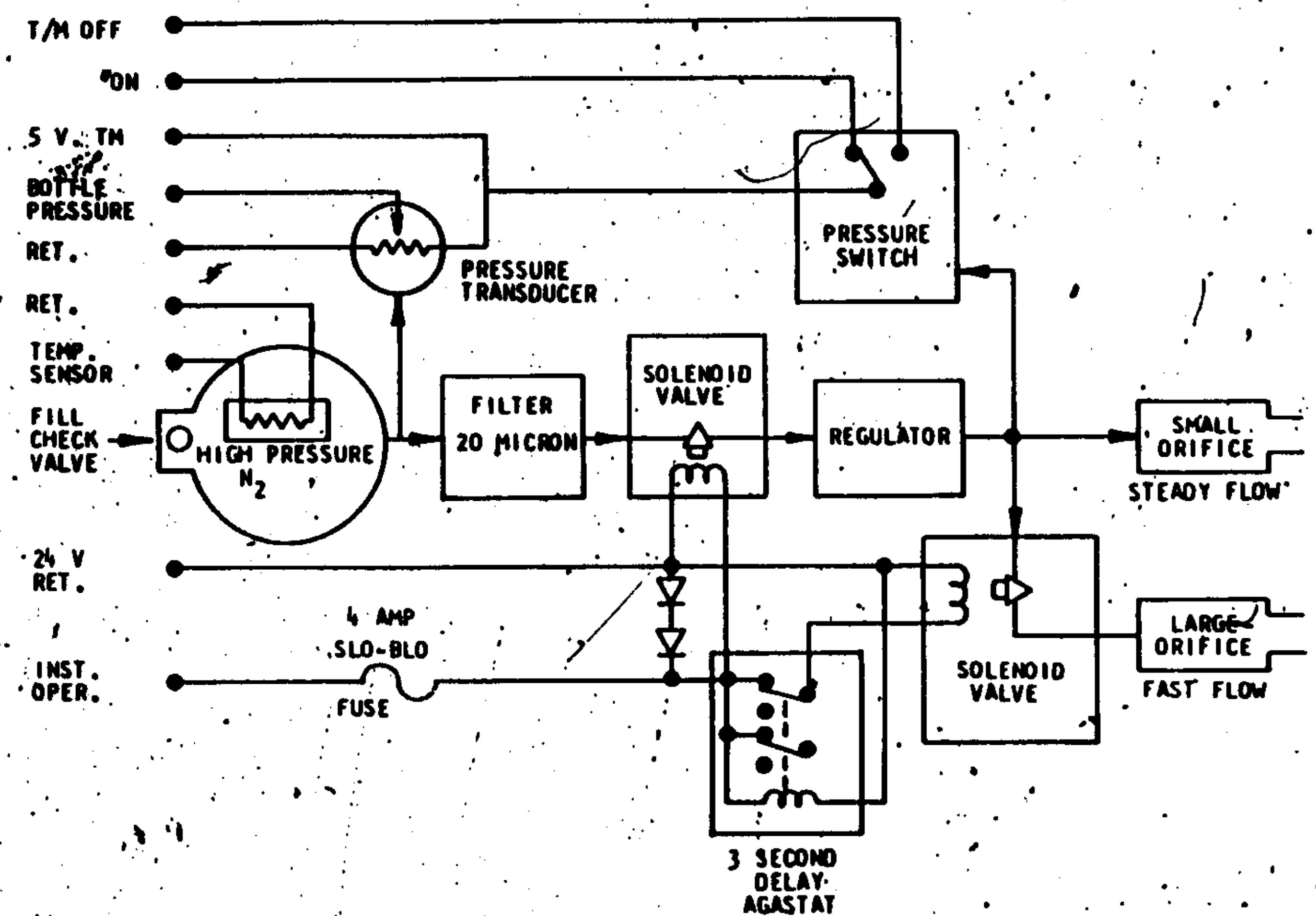

Figure K-2   Pressure Make-Up System Function Block Diagram

[redacted]

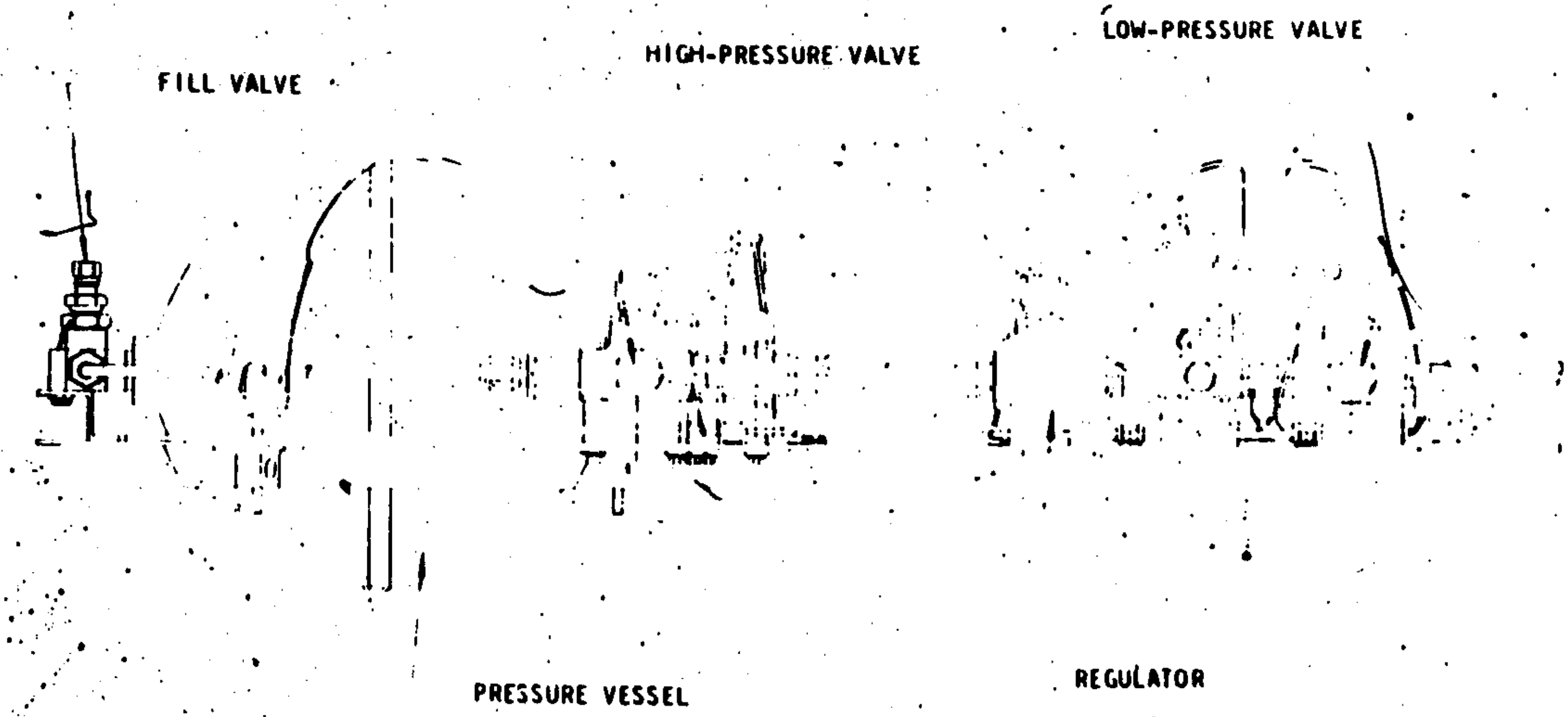

Figure K-3 Pressure Make-Up System

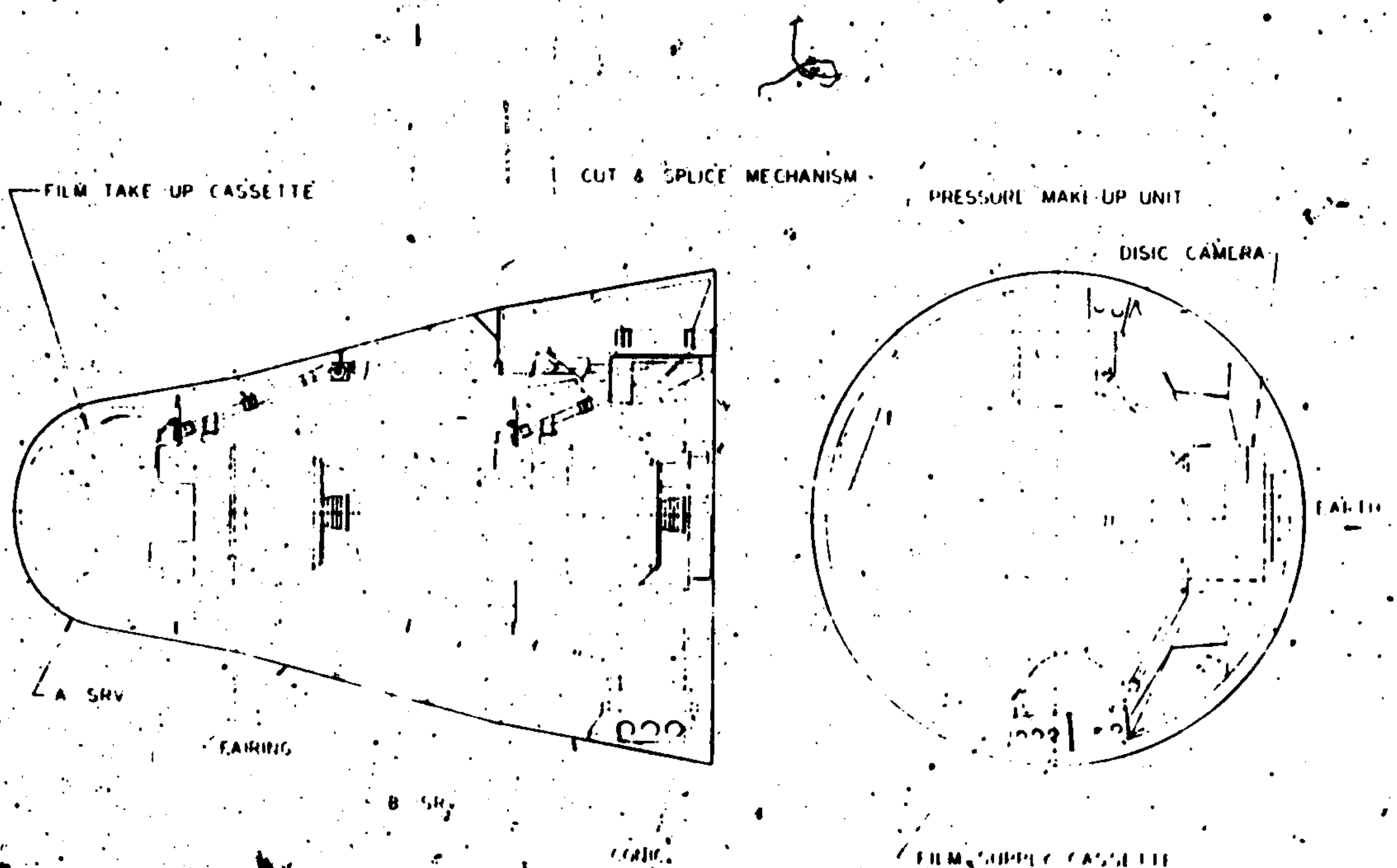

Figure K-4 Location of Pressure Make-Up Unit

SECTION L

COMMAND SUBSYSTEM

L-1.0 PURPOSE

The purpose of the command subsystem is to accept stored program and real time commands from the Agena and to process and distribute them for command and control of the CR camera, DISIC, SRV, and other related subsystems.

L-2.0 CHARACTERISTICS

Major components of the command subsystem, such as stepper switches, relays, time delays, etc., are housed in the command box. It is approximately 17 x 14 x 6 inches in size and weighs 15 pounds.

L-3.0 LOCATION

The command box is located between the -Y and +Z axes near the aft end of the instrument barrel. See Figure E-2.

L-3.1 <u>Command Subsystem Design Requirements (Inputs)</u>

The command subsystem controls, directly or indirectly, all operations of the various subsystems.

L-3.1.1 Command Inputs

L-3.1.1.1 Stored Program Commands

The stored program command (SPC) source is the Agena vehicle orbital programmer.

Commands are stored in the form of 1/32 inch square holes punched in 35 mm tape. The tape travels one inch in 600 seconds, which is 0.1 inch/min. or 0.00167 ips. Each of 13 tracks across the tape is an SPC, the timing of which is governed by the brush contact through the time slot. Successive events of the same brush (SPC) are limited by the minimum brush slot length, which is equal to about 19 seconds, and by the strength required to resist tearing when the brush lifts. The minimum OFF time interval must be at least 6 seconds, and normally will be at least 14 seconds. Therefore, the minimum successive event interval is about 33 seconds. Time delay for the brush to make contact will vary between one and two seconds. Brush contact dwell time is between 10 and 15 seconds. Electrically, the brush contact completes a circuit to unregulated (24 VDC) power return. The current capacity is limited to 300 milliamps for one brush, and to one ampere for simultaneous or overlapping brush events for each set of 13 brushes. One brush can energize six relays with 600 ohms coil resistance.

L-3.1.1.2 Real Time Commands

Unsecure, real time commands (RTC's) may be initiated during vehicle acquisition and are disabled at all other times. The electrical characteristics are +24 VDC unregulated up to two amps, with pulse duration from 200 to 1300 milliseconds and an OFF interval from 0.7 to 1.8 seconds. This includes a pulse repetition period of one to two seconds, which includes both sources of RTC's.

These command sources from Agena are UNCLE, UHF Beacon Digital Decoder Commands, and ANA, S-Band Beacon Analog Commands. See Section B. Secure, Real Time Commands may be initiated once during an acquisition and are thereafter disabled. The electrical characteristics are +24 VDC unregulated up to 2 amps with duration from one second to continuous. Secure RTC KIK-ZORRO 38 is used to accomplish early main A to B Transfer function. Secure RTC KIK-ZORRO 39 is used to accomplish early DISIC A to B Transfer function.

L-3.1.1.3 Digital Storage Register Commands

The Digital Storage Register Command subsystem consists of a core memory storage register, decoding logic, gating, and output relay drivers and other solid-state circuitry necessary to store and generate on command 32 five-bit parallel data words which select panoramic camera operations from a cascade of 16 H-Timer stored program commands. The subsystem also contains all other command functions necessary for the operation of the J-3 payload, such as DISIC control and A to B Transfer.

The subsystem has two independent modes of pan camera operation: Normal and Emergency. The Normal mode consists of camera operations generated by ON and OFF execute commands selected from a cascade of 16 H-Timer brushes by means of enabling command data bits stored in a magnetic core storage register.

The Emergency mode allows limited pan camera programming and an operational capability consisting of two programs, a four-orbit intermix utilizing separate ON and OFF H-Timer tracks for the two alternate programs, and Analog/Uncle real time commands for Program Select, Operation Intermix Select, and Normal (Mono/Stereo)/Emergency Select.

The DISIC control within the subsystem includes the Slave (Mode 1) and Independent (Mode 2) modes of operation, East-West Capping control, Independent mode operate command, and A to B Transfer utilizing real time Analog/Uncle commands and separate ON and OFF H-Timer stored program commands. In addition, the subsystem contains those functions which are conditioned within the command subsystem such as A to B Transfer, Orbit Mode control, PMU control, and the functions which go directly to the subsystem concerned such as V/h control, exposure control, and CR filter change.

L-3.1.1.3.1 Normal Mode CR Camera Control

The Normal mode is enabled by Analog 10/Uncle 120 command which also is used to enable the Emergency Mode and to Select Normal mode, Stereo or Mono. Each command steps a four-position counter one step. Each step is identified as follows:

a. Normal mode Stereo
b. Normal mode Mono 1
c. Normal mode Mono 2
d. Emergency mode (Stereo)

After one of the three Normal mode positions has been selected, the camera operations are controlled by executes originating from the cascaded H-Timer punches in conjunction with the storage register. The action is as follows:

The H-Timer execute punches are selected by means of gates, enabled by the four-bit parallel decoded output of the core register which has the capacity of storing 32 five-bit parallel words generated by the vehicle Type 22 decoder. Four of the parallel bits, when decoded, result in one of the 16 outputs of the decoding matrix being at a high (enabling) level. The high-level decoded output enables a gate corresponding to one of the 16 execute tracks. The fifth parallel bit directs the enabled punches to be either a camera system ON or OFF. These execute punches are cascaded on the 16 H-Timer tracks and occur at a minimum of 10-second intervals, leaving an interval of at least 160 seconds between successive cascades. The overlap from using the 10-second interval of punches on adjacent tracks, as well as the use of 17-second brush bounce filters, precludes operations generated from adjacent tracks unless these are separated by at least one cascade. The four bits from the storage register, which enable the execute track, are coded such that the 16 tracks correspond to the assigned SPC's as follows:

Bit Configuration	Track No.	SPC No.
0000	0	30
1000	1	31
0100	2	32
1100	3	33
0010	4	34
1010	5	35

[redacted]

Bit Configuration	Track No.	SPC No.
0110	6	36
1110	7	37
0001	8	38
1001	9	39
0101	10	40
1101	11	41
0011	12	42
1011	13	43
0111	14	44
1111	15	45

Each operation requires two execute commands, and each execute command is generated as a result of a five-bit parallel word at the output of the storage register which enables one of the 16 execute tracks; which in turn causes the next stored word to output. Since the storage register capacity is 32 stored five-bit parallel words, a maximum of 16 controlled operations are available between acquisitions-each skipped cascade counting as an operation. Loading of parallel data into the storage register is enabled upon the receipt of Uncle 109 command Load Enable. This command also generates a Logic Disable signal during loading, which inhibits the execution of commands generated by the bits stored in the latching relays on the output of the storage register. The Load Enable command also turns the CR instruments OFF if they are operating at the time the signals arrive. Upon the receipt of Analog 9/ Uncle 119 command Load Disable, the loading process is terminated and the Load Enable and Logic Disabel signals are removed. A Logic Disable is also generated for execute command inhibition during the interval prior to and immediately after the shifting of parallel data out of the storage register.

L-3.1.1.3.2 Emergency Mode CR Camera Control

If the Emergency Mode position of the four-place counter is selected, the output of the Normal mode logic is completely disabled and Emergency Mode back-up relay logic controls camera positions.

Two alternate programs are prepunched on four H-Timer tracks utilizing conventional ON and OFF brush techniques. The program

[redacted]

desired is selected with a toggled RTC Analog 6/Uncle 116. Four-orbit operation intermix is provided by the Emergency Mode Logic. The capability is provided for automatically editing a series of four orbits of operations from the Program Select output. Therefore, 16 combinational sequences of orbit operational intermix are available (24 combinations). The desired sequence is selected by stepping a four-stage counter to the proper configuration with RTC Analog 8/ Uncle 118. A two-stage, four-orbit counter is advanced by brush 14 to establish coincidence between orbit counter and the orbit operation intermix counter, in order to enable or inhibit operations during the entire orbit (as dictated by the sequence stored in the intermix counter).

L-3.1.2 Processing of Commands in Command Subsystem

Stored program commands are inverted from a switched return info a switched +24 VDC unregulated power. Unsecure real time commands are used directly without processing to actuate stepping switches and relays. Secure real-time commands KIK-ZORRO 38 and 39 actuate relays in a timing circuit such that each is a single-shot function and is self-disabling after 30 or 35 seconds so as not to repeat. See Appendix DD. ARM SRV A signal also disables subsequent KIK-ZORRO 38 and 39 from performing any function. Note: For a complete listing and description of real time commands, also see Section V.

L-3.1.3 Constant Rotating Panoramic Camera Commands (see Figures L-1 and L-2) Stored Program Commands 30 through 47 provide nine Camera Operate programs. A Camera Operate Program is composed of a set of one ON program and one OFF program. Even-numbered brushes (SPC) are ON programs, and the next higher odd-numbered brushes are the corresponding OFF programs. Consecutive ON-OFF SPC's are called "sets".

L-3.1.3.1 Corresponding SPC sets are selected by RTC ANA-67/UHF-116, Camera Program Select, which controls stepping switch S1. Positions 1 to 9 correspond to Programs 1 to 9, and positions 10 and 11 are OFF for the normal operating modes. These nine programs can be used to program for orbit parameter dispersions, alternate target locations, high rate or low rate usage, probable cloud cover, or any other programming philosophy which may be established a few days prior to launch.

L-3.1.3.2 The selected Camera Operate program can be subjected to editing logic so that some operating periods can be deleted from the selected stored program. The operation editing logic sequence [redacted] [redacted]

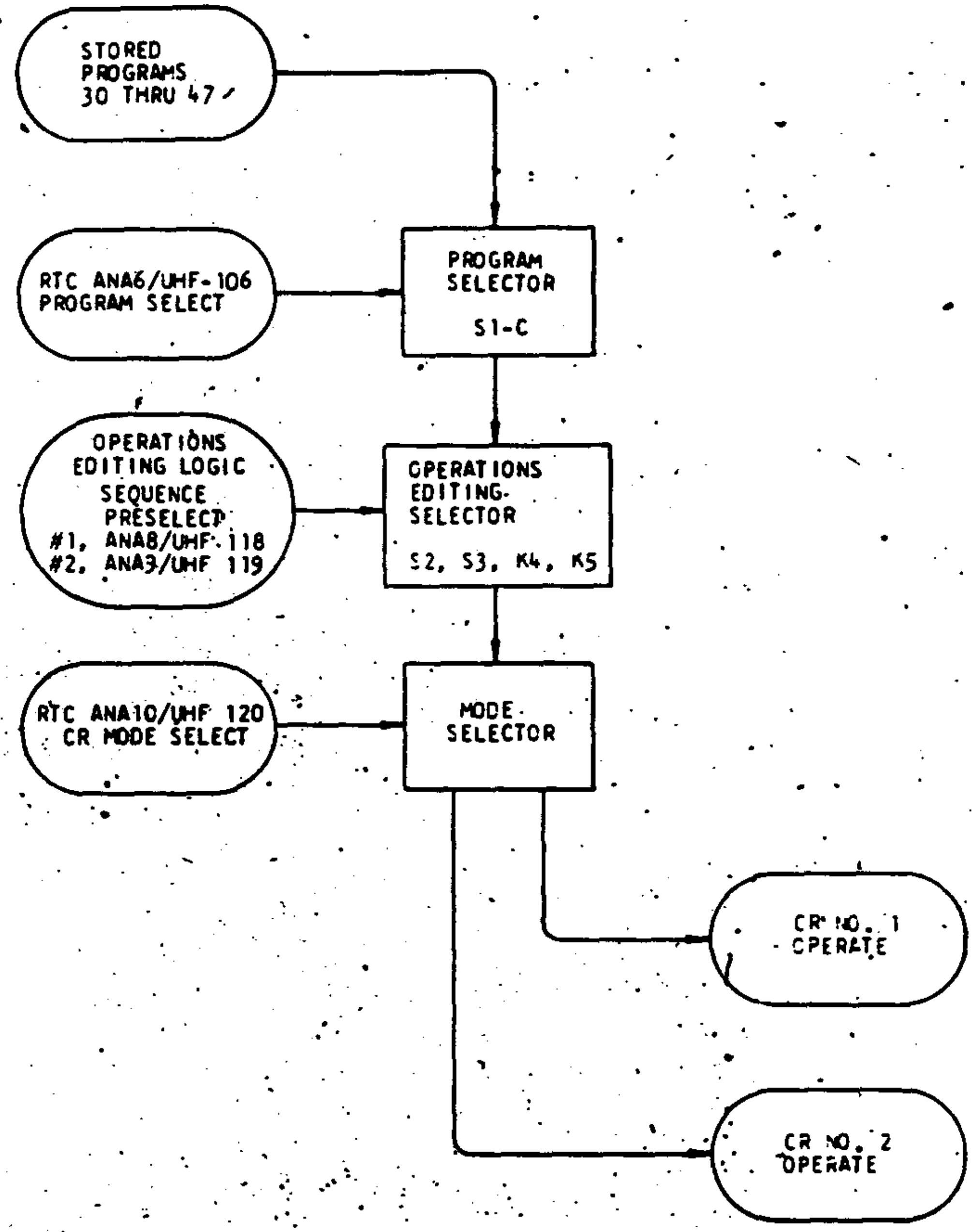

Figure L-1 Normal Operation, CR Instrument

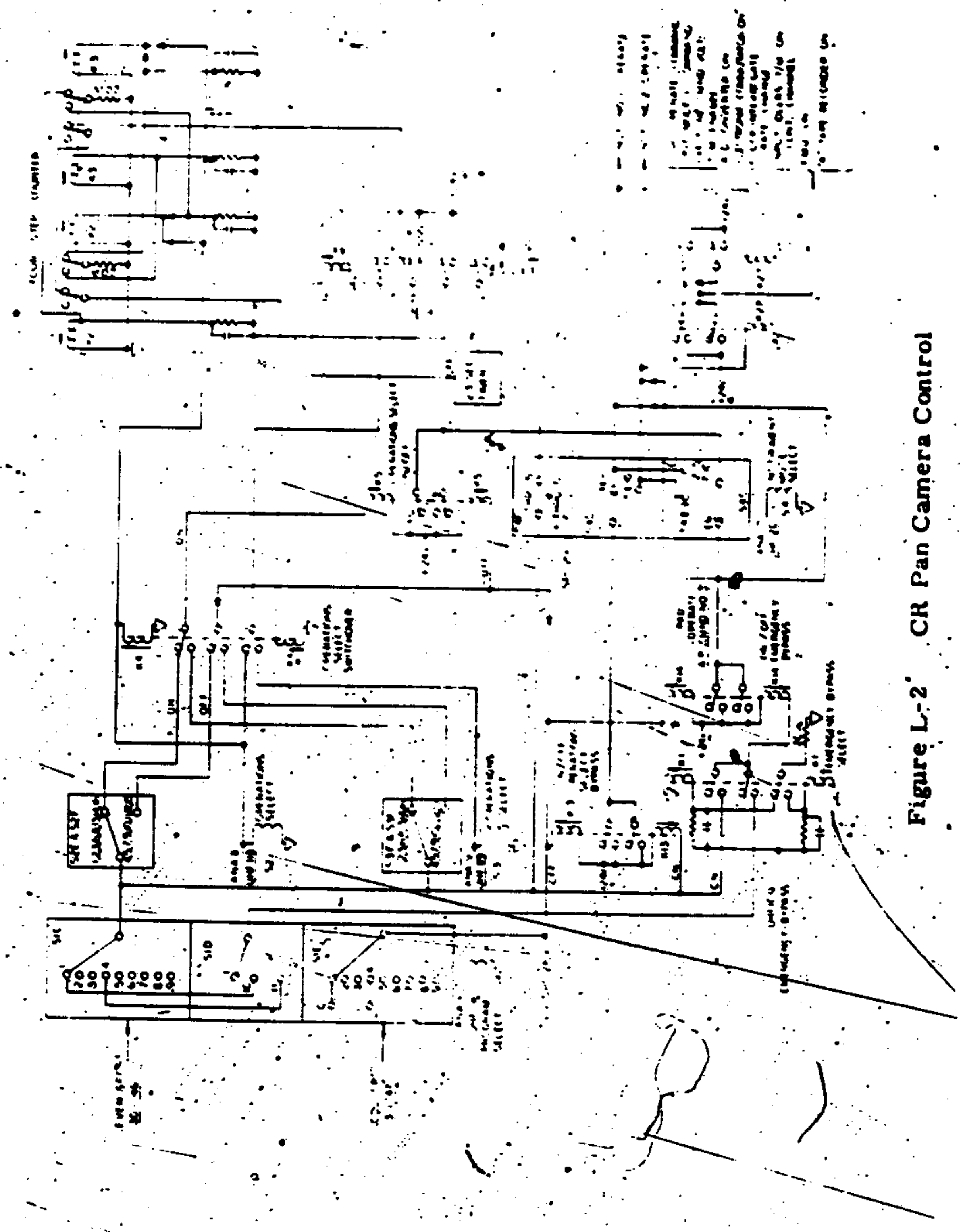

Figure L-2 CR Pan Camera Control

is used to preselect the first four logic bits by controlling the starting position of stepping switch S2.

L-3.1.3.3 ANA9/UHF-119, Operations Select No. 2, controls the starting position of S3, the editing logic sequencer for logic bits number 5 through 8 or more.

The purpose of this functional capability, of selecting one of nine stored Camera Operate programs and editing the next subsequent eight programmed operations, is to inhibit camera operation where cloud cover or other reasons make photography undesirable. The film saved can be used later in the mission to increase the effective coverage.

L-3.1.3.4 CR Camera Mode Selection is made by RTC ANA-10/UHF-120, which advances stepping switch S4, to provide various combinations of stereoscopic or monoscopic operation with editing logic controlled either by the selected ON-SPC (or Start SPC), or by SPC 29, Editing Logic Control program. Either CR camera No. 1 or No. 2 can be operated directly by the selected stored Camera Operate program while the other camera is operated by the edited program. The result of this is monoscopic coverage for all programmed operation and stereoscopic photography for selected operating periods of the sequence.

Editing Logic Control function has two modes of operation, selected by RTC ANA-10/UHF-120, CR Camera Mode Selector commands, which control the position of S4. S4E selects either SPC 29, Editing Logic Control program, or the Selected Camera Program Start (or ON) SPC to advance the editing logic stepping switch sequence. Relay K11 performs a single-shot function as a brush bounce filter, self-resetting after a time delay of 23 seconds. Change of the editing logic to the next bit is delayed 23 seconds until after the stepping switch actuating solenoid is released.

[redacted]

The editing logic is not advanced to the next step during the SPC signal dwell time, which is approximately 13 sec. ± 3 sec., but is delayed for 23 seconds. Therefore, the status monitor will indicate the next subsequent logic 23 seconds after the start of an operating period.

L-3.1.3.5 Emergency Stereo Operate command, RTC CHF-10, actuates relay K1 in a toggle or alternate action enabling the Selected Emergency Mode Start (ON) SPC to actuate relay K14 from stepping switch S1-D. Any one of the nine camera programs can be Selected for emergency stereo operation, by RTC ANA-6/CHF-11, Camera Program Select. Positions 1 to 9 correspond to Programs 1 to 9, and positions 10 and 11 are Programs 1 and 4, respectively, for this emergency bypass stereo operate mode. This operating mode can be used to provide a stored stereo program operating mode, bypassing the normal operating mode selection and editing circuits. This provides command redundancy for stereo operation.

L-3.1.4 CR Panoramic Camera Command During A to B Transfer

The transfer of exposed film from SRV A cassettes to SRV B take-up cassettes is a critical mission event, and is therefore commanded by a Secure RTC, KIK-ZORRO 38, Early Main A to B Transfer. After 30 seconds of stereoscopic panoramic operation, the circuit locks out the function from repeating. ARM SRV A provides a back-up command for this function.

The cameras operate at a low slewing rate, determined by the A to B Transfer voltage circuit in the V/h programmer, to wrap four frames onto the SRV B take-up cassettes within about 30 seconds as part of the cut-and-wrap sequence.

The panoramic film is cut by the main waterseal, a pyrotechnic dimple motor actuated device which triggers a spring-loaded cutting blade. The light seal assembly provides drag for back

[redacted]

tension and a light seal for the B mission. A few turns of film are wrapped onto the SRV B take-up cassettes, and then the system is ready for the next operation.

The CR Operate signal is generated by K27 and K28. This signal is used for controlling several functions as follows

a. Clock Interrogate Command

b. Dynamic TM Enable

c. SRV A Tape Recorder ON Command

d. Pressure Makeup Unit Operate Command

e. DISIC Mode 1 Command (to DISIC K110, Slave Mode Function select relay)

f. DISIC Mode 1 Operate Command (program timing)

L-3.1.5 DISIC Command and Control (See Figures L-3 and L-4)

DISIC Operate command is derived from either panoramic camera No. 1 or No. 2 operate command, or from an independent program. The DISIC Independent Program uses SPC 48 for START and ON, and SPC 49 for STOP or OFF. RTC ANA-14/UHF-124, DISIC Independent Mode Enable-Inhibit command, is a toggle or alternate action command which enables DISIC operation in the independent or quiescent mode (Mode 2) for continuous overlapping strip mapping photography when programmed by SPC 48 and SPC 49.

DISIC Mode 1 operation is controlled by, or slaved to panoramic camera operation for stellar and terrain indexing. The Mode 1 command sent to DISIC is derived from the actuation of K27 or K28, inclusively, generating the CR Operate signal.

DISIC Capping and Control is a sequence of four conditions selected by RTC UHF-107. The four steps of control correspond to TM volts and function as follows:

TM Volts	Stellar Functions	Capping Command
1	OFF, no DISIC Operate	No capping

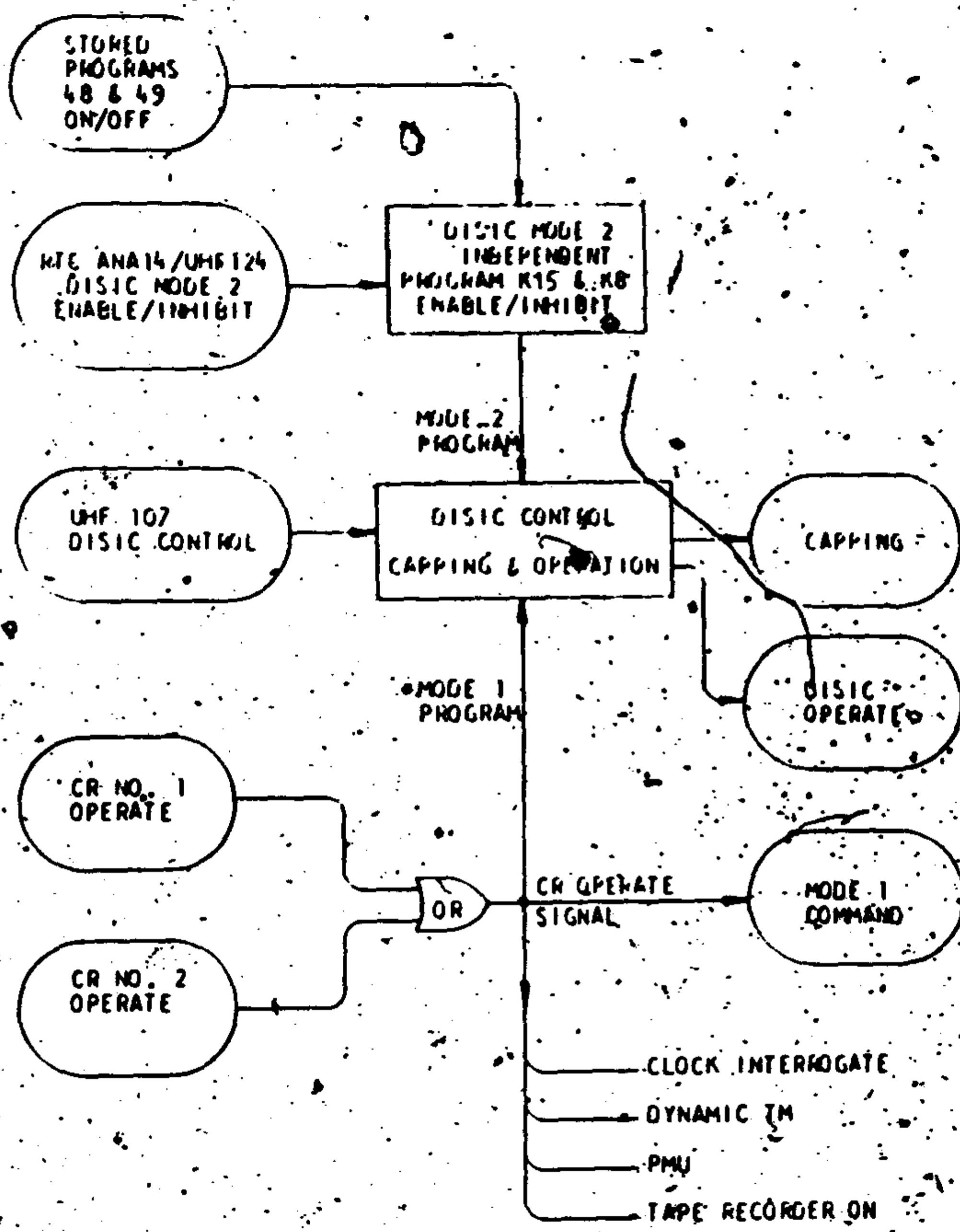

Figure L-3 DISIC Camera Control

[redacted]

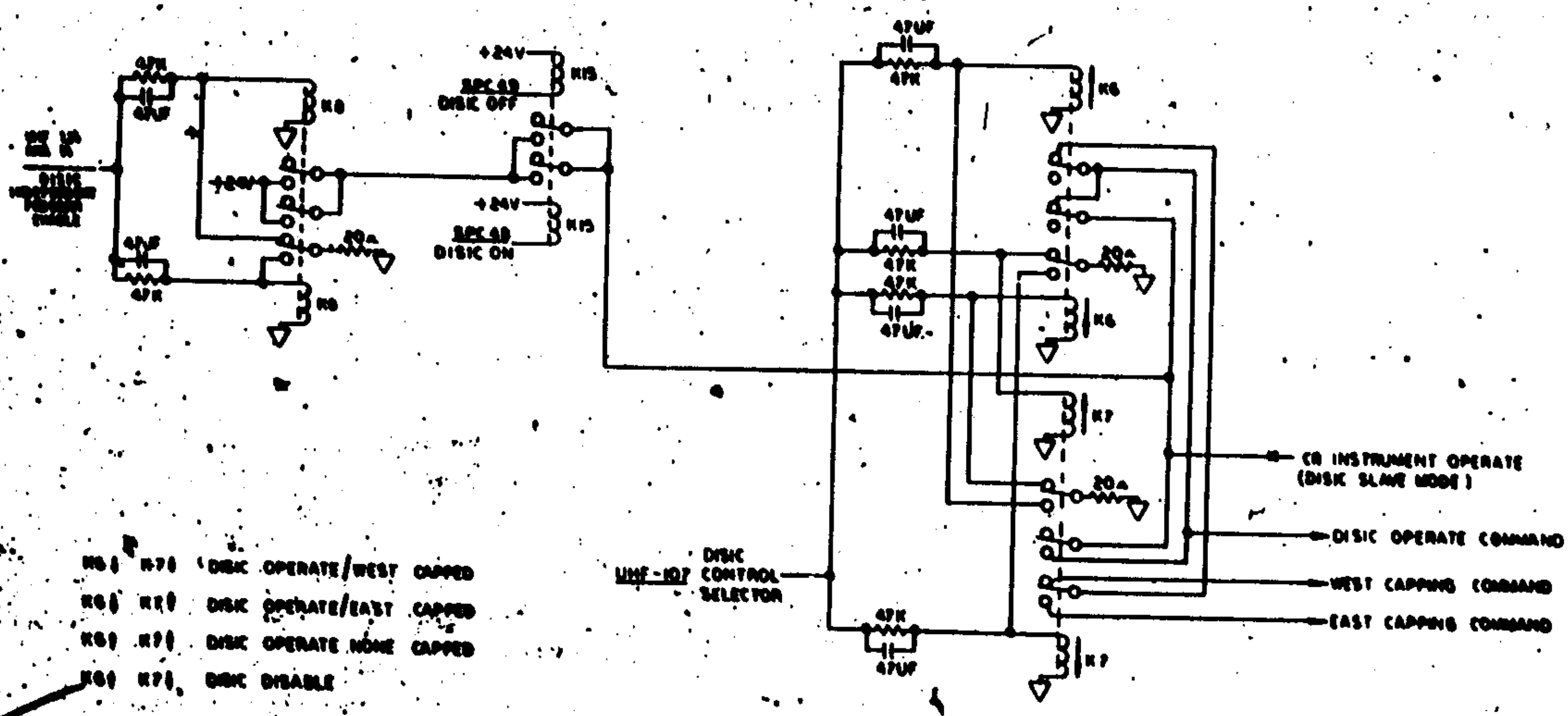

Figure L-4 DISIC Camera Control

TM Volts	Stellar Functions	Capping Command
2	East, Operate	West Stellar Capping
3	West, Operate	East Stellar Capping
4	Both, Operate	No capping

NOTES: (1) The capping commands could be called more precisely the uncapping inhibit commands for the function performed in the DISIC.

(2) The indexing photography results from step 2, 3, or 4.

(3) East is left for a southbound nose-forward flight.

L-3.1.6 DISIC Command During A to B Transfer

Exposed film take-up control must be transferred from SRV A cassettes to SRV B cassettes. This critical mission event can be commanded by a Secure RTC, KIK-ZORRO 39, Early DISIC A to B Transfer. After 35 seconds of take-up operation, the circuit is self-disabling and the function cannot repeat. ARM SRV A provides a backup command for this function.

The DISIC A to B Transfer signal switches control from SRV A cassettes to SRV B DISIC cassette motors and TM pots, activates the pyrotechnic-actuated cut and splice mechanism, generates a dynamic TM Enable signal, and after 30 seconds applies reduced take-up current for five seconds to SRV B cassettes for eliminating any slack.

L-3.1.7 Orbit Mode Signal

The Orbit Mode Signal removes all electrical loads from In-Flight-Reset command lines, provides backup command for activating the pyrotechnic-actuated ejection of port covers, and removes power from the takeup cassettes providing dynamic tension during launch mode.

[redacted]

A/P Umbilical Command No. 5, Orbit Mode Signal Bypass, is used to verify orbit mode operating tension during launch pad checkout. Diodes isolate A/P Umbilical Command No. 5 from Orbit Mode signal so that the port covers aren't blown off during pad checkout. Relay Reset returns everything to launch mode.

Telemetry Indication of Launch/Orbit Modes. See Section N, Telemetry.

L-3.1.8 Satellite Re-Entry Vehicle Commands and Controls

L-3.1.8.1 Beacon and Telemeter Test

A/P Umbilical command Nos. 2 and 4 (Arm Bypass) apply power to verify function of the Recovery Beacon and the Blossom telemeter in each SRV by RF monitors. Removal of this command will effectively re-set these units to launch readiness, which is the same as Orbit Mode for these units.

L-3.1.8.2 SRV Battery Heater Control

A/P Recovery Enable command, derived from KZ 36 or 37, is normally given approximately one orbital pass (or about 75 minutes) prior to SRV A ARM command. This applies heater power from the Agena +24 V unregulated supply to the recovery battery, so as to assure more reliable low temperature activation. Battery temperature is controlled by a thermostat which turns heater power on when the battery temperature is 60°F or lower and turns the power off when the battery temperature reaches 90°F.

L-3.1.8.3 SRV Reset Commands

The recovery programmer is reset after testing by Relay Reset command. The Blossom Telemeter Reset command (J1-a) is not a pad function, but is to be provided externally to the SRV test connector J3152-x after recovery in order to turn off the telemeter transmitter. It requires momentary application of +24 VDC $\pm$ 6 V

[redacted]

at about 0.1 amp for 10 milliseconds to continuous. Failure to reset will allow the transmitter to be tracked for about 1 1/2 hours after initiation (ARM). The recovery beacon must be reset also as soon as recovered, because its battery is designed to last a minimum of 10 hours and likely would not be dead in less than 30 hours. due to redundancy.

Resetting the SRV to turn off the beacon requires actuating reset coils of 11 relays, including K4 and K11 (momentary application of + 20 VDC ± 10 VDC at about one ampere for 10 milliseconds minimum to a few seconds maximum). A momentary switch applies a 30 V battery to J3152-d, from an external device provided to the recovery aircraft.

L-4.0 SEQUENCE OF EVENTS

A typical sequence of events for a J-3 mission is listed on Figure L-5. It encompasses Agena commands for cameras operations, switch from A to B operation, and A and B recoveries.

L-5.0 MONITORING, TLM

For telemetry indication and monitoring of commands, refer to Section N. of this manual.

L-6.0 REFERENCE DOCUMENTS

[redacted] A/P-SV Electrical Interface
Command System Functional Schematic
Command Box Schematic
Command Box Schematic
A/P-SRV Electrical Interface

[redacted]

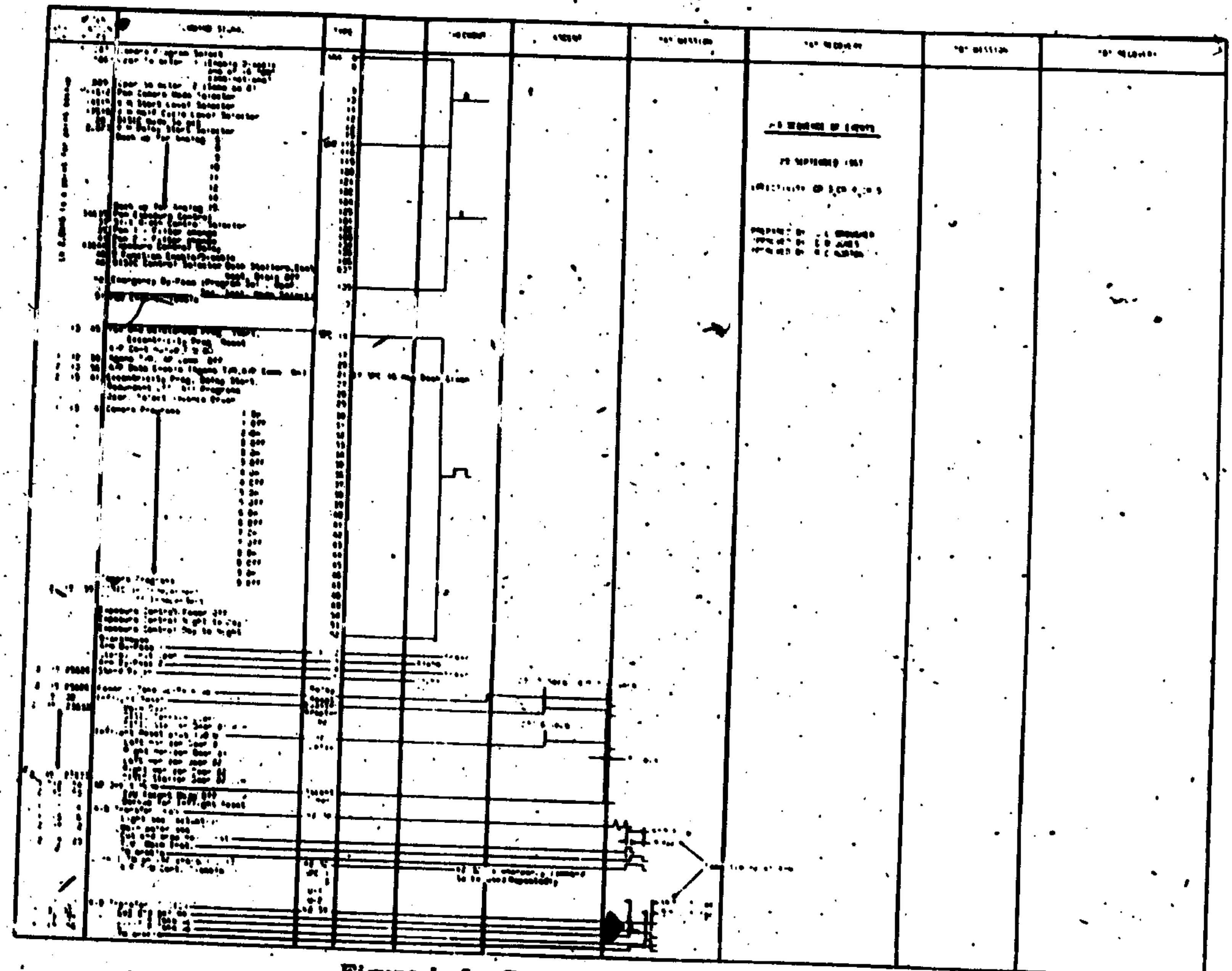

Figure L-5 Command Sequence (Sheet 1 of 2)

[redacted]

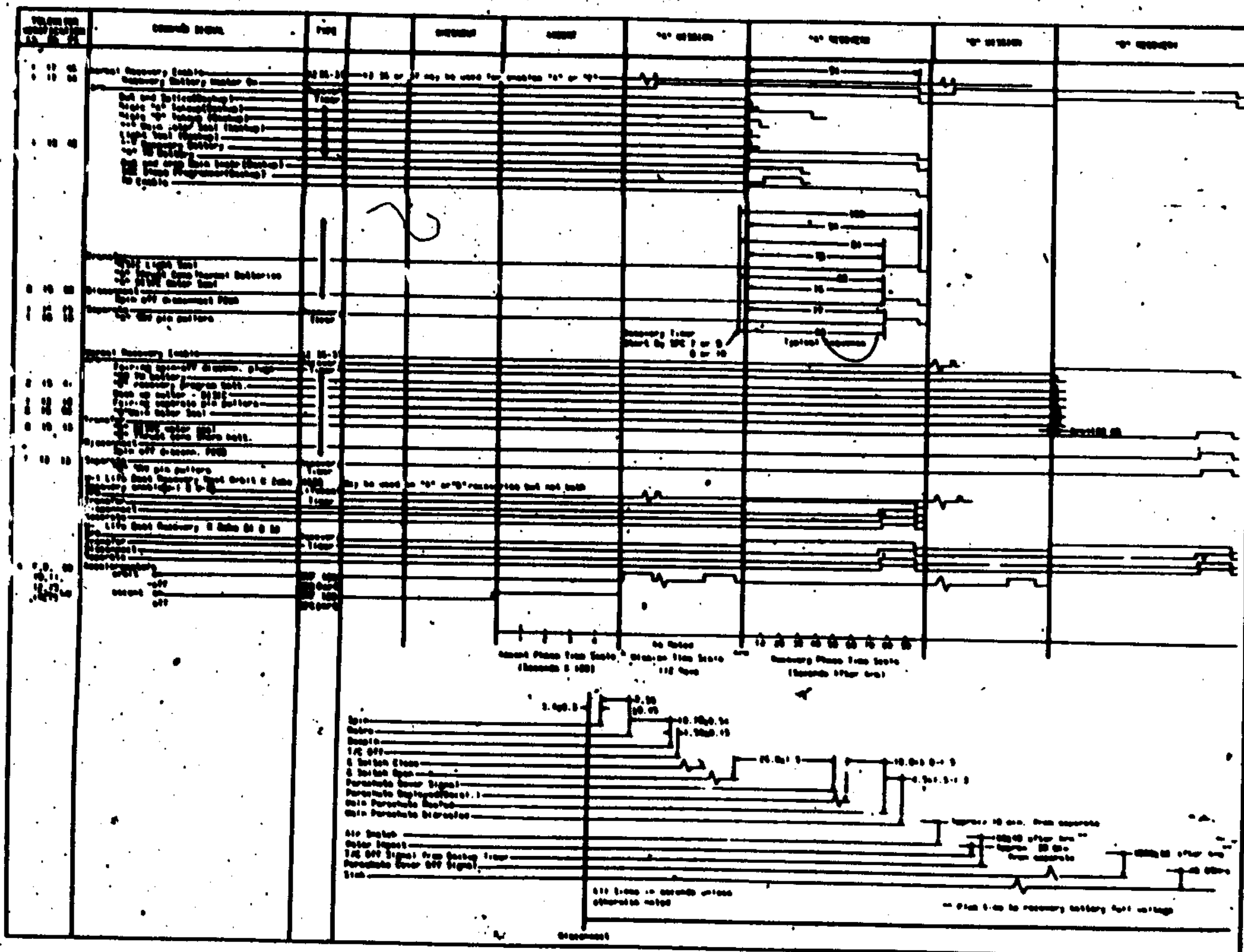

Figure L-5 Command Sequence (Sheet 2 of 2)

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SECTION M

ELECTRICAL POWER -- DISTRIBUTION AND CONSUMPTION

M-1.0 PURPOSE

The purpose of the electrical distribution subsystem is to accept electrical energy from the Agena batteries and distribute it to the payload power consuming equipment, meeting at least the minimum requirements for proper operation.

M-2.0 CHARACTERISTICS

Tables M-1 and M-2 list pertinent information concerning electrical power distribution characteristics. (Also refer to Figures M-1 through M-6 at the end of this section.)

Table M-1 Power Boxes

ITEM	PARAMETER
PHYSICAL DIMENSIONS:	
FORWARD POWER BOX	4 X 7 X 5 INCHES
WEIGHT	1.5 LBS.
AFT POWER BOX	7 X 8 X 4 INCHES
WEIGHT	4.0 LBS.

Table M-2 Interface Power Limits

STEADY-STATE VOLTAGE

A. 21.0 - 29.0 VOLTS UNREGULATED (ZERO TO RATED LOAD)

B. 22.0 - 29.5 VOLTS PYRO (ZERO LOAD)

C. 112.7 - 117.3 VOLTS RMS, 400 HZ

Table M-2 Continued

RATED-LOAD CURRENTS

A. +24V UNREGULATED BUS 26A (1)

B. +24V PYRO BUS 60A (4)

C. 115V 400 HZ, ØAB BUS 0.1A (3)

D. 115V 400 HZ, ØBC BUS 0.5A (2)

AC CHARACTERISTICS (RATED LOAD)

A. FREQUENCY: 400 HZ ± .008 HZ

B. HARMONICS DISTORTION: 5 PERCENT

C. AMPLITUDE MODULATION (BELOW FUND.): 7.0V(P-P)

D. VOLTAGE TRANSIENTS (WORST CASE): 162.6V $^{+100V}_{-50V}$ PEAK(5)

E. POWER FACTOR: 0.80 LAGGING, 0.95 LEADING

(1) PEAKS NOT TO EXCEED 38A FOR 3 SECONDS.

(2) SURGES NOT TO EXCEED AN ADDITIONAL 0.25 AMPS FOR 500 MS.

(3) NO PEAKS ANTICIPATED.

(4) FOR 5 MS WITH BUS AT 16 ± 2 VOLTS.

(5) RECOVERY TIME 25 MS IN ONE TIME CONSTANT

M-3.0 ELECTRICAL DISTRIBUTION SUBSYSTEM

All electrical power for the payload system, except that required by recoverable payloads, comes from batteries located within the Agena (see Section B). These batteries, together with an inverter, supply unregulated, pyro, and 400 Hz power to the payload interface, which is supplied continuously during prelaunch, launch, and on-orbit. During the prelaunch operation, pyro power is removed when the Internal/External switch is in the External position.

The power consumption and load characteristics of the payload using subsystems determine the design parameters of the power distribution subsystem. The design to these parameters assures satisfactory operation of the various subsystems, either singly or jointly, and with a minimum of electromagnetic interference.

The power supplied at the payload interface is as shown in Table M-2. The DC voltage variations are as a result of peroxide formation on initial activation of vehicular batteries (see Figure M-5). The battery connections for unregulated and pyro power are as shown in Figure B-19, and the wiring to the interface connector AP22X is as shown in Figure M-6.

M-3.1 Power Distribution

Wire sizes and lengths for the distribution of unregulated power are shown in Figures M-1 and M-6. Figures M-2 and M-6 show the same information for pyro power distribution. Figure E-3 shows the complete power distribution system for the payload.

M-4.0 POWER CONSUMPTION

The following Table (M-3) is an estimate of the power consumption requirements for the J-3 subsystems.

[redacted]

C TOP SECRET [redacted]

Table M-3 Power Consumption Estimate

	POWER (WATTS)	CURRENT (AMPS)	DURATION (HOURS)	MISSION TOTAL 14 DAYS (WATT-HOURS)
INSTRUMENT SUBSYSTEM (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	235	9.0	3.6	766
START-UP	600	24	1/8	75
400 CPS 115 VAC				
AVERAGE OPERATION	57		3.6	194
TOTAL INSTRUMENT SUBSYSTEM				1035
DISIC (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	75	3.0	12.5	940
CLOCK (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	8.5	.34	336	2860
SLOPE PROGRAMMER (M)				
UNREGULATED 28 VDC				
CONTINUOUS OPERATION	2.5	.10	336	840
INTERMITTENT OPERATION	5	.20	224	1120
INTERMITTENT OPERATION	2.5	.10	30	75
400 CPS 115 VAC				
AVERAGE OPERATION	6		336	2020
TOTAL SLOPE PROGRAMMER				4055
TAPE RECORDER SUBSYSTEM (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	15	.61	3.6	52
14 DAY AVERAGE:	3.7 WATT-HRS./DAY			
STORAGE REGISTER COMMAND SYSTEM (C)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	10	.42	84	*840
14 DAY AVERAGE:	60 WATT-HRS./DAY			
XENON LAMP SYSTEM (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	31	1.3	3.6	112
14 DAY AVERAGE:	8 WATT-HRS./DAY			
EXTENDED OPERATION (ETO)				
ADDITIONAL INSTRUMENT (INCLUDING PMU & SLP)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	235	9.0	1.7	*400
START-UP	600	24	1/8	75
400 CPS 115 VAC				
AVERAGE OPERATION	57		1.7	97
				572
14 DAY AVERAGE:	41 WATT-HRS./DAY			

* T/M OPERATION IS A TIME FUNCTION OF LINK 1 PROGRAMMING AND VARIES WITH ORBITAL INCLINATION.
(M) INDICATES MEASURED VALUES.
(C) INDICATES CALCULATED OR VENDOR-SUPPLIED VALUES.

	POWER (WATTS)	CURRENT (AMPS)	DURATION (HOURS)	MISSION TOTAL 14 DAYS (WATT-HOURS)
SWITCH PROGRAMMER (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	7.5	.30	140	1050
DATA CONDITIONER (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	5.5	.23	3.6	19
T/M HEATER (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	5.7	.20	84	480
BATTERY HEATER (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	55	2.4	3	165
PRESSURE MAKE-UP SUBSYSTEM (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	5	.20	3.6	17
T/M (M)				
UNREGULATED 28 VDC				
AVERAGE OPERATION	7.5	.31	*	
SYSTEM TOTAL				10621
14 DAY AVERAGE (LESS LINK 1 T/M POWER)				750 WATT-HRS-DAY (BASIC RATE)

C TOP SECRET [redacted]

TOP SECRET
[redacted]

[redacted]

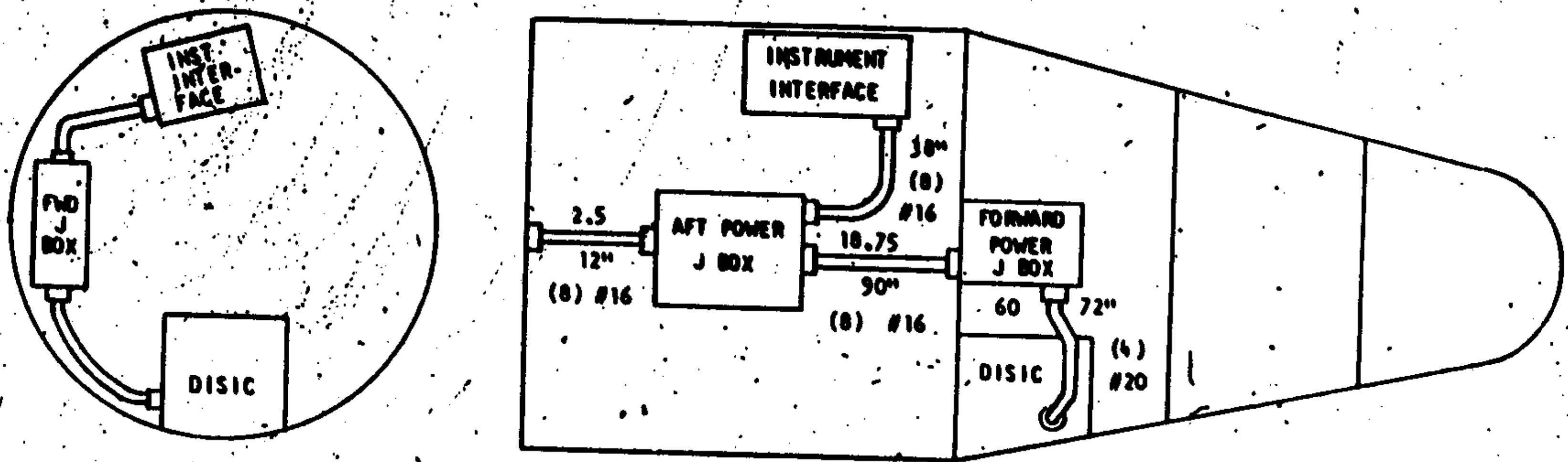

Figure M-1 Unregulated Power Distribution

TOP SECRET
[redacted]

C TOP SECRET [redacted]

[redacted]

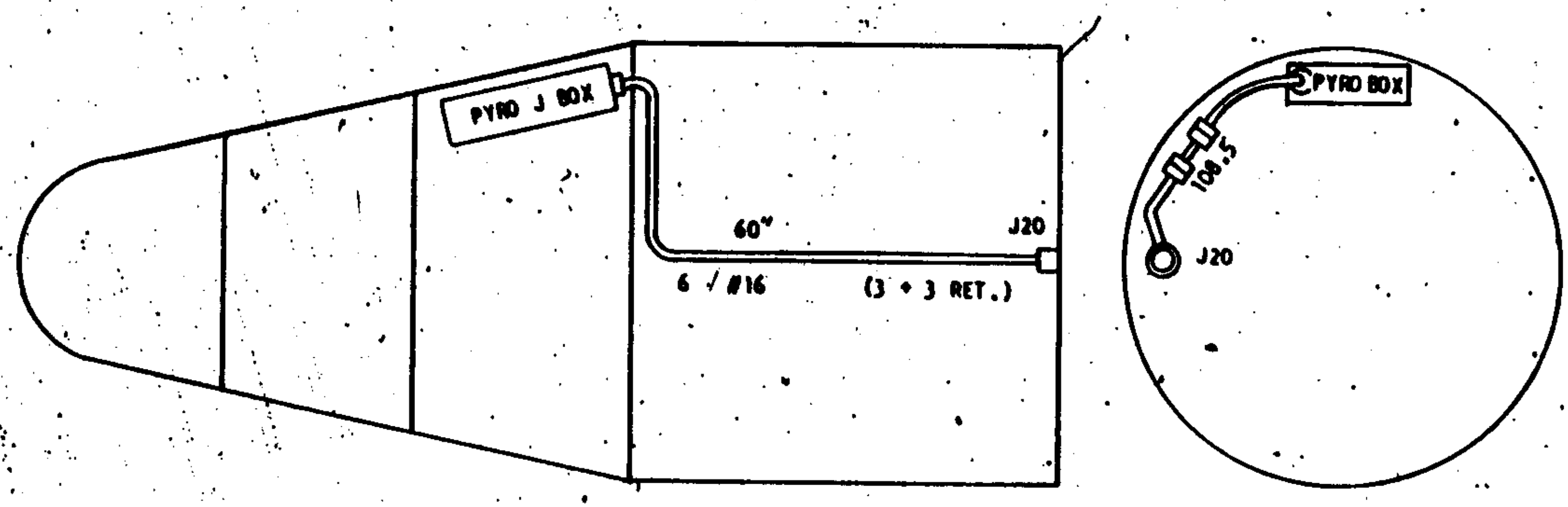

Figure M-2 Pyro Power Distribution

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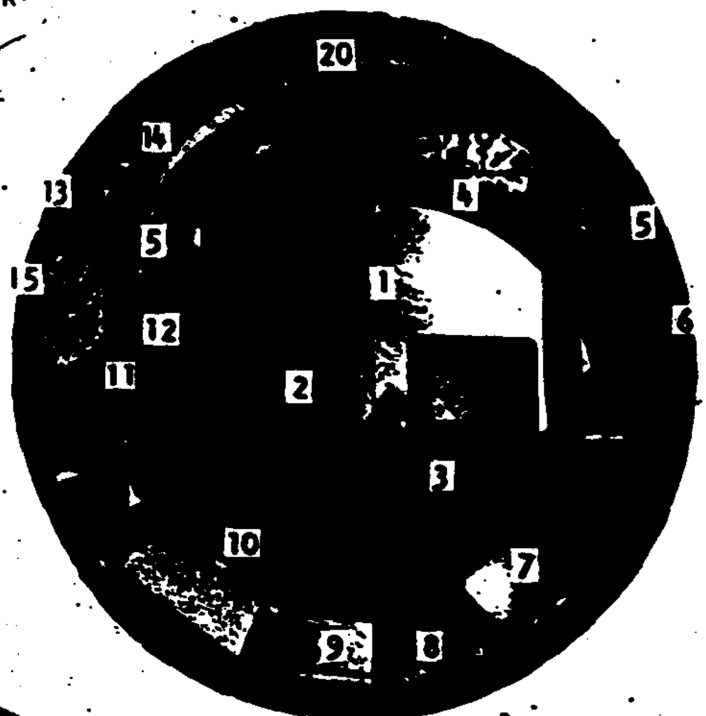
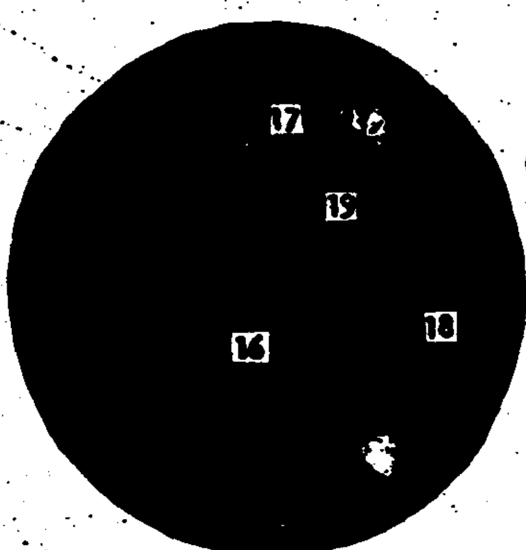
[redacted]

1. MAIN INSTRUMENT DRUM ASSEMBLY
2. MAIN INSTRUMENT ACCESS PANEL
3. MAIN INSTRUMFNT BOOT
4. MAIN INSTRUMENT TRANSPORT ASSY
5. AUXILIARY OPTICS BOOT
6. SWITCH PROGRAMMER
7. SLOPE PROGRAMMER
8. SLP CONDITIONER
9. CLOCK
10. COMMAND BOX

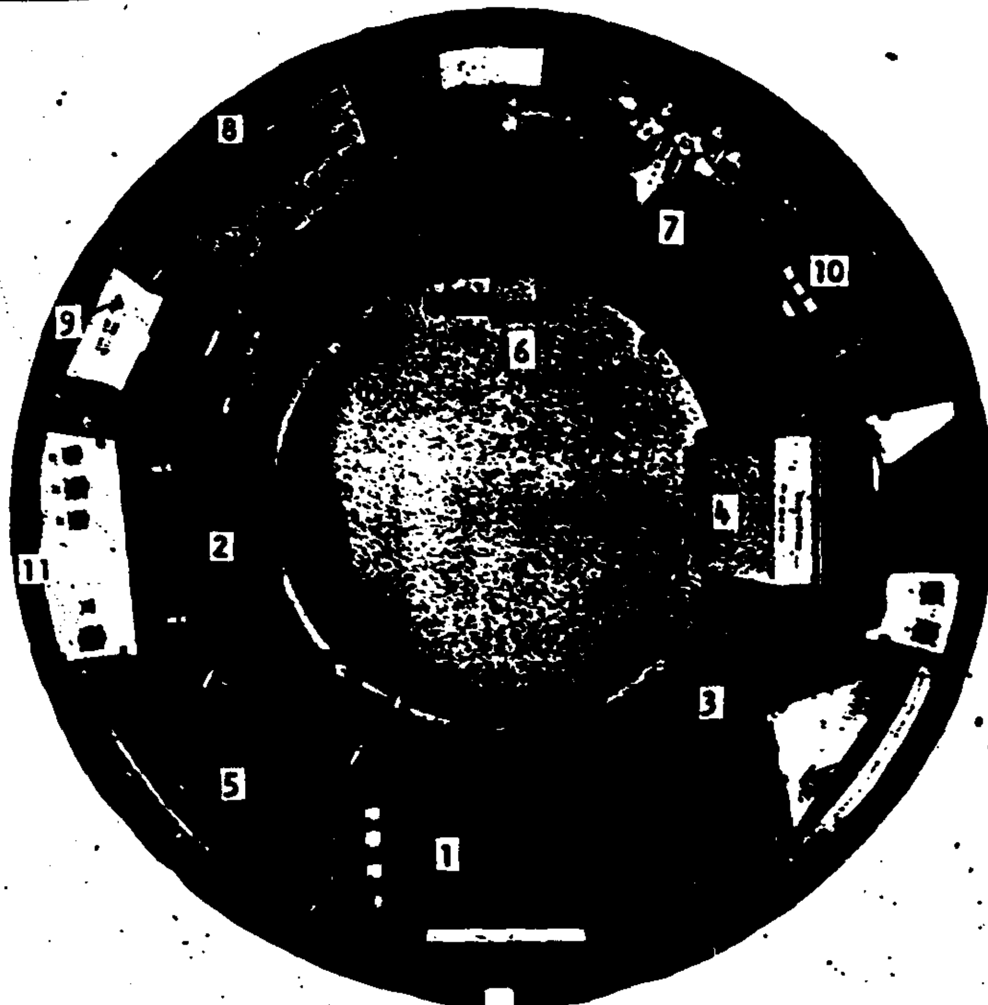




(VIEW LOOKING FORWARD INTO INSTRUMENT BARREL)

11. AFT POWER BOX
12. AUXILIARY OPTICS AIR VENT
13. CURRENT MONITOR
14. SKIN TEMPERATURE SENSOR
15. AGENA/PL INTERFACE PANEL
16. MAIN INST SUPPLY CASSETTE
17. SC MOUNTING DELTA
18. CONSTANT TENSION DEVICE
19. OUTRIGGER ASSEMBLY
20. PHOTOMETER ACCESS PORT

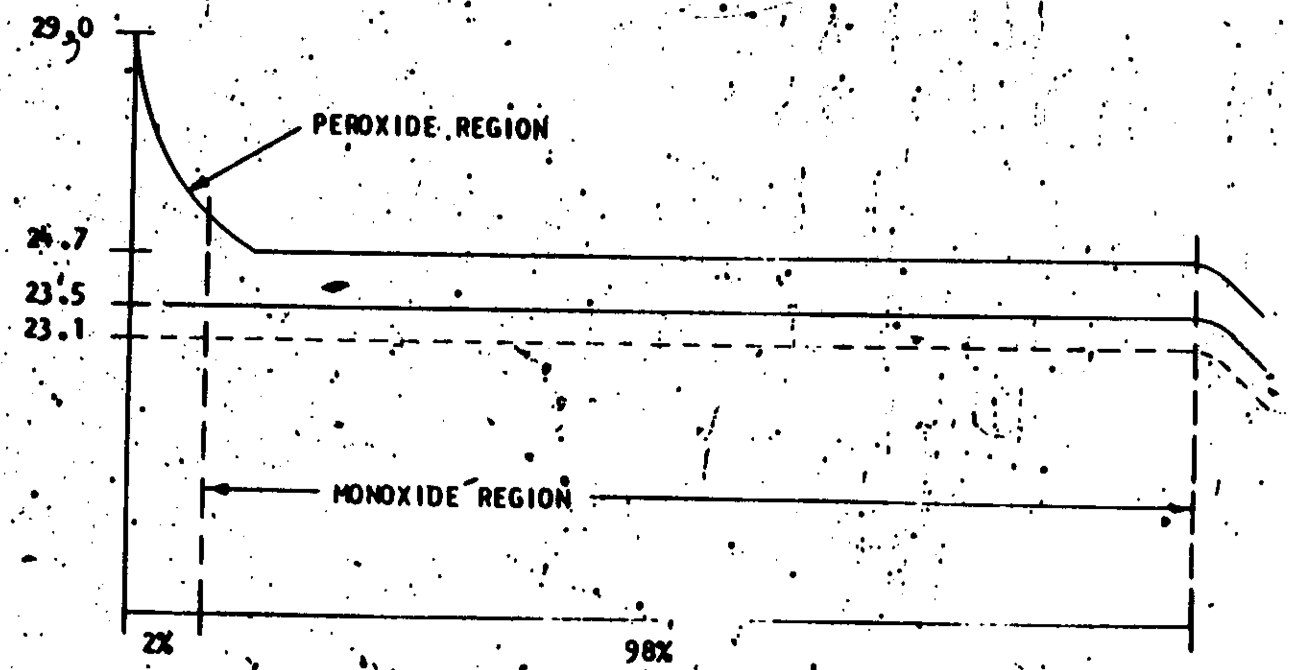
Figure M-3 Instrument Barrel/Agena Interface



(VIEW LOOKING FORWARD INTO DISIC CONIC)

1. DISIC INSTRUMENT
2. DISIC SUPPLY CASSETTE
3. FILM CHUTE
4. TUNA
5. STELLAR BOOT
6. INTERMEDIATE ROLLER ASSEMBLY
7. PRESSURE MAKE-UP UNIT
8. TRANSFER BOX
9. FWD POWER BOX
10. PYRO BOX
11. INTERFACE PANEL

Figure M-4 DISIC Conic/Instrument Barrel Interface



ESTIMATED % DEPLETION VOLTAGE TO PAYLOAD UNDER NORMAL FLIGHT CONDITIONS. DEPLETION OF BATTERY CAPACITY IS SHOWN IN PERCENTAGE OF WATT HOURS. BROKEN LINE SHOWS WORST CASE VOLTAGE AND 30 AMPERE SURGES. (NOT DRAWN TO SCALE.)

Figure M-5   Agena Battery Terminal Voltage Characteristics

[redacted]

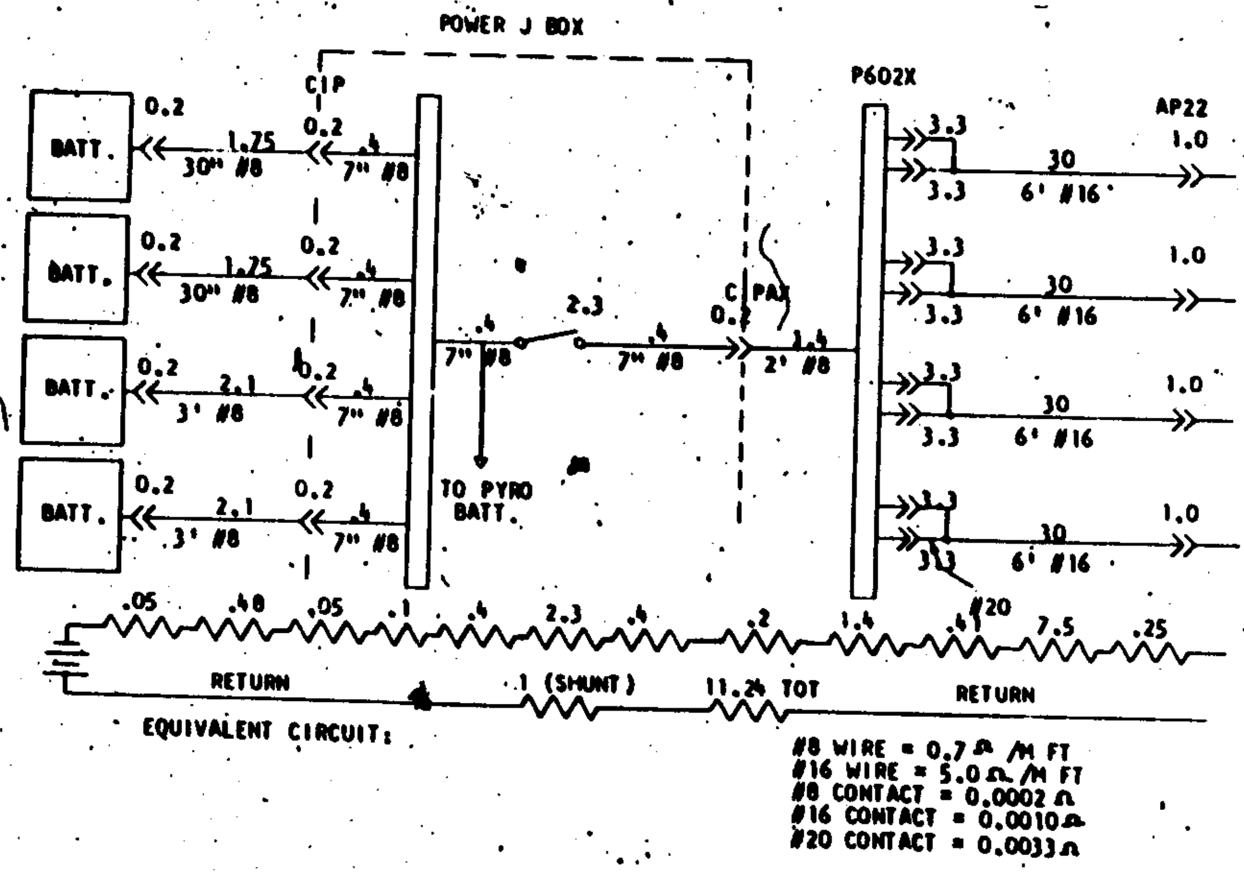


Figure M-6 Agena Unregulated Bus

[redacted]

SECTION N

TELEMETRY SUBSYSTEM

N-1.0 PURPOSE

The purpose of the telemetry subsystem is to obtain operational and performance data for use in evaluation of payload vehicle performance, as expressed in real time or as expressed by a tape recorder.

N-1.1 Function

To accomplish the task of furnishing in-flight real time and recorded operational and performance data, the telemetry subsystem must perform the following functions:

a. Collect the telemetry signals from the various system telemetry transducers.

b. Condition the signals to be compatible with the vehicle telemeter VCO (voltage-controlled oscillator) requirements.

c. Provide commutators and control for the commutation of telemetry data for optimum channel utilization.

d. Provide excitation voltage to transducers and temperature sensors.

e. Incorporate switching to disable continuous-channel instrument dynamic signals, except during engineering passes or A to B Transfer operations.

f. Multiplexing of dynamic signals for efficient utilization of available continuous channels.

g. Provide programming connectors to allow flexible patching of performance or operational data to various commutator points or tape recorder functions.

h. Provide calibration and sync voltages for the commutated channels to allow accurate reduction of the data.

In addition, the telemetry subsystem is required to perform auxiliary functions such as periodic clock serial time interrogate, clock sync pulse stretching, and analog-to-digital converter control for the digital tape recorder subsystem.

N-2.0 CHARACTERISTICS

The following tables provide pertinent information concerning the characteristics of the telemetry subsystem:

NOTE: This manual will not consider individual transducers and the assignment of specific commutator points. Instrumentation schedules issued on a per-vehicle basis will contain current assignment of telemetry data to commutator ~~points and~~ continuous channels.

Table N-1 . T/M System Summary

COMMANDS	FUNCTION
LINK I T/M ON	APPLIES POWER TO T/M SYSTEM
	DISABLE CONTINUOUS CHANNEL
	SERIAL CLOCK INTERROGATE EVERY 20 SECS.
SPC 17	CONTINUOUS CHANNEL ENABLE FOR ENGINEERING PASSES
KIK-ZORRO 38, KIK-ZORRO 39	CONTINUOUS CHANNEL ENABLE DURING REAL TIME A TO B TRANSFER SEQUENCE
ARM COMMAND	1. CONTINUOUS CHANNEL ENABLE DURING A TO B TRANSFER SEQUENCE
	2. PROVIDES PRIMARY INST. DYNAMIC DATA TO AGENA ANALOG TAPE RECORDER
CR INST. OPERATE COMMAND	APPLIES POWER TO T/M SYSTEM APPLIES POWER TO DIGITAL TAPE RECORDER SYSTEM
A/P DATA ENABLE	APPLIES POWER TO T/M SYSTEM TEMP. SENSOR DATA RECORDED ON TRACK 1 OF AGENA TAPE RECORDER. OPERATIONAL DATA RING RECORDED ON TRACK 2 OF AGENA TAPE RECORDER.

Table N-2 T/M Instrumentation List

A. SIX CONTINUOUS CHANNELS

1. TERRAIN IDLER, TERRAIN SHUTTER & STELLAR IDLER, DISIC CUT AND SPLICE.
2. PAN #1 OUTPUT IDLER ROTATION, 99/101 CLUTCH COMMAND.
3. PAN #1 LENS ANGULAR POSITION, CENTER OF FORMAT COMMAND, PYRO CURRENT MONITOR DURING ASCENT.
4. PAN #2 OUTPUT IDLER ROTATION, 99/101 CLUTCH COMMAND.
5. PAN #2 LENS ANGULAR POSITION, CENTER OF FORMAT COMMAND.
6. CLOCK SERIAL WORD (TIME SHARED WITH PAN #2 INPUT IDLER).

B. FOUR COMMUTATED CHANNELS

1. TEMPERATURE MEASUREMENTS

TIME SHARED WITH PAN #1 INPUT IDLER

0.4 RPS X 60 POINT COMMUTATOR RING B

A. 22 TEMP. SENSORS ON STRUCTURE & SKIN
B. 16 INSTRUMENT TEMP. SENSORS
C. 4 SRV TEMP. SENSORS
D. 2 DISIC TEMP. SENSORS
E. 2 BLAST SHIELD TEMP. SENSORS
F. 1 TEMP. SENSOR ON IMC PROGRAMMER
G. 1 PMU TEMP. SENSOR

2. OPERATIONAL CONTROL

0.4 RPS X 60 POINT COMMUTATOR RING A

A. RTC & SPC STATUS MONITORS
B. PAN #1 & #2 CYCLE COUNTER MONITOR
C. TERRAIN CYCLE COUNTER
D. DOOR SEPARATIONS
E. YAW GENERATOR POSITION
F. FMC FUNCTION OUTPUT
G. ECCENTRICITY PROGRAM OPERATE DELAY
H. STELLAR & TERRAIN TAKE-UP DIAMETER
I. PAN #1 & PAN #2 TAKE-UP DIAMETER

3. REDUNDANT OPERATIONAL CONTROL

5.0 RPS X 60 POINT COMMUTATOR RING A

4. DIAGNOSTIC MEASUREMENTS

5.0 RPS X 60 POINT COMMUTATOR RING B

A. WATER SEALS
B. METERING MONITORS
C. SRV RECOVERY BATTERY MONITOR
D. PLATEN POSITIONS
E. SRV SEPARATIONS
F. CURRENT MONITORS
G. VOLTAGE MONITORS
H. FAIRING SEPARATIONS
I. PAN #1 AND PAN #2 FILM CHANGE DETECTOR

[redacted]

Table N-3 Mechanical Summary

SIZE:	FWD T/M BOX	8 X 8 X 4 INCHES
	AFT T/M BOX	18 X 9 X 9 INCHES
LOCATION:	FWD T/M BOX	FAIRING
	AFT T/M BOX	FORWARD END OF INST. BARREL

N-3.0. DESCRIPTION

The J-3 system telemetry interface with the Agena vehicle consists of eight channels of primary telemetry data on Link I, two channels of telemetry data on Link II, and two channels of analog tape record capacity (See Section B).

Link I consists of a crystal-controlled, 2 watt VHF FM transmitter with carrier modulated by a composite FM signal. The composite FM signal is derived from subcarriers, each of which is a standard IRIG voltage-controlled oscillator (VCO). The VCO outputs are summed and amplified by a modulation amplifier, and the result is the modulation bus composite signal. Modulating the FM transmitter carrier with the FM composite signal results in an FM/FM frequency division telemetry signal. The VCO's require a 0 to 5 volt input signal for which the carrier is deviated by $\pm$ 7.5 percent from the center frequency.

A + 2.5 volt input signal maintains the VCO at its center frequency. Therefore, it is necessary for the payload telemetry subsystem to condition all transducer signals to comply with the 0 to 5 volt VCO input requirement to result in a 0 to 100 percent bandwith deviation of the subcarrier channels. Because of signal-to-noise ratio considerations, it is desirable to maintain a modulation index of 5 for each subcarrier channel. As the modulation index tends to vary inversely with frequency, it is common practice to boost or pre-emphasize the higher frequency channels. Pre-emphasis is accomplished in the Agena FM/FM telemetry systems by adjusting the gain of the individual VCO's whereby channels 14 and 15 are set to twice the average values of 1 through 13, and channels 16, 17, and 18 are three times the values of 1 through 13. The Link I T/M ON signal is generated by the vehicle to indicate that the Link I Telemeter is operating. This signal is + 24 volts unregulated voltage, continuous during vehicle acquisition.

Link II is also an FM/FM telemeter similar in all important respects to Link I, and will not be discussed separately.

The Agena analog tape recorder is a two-channel recorder using FM recording techniques in order to record very low-frequency signals. The tape recorder modulator electronics requires the same 0 to 5 volt input signals as the Link I and II VCO's. Because of tape speed and carrier frequency limitations, the maximum square wave frequency that can be recorded is less than 30 pps. The A/P Data Enable signal is generated by the vehicle each time payload functions are to be tape recorded. This signal is a continuous + 24 volts unregulated voltage during the tape recording of A/P data.

The data which must be telemetered can be grouped in the following major categories:

a. Instrument dynamic data
b. Command and equipment status monitors
c. Functional performance data (diagnostic)
d. Temperature data

In general, command and equipment status monitor signals consist of discrete levels (up to a maximum of ten), while functional performance (diagnostic) and temperature data consist of variable analog signals. The characteristics of the major categories are as follows:

NOTE: See Appendix EE for Telemetry Link Channel and Commutator Assignments. Also see Section V.

N-3.1 <u>Instrument Dynamic Data</u>

Lens Angular Position, Center of Format Command data requires continuous channels, and is the result of multiplexing the Lens Assembly Rotation monitor with the Center of Format command. The Lens Assembly Rotation monitor consists of a continuously rotating 5K ohm potentiometer having an electrical angle of not less than 350 degrees. The Center of Format command is an unconditioned, + 24 volts unregulated pulse. The No. 1 and No. 2 CR instruments each generate independent Lens Assembly Rotation signals and Center of Format commands.

Output Idler, 99/101 Clutch Command data requires continuous channels, and is the result of multiplexing the Output Film Idler Monitor with the 99/101 Clutch Command. The Output Film Idler monitor consists of a continuously rotating 5K ohm potentiometer having an electrical angle of not less than 350 degrees. The 99/101 Clutch Command is an unconditioned, + 24 volts unregulated pulse. The No. 1 and No. 2 CR instruments each generate independent output film idler signals and 99/101 Clutch Commands.

Input Idler data requires continuous channels, and is enabled during instrument operation engineering passes with SPC 17 or either DISIC or CR A to B Transfer operations. The Input Idler monitor consists of a continuously rotating 5K ohm potentiometer having an electrical angle of not less than 350 degrees. The No. 1 Input Idler time shares a continuous channel with the Temperature Sensor commutator I ring B. The No. 2 Input Idler time shares a continuous channel with the clock serial time word.

Terrain Idler, Terrain Shutter, and Stellar Idler data require a continuous channel, and are the result of multiplexing the Terrain Idler monitor and the Stellar Idler monitor with the Terrain Shutter command. The Terrain Idler monitor consists of a three-segment commutator rotating 1.5 revolutions for each metered frame. The segments subtend angles of 60, 90, and 120 degrees, respectively, and the gaps subtend angles of 30 degrees. The Stellar Idler monitor rotates 0.5 revolutions per metered frame. The Terrain Shutter command is a + 24 volts unregulated pulse with a minimum duration of 150 milliseconds.

Miscellaneous dynamic data are generated by both the CR instruments and DISIC. These data consist of continuously rotating 5K ohm potentiometer monitors such as Input Metering Rollers, Framing Rollers, and Intermediate Rollers. Unconditioned + 24 volts unregulated pulses such as HO Shutter Command, HO Platen Command, Terrain and Stellar Capping Commands, and Terrain and Stellar Clutch Commands are also available. These miscellaneous dynamic functions are not monitored continuously, but are assigned to commutator points on the 5 RPS Diagnostic Commutator (Ring B Comm. II).

N-3.2 Command and Equipment Status Monitors

Command and equipment status monitors are assigned to the two operational commutator rings. The Link I Operational commutator is ring A of the 0.4 RPS commutator (Comm. I). The redundant operational commutator is ring A of the 5 RPS commutator (Comm. II).

Command status monitors are always conditioned so that the signals are in even 1 volt steps from 1 to 5 VDC for a maximum of five levels on any commutator point. If a command monitor requires more than five levels, two commutator points are used -- each with 1 volt steps to obtain a two-digit quinary count (5 x 5 code).

Status monitors other than command use 1 volt steps at the 0.5, 1.5, 2.5, 3.4, and 4.5 VDC levels to preclude ambiguity with the command status monitors.

Cycle counters do not adhere to the 1 volt step requirement. The two CR cycle counters and the DISIC Terrain cycle counter use

0.5 volt steps from 0.5 to 5 VDC, for a total of ten levels per commutator point, to obtain a four-digit decimal count.

Status data generated by the various subsystems, except for the Command subsystem, are generally unconditioned, and the telemetry subsystem provides the signal conditioning networks. Resistors used to condition discrete level status data have a tolerance of ± 1.0 percent.

N-3.3 Functional Performance Diagnostic Data

Functional performance or diagnostic data are assigned to the 5 RPS commutator II, ring B for transmission over Link II only.

Performance data generated by the various subsystems are generally unconditioned transducer outputs, and the telemetry subsystem provides the signal conditioning or divider networks. Resistors used to condition analog signals have a tolerance of ± 1 percent and a dissipation rating of 1/8 watt or greater. The temperature coefficient of resistance of the analog conditioning resistors is 100 PPM per degree centigrade or less.

N-3.4 Temperature Data

Temperature data are assigned to the 0.4 RPS commutator I ring B for transmission over Link I and for recording on Agena analog tape recorders.

Temperature sensors used in the J-3 system have a nominal resistance of 2000 ohms ± 2 percent at 70°F, and the coefficient of resistance is such that a 200°F change in temperature will result in a 90 ± 2 percent change in resistance.

The temperature sensors have an appreciable self-heating effect when the sensors dissipate more than 20 milliwatts of power. In order to preclude self-heating and the resulting errors in the calibration of the temperature sensors, the power dissipation of the devices are limited. This is accomplished by using a low-voltage

(+ 5 volt) sensor excitation and a high-input impedance differential amplifier to amplify the signal. The differential amplifier has a gain of 11, and is referenced to + 2.5 volts corresponding to 50 percent bandwidth of the telemetry channel.

The temperature sensor divider resistors are selected to result in temperature ranges as follows:

a.	Fairing and DISICONIC	(-30 to 250° orbit (0 to 500° ascent
b.	Skin	-30 to 250°F
c.	DISIC, Slope Programmer, SRV Internal	20 to 120°F
d.	CR Instruments	0 to 100°F
e.	DRCG, PMU	0 to 200°F
f.	Retro	15 to 135°F

The fairing and CONIC require different ranges during ascent and orbit modes. The Orbit Mode Signal, which is generated by the vehicle at the end of powered flight, is used to command the necessary range switching.

N-3.5 Digital Tape Recorder Functions

Digital tape recorders are located in each SRV, with the capability of recording on-orbit data during CR instrument operation. An analog to digital multiplexer and electronic commutator, which are required as part of the tape recorder subsystem, are physically located in the aft telemetry box (details are discussed in Section P, the Digital Instrumentation Subsystem).

N-3.6 Sync Pulse Stretcher

During instrument operation, the DRCG generates Sync pulses which are synchronized with the Parallel Time Interrogates from the CR instrument, and which occur at the time indicated by the Time Word. These Sync pulses are used by the digital tape recorder subsystem to enable interpolation between recorded data and DRCG time. The Sync pulses are each approximately 60 microseconds in duration. The duration of the Sync pulses is increased by pulse stretchers in the Aft T/M J-Box. The No. 1 Sync Pulse is stretched to 350 microseconds and the No. 2 Sync pulse is stretched to 650 microseconds. The outputs of the pulse stretchers are supplied to the tape recorder subsystem.

N-3.7 Serial Time Data

The Serial Time Word is also carried on a Link I continuous channel. Whenever the Link I T/M ON signal is present and the instrument dynamic channels are not enabled, the DRCG is interrogated once every 20 seconds by a relaxation oscillator, and the serial time word is transmitted via channel 18 on Link I. During instrument operation, the DRCG is interrogated by the A to D Multiplexer, and the Serial Time Word is transmitted via Channel 18 Link I and also used for digital tape recording.

N-3.8 Continuous Channel Enable

During telemetry acquisitions it is not desirable to transmit instrument dynamic data except for engineering passes or A to B Transfer. Therefore, switching is arranged so that the Link I T/M ON signal only results in the following telemetry transmission on Link I:

a. Temperature measurements Comm. I, Ring B
b. Operational measurements Comm. I, Ring A
c. Serial Time Word

If SPC 17 is received and the instruments are operating and Link I is ON, then the following data will be transmitted via Link I:

a. Terrain Idler, Terrain Shutter, and Stellar Idler
b. CR 1 Output Idler, 99/101 Clutch Command
c. CR 1 Lens Angular Position, Center of Format Command
d. CR 2 Output Idler, 99/101 Clutch Command

e. CR 2 Lens Angular Position, Center of Format Command

f. CR 1 Input Idler

g. CR 2 Input Idler

h. Operational Measurements Comm. I, Ring A

During A to B Transfer, either early or normal, the command subsystem generates a Dynamic T/M Enable signal. This signal is generated from KIK-ZORRO 38, KIK-ZORRO 39, or ARM, and lasts approximately 35 seconds in order to observe instrument dynamics during the transfer process. The data transmitted via Link I is the same as shown above for the SPC 17 continuous-channel enable.

Two Link I continuous channels are time-shared, and the data switching is accomplished by the continuous channel enable, either SPC 17 or A to B Transfer. Temperature Measurement Commutator I, ring B, shares a channel with CR 1 Input Idler. Serial Time Word shares a channel with CR 2 Input Idler.

N-1.9 Agena Analog Tape Recorder.

The Agena provides an A/P Data Enable signal to the payload whenever payload data are to be recorded on the Agena tape recorder. During A to B Transfer with the ARM command, the primary instrument dynamic monitors are recorded on both tracks of the Agena tape recorder. Tape recording is required because A to B transfer with the Arm signal is generally accomplished where telemetry readout with Link I and Link II is not possible. On orbit the temperature sensor data on the 0.4 pps commutator is also recorded on Track 1 of the Agena tape recorder. The purpose of this is to obtain temperature data of the system over unacquired area.

[redacted]

N-3.10 Accelerometer Measurement

For CR-1 through CR-4, accelerometer instrumentation has been provided primarily to measure ascent acceleration levels on the structure and the CR instrument. Data are read out on eight channels of the Agena Link IV T/M System. The control circuit for this instrumentation is performed in the Agena.

N-4.0 REFERENCE DOCUMENTS

[redacted]

SECTION O

DIGITAL INSTRUMENTATION SUBSYSTEM

O-1.0 PURPOSE

The purpose of the digital instrumentation subsystem is to provide a means for recording payload system data in digital form suitable for rapid and automatic data processing.

O-2.0 CHARACTERISTICS

O-2.1 Data Recording

The digital instrumentation subsystem will be used on at least the first four J-3 Systems for monitoring the following data:

a. The serial time word from the DRCG clock will be monitored during all instrument operations. This clock information will be used to time correlate all recorded data.

b. The times at which the six roll, pitch, and yaw thrust monitor pulses occur. These represent the intervals during which the Agena guidance subsystem gas valves are correcting the attitude of the satellite.

c. Parallel time word sync pulses corresponding to the start of both instrument #1 and instrument #2 parallel time word readouts.

d. 120 payload system status function monitors.

O-2.2 Input Data Capability

The digital instrumentation subsystem provides a broad and flexible data interface which is suitable for accumulating data at various sampling rates. The following is a brief introduction to the principle data interfaces associated with the digital instrumentation subsystem:

a. Digital data can be recorded on two channels at the tape recorder data input interface. The maximum digital data rate on each channel is 10,000 bits per second for nonreturn to zero (NRZ) data.

b. Sixteen analog data channels are available at the Pulse Code Modulation (PCM) unit data input interface. Each of these sixteen analog input channels is sampled at the rate of 55 times per second.

c. 120 analog input channels are available at the electronic commutator data input interface. Each of the 120 analog input channels is sampled at a rate of approximately once per second.

O-2.3 <u>Data Processing of Recorded Data</u>

The digital form of the data recorded by the tape recorders is highly suitable for automatic data processing techniques. An Aerospace Ground Equipment (AGE) data processing system will be used to time-correlate and to IBM-format the data on magnetic tapes which are compatible with IBM 2400-type tape recorders. This AGE has been given the acronym of ADAPS, which means Automated Digital and Analog Processing System.

Computer software programs will be used to organize and to accomplish further processing of the data as required by the customer, or for test or postflight data analysis purposes.

O-2.4 <u>Location</u>

The first four J-3 systems have a tape recorder in the A SRV and another in the B SRV. A mounting tray is provided in the SRV on the -Y axis at a station line approximately equal to the axis of the main spools.

O-2.5 Parameters

The physical and operational characteristics of the Digital Instrumentation Subsystem are summarized in Table O-1.

Table O-1 Characteristics of Principle Assemblies Used In The Digital Instrumentation Subsystem

CHARACTERISTIC OF UNIT	DIGITAL TAPE RECORDER UNIT	ELECTRONIC COMMUTATOR UNIT	PULSE CODE MODULATOR UNIT
WEIGHT	LESS THAN 5.5 LBS.	LESS THAN 40 OUNCES	LESS THAN 50 OUNCES.
SIZE	6 X 5 X 5 IN.	4.56 X3.25 X2.61 IN.	4.56 X2.75 X3.25 IN.
DESIGN CONTROL SPECIFICATION NUMBER	T3-6-028C	T3-6-052B	T3-6-051C
ENVELOPE CONTROL DRAWING	T33-5114E	T33-5116B	T33-5115B
OPERATING POWER REQUIRED	LESS THAN 6 WATTS	LESS THAN 5.0 WATTS	LESS THAN 5.5 WATTS
NUMBER OF INPUT DATA CHANNELS	TWO (2)	120	16
TYPE OF INPUT DATA CHANNELS	DIGITAL NRZ DATA	0 TO 5 VOLT ANALOG SIGNALS	0 TO 5 VOLT ANALOG SIGNALS
NUMBER OF OUTPUT DATA CHANNELS	TWO (2)	TWO (2)	ONE (1)
TYPE OF OUTPUT DATA CHANNELS	DIGITAL NRZ DATA	COMMUTATED 0 TO 5 VOLT ANALOG SIGNALS	PULSE CODE MODULATED (PCM) DIGITAL DATA IN NRZ FORMAT
INPUT DATA CHANNEL IMPEDANCE	GREATER THAN 100K	GREATER THAN FOUR MEGOHMS	GREATER THAN FOUR MEGOHMS
OUTPUT DATA CHANNEL IMPEDANCE	LESS THAN 1000 OHMS	LESS THAN 100 OHMS	LESS THAN 100 OHMS

O-3.0 DESCRIPTION

The purpose of this section is to describe the digital instrumentation subsystem and principle components within this subsystem.

O-3.1 Digital Instrumentation Subsystem Data Flow

The block diagram shown in Figure O-1 shows the data flow paths within the digital instrumentation subsystem. The A tape recorder unit records the two digital data channels at all times during which film is being supplied to the A SRV unit. After A to B switchover, the B tape recorder unit records the two digital data channels at all times during which film is being supplied to the B SRV unit. The Digital Data (1) channel contains [illegible]0,000 bit-per-second, digitally multiplexed data from the PCM (pulse code modulation) unit.

The Digital Data (2) channel contains the diode-coupled output of two pulse-type inputs, each of which has a distinct pulse width. The pulse width corresponding to the No. 1 sync output is 350 microseconds long, and the pulse width corresponding to the No. 2 sync output is 650 microseconds long. The No. 1 and No. 2 sync output pulse [illegible] independently [illegible] at the same time as the corresponding part [illegible] time word [illegible]. As each pulse [illegible] the clock, the pulse width is too short to be handled directly by the tape recorder. The one-shot pulse networks [illegible] the pulses to a length that can be readily handled by the tape recorder, and they generate identifiable pulse widths which make it possible to distinguish between the sync No. 1 and sync No. 2 signals from the clock when recording the Digital Data (2) information.

The PCM unit interrogates the clock at a [illegible] with respect to all PCM data words, and [illegible] frequency of once every 0.[illegible] seconds. [illegible] which includes the [illegible] pulse and the [illegible] bits, lasts for approximately [illegible] and [illegible] millisecond of the time [illegible]. The insertion of the [illegible]

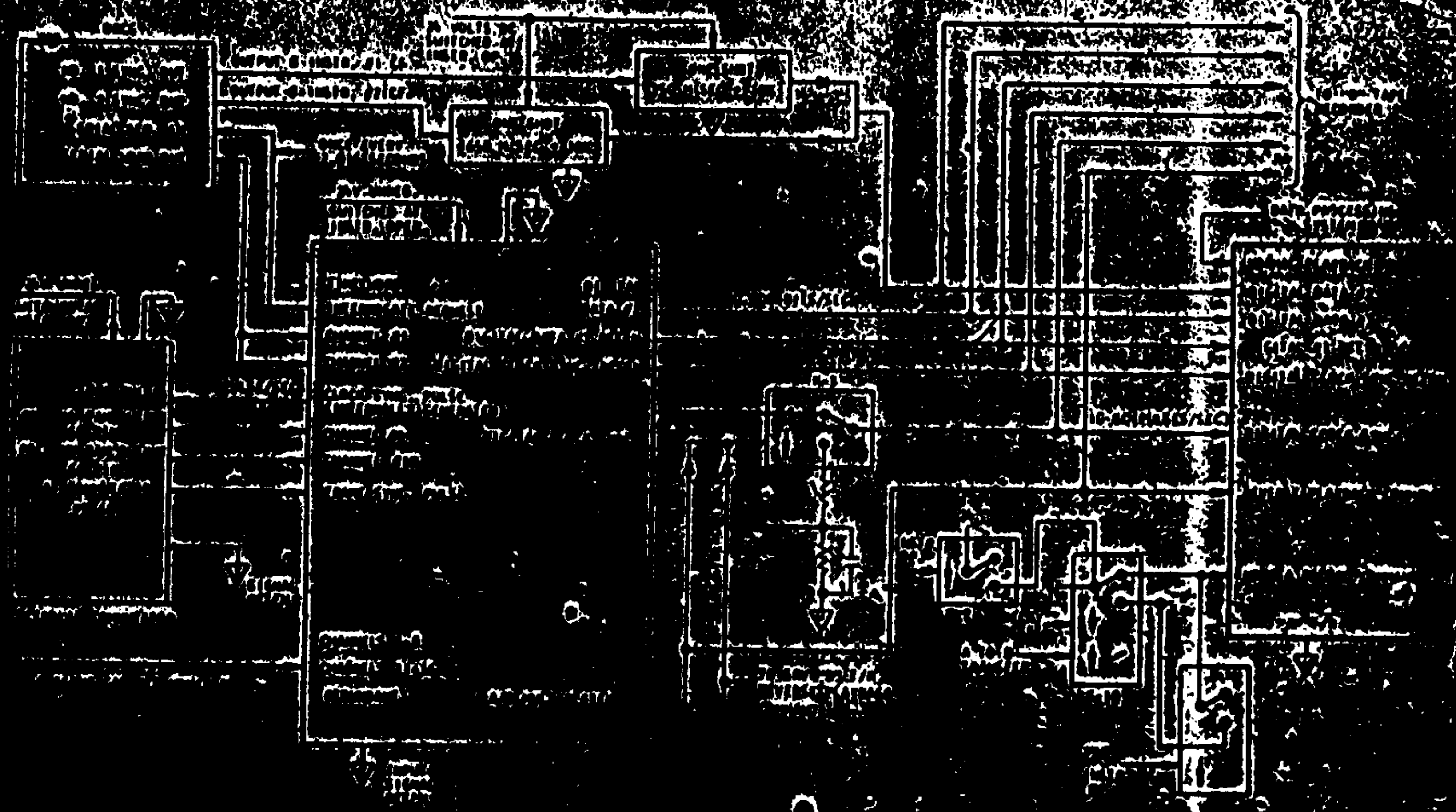


Figure [illegible]-1 Tape Recorder Subsystem Block Diagram

[redacted]

at discrete points in time, in conjunction with the digital nature of the subsystem, provides the basis for time-correlation of all recorded data. The time-correlation, IBM formatting, and data indexing of both Digital Data #1 and Digital Data #2 are accomplished by means of an Automated Digital and Analog Processing System (ADAPS), which is the aerospace ground equipment associated with the tape recording subsystem. This AGE unit is defined in the ADAPS design control specificatio[redacted].

The PCM unit has 16 analog input channels. Each of these 16 channels is sampled and converted into a digital word at the rate of 55.5 times per second. Twelve of these 16 channels contain six gas jet monitors which are each supplied as inputs to two of the PCM channels. The gas jet monitors contain pulses which are each approximately 21 milliseconds long. The frequency of these pulses is determined by the times during which the roll, pitch, and yaw thrusters in the Agena are emitting gas. During stable instrument operations, the pulses will occur about once every 10 seconds, but they will occur at a higher rate during instrument start-up operations. See section B.

The serial time word is supplied to channels 1 and 2 of the PCM unit, upon request by a time word request pulse generated by the PCM unit. Two poles of electronically commutated data are being supplied to the remaining two PCM unit input channels.

Each of the two electronic commutator output channels consists of a commutated wave train containing 60 distinct analog inputs, and the analog output data rate to the PCM unit is 55.5 samples per second. The electronically commutated data are synchronized with the PCM unit, as the electronic commutator clock sync signal is supplied by the PCM unit and the electronic commutator supplies a commutator frame sync pulse to the PCM unit. The commutator frame sync pulse marks the sampling of channel 60 on the commutator, and the PCM unit frame sync word gets complemented every 60 PCM data frames by means of the commutator frame sync pulse. Therefore, the frame at which the PCM unit samples channel 60 of the electronic commutator outputs is encoded in the Digital Data #1 output from the PCM unit.

O-3.2 Digital Instrumentation Subsystem Power and Command On Orbit Interface

The block diagram in Figure O-1 shows the power, command, and checkout interface for the Digital Instrumentation Subsystem. During orbital operations, the subsystem is functioning during the Instrument Operate mode. In order to operate the subsystem, unregulated power is supplied to the PCM unit, to the electronic commutator, to the one-shot networks, and to one of the two tape recorders.

The A to B switchover command is used to actuate relay K10, and this switches the record power and command line (which is routed to the A recorder during initial phases of a mission) over to the B recorder during the last half of a mission.

O-3.3 Digital Instrumentation Subsystem Ground Checkout Interface

During system ground test operations, the subsystem can be operated by means of the Instrument Operate Command. In addition to the Normal Operate mode, A/P Command #3 (Pad Checkout Command) can be used to operate the subsystem, and this command enables both recorders to operate simultaneously. The T/M and Beacon On commands associated with each tape recorder provide two separate and independent playback commands for checkout purposes. During playback, A/P umbilical monitor #6 verifies tape recorder operation by means of a DC level obtained from an RC (resistor-capacitor) network. During ground testing, the two PAM (pulse-amplitude modulation) outputs from the electronic commutator are monitored at the system test console. The Digital Data #1 output and the digital clock sync output can also be monitored at the system test console during ground testing.

O-3.4 Electronic Commutator

The characteristics applicable to the electronic commutator unit are shown in Figure O-2. The input impedance for each of the 120 electronic input channels is greater than four (4) megohms. There are two commutated output signals from the electronic commutator unit, and there are 60 input channels associated with each of the two output channels. The output impedance for each of the two data output channels is less than 1000 ohms.

The electronic commutated unit is functionally equivalent to the two ~~king~~ mechanical commutators which are also being used on the J-3 Program. The electronic commutator unit has no moving parts, and the sampling rate is controlled by the clock pulses from the PCM unit. The electronic commutator unit has the capability of being sampled at rates up to many thousands of samples per second, down to as slow a rate as desired. The unit can operate from an external clock source or by means of the internal clock source contained within the unit.

O-3.5 Pulse Code Modulation (PCM) Unit

The characteristics applicable to the PCM unit are shown in Figure O-3. The input impedance for each of the sixteen PCM unit input channels is greater than four megohms. Each of the sixteen input channels accepts analog data in the voltage range from 0 to 5 volts, and the unit multiplexes and accomplishes analog-to-digital conversion on the input data. The output data from the PCM

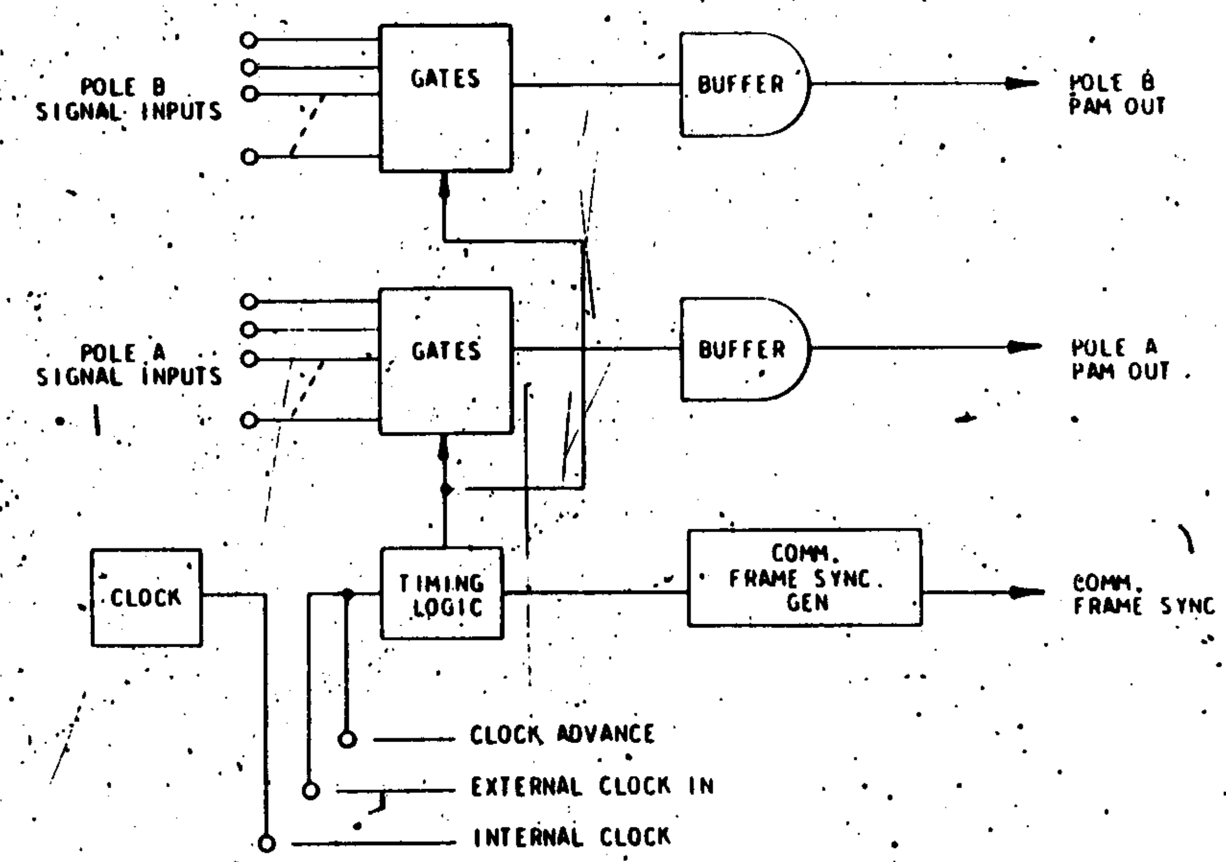


Figure O-2 Electronic Commutator Block Diagram

[redacted]

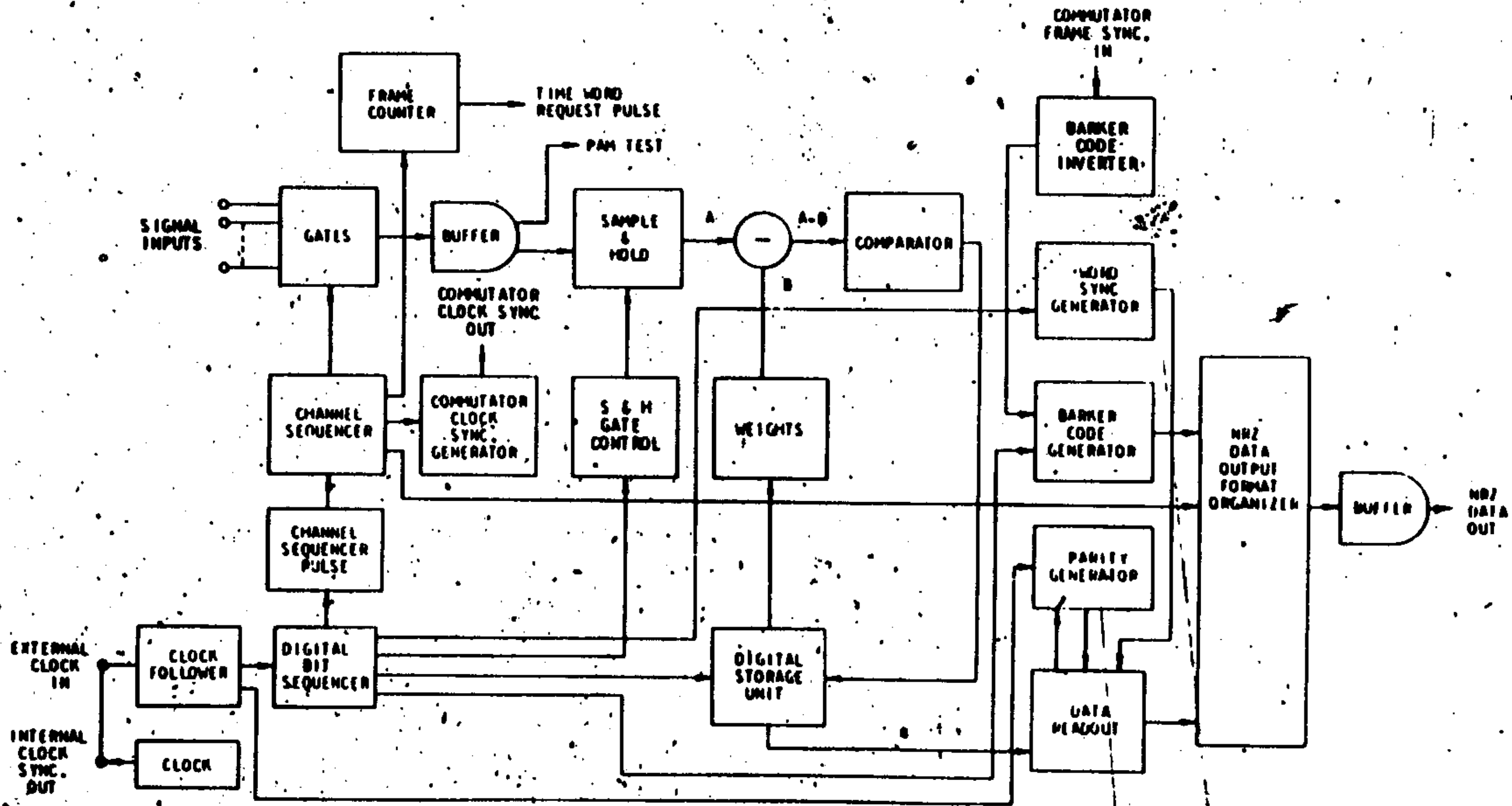


Figure O-3 Analog to Digital Block Diagram unit consist of a single channel of serial digital Pulse Code Modulated data.

Each serial digital data frame contains sixteen 10-bit data words and two 10-bit Barker Code words. The Barker code words are used for PCM unit frame sync purposes, and these words consist of the following bit pattern.

a. First Barker Code Word. 1110001001

b. Second Barker Code Word: 0001110110

It should be noted that the second Barker code word is the complement of the first Barker code word. This frame sync pattern permits the ADAPS system to properly process and correlate the PCM output data. In addition to the frame sync pattern, each of the 10-bit words begins with a digital "one," which is used for word sync purposes, and the tenth bit is an odd parity bit. The tenth bit will assume either a digital one or a digital zero within any given 10-bit word, as required to achieve odd parity for the 10-bit word.

When the electronic commutator reaches point number 60, it sends a No. 18 commutator frame sync pulse to the PCM unit. The PCM unit reverses the order of the Barker Code Words for one frame of data every sixty PCM unit data frames, during the frame in which the PCM unit received a commutator frame sync pulse.

The PCM unit also supplies a Time Word Request Output Signal which is used to provide a serial time word interrogate pulse to the DRCG (clock) unit. The interrogate pulse always occurs coincident with the interval during which data are being sampled on Channel 1 of the PCM unit. The method which is used to acquire serial time words provides precise time correlation of all data supplied to the PCM unit.

The 10,000 bit-per-second, serial digital output signal from the PCM unit is supplied to one of the two input channels on the

Digital Tape Recorder. The PCM unit also supplies a 10 KHz square wave to the Digital Tape Recorder for digital sync purposes. The signal output impedance of the PCM unit is less than 100 ohms when supplying load currents of less than 250 microamps.

Twelve of the PCM unit input channels are used to monitor Agena gas thruster firings. The time occurrence of the gas firings can be used to correlate vehicle rate changes. Each roll, pitch, or yaw gas firing should result in a fairly repeatable change in rate. This change in rate information can therefore be used to improve on the estimated attitude for time intervals between DISIC frames.

The PCM unit provides an extensive data gathering and format capability to the J-3 systems on which it is installed. Fifteen of the sixteen PCM unit input channels could be used to accept commutated input signals. This would mean that 200 analog points could be sampled within the J-3 system, and all of these data could then be provided on one signal line along with clock sync pulses and signal returns to either a transmitter, a digital tape recorder, or the ADAPS system.

O-3.6 Digital Tape Recorder

The characteristics applicable to the Digital Tape Recorder unit are shown in Figure O-4. The input impedance for each of the two input channels on the tape recorder unit is greater than 100 K. The unit has both a record and playback capability. The playback capability is not presently being used to play back data while the unit is physically installed in the J-3 system. The playing back of data from the recorder is accomplished while the tape recorder is located in a re-entry bucket which has been removed from one of the J-3 systems. The tape recorder is connected to the ADAPS system during the playing back of data, and the data are processed and formatted onto IBM-compatible

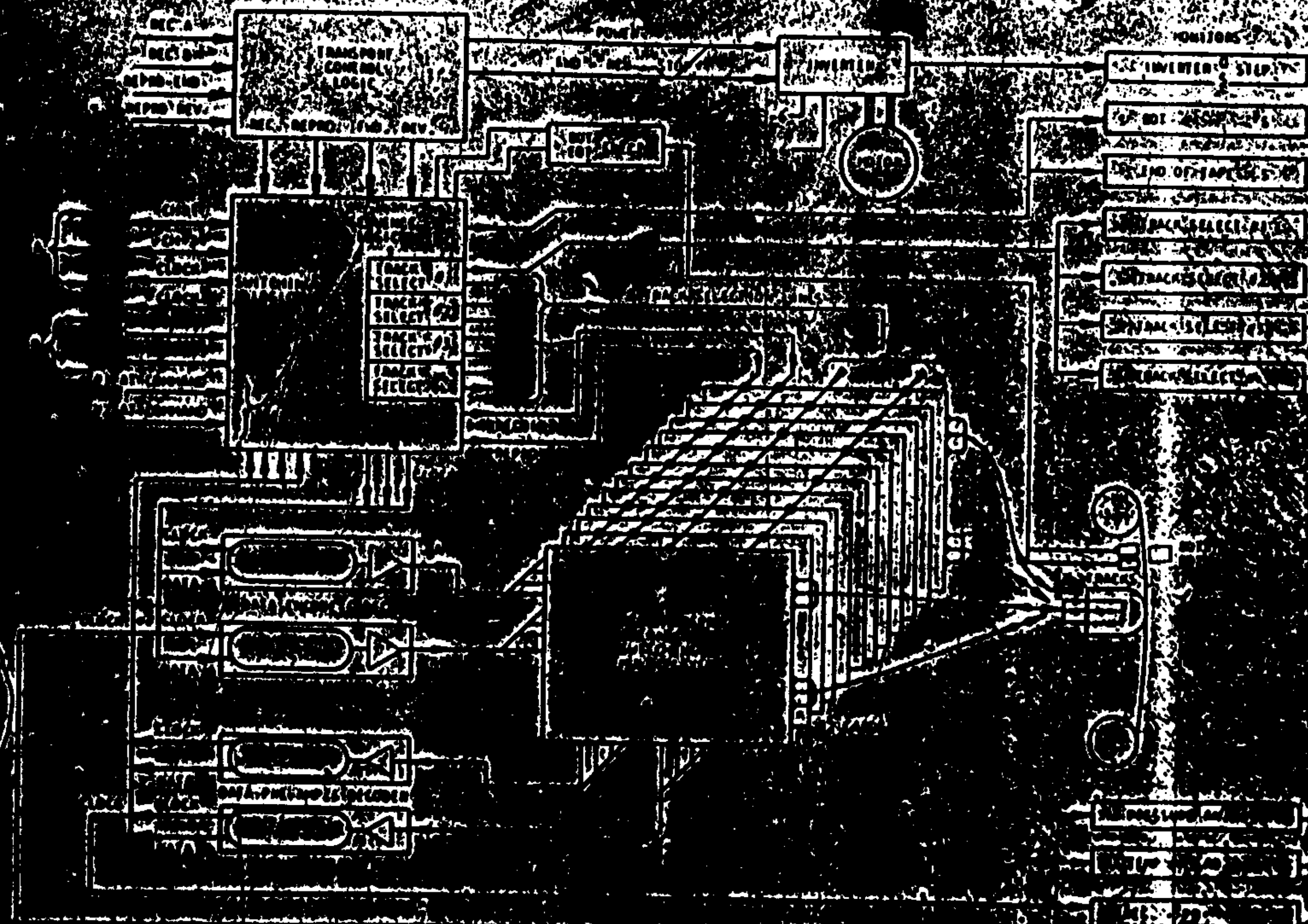


Figure 0-4 Digital Tape Recorder Block Diagram

[redacted]

tape during the time in which it is being played back from the Digital Tape Recorder.

The data supplied to one of the two tape recorder input channels, which has been designated as the Digital Data #1 channel, consist of the PCM unit output data. The data which are contained on the other tape recorder channel, which is designated as the Digital Data #2 channel, records the diode-coupled output from two pulse stretcher circuits described in paragraph O-3.1, above.

Each tape recorder has a capability of storing up to 288,000,000 bits of digital data. Each unit can record data for a total time period of at least four hours. Data are played back from the unit at the same rate at which they are recorded, and the record/playback ratio is therefore 1 to 1.

O-4.0 AUTOMATED DIGITAL AND ANALOG PROCESSING SYSTEM (ADAPS) DESCRIPTION

The digital data recorded on the digital tape recorder are processed by the Automated Digital and Analog Processing System. The ADAPS hardware generates processed output data on IBM compatible magnetic tapes.

O-4.1 Digital Word Structure

The processed output data which are contained on the IBM compatible tapes are in the form of 48-bit digital words. Each of the 48-bit digital words contains the the following information.

a. Twenty-Nine Bits of Time Information

The 29 bits of time information time correlate the data contained in each 48-bit word to an accuracy of one millisecond. The indicated time represents the actual time at which the data contained in each 48-bit word were acquired by the PCM unit. The time associated with each voltage measured by the Digital Instrumentation Subsystem provides the time function for each variable

The time associated with each event measured by the Digital Instrumentation Subsystem is a precise measurement of the time of occurrence of each event which is being monitored.

b. Four Bits of Channel Number Information

Four of the bits contained in each 48-bit word are used to encode the PCM unit channel number which is associated with the voltage level information. The binary number associated with the channel number identifies the channel number as one of the 16 channels associated with the PCM unit.

c. One Bit Encoded Event Data

One bit is used to indicate the presence or absence of an event which is defined as a voltage level less than 2 volts. A voltage level greater than 2 volts is indicative of no event. A digital "1" is used to indicate the occurrence of an event, and a digital "0" is used to indicate [illegible].

d. Eight Bits of Voltage Level Data

Eight bits are used to encode the voltage level data. The binary number indicating voltage level multiplied by [illegible] millivolts gives the actual voltage level which was interpreted by the Digital Instrumentation Subsystem. [illegible] voltage level measurements [illegible] millivolts [illegible] of the type [illegible] PCM unit. [illegible] voltage which will be [illegible] millivolts, and the [illegible] voltage which will be [illegible] millivolts.

e. [illegible] Bits of [illegible] Information

[illegible] bits are used to indicate the [illegible] tape number [illegible] in each 48-bit word. [illegible] beginning with [illegible]

O-1.2 Computer Print-Out of Data

Data handling of the 48-bit words from the ADAPS output tape is accomplished by the IBM 360 computer. Programs have been developed to sort and use the data as necessary for present system analysis requirements. There are presently three programs used for test and flight data analysis.

a. The most useful program, called COMM for command dump, provides an overall look at a given test or flight for general instrument and other subsystem performance. The program sorts the data into operations of the camera system.

The command settings, cycle counter readings, and many other pertinent status points are printed out at the start and end of each operate. This program prints out all cycle periods as determined by the center-of-format pulses.

b. Another program, called COMANL for command list, reads, sorts, and prints out any set of 20 commutator pin data over any preselected time interval. This program provides print-outs to diagnose proper or discrepant system operations.

c. The third program, called PCMCHK for PCM check, allows the printout of all data contained on the ADAPS tape. This program is used to obtain specific bits of all data to analyze suspected discrepant operation of the ADAPS or tape recorder subsystem. This program is used sparingly, as one minute of data could fill as much as 180 pages of computer paper.

These three programs comprise all the presently programs available for test and flight analysis.

O-4.3 Additional Capabilities of the ADAPS Hardware

In addition to the above characteristics of the ADAPS hardware, the ADAPS system can also be operated in a Data Compression mode. When the system is operated in the Data Compression mode, the amount of data which is formatted on the IBM compatible magnetic tapes which are generated by the ADAPS hardware is greatly reduced. The data compression is accomplished in the following manner:

a. Each new voltage level value of any of the variables is compared with the previous voltage level value of the same variable which was formatted on the IBM compatible output tape.

b. Any time the voltage levels are the same for any variable, no new data is formatted for that variable. Any time the voltage level values are not the same, new data are formatted.

c. The compression is accomplished for up to 900 variables, if the ADAPS system is processing PCM input data which uses commutated data on all fifteen input channels to the PCM unit. In the present J-3 use of the Digital Instrumentation Subsystem, electronically commutated data are supplied to only two of the PCM unit input channels. The data compression characteristics will greatly reduce the length of magnetic tape which will be generated by the ADAPS hardware during any given application. It should be noted that the data compression characteristic can be used, or not be used, as desired by the ADAPS System Test Controller.

O-4.4 Real Time Analog Output Capability

The ADAPS hardware has two principal types of Real Time Analog Output capability, which are described as follows:

a. While the ADAPS hardware is processing data, the voltage associated with each of the sixteen PCM unit data channels is available as an analog output voltage which is suitable for oscillographic-type recordings.

b. Any one of the up to 900 variables which are possible when using the ADAPS hardware can be selected for display in the form of an analog output voltage which is suitable for oscillographic-type recording.

SECTION P

PYRO SUBSYSTEM

P-1.0 PURPOSE

The purpose of the pyro-subsystem is to provide a controllable, compact, and efficient one-shot source of energy to operate or propel J-3 devices. Pyro initiation is controlled by electrical or mechanical means.

P-2.0 CHARACTERISTICS

The characteristics of two of the most extensively used J-3 pyro devices are summarized as follows:

P-2.1 M-11 Pressure Squib of (McCormick-Selph, M-11).

P-2.1.1 Explosive Content

Bridgewire primer: Zirconium-Barium chromate

Main powder charge: 65 milligrams Hercules "Bullseye" powder

P-2.1.2 Performance

Peak pressure: 3700 ($\pm$700) psi in 2-cc bomb

Time to peak pressure: 15 milliseconds (max) at 5 amps
75 milliseconds (max) at 2.0 amps

P-2.1.3 Electrical

Schematic: See Figure P-1

Resistances: Bridge circuits: 0.45 to 0.85 ohms
Any pin to case: 200,000 ohms at 50 VDC

Maximum test current: 10 milliamps per bridge

Maximum safe current: 0.5 amps per bridge for 5 minutes

Minimum sure-fire current: 2.0 amps per bridge

P-2.1.4 Storage Shelf Life: 3 years (maximum) at 120°F (max)

P-2.1.5 Surveillance Test Frequency: Every 9 months

P-2.1.6 Application:

Used as a pressure cartridge to function a variety of valves, pin pullers, and pin pushers.

P-2.2 <u>Dimple Motor Squib</u> (Hercules Powder Co., P/N DM2547)

P-2.2.1 Explosive Content

Bridgewire primer: Lead styphnate

Main powder charge: LMNR black powder

P-2.2.2 Performance

When functioned in a test chamber at a temperature of $70 \pm 20^{\circ}F$, the dimple center shall move a minimum of 0.10 inch against an 8-pound spring load and within 10 milliseconds.

P-2.2.3 Electrical

Schematic: See Figure P-2

Resistances: Bridge circuits: 0.1 to 0.4 ohms

Any pin to case: 50 megohms (min) at 50 VDC

Maximum test current: 10 milliamps

Maximum safe current: 0.5 amp for 30 seconds

Minimum sure-fire current: 2.0 amps

P-2.2.4 Storage Shelf Life: 3 years (maximum) at 120°F (max)

P-2.2.5 Surveillance Test Frequency: Every 9 months

P-2.2.6 Application

Provides an expanding gas force to actuate switches, latches, releases, and similar devices requiring a short linear motion for operation.

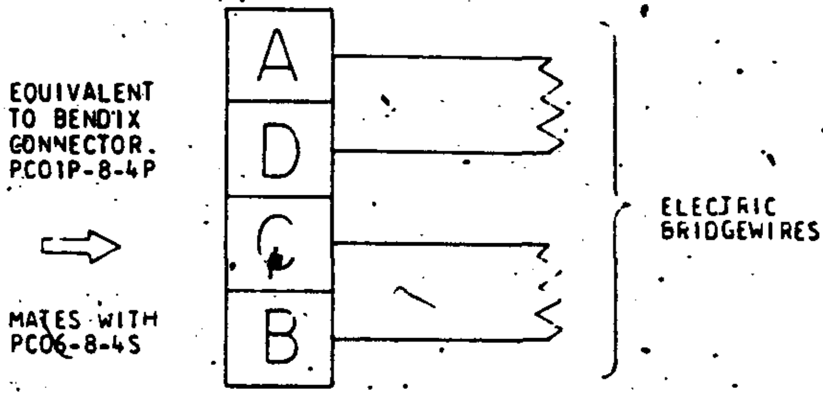


Figure P-1 Electrical Schematic of M-11 Pressure Squib

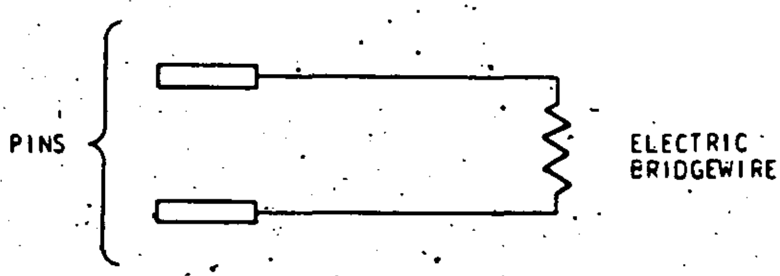


Figure P-2 Electrical Schematic of Dimple Motor Squib

P-3.0 DESCRIPTION

P-3.1 Pyro Subsystem

P-3.1.1 Description of Uses

Pyros are used (with appropriate hardware) to open or close valves, to latch or unlatch pin pullers, to operate various types of ejector devices, to activate batteries (by pumping electrolyte from an internal reservoir into individual battery cells), to trigger sear latches to release spring-operated devices, to ignite electrochemical "matches" (to activate thermal batteries), and as ignition devices for the solid-propellant fuel of the SRV retrorocket. The retrorocket is in itself a large pyrotechnic propulsion device. Pin pullers release the SRV, the fairing, and the main door. Ejectors eject smaller doors and operate other ejector mechanisms such as the aft parachute cover of the SRV. Dimple motors trip sear latches to release spring-operated devices (cut and splice; main and DISIC door seals, and water seals). Squib-operated spin-off devices disconnect the SRV and fairing disconnect plugs (these are another form of ejector device). Various SRV pyro functions such as battery activation, spin, despin, retro, thrust cone release, and parachute deployment are discussed in more detail in the SRV section.

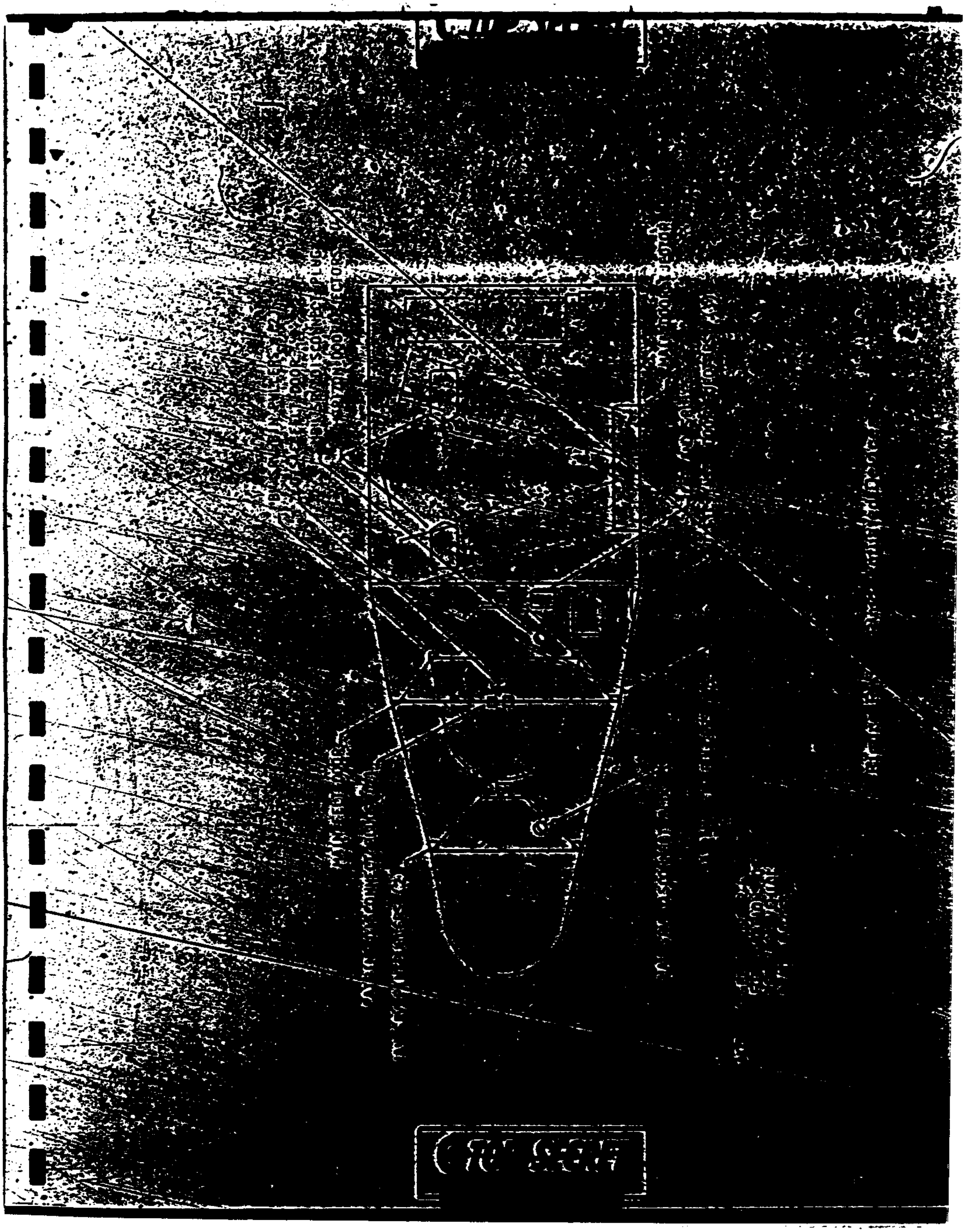
P-3.1.2 Location of Devices

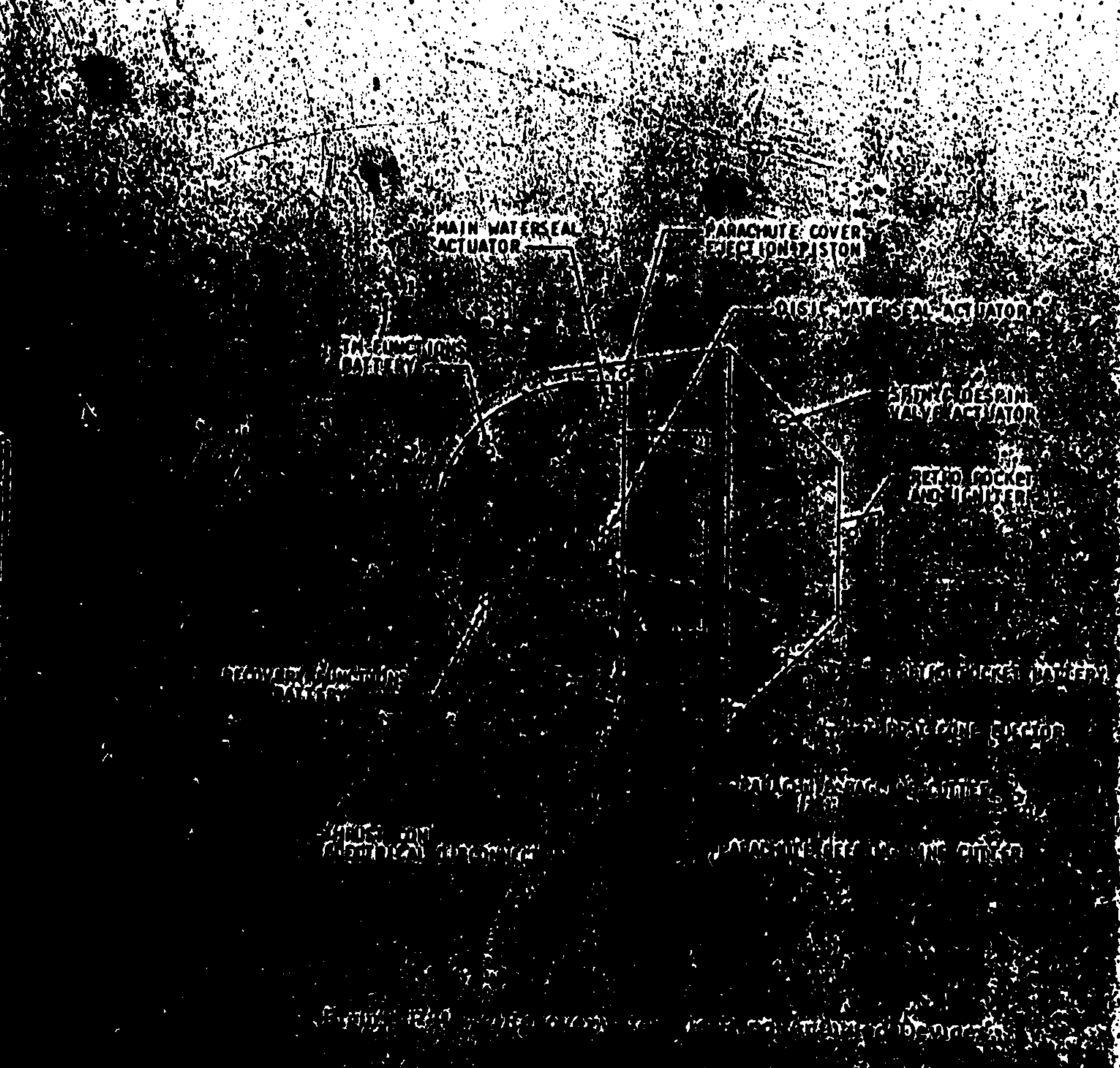
Figures P-3 and P-4 show the location of all pyro-actuated devices in the J-3 system. Figure E-2 shows the location of all allied circuit controls. The pyro J-box, the transfer box, and the forward power J-box are located in the DISICONIC, as shown in Figures E-2 and M-4. T/M boxes that report pyro events are also shown in Figure E-2.

P-3.1.3 Pyro Circuits

P-3.1.3.1 Redundancy

Redundancy is used wherever possible to assure that no




MAIN WATERSEAL ACTUATOR
PARACHUTE COVER EJECTION PISTON
DISIC WATERSEAL ACTUATOR
RETRO ROCKET AND IGNITER

single pyrotechnic circuit failure [illegible]
In general, two completely independent [illegible]
every pyro event requirement [illegible]
power lines, relay coils, relay contacts [illegible]
pyro initiator, bridgewire, primer [illegible]
will not have [illegible]

P-2 [illegible] Power Distribution

[illegible] tribute power to the pyro [illegible]
power [illegible]
with return [illegible]
equal number [illegible]
the loads [illegible]
connected [illegible]
to design [illegible]
of [illegible]
the ignition circuits [illegible]
busses [illegible]
Y connection [illegible]
occur in one of the ignition circuits [illegible]
inherent [illegible]
the jumper [illegible]

The pyro [illegible]
surge to 60 amperes [illegible]
damage to the [illegible]
system. This [illegible]
cation of [illegible] pyro [illegible]
one time delay module [illegible]
ignition circuit [illegible]
short circuit [illegible]

the Y connection [illegible] circuits to remain active.

P-3.1.3.3 Peak Current Load

Peak current surge supplied for [illegible] pyro events is limited by the [illegible] by wiring and connectors [illegible] detailed analysis is [illegible] characteristics. However, [illegible] assuming that the pyro [illegible] like 2 VDC with [illegible]

P-3.1.3.4 Gradual [illegible] Current [illegible]

Wiring for [illegible] provide [illegible] mode [illegible] [illegible] gauge [illegible] current.

P-3.1.3.5 Relay [illegible]

Relays [illegible] apply high current [illegible] loads. (This [illegible]) tions.) Reliability requirements for [illegible] function [illegible] can be exceeded [illegible] Even the [illegible] relays [illegible]

P-3.1.3.6 Circuit Protection [illegible]

[illegible] protect [illegible] power distribution system by [illegible] in magnitude and time. [illegible]

series with [illegible]

P-3.1.5.3.7 Shielding and Isolation

Wiring harnesses and connectors [illegible] wherever practical from other circuits to minimize [illegible] and trouble with [illegible] failure. Twisted [illegible] grounds [illegible] connector pins.

P-3.1.5.3.8 Electric Ignition

[illegible] mize problems of electromagnetic compatibility (EMC) [illegible] peak currents [illegible] other circuits. [illegible] to keep [illegible] physically separated from other [illegible] Further isolation [illegible] pyro ignition circuits.

P-3.1.5.3.9 Current-test connections

Test points [illegible] verification of pyro circuit integrity. [illegible] must be significantly smaller than the [illegible] minimize hazard to the pyro circuit. [illegible] accommodated by [illegible]

P-3.2 Pyro Devices

P-3.2.1 Standardization [illegible]

Pyrotechnic devices [illegible] cost of handling, procurement, [illegible] changeability [illegible] the M-11 [illegible] reliability. [illegible] ejector assemblies [illegible] operated pressure devices.

P-3.2.2 Principle of Pyro Operation [illegible]

Pyrotechnic [illegible] a power charge [illegible] are used to actuate [illegible] devices. The [illegible] fully contained [illegible] the squib [illegible] an electrical [illegible]

P-3.2.3 Self-Contained [illegible]

[illegible] devices [illegible] be self-[illegible] actuating mechanical [illegible] pressurized [illegible] produced by the combustion [illegible] the squib [illegible] prevent damage to film [illegible] equipment [illegible] which expand [illegible] (usually to [illegible]) contain the products of the pyrotechnic [illegible] within the [illegible] squib [illegible]

P-3.2.3.1 [illegible]

The squib [illegible] two electrical [illegible] hermetically [illegible] plastic cap. [illegible]

TOP SECRET

[illegible]

PCO [illegible] length is 0.90 inch [illegible] teristics of the squib [illegible]

P-3.2.3.2 Dimple Motor

The squib [illegible] a single electric bridge [illegible] cally sealed by [illegible] end of the unit [illegible] upon activation [illegible] leads [illegible] of the squib [illegible]

P-3.2.3.3 Retro Rocket

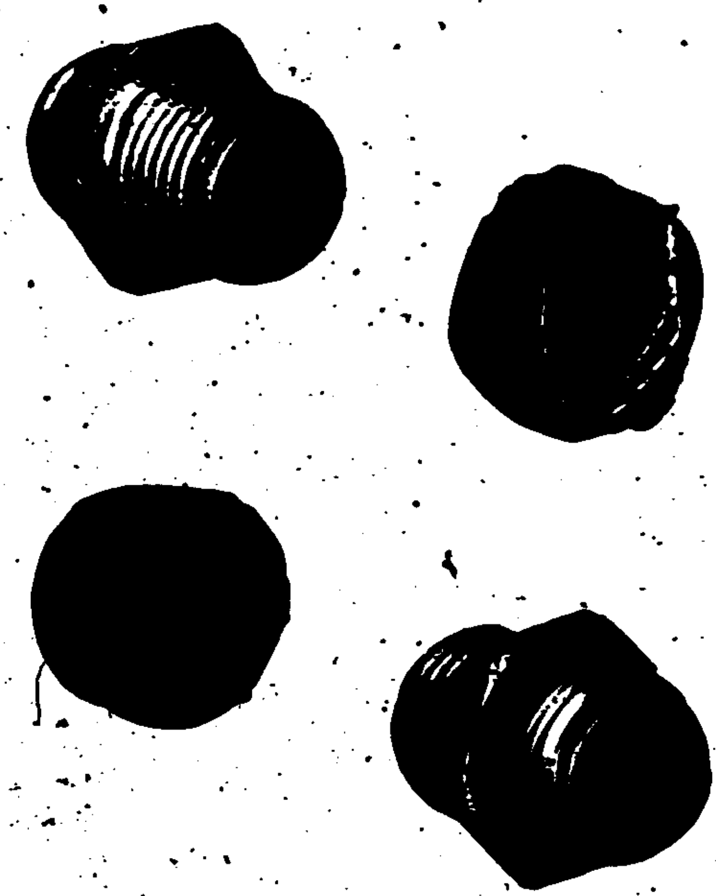
[illegible] directly [illegible] by [illegible] intense [illegible]

Retro [illegible] from the [illegible] thermally [illegible] in the retro rocket igniter [illegible] to ignite the solid propellant [illegible]

P-3.2.4 Mechanical [illegible]

[illegible] used in the [illegible] Section C [illegible] weighs [illegible] pounds [illegible] the pyro [illegible]

[illegible]



[redacted]

Figure P-5 M-11 Pressure Squib

P-4.0 COMMANDS

P-4.1 Pyro Functions and Events

Timed signals from the Agena actuate relays for control and command of pyro functions or events. The closing of a relay to switch the pyrotechnic ignition circuit to the source of power is also a pyro command. (Pyro power, through a fusistor and relay contacts to a bridgewire, completes the pyro command.) A pyro event is the accomplishment of a mission function by a pyro-actuated device. The commands required to operate the J-3 pyro devices are discussed in Section L. The T/M indications by which the pyro events are monitored are discussed in Section N.

P-4.2 Operation of Pyro Commands

A detailed description of the operation of the pyro commands and their operation in the J-3 system is presented in Section L and Section R.

P-5.0 MONITORING

Verification of ground pyro commands is accomplished by T/M monitoring. Pyro commands usually operate specific relays provided for a particular command, but in some instances a command may actuate several events simultaneously with the closure of a single relay. The T/M monitor circuit is completed through the normally open relay contacts to monitor relay operation. Some relays are actuated by a pyro-activated event to provide more positive monitoring of the occurrence of the event.

P-6.0 SAFETY

Safety requirements in handling and testing pyrotechnic devices include protection of personnel from injury, prohibiting premature firing and damage to equipment, and protecting the functional integrity of the devices. Test current for continuity and resistance measurements must be less than 10 milliamps in order to stay well below the rated no-fire current.

P-7.0 STORAGE AND CALENDAR LIFE

Pyrotechnic devices must be stored in approved magazines where the temperature and humidity are continuously controlled to specific values with fixed tolerances. The devices must be qualified and rated for calendar life, because chemical change can occur under adverse conditions. Calendar life is now 36 months from date of manufacture; therefore, pyros are controlled-configuration articles. See storage and surveillance test frequency data stated in paragraphs P-2.1.4, P-2.1.5, P-2.2.4, and P-2.2.5.

P-8.0 INSTALLATION REQUIREMENTS

Covered access ports are desirable for convenient installation and test of all pyro devices. This permits optimum retention of mechanical integrity of the vehicle, while allowing access to the pyros at the highest possible level of assembly and at the latest possible time prior to launch.

P-9.0 APPLICABLE DOCUMENTS

LMSC Dwg. No. 1464811-A	Squib, Dimple Motor
LMSC Spec No. 1417813-N/C	Specification for Squib, Dimple Motor
LMSC Dwg. No. 1463174-G	Squib, Pressure
LMSC Spec No. 1415503-B	Specification for Squib, Pressure

SECTION Q

SATELLITE RECOVERY VEHICLE (SRV)

Q-1.0 PURPOSE

The purpose of the satellite recovery vehicle (SRV) is to provide a structural, heat-resistant nose cone section for the launch vehicle, to provide thermal protection for the inner capsule during orbital operations and re-entry, and to provide a separable re-entry vehicle with appropriate subsystems to de-orbit selected physical data.

Q-2.0 CHARACTERISTICS

Q-2.1 <u>Weights</u>

Launch weight SRV:	323 lbs.
Suspended recovered capsule:	216 lbs.
CR film recovered:	80 lbs.
DISIC film recovered:	11.3 lbs.

Q-2.2 <u>Basic Configuration</u>

Figure Q-1 presents an exploded view of an SRV. Figures Q-2 thru Q-9 are photographs with the subassemblies and components detailed.

Q-2.3 <u>Product Integration</u>

The J-3 system SRV as flown and recovered is an integrated composite of equipment supplied by a group of associate contractors as GFE, with A/P as the systems integrator.

a. The forebody, capsule, and thrust cone of the SRV are supplied by General Electric.

b. ITEK and Fairchild provide the main camera take-up

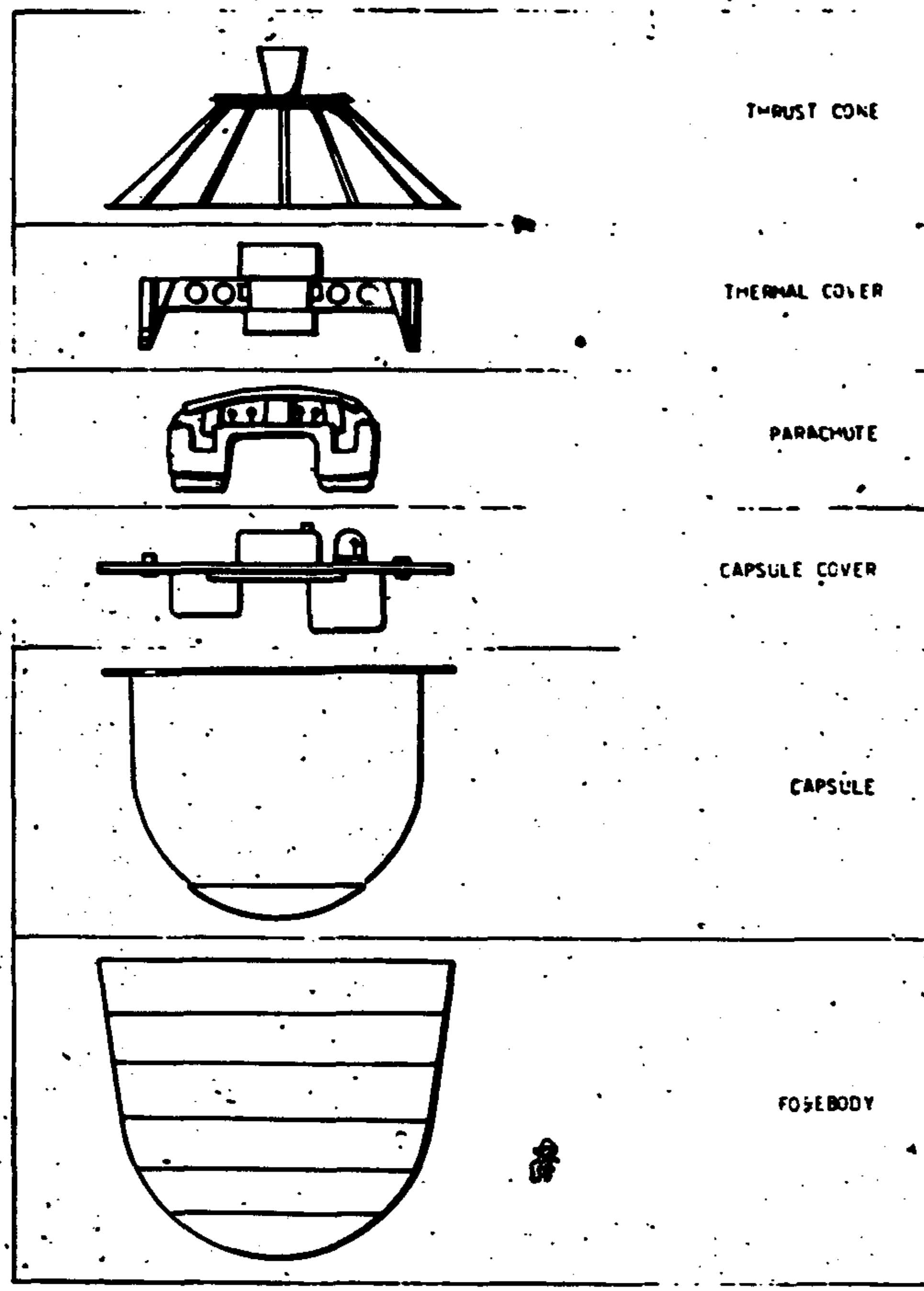


Figure Q-1 Satellite Recovery Vehicle Stack-up

cassette and the DISIC take-up cassette, respectively.

c. Lockheed provides the tape recorder, telemetry system with T/M battery, the parachute recovery subsystem, the MAIN and DISIC waterseals, and the spin and despin valves and pyro squibs for the cold gas spin system. The waterseals and the spin valves are acceptance tested at Lockheed and then shipped to GE for installation in the SRV.

When received at A/P, all equipment is considered as GFE (Government Furnished Equipment). A/P installs, assembles, and integrates the interfacing subsystems from other associates, and also tests and integrates the SRV as a self-contained system and as an integrated subsystem of the J-3 system.

Q-3.0 DESCRIPTION

Q-3.1 General

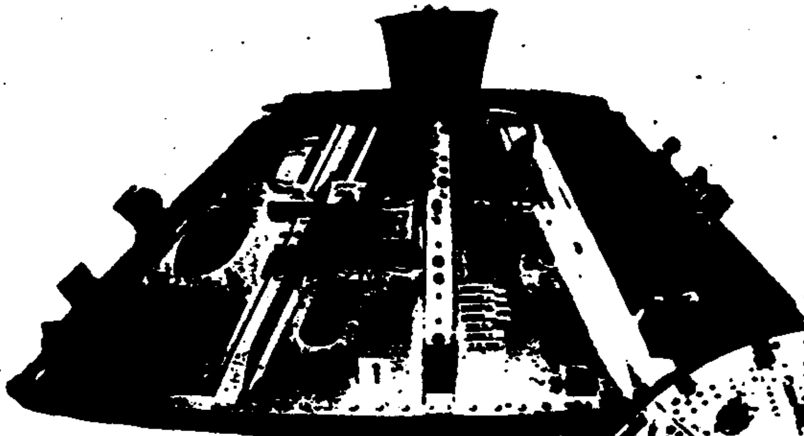
The recovery system stores the exposed film while on orbit, and after ejection from the satellite the SRV serves as the de-orbiting re-entry vehicle. The inner capsule becomes a recovery vehicle upon completion of the re-entry events.

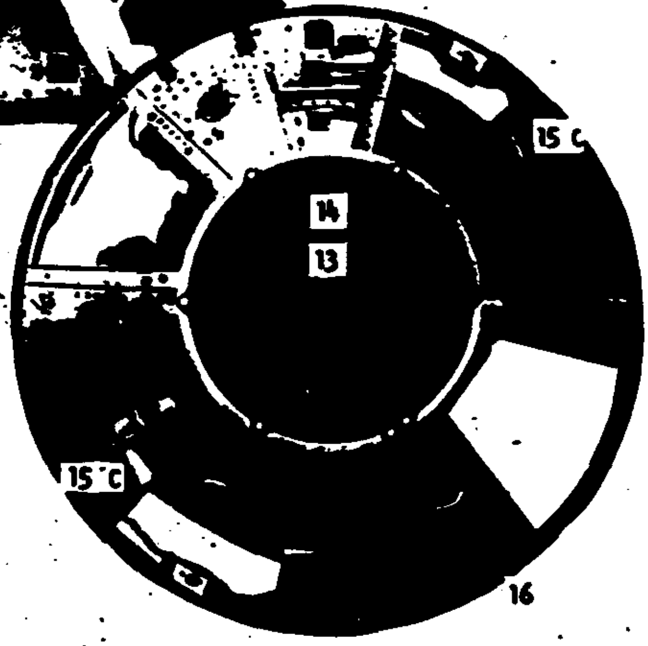
A "recovery enable" real time command, transmitted to the Agena as the satellite passes over the northern polar regions on a north to south pass (one revolution earlier than the orbit in which recovery is desired), enables the orbital programmer to send an SPC to start the recovery programmer and the SRV Battery heaters. The pitchdown of the Agena, and the ARM, TRANSFER, DISCONNECT, and SEPARATE commands from the recovery programmer are described in Section B. The events in the SRV triggered by the recovery programmer are described in Section R.

Q-3.2 Subsystems Hardware

See Figures Q-1 through Q-9 for hardware.

[redacted]





1. THRUST CONE
2. W3A HARNESS
3. THRUST CONE PROGRAMMER
4. BAROSWITCH
5. A103 TRANSFER MODULE
6. A104 THERMAL RELAY MODULE
7. A105 THERMAL RELAY MODULE
8. THERMAL BATTERIES (2 EA.)

9. THRUST CONE/CAPSULE DISCONNECT SQUIBS
10. THRUST CONE/FOREBODY GUILLOTINE CABLES
11. SPIN VALVE SQUIBS*
12. DESPIN VALVE SQUIBS*
13. RETRO ROCKET IGNITER
14. RETRO ROCKET
15. COLD GAS SPIN/DESPIN SYSTEM
    A. SPIN AND DESPIN PRESSURE BOTTLES
    B. SPIN AND DESPIN SQUIB ACTUATED VALVES*
    C. SPIN AND DESPIN NOZZLES
    D. SPIN AND DESPIN TUBING ASSEMBLIES
    E. SPIN AND DESPIN BOTTLE MOUNTING BRACKETS
16. SRV SEPARATION SWITCH ACTUATING BRACKETS
17. TEMPERATURE SENSORS
18. SEPARATION SPRINGS*

Figure Q-2 Thrust Cone Assembly

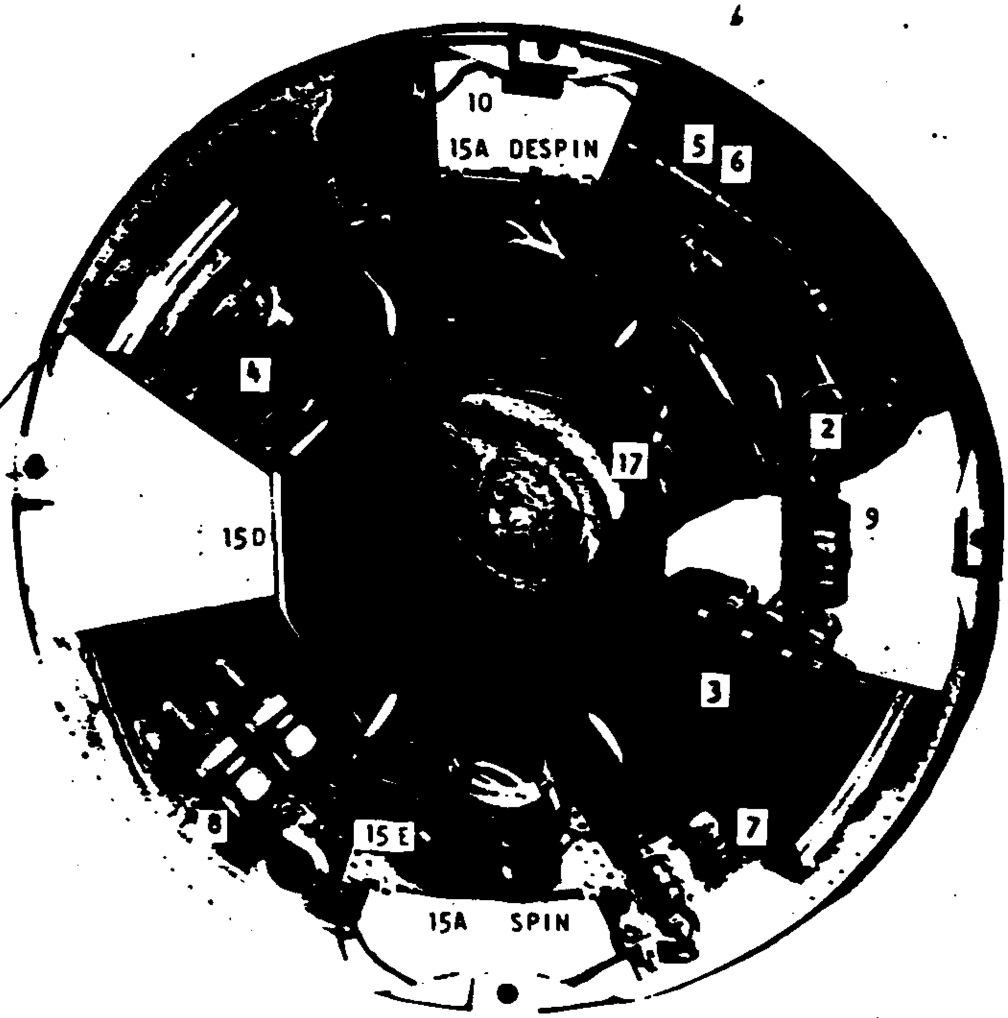


Figure Q-3 Inner View Thrust Cone Assembly

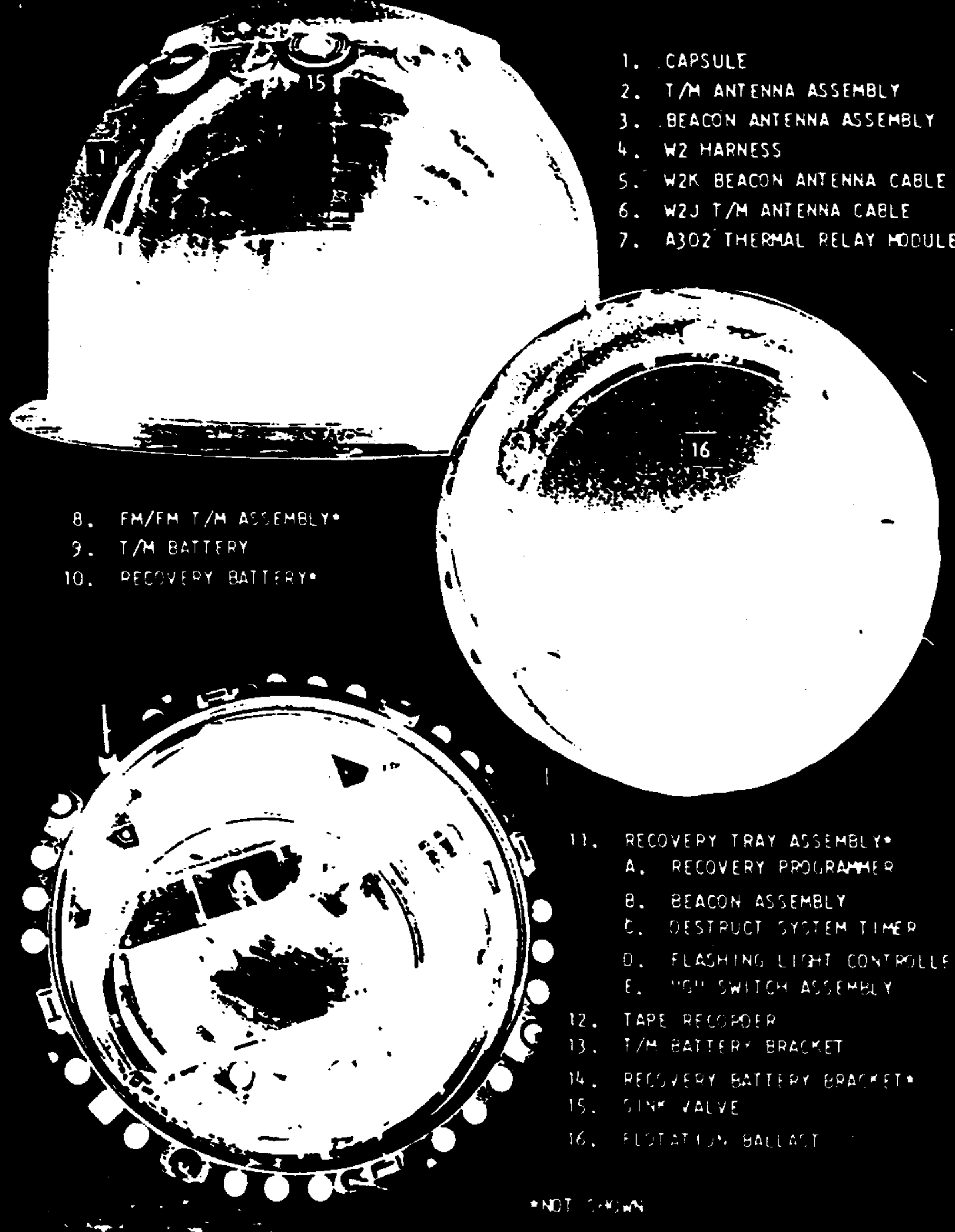


Figure Q-4 Capsule Assembly

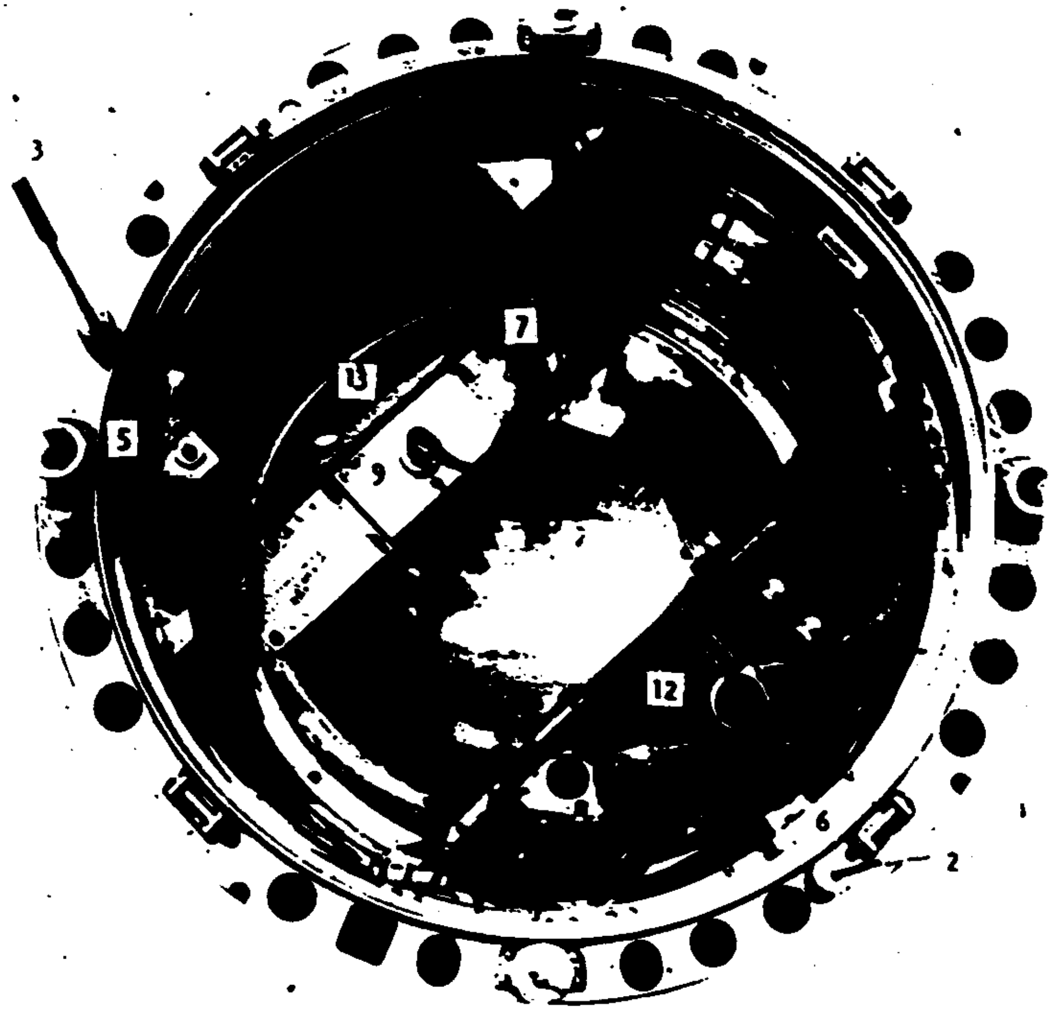
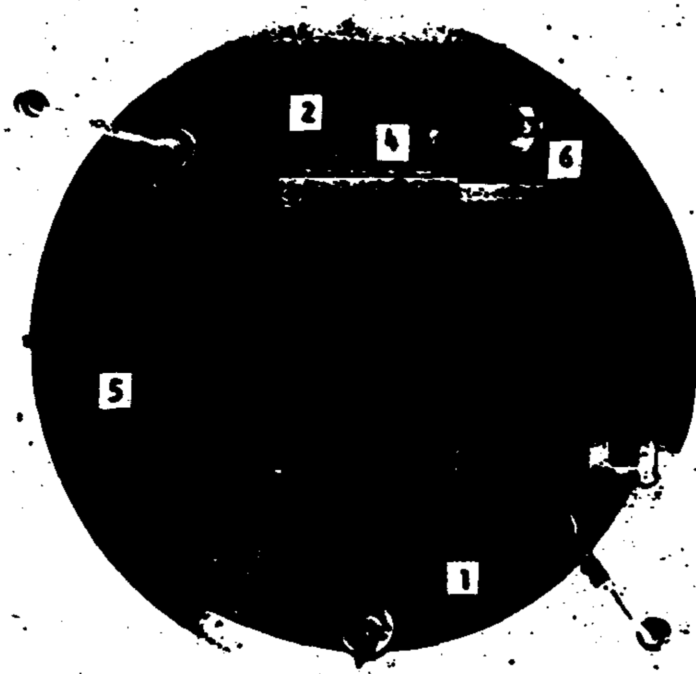


Figure Q-5 Inner View of Capsule Assembly



1. COVER
2. MAIN WATERSEAL ASSEMBLY
3. DISIC WATERSEAL ASSEMBLY
4. ASCENT VALVE
5. VENT SEAL ASSEMBLY
6. FLASHING LIGHT ASSEMBLY
7. P/J 3181 WATERSEAL CABLE*
8. P/J 3153 WATERSEAL CABLE*
9. W2 INTERCONNECT CABLE*
10. CAPSULE COVER RETAINING RINGS*
11. A315 WATERSEAL MODULE

*NOT SHOWN

Figure Q-6 Capsule Cover Assembly

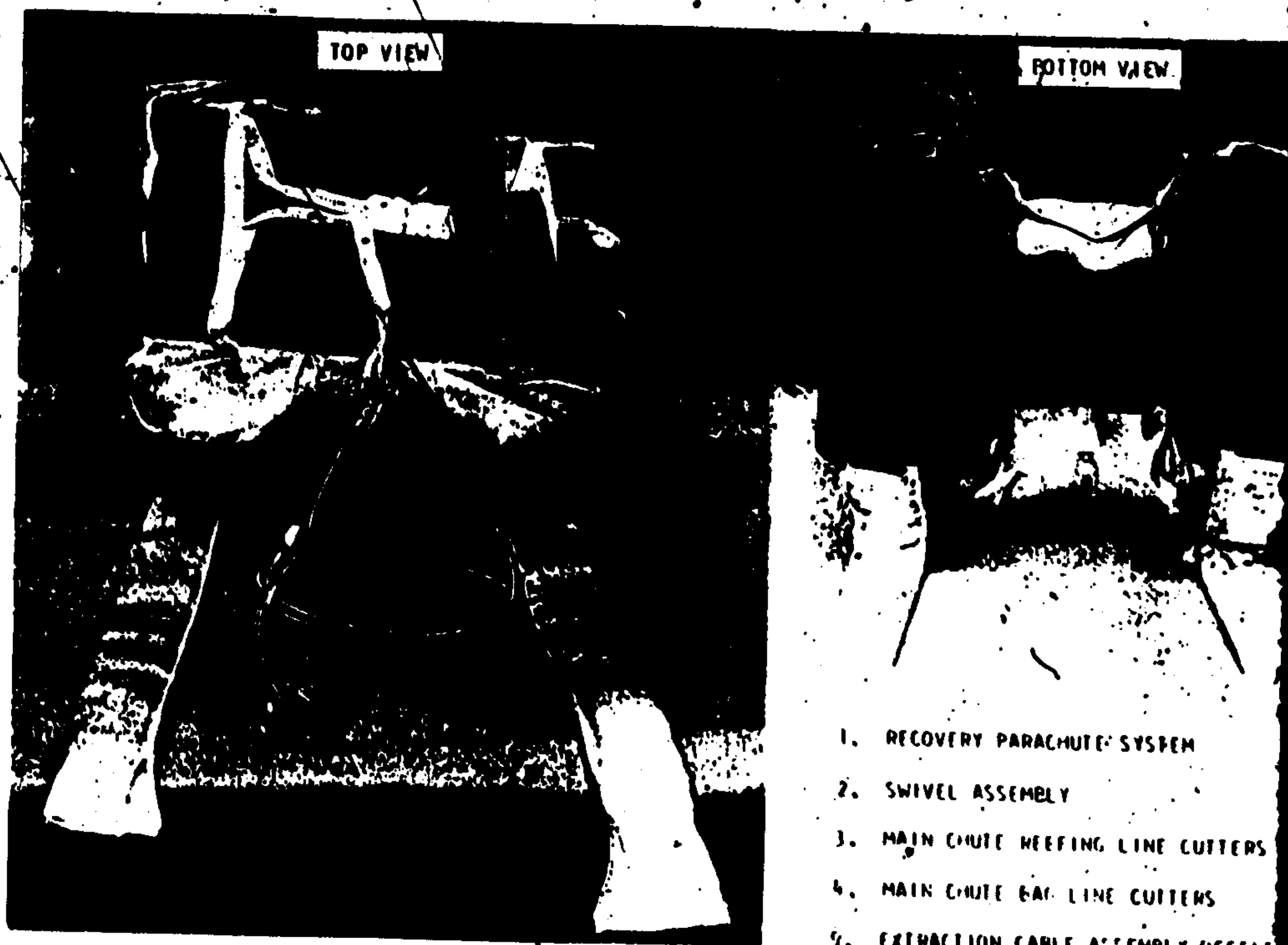


Figure Q-7 Parachute Assembly

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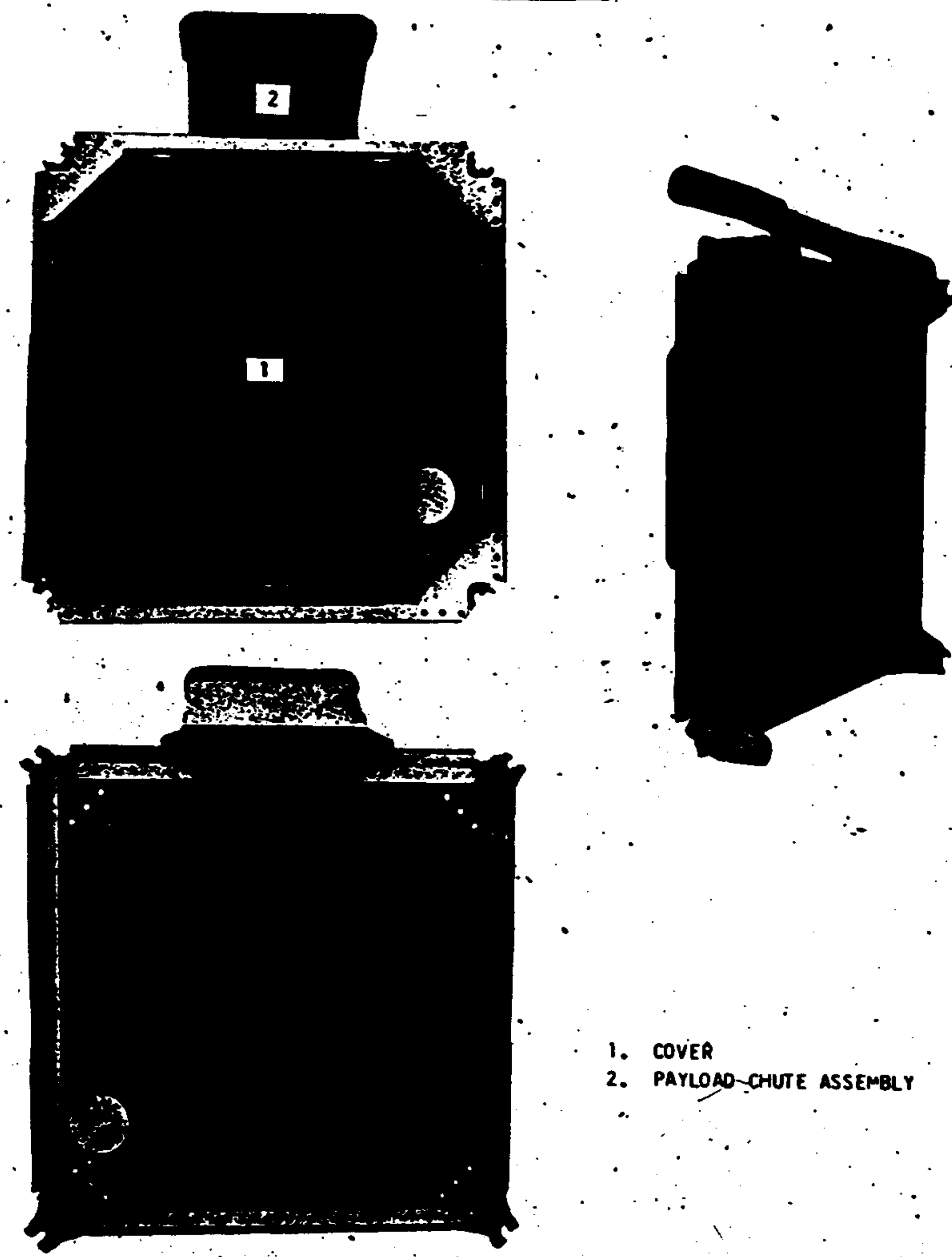
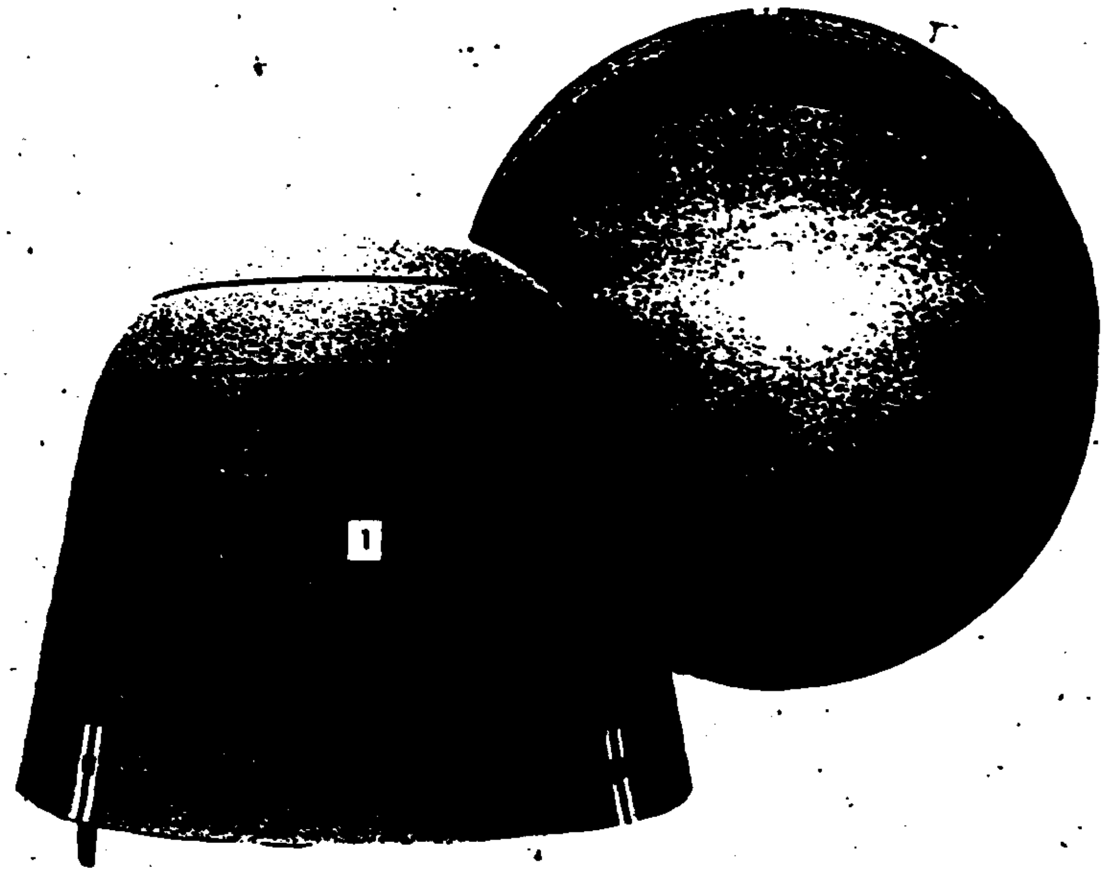


Figure Q-8 Thermal Cover Assembly



1. ABLATIVE SHELL
2. PISTON EJECTORS
3. PISTON EJECTOR SQUIBS*
4. PISTON EJECTOR MOUNTING HARDWARE
5. CAPSULE GUIDES
6. W1A HARNESS
7. W1C HARNESS

*NOT SHOWN

Figure Q-9 Forebody Assembly

See G. E. Drawing 47R197134 system schematic for electrical wiring of the SRV. Also see Figure Q-10.

Q-3.2.1 Orbit Ejection Subsystem

The thrust cone is a truncated cone, aluminum structure upon which the components performing the orbit ejection functions are mounted.

Q-3.2.1.1 Electrical Power

An independent source of electrical power is provided in each RV to support orbit ejection and separation of the thrust cone. This power is provided by dual thermal batteries, each capable of supplying loads up to 9.0 amperes at 31 volts direct current for a period of 20 seconds minimum.

Q-3.2.1.2 Thrust Cone Components

The spin system is composed of a gas reservoir, a pyrotechnically actuated valve, and two nozzles which are located diametrically opposite each other and similarly pointed in a direction to allow the gas to spin the RV in an axial, counterclockwise rotation. The spin tank reservoir is a welded, stainless-steel sphere with a burst pressure of 7,000 pounds psi gas pressure. The flight tank is filled with a combination of gases to a working pressure of 3000 psi.

a. The bottles are 5 inches in diameter, are filled with 89 percent nitrogen and 10 percent Freon, and have a trace of helium (1 percent) for leak detection purposes.
b. Gas weight per bottle is 0.65 pound.
c. Specific impulse $= 59.5 \dfrac{\text{lb. secs.}}{\text{lbs. of gas}}$
d. Total impulse $= 59.5 \dfrac{\text{lb. secs.}}{\text{lbs. gas}} \times 0.65 \text{ lb.} = 39 \text{ lb. sec.}$

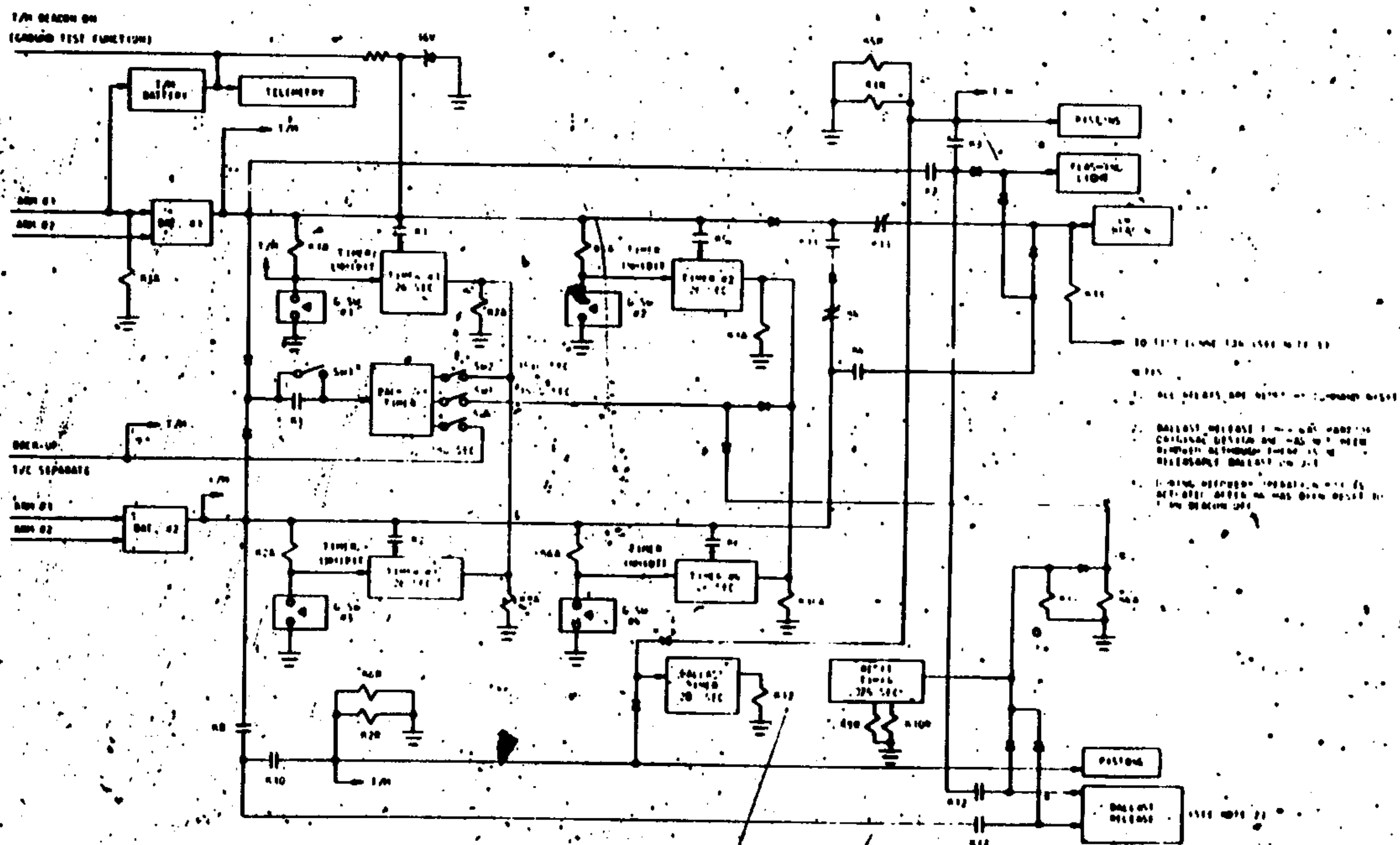


Figure Q-10 . Functional Block Diagram Recovery System

The despin system duplicates the spin system; except that the nozzles are pointed in the opposite direction to effect a clockwise spin and are located 90 degrees from each spin nozzle. The despin tank has a working gas pressure of 2400 psi.

The retro rocket is a solid-propellant rocket which imparts a thrust of 1,000 pounds for approximately 10 seconds duration. The purpose is to decelerate the RV (see Figure Q-11). The physical characteristics are listed as follows:

a. Total packaged weight is 63 pounds.

b. Burn time is approximately 8 seconds.

c. Propellant weight is 40 pounds.

d. Specific impulse = 260 $\frac{\text{lb. secs.}}{\text{lbs.}}$.

e. Total impulse = 260 $\frac{\text{lb. secs.}}{\cancel{\text{lbs.}}}$ x 40 lbs. = 10,400 lb. secs.

f. Average thrust = 1136 lbs.

g. Maximum thrust = 1609 lbs.

The rocket fuel is polyurethane and the oxidizer is ammonium perchlorate. The igniter is composed of boron pellets.

The ejection programmer is a solid-state electrical timer which feeds precisely timed electrical impulses to the spin-despin system, the retro rocket, in-flight electrical disconnect, and the thrust cone retainer pyrotechnics (guillotine); which, with the aid of four separation springs, effect separation of the orbit ejection subsystem form the recovery vehicle.

Q-3.2.1.3 Orbit Ejection Function

The functional sequence of events is as follows:

a. Separation of the re-entry vehicle from the system by pyrotechnically released pin pullers in conjunction with spring pushers.

b. Spin-up of the SRV, producing a roll rate of 55 to 65 rpm under conditions of maximum roll inertia.

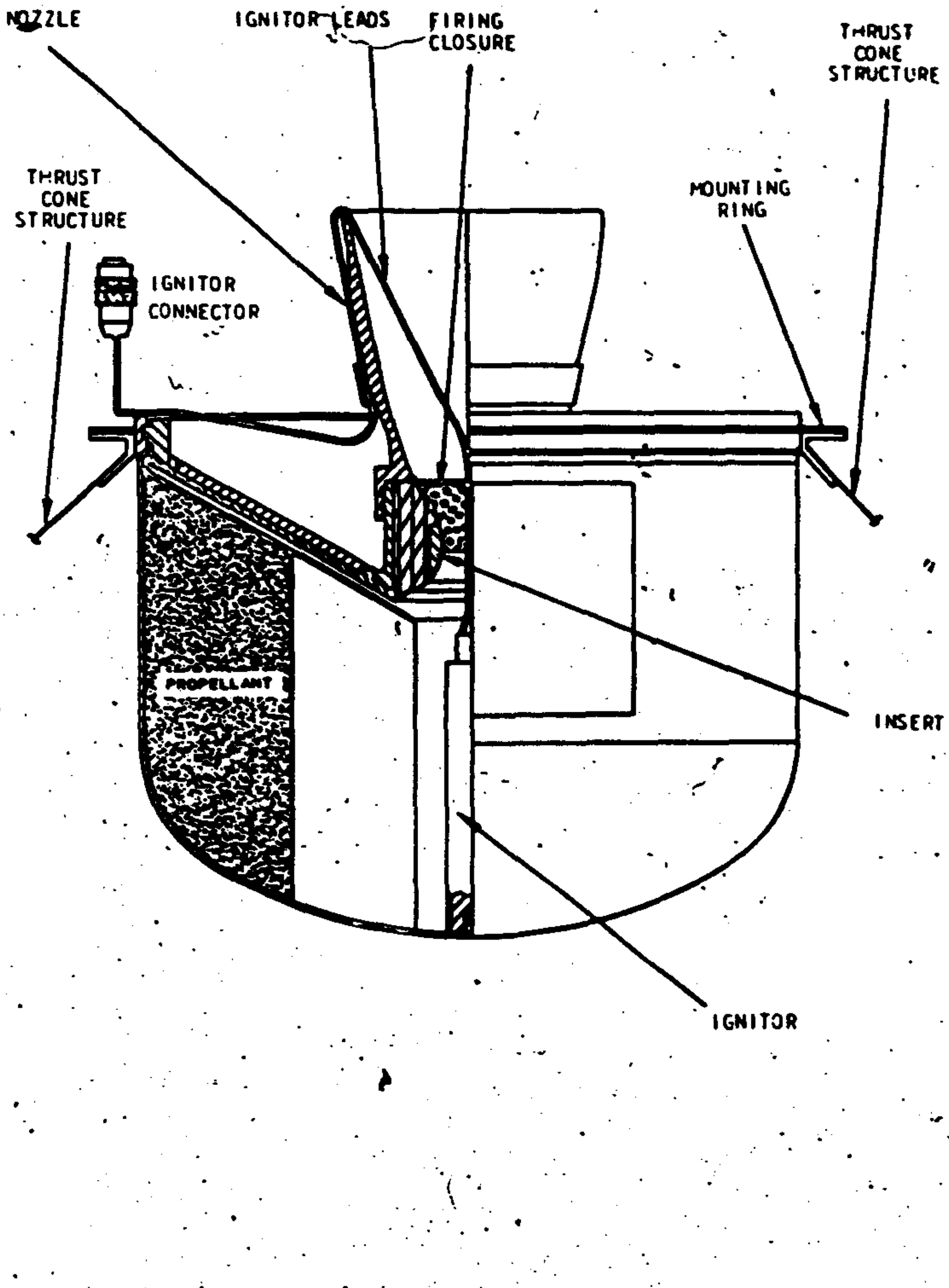


Figure Q-11 Retro Rocket Cross Section

c. Thrust generation to produce the orbit ejection velocity increment. The thrust must be sufficient to impart a nominal velocity along the thrust vector of not less than 800 feet per second for nominal mass conditions. Retro ignition occurs approximately 6 seconds following disconnect.

d. Despin of the RV slows the spin rate to yield a residual spin of approximately 9 rpm to distribute reentry heat uniformly over the surface of the forebody. The despin operation requires less gas than the spin operation.

e. The thrust cone is then jettisoned approximately 18.25 seconds from disconnect.

Q-3.2.2 Recovery Capsule and Recovery Equipment

Q-3.2.2.1 Capsule Structure

The capsule is a dome-shaped, spun-aluminum structure. It is plated with gold for thermal purposes and has a sink valve to allow it to sink if the capsule is lost at sea (see Figure Q-12). The capsule houses the following components or subassemblies:

a. The main take-up cassette and its mounting hardware.
b. The DISIC take-up cassette and ancillary hardware.
c. A tape recorder.
d. The recovery equipment. - A remeotely activated 5 ampere-hour battery powers the recovery equipment (except the telemeter subsystem) by providing a voltage output of 14.8 to 17.0 VDC at 0.7 to 1.2 amperes load from each of two batteries housed in one stainless-steel envelope. These batteries are required to furnish power (from shortly prior to

VIEW OF BOTTOM OF RECOVERY VEHICLE

1. SINK VALVE ASSEMBLY
2. BALLAST

Figure Q-12 Sink Valve

to separation to a minimum of ten hours after water impact) to eject the parachute, and to operate the recovery aids, a flashing light, and a radio beacon transmitter.

e. The telemetry subsystem Recovery event data are transmitted to the ground stations by a telemetry transmitter. The telemeter system consists of three VCO's, one each for IRIG channels 7, 9, and 11; an accelerometer, with a range of ± 5 g's; and a 1.5 watt transmitter, on a frequency of 228.2 megacycles. The T/M system is powered by a single silver-zinc battery having a nominal 28 VDC rating and a minimum capability of 0.6 ampere-hours. The power duration is required to be a minimum of 30 minutes. The battery is remotely activated by ARM 1 command.

f. The backup timer. - An electronic timer initiates a Destruct command in the event a malfunction prevents successful re-entry prior to 1500 seconds after ARM command. The timer bypasses the Retro command, and provides the Separate command to the thrust cone and parachute system. This command sequence serves to disallow a successful re-entry by providing sufficient drag force to result in burning up the RV.

g. The recovery beacon transmitter. - This VHF unit operates on a carrier frequency of 225 megacycles ± 0.01 percent. Average power is 400 milliwatts, powered by the recovery battery. The signature is a unique, variable pulse rate frequency signal. The purpose during descent and/or water impact is to provide a recognizable sound to the search aircraft until the capsule is visually sighted and retrieved.

h. The flashing light. - A backup recovery aid used to assist recovery crews in locating a capsule at night. The light is omnidirectional above the horizon, and is so designed that it will be visible at sea on a cloudless night by a search plane 5 miles away away and flying at an elevation of 10,000 feet.

i. The recovery programmer. - A solid-state timer which issues electrical commands through a variety of time delay relay activities, initiating the events subsequent to the orbit ejection sequence. These events are known as the recovery events and are listed below:

(1) Ejection piston pyro-actuated
(2) Flashing light energized
(3) Parachute sequence
(4) Back-up timer energized

j. The inertia switch module. - Comprised of a bank of four viscous damped 3 g inertia switches, any two of which must operate (see Figure R-10). The purpose of these switches is to provide a time delay between orbit eject and recovery events, using the re-entry dynamics properties to trigger the recovery programmer.

k. The water seals. - Installed on the capsule cover, the water seals have a twofold purpose:

(1) To cut the main camera and DISIC films
(2) To seal the capsule from light, water, and other contaminants (see Figures Q-13 and 14).

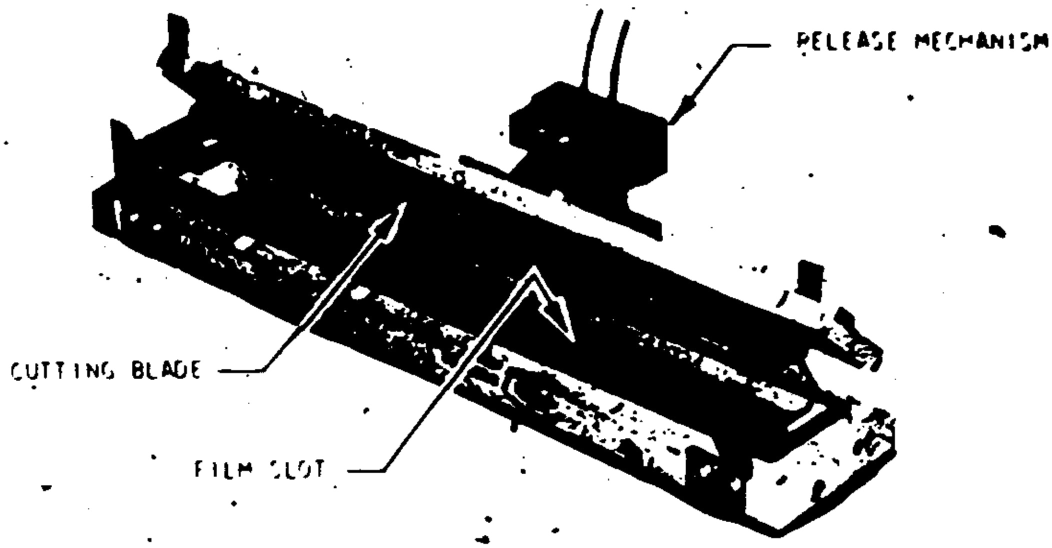


Figure Q-13 DISIC Waterseal

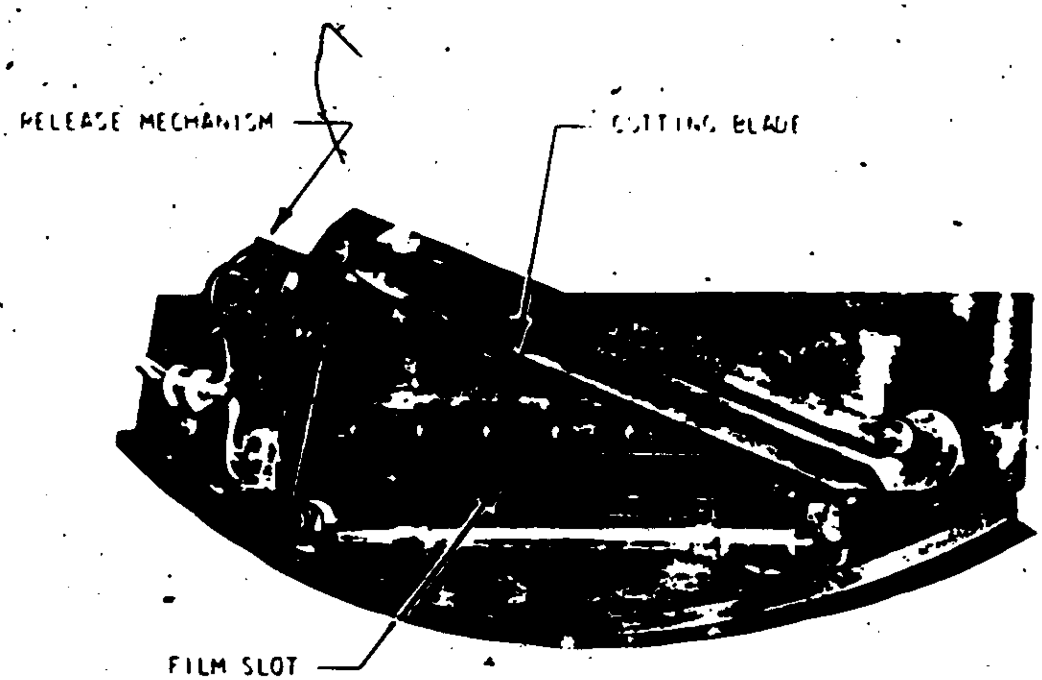


Figure Q-14 Main Waterseal

[redacted]

Q-3.2.3 Forebody (Heat Shield)

Q-3.2.3.1 The forebody (Figure Q-9) is constructed using a substructure of phenolic and fiberglas, called the "liner," and an external skin of phenolic-impregnated nylon. The thickness of the inner liner is of constant thickness and is formed by winding the glass about a mandrel. The outer skin is a hand lay-up pattern which varies in thickness from the nose (or stagnation point) to the aftmost edge (or skirt) in respect to the anticipated re-entry heating on this shape of body.

Q-3.2.3.2 The forebody outer skin is an ablative material. As an ablator, it dissipates the heat encountered during re-entry. As the shield is heated, a char is formed and the heat is dissipated by the gas that is inherent with the char process. The capsule and its components, as well as the parachute system, are kept at temperatures which are less than 150°F internal capsule temperature, and less than 300°F on the parachute system.

Q-3.2.4 Parachute System

The parachute assembly is a three-stage, two-parachute system (see Figure Q-7).

Q-3.2.4.1 Deceleration Parachute

The deceleration parachute is a 6.9-foot, ribbon-type canopy which is used to separate the attached capsule from the forebody, and to decelerate the vehicle to a velocity suitable for main parachute deployment. The deceleration parachute also pulls the firing pins on the main parachute bag closure cord cutters. The deceleration parachute serves as the first stage of the three-stage deceleration parachute system (see Figure R-5).

Q-3.2.4.2 Main Parachute

The main parachute is a 29.6 foot, ring-slot canopy which serves as the second-and-third-stage decelerator, as well as being the target which is engaged by the recovery aircraft. See Figures R-5 and R-6. The main parachute is released from its bag as the time delay expires on the bag closure cord cutters.

The main parachute, when released, is deployed first in a reefed condition. In order to assume its full open diameter, the reefing line is severed by four reefing line cutters having a four-second time delay. The firing pin is pulled from the cutter by utilizing a lazy-leg configuration on two of the suspension lines. After the four-second delay, the reefing line is cut, allowing the main canopy to disreef completing the third and final stage of parachute deployment.

Q-3.2.5 Parachute Cover

The parachute cover (Figure Q-8) is a fiberglas cover. It is used to provide thermal protection to the cloth bag of the parachute. The cover is ejected by using pyrotechnically activated pusher pistons (Figure Q-15) located in the forebody, and simultaneously releasing the capsule and streaming the deceleration parachute to begin Phase 1.

The parachute cover is physically tied to the deceleration chute deployment bag. When the piston fires, the velocity imparted to the cover pulls the parachute out of the capsule and the air stream provides the dynamics necessary to deploy the parachute.

[redacted]

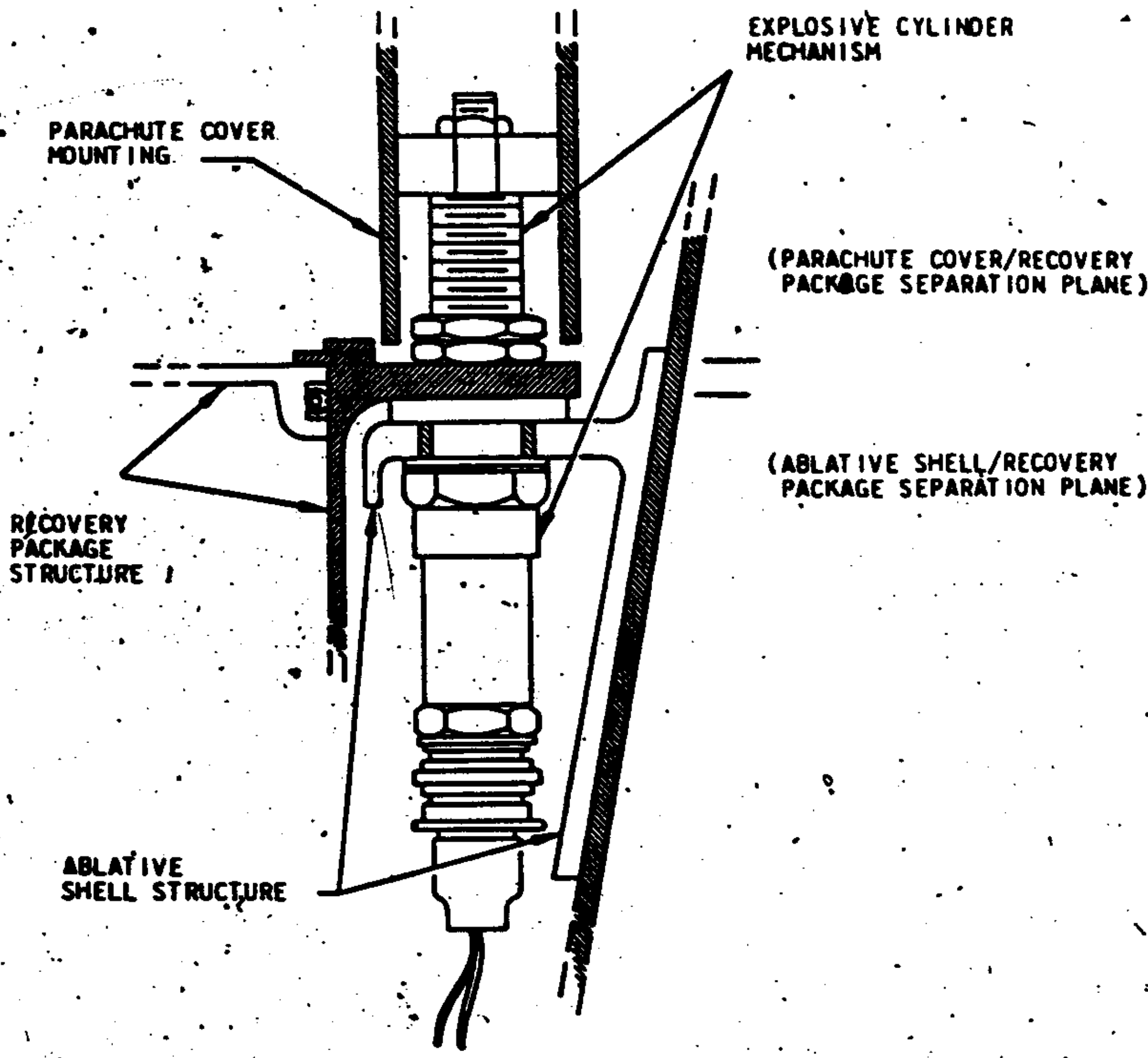


Figure Q-15 Parachute Cover Separation Mechanism and Planes

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SECTION R

RE-ENTRY AND RECOVERY

R-1.0 PURPOSE

The purpose of re-entry and recovery is to accomplish the atmospheric re-entry of the recovery vehicle (as defined in Section FF) and the subsequent air snatch or water retrieval of the capsule (containing exposed film and tape-recorded gas jet, time word, slit width, and filter position data).

R-2.0 SUMMARY OF EVENTS

The de-orbit, re-entry, and retrieval functions comprise a sequence of events involving the satellite, the SRV, the tracking stations, and the air and sea recovery forces as illustrated in Figures R-1 through R-6, and in Table R-1.

R-3.0 RECOVERY SEQUENCE

The recovery sequence is normally started from [redacted] by an enable command, backed up by a command from [redacted] Normally, the trajectory of the RV is within radar range (see Figures R-1 and R-2).

The recovery force aircraft are deployed to cover the computed recovery impact point in a controlled search pattern at 10,000 to 20,000 feet altitude. The aircraft and tracking station search equipment is tuned to the frequencies of the RV RF beacon and the RV Blossom T/M such that the position of the RV may be determined by triangulation.

The orbital parameters and the nominal free-flight ballistic trajectory of the SRV are pre-computed, and these data

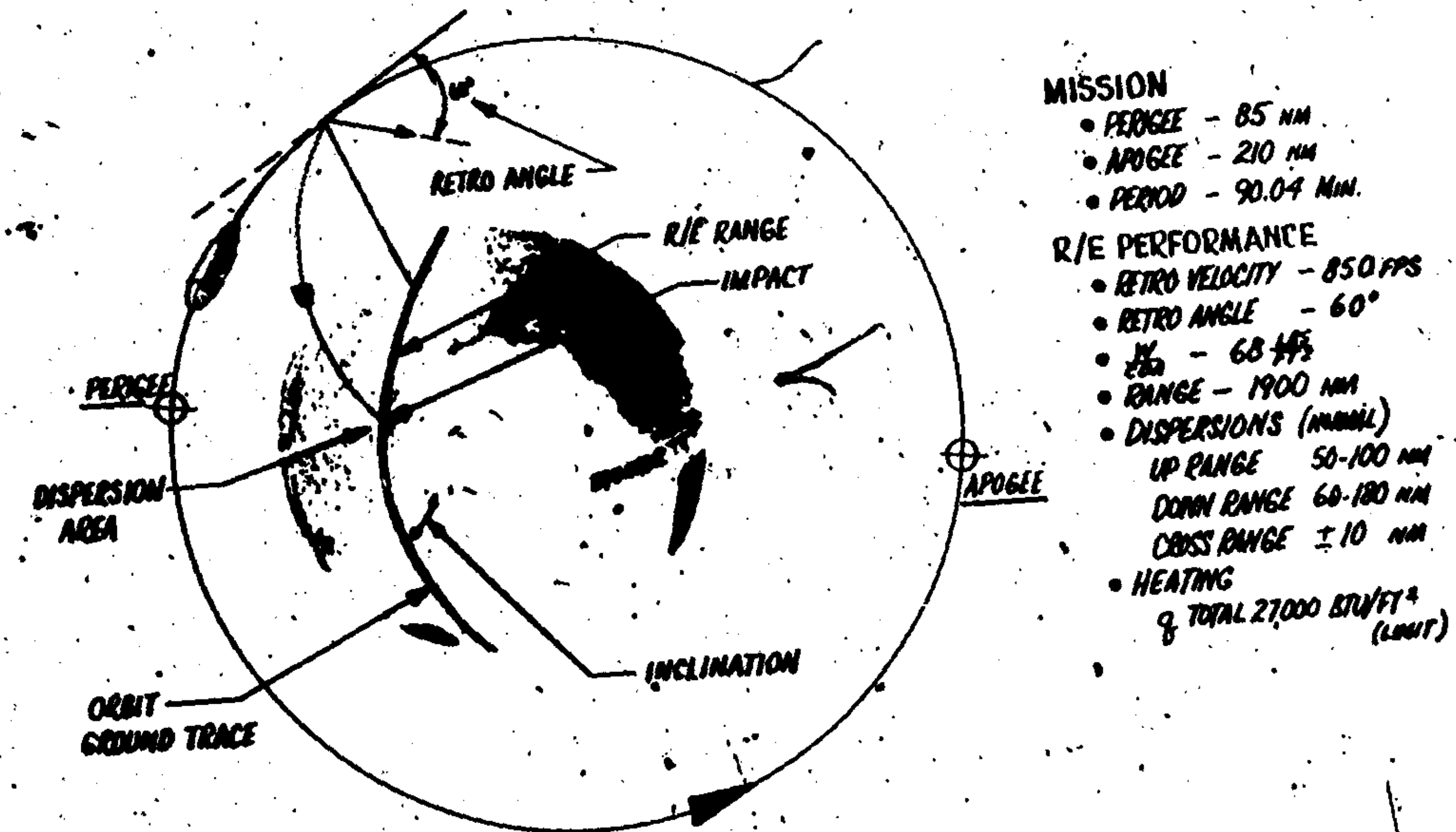
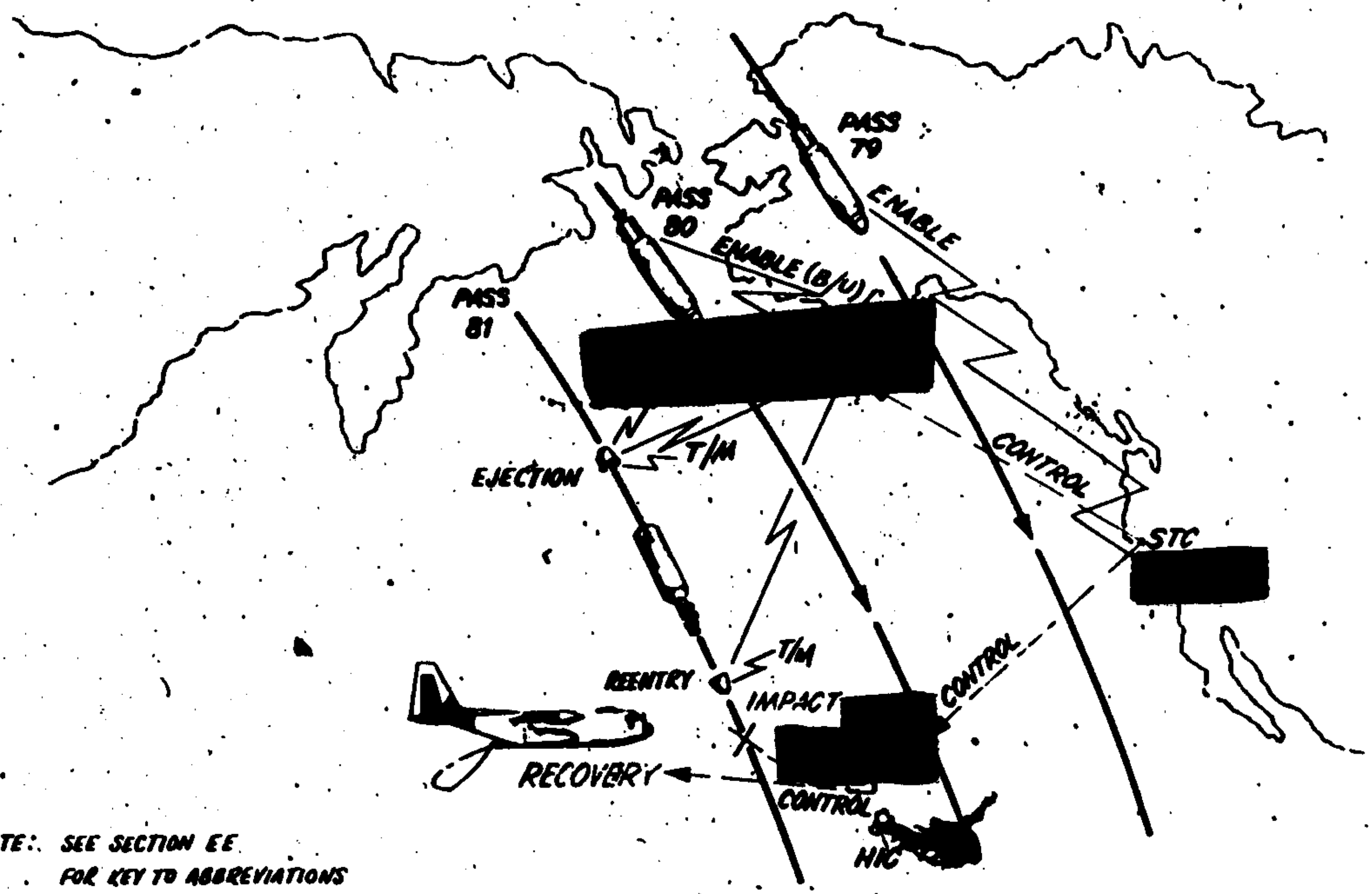


Figure R-1 Re-Entry Parameters

[redacted]



NOTE: SEE SECTION EE
FOR KEY TO ABBREVIATIONS

Figure R-2 Satellite Control Facility Operation

[redacted]

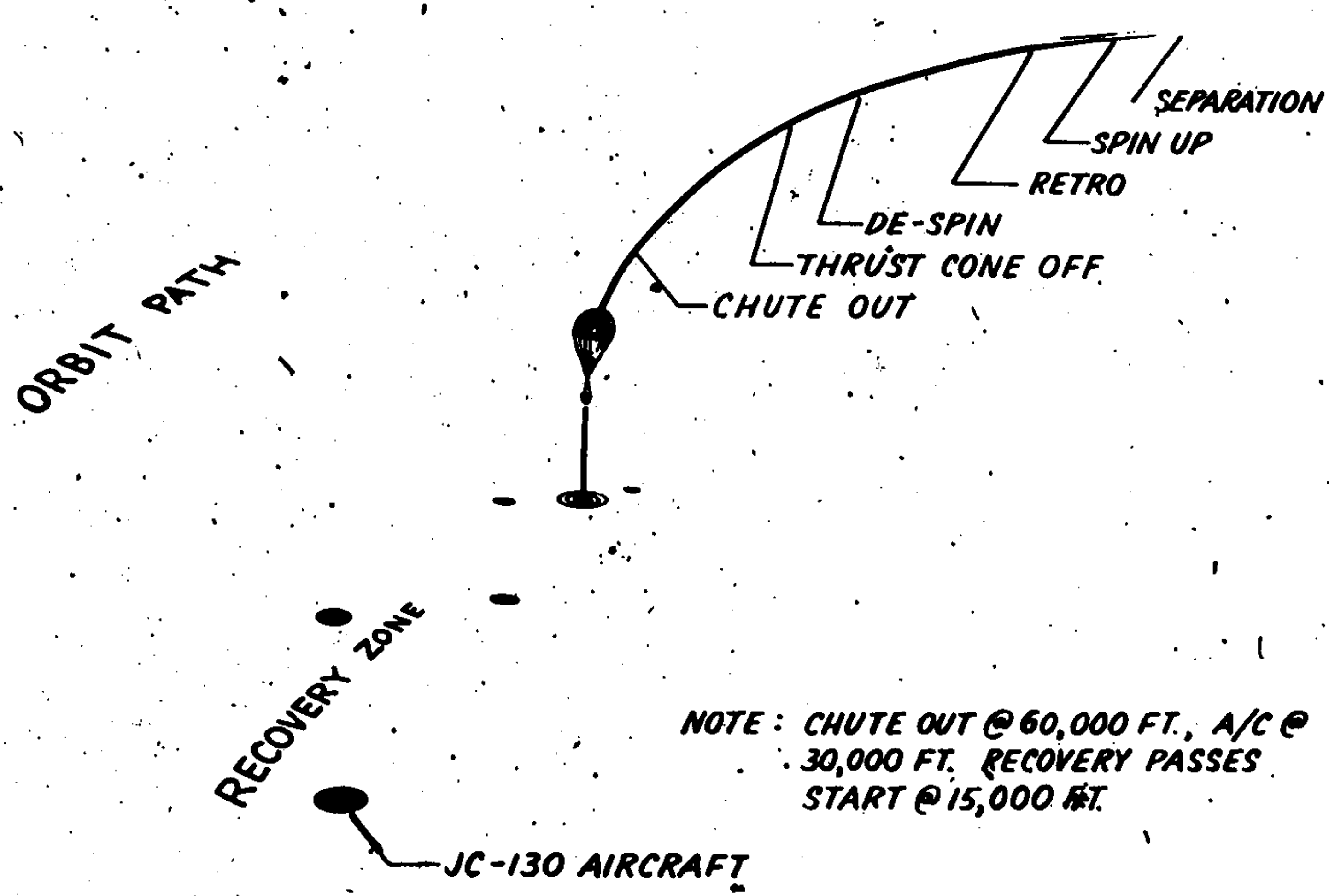
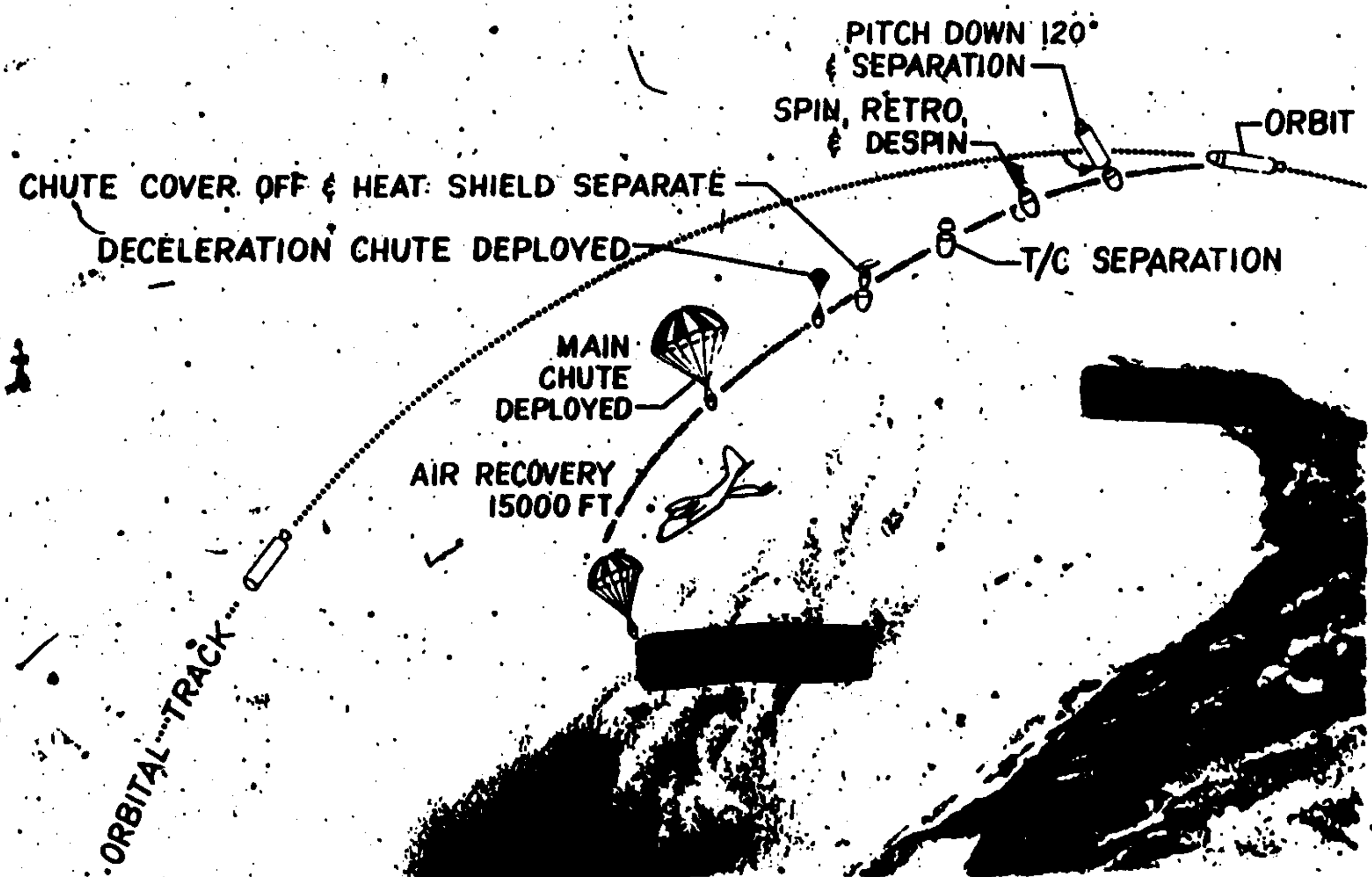


Figure R-3 Recovery Sequence



[redacted]

Figure R-4 Recovery Sequence of Events

[redacted]

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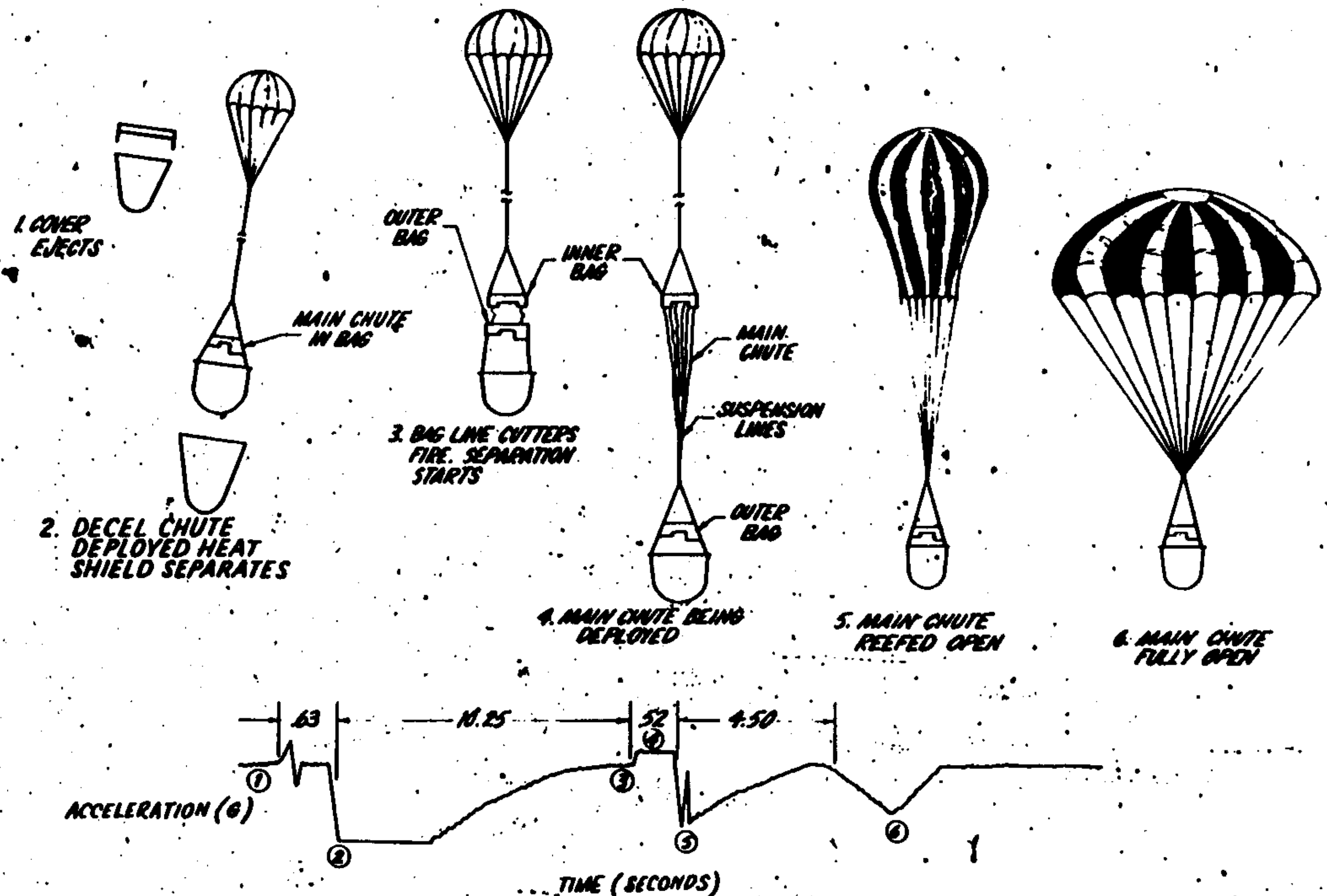

Figure R-5 Normal Parachute Sequence

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[redacted]

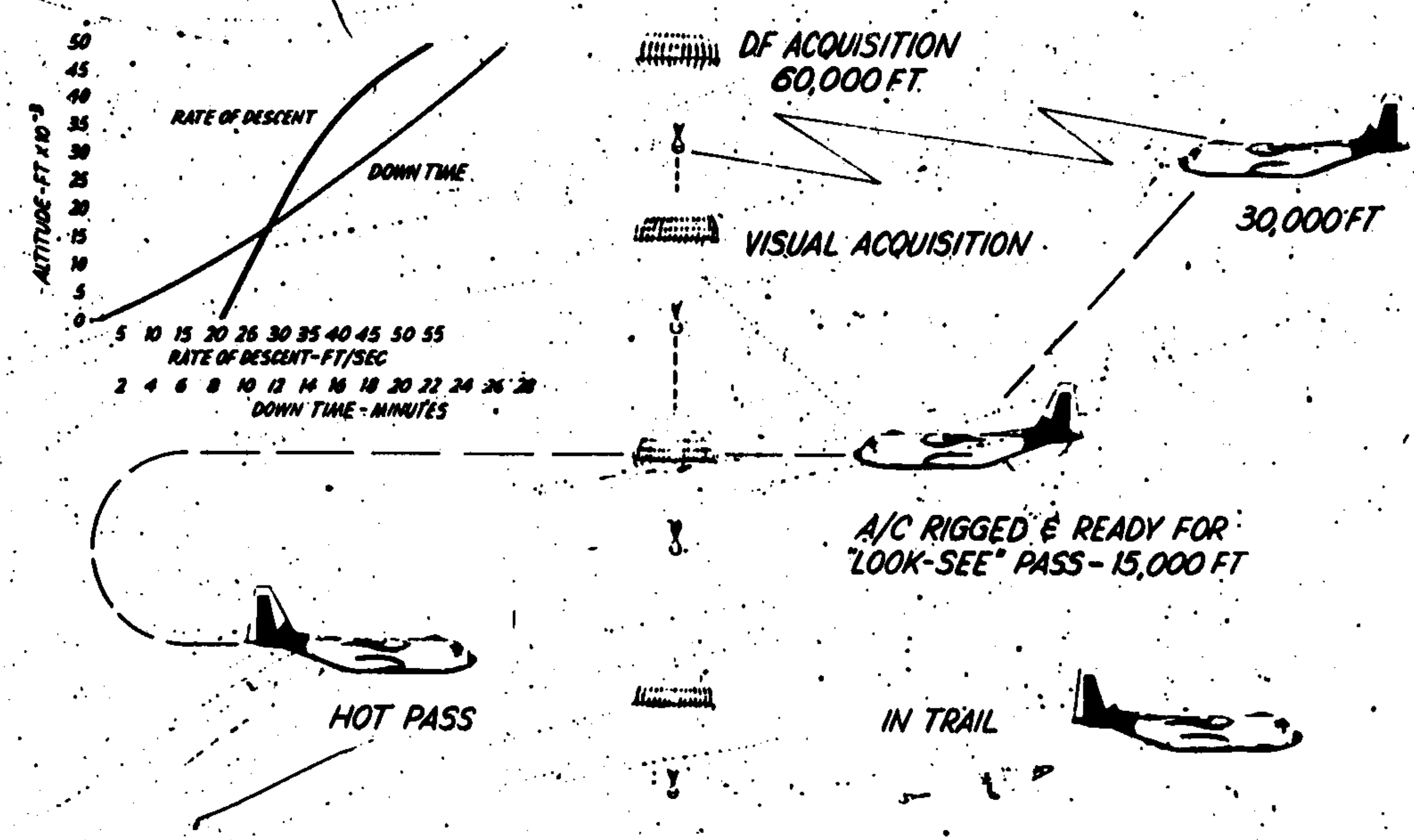

Figure R-6 Typical Air Recovery Sequence are updated and corrected for known variables shortly before the start of recovery operations.

The satellite assumes the required spatial orientation (120° for orbit vector for primary modes, and variable for Lifeboat modes) to eject the SRV in the required direction for atmospheric re-entry, upon receipt of the proper Secure RTC (real time command). The internal events occurring in the Agena during the 120-degree pitchdown maneuver, together with the associated pyrotechnic events occurring in the J-3 payload system, prepare the SRV for free-flight operation during de-orbit.

R-3.1 Communication, Acquisition, Command and Control Network

R-3.1.1 Satellite Test Center (STC)

The STC, located at LMSC, is the center for mission communications, acquisition, command and control. Major mission decisions emanate from STC, such as time and location of recovery, recovery initiation, length of mission, and mission conclusion.

R-3.1.2 Tracking Stations

Network tracking stations provide satellite vehicle (SV) status as to orbit, velocities, and telemeterized functions, and command the SV as required by STC.

R-3.1.2.1 [redacted] Tracking Station

The prime tracking station location for performance of this synchronism and recovery initiation is at [redacted] on the proper pass.

R-3.1.2.2 [redacted] Tracking Station

In addition to performing normal tracking station functions, [redacted] acts as the center for the RV recovery and recovery forces.

R-3.1.3 Aircraft Function

Four Lockheed JC-130 type military aircraft, especially adapted for aerial capsule recovery, are used for recovery (see Figures R-7 and R-8). They are spaced at selected intervals in the planned recovery area at an altitude of approximately 10,000 to 20,000 feet. When the RV has passed through the blackout zone and the parachute has deployed, the aircraft home in on the RF beacon. On visual capsule contact, an inspection pass is made by the sighting aircraft. When the capsule has descended to 15,000 feet or lower, a final pass is made during which the capsule parachute is engaged in the aircraft hooking equipment.

R-3.1.4 Ship's Function

The tracking ship (naval communications-type) provides similar duties as the tracking stations, but in a mobile fashion. On board are also "frogmen" in event a water retrieval of the capsule is required. 6

R-4.0 RECOVERY SEQUENCE

R-4.1. General

The recovery sequence is illustrated in the preceding Figures R-3 through R-6. The detailed SRV events are presented in Table R-1 for reference. However, the following discussion of significant events will clarify the recovery sequence.

R-4.1.1 Separation

The separation sequences of SRV A and SRV B are similar, except that A-to-B transfer precedes the SRV A separation, and the fairing ejection precedes the SRV separation (see Figure R-9). Both events are initiated by the Recovery Enable command from the Agena (see Section L for details), but the fairing eject pyro circuits are disabled during SRV A Recovery Enable.

C TOP SECRET [redacted]

[redacted]

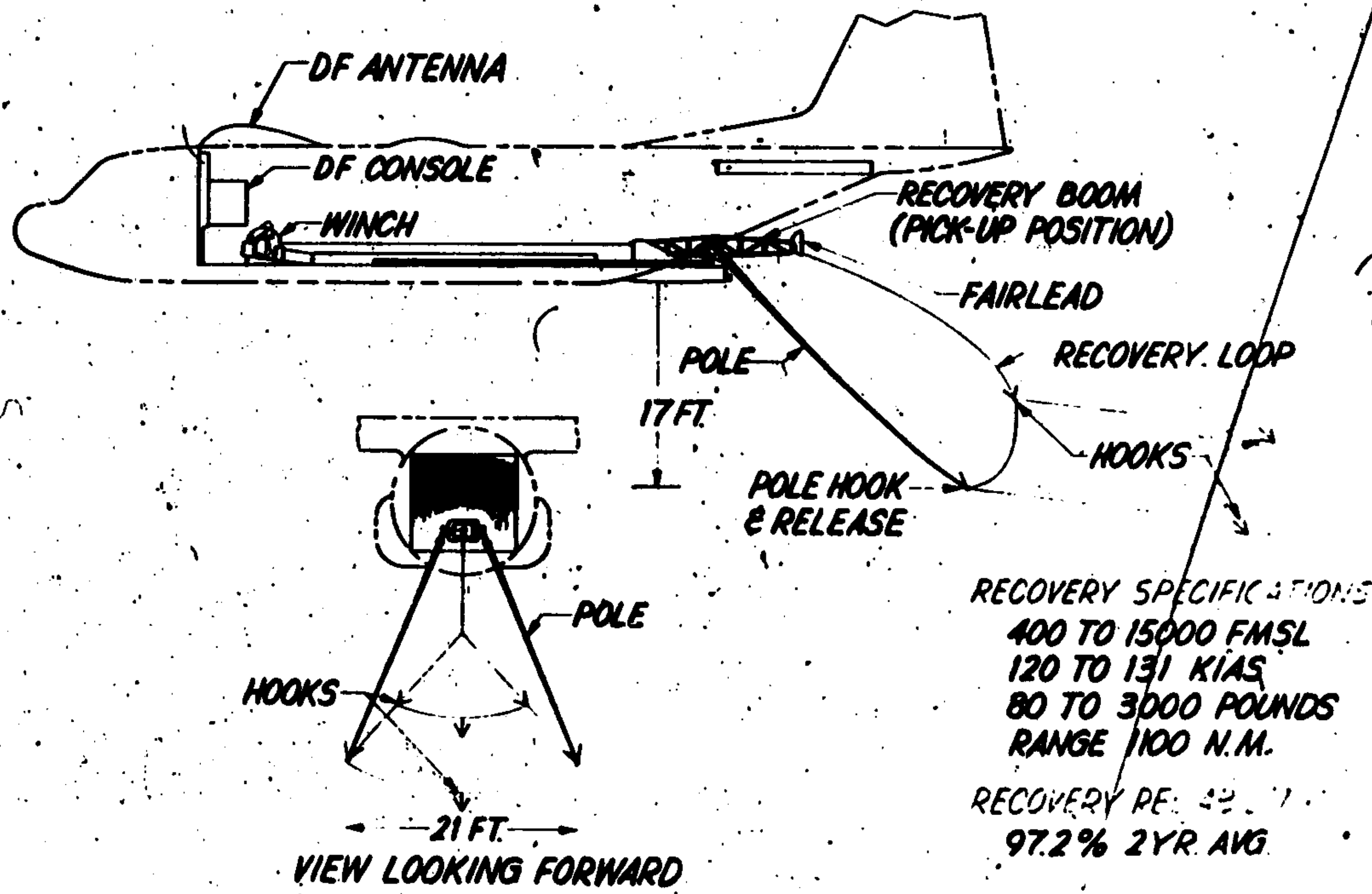

Figure R-7 Diagram of Air Snatch System

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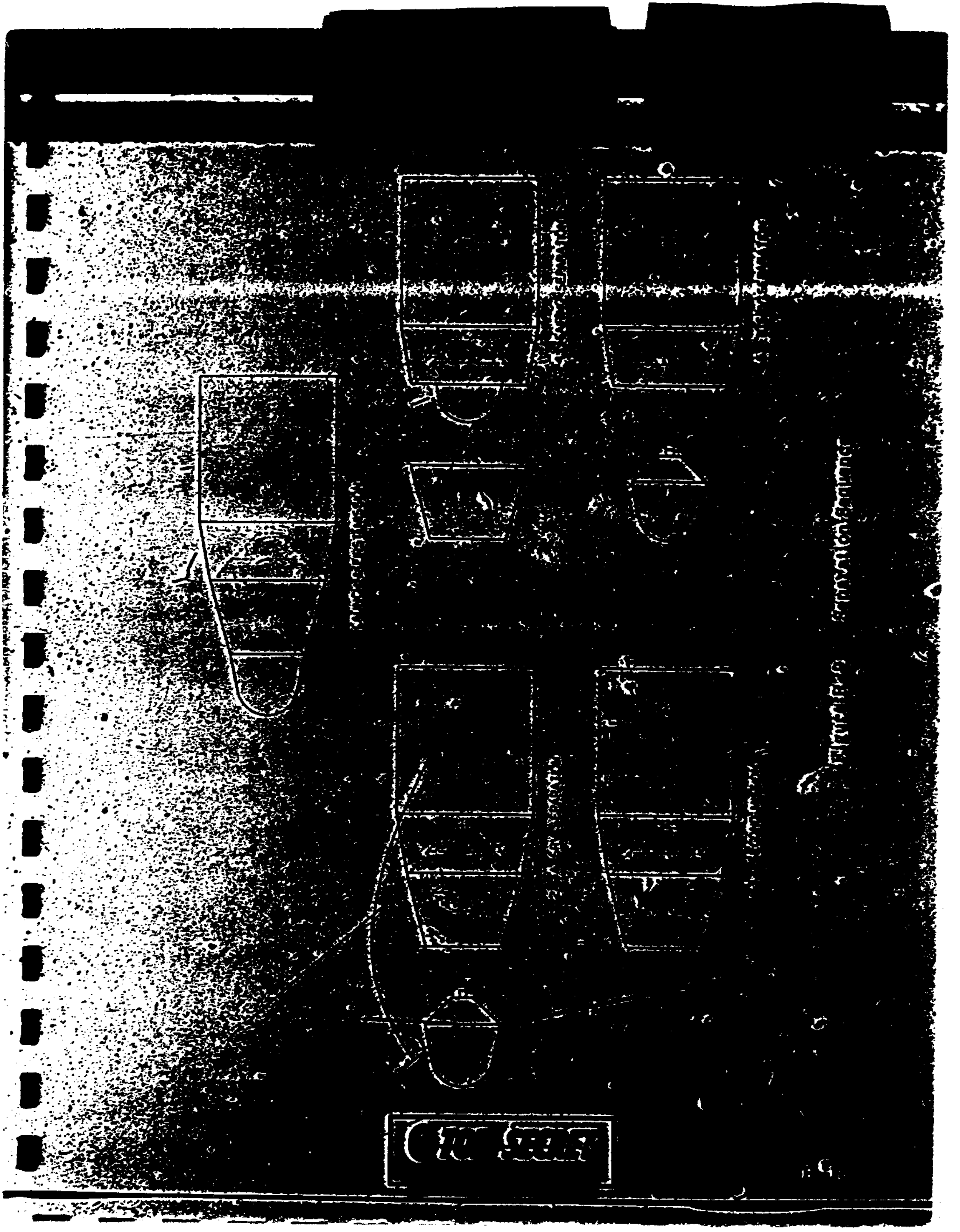
Figure R-8 Air Snatch by JC-130

Table R-1 SRV Sequence of Events

EVENT OR COMMAND	TIME OF OCCURRENCE (SEC.)	DESCRIPTION	SIGNAL SOURCE		SIGNATURE (REQMTS.)	
			ORIGIN	DESTINATION	VOLTAGE/CURRENT	DURATION
1. COMMAND RESET	PRE LIFT-OFF	RELAYS IN PROGRAMMERS AND SRV T/M ARE RESET	AGE	RECOV. PROG. EJECT. PROG. SRV T/M	21.0 TO 29.5 V/ 3.0 A MAX.	60 SEC. MAX.
2. COMMANDS #1 & #2	VARIABLE	ACTUATION OF DIMPLE MOTORS #1	SV	DIMPLE MOTORS	6.0 V/A.0 A	SV CONTROLLED
3. ARM SIGNAL #1	T_0-76 ± 0.5	ACTIVATION OF SRV T/M BATTERY. T/M STARTS OPERATING	SV TIMER	T/M BAT. SQUIBS	18.0 V/10.0 A	CONTINUOUS TO SV/SRV ELECT. SEPARATION
		BACKUP TIMER STARTS TIMING AFTER START RELAY IN RECOV. PROG. IS ACTUATED		RECOV. PROG.		
		ACTIVATION OF RECOV. BAT. #1 & #2 (BEACON TURN ON OPERATING FROM BAT. #1 ONLY). RECOVERY PROG. ARMED EJECT. PROG. ARMED.		RECOV. BAT. SQUIBS. RECOV. PROG. EJECT. PROG.		
4. ARM SIGNAL #2	T_0-76 ± 0.5	ACTIVATION OF RECOV. BAT. #1 & #2 (BEACON TURN ON OPERATING FROM BAT. #1 ONLY) RECOV. PROG. ARMED EJECT. PROG. ARMED (ABOVE EVENTS REDUNDANT WITH EVENT 3).	SV TIMER	RECOV. BAT. RECOV. PROG. EJECTION PROG.	18.0 V/8.0 A	CONTINUOUS TO SV/SRV ELECT. SEPARATION
5. TRANSFER SIGNALS #1 & #2	T_0-1.0 ±0.5	ACTUATION OF DIMPLE MOTORS #2. ACTIVATION OF EJECT. BAT. #1 & #2	SV TIMER	DIMPLE MOTORS EJECT. BAT. SQUIBS.	18.0 V/9.0 A	CONTINUOUS TO SV/SRV ELECT. SEPARATION
	T_0 (FOR SRV)	SV/SRV ELECT. DISCONNECTION (EJECT. PROG. STARTS T_S TIMING)		IFD #1 SQUIBS	SV CONTROLLED	
	T_0 +(LATER)	SV/SRV MECH. SEPARATION		ADAPTER PIN PULLERS	SV CONTROLLED	
6. SPIN SIGNAL (T_S)	3.4 ± 0.3 AFTER ELECTRICAL DISCONNECT	SPIN INITIATED (EJECT. PROG. STARTS T_R TIMING)	EJECT. PROG.	SPIN SQUIBS	8.0 A PER EJECT. BAT.	10 MS MIN.
7. RETRO SIGNAL (T_R)	T_S + 7.55 ± 0.45	RETRO ROCKET IGNITION (EJECT. PROG. STARTS T_{DS} TIMING)	EJECT. PROG.	ROCKET IGNITER	6.0 A PER EJECT. BAT.	40 MS MIN.
8. DESPIN SIGNAL (T_{DS})	T_R + 10.75 ± 0.50	DESPIN INITIATED (EJECT. PROG. STARTS THE JETTISON TIMING)	EJECT. PROG.	DESPIN SQUIBS	6.0 A PER EJECT. BAT.	10 MS MIN.
9. T/C JETTISON SIGNAL	T_{DS} +1.50 ± 0.15	GUILLOTINES ACTUATED TO RELEASE T/C-FOREBODY ATTACHMENTS. T/C-CAPSULE ELECTRICAL DISCONNECT	EJECT. PROG.	GUILLOTINES AND IFD #2	10.5 A PER EJECT. BAT.	20 MS MIN.
10. G SWITCH CLOSURE	3G INCREASING ACCELERATION	RECOV. PROG. TIMING CIRCUITS ENERGIZED	G SWITCH	RECOV. PROG.	CONTACT CLOSURE	VARIABLE
11. G SWITCH OPENING	3G DECREASING ACCELERATION	RECOV. PROG. TIMING STARTED	G SWITCH	RECOV. PROG.	CONTACT OPENING	VARIABLE
12. PARACHUTE COVER EJECTION SIGNAL (T_1)	26.0 ± 1.5 AFTER G SWITCH OPENING	COVER EJECT. PISTONS ACTUATED AND COVER EJECTED. FLASHING LIGHT ON FROM RECOV. BAT. #1. RECOV. PROG. STARTS. RECOV. PROG. RELAYS RESET.	RECOV. PROG.	PISTON SQUIBS FLASHING LIGHT	16.0 A PER RECOV. BAT.	20 MS MIN.
13. DECEL. PARA. DEPLOYED (T_2)	VARIABLE	DECEL. PARA. BAG LIFTED FROM CAPSULE. MAIN PARA. BAGLINE CUTTERS INITIATED FOREBODY SEPARATES FROM CAPSULE.	MECHANICAL EVENTS			
14. MAIN PARA. DEPLOYED (REEFED) (T_3)	T_2 +10.0 (+3.0, -1.5)	MAIN PARA. BAGLINE CUTTERS OPERATED DECEL. PARA. STRIPS MAIN PARA. FROM BAG. MAIN PARA. DEPLOYED (REEFED) REEFING LINE CUTTER INITIATED	PYRO DELAY AND MECH. EVENTS			
15. MAIN PARA. DIS-REEFED	T_3 +4.5 (+1.5, -1/3)	REEFING LINE CUTTERS OPERATED MAIN PARA. DISREEFED	PYRO DELAY AND MECH. EVENTS			
16. AIR SNATCH	VARIABLE	CAPSULE SNATCHED BY AIRCRAFT DURING DESCENT	MECH. EVENTS			
17. WATER IMPACT	VARIABLE	CAPSULE IMPACTS				
18. T/C JETTISON SIGNAL FROM BACKUP TIMER	(100-205) ± 60 SECS. AFTER ARM SIGNAL #1 (EVENT #3) (MAX. RECOV. BAT. ACTIVATION TIME = 35 SECS.)	GUILLOTINES (6) ACTUATED TO RELEASE T/C - FOREBODY ATTACHMENTS, T/C-CAPSULE ELECTRICAL DISCONNECT (ABOVE EVENTS OCCUR ONLY ON MALFUNCTION OF EVENT 9)	BACKUP TIMER GUILLOTINES AND IFD #2		10.5 A PER RECOV. BAT.	30 MS. MIN.
19. PARA. COVER EJECT. SIGNAL FROM BACKUP TIMER	(1500-1530) ± 30 SECS. AFTER ARM SIGNAL #1 EVENT #3 (MAX. RECOV. BAT. ACTIVATION TIME = 35 SECS.)	COVER EJECT. PISTONS ACTUATED (HEAT SHIELD RELEASED)(ABOVE EVENT OCCURS ONLY IF EVENT #12 HAS NOT OCCURRED)	BACKUP TIMER (THRU RECOV. PROG.)	PISTON SQUIBS	16.0 A PER RECOV. BAT.	20 MS MIN.
20. BEACONS AND RETRIEVAL	VARIABLE	BEACONS AND FLASHING LIGHT OPERATING				10 HOURS AFTER ARM SIGNAL #3 (MIN.)
21. SINK	48 TO 96 HOURS AFTER WATER IMPACT	CAPSULE SINKS (OCCURS ONLY IF EVENT #16 IS NOT SUCCESSFUL)	SALT WATER GALVANIC ACTION IN SINK VALVE			



SRV A Separate Command fires two pyro-actuated pin pullers in the fairing, which releases SRV A from the fairing. Four spring-loaded pushers in the fairing push on the rim of the thrust cone to eject SRV A straightaway from the main satellite at a velocity of 1.0 to 2.0 fps. Spin-up of the A SRV occurs approximately 3.4 seconds after separation.

After ejecting SRV A, the satellite pitches back up to the normal nose-first flight attitude, returns attitude control to the IRP guidance system, and resumes the normal minus 4 degrees/minute pitch rate necessary to keep the cameras pointing earthward during the B part of the mission. Upon command, the satellite again pitches nose down 120 degrees to the proper attitude for the SRV B recovery.

For B SRV separation, the second Recovery Enable command initiates firing of three pyro-actuated pin pullers located on the forward rim of the cone to release the fairing. Three spring-loaded pushers eject the fairing forward with a [illegible] fps velocity just prior to the start of the second 120 degree pitchdown. The SRV B sequence is now the same as the sequence used on SRV A.

R-4.1.2 Spin-Up

The SRV is spun up to [illegible] rpm by the cold-gas spin system. Spin-up is performed so that the SRV will provide a stable platform on which to fire the retrorocket, thus concentrating the retro force in the desired direction.

R-4.1.3 Retrorocket Fire

The retrorocket fires [illegible] the SRV [illegible]

[illegible]

R-4.1.4 Despin Phase

A residual spin (10 rpm) is desirable for vacuum flight stability. This provides a predictable atmospheric entry attitude while having a minimum resistance to angle of attack convergence prior to parachute deployment. The SRV is de-spun by a cold gas system identical to the spin system, except for a bottle pressure of 2400 psia (as opposed to 3000 psia for the spin system).

R-4.1.5 G Switch Activation and Operation

The RV during descent begins to decelerate as the air becomes more dense. This deceleration increases from [illegible] 3 G's up to a maximum of [illegible] G's, at which time it begins to decrease and attains 3 G's for the second time. When a deceleration of 3 G's is attained the first time, the G switches close [illegible] the recovery timing circuit. When a deceleration of 3 G's is attained for the second time, the G switches open [illegible] the recovery sequence. In this manner it is possible to assure parachute deployment at the proper RV altitude and velocity. A representative curve is shown in Figure R-10.

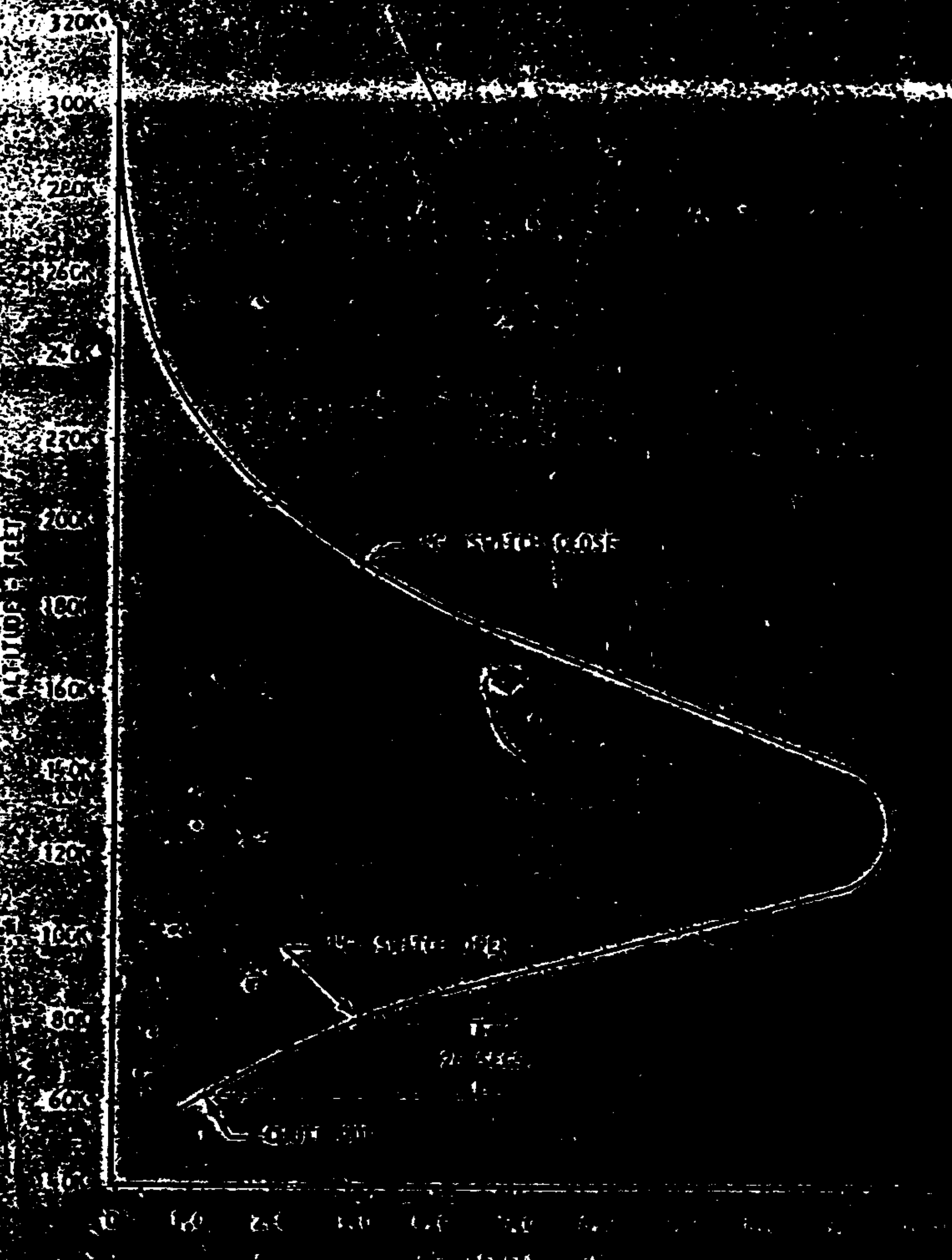
R-4.1.6 Parachute Deployment

Figure R-[illegible] shows [illegible] sequence is as follows:

a. At approximately [illegible] feet [illegible] [illegible] the [illegible].

b. As the [illegible] [illegible] [illegible].

[redacted] TOP SECRET



d. The main parachute actuates two parallel, four-second delay cutters connected to the reefing lines, which initially prevent full deployment in order to prevent excessive loads caused by deceleration.

R-5.0 RECOVERY, AIR/WATER

Normally, a recovery aircraft sights the descending capsule with ample time to perform an air catch. Should the aircraft fail to air catch, however, the capsule is designed to descend and remain afloat for a minimum of 48 hours. In 48 to 65 hours the capsule will sink, due to the action of an electrolytic sink valve located in the bottom of the capsule. During the time interval mentioned, and if sea state permits, the capsule may be retrieved by personnel and equipment parachuted into the impact area.

R-5.1 Lifeboat recovery is explained in paras. B-7.2.5.2 and B-7.2.5.3.

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SECTION S

QUALIFICATION TESTING

S-1.0 PURPOSE

The purpose of qualification testing is to simulate in the laboratories, and apply to the flight equipment, environments of at least the magnitude of those encountered in actual flight, thus assuring flight worthiness.

S-2.0 SUMMARY OF TESTS

The various environmental tests employed at AMR and its associates are summarized as follows:

a. Thermal
b. High-altitude
c. Vibration
d. Acceleration and/or loading
e. Shock
f. Electrical breakdown
g. [illegible]
h. Electromagnetic interference
i. Agena compatibility

S-3.0 ENVIRONMENTAL TESTING

S-3.1 Components and Subsystems [illegible] [illegible] of the [illegible] [illegible]

[illegible]

C-700 SERIES

S-3.1.1 Qualification Testing

Qualification testing means verifying the integrity of the design of a piece of equipment. Ordinarily, a newly designed unit comes to the qualification test unproven as to its ability to stand the stresses to which it will be subjected in use. Engineering calculations alone are not precise enough to guarantee performance. The new equipment, manufactured according to production drawings, is tested in the simulated environment mentioned in paragraph S-2.0, (a) through (l), as these tests apply. The levels of stress are purposely set higher than the equipment will experience in use, to insure that an adequate margin of safety has been included in the design.

S-3.1.1.1 Combined Thermal-Altitude Testing

[illegible] The pressure-temperature-altitude environments are categorized by equipment complexity and location. The categories are nonrecoverable and recoverable systems (including the complete payload vehicle), nonrecoverable and recoverable components, and SRV components. Generally, the environment for recoverable equipment is more severe than that for nonrecoverable, and that prescribed for components is more severe than for systems. The most severe environment is that to which SRV components are exposed. The equipment [illegible] operational [illegible] satisfactory performance [illegible] cations.

S-3.1.1.2 [illegible]

[illegible]

encountered during the boost phase of powered flight. These are random and sinusoidal, as follows:

a. Random Vibration - Random vibration is actually the response of the system (and the equipment) to acoustical excitation which occurs [illegible] during the period of transonic flight.

The acoustic [illegible] radiated directly from the turbulent engine [illegible] and pad facilities. The severe acoustic environment which occurs during transonic flight [illegible]

[illegible]

of the Agena. Analysis of the random vibration data from a transducer at the same location yielded overall rms levels of [illegible]

b. Sinusoidal

Although both the CMSC and AVE qualification frequency range [illegible] specified for sinusoidal vibration [illegible] 2000 cps, the only [illegible] disturbance occurs near 20 cps. The phenomenon, POGO, is the result of coupling between the [illegible] propulsion system and the [illegible]

[illegible]

applied separately [illegible] three axes. [illegible] test consists of a single sweep [illegible] minute per octave, and the random [illegible] applied for [illegible].

During [illegible] than those in the POGO [illegible] monitor [illegible] to limit the input to [illegible] such that the equipment will [illegible] beyond the [illegible] specified.

There [illegible] no requirement for [illegible] vibration [illegible] starting [illegible] complete [illegible]

S [illegible] [illegible]

[illegible] The environment [illegible] dynamic forces [illegible] booster/vehicle [illegible] acceleration [illegible] longitudinal [illegible] subjected [illegible] acceleration [illegible]

S [illegible]

[illegible]

[redacted]

chute deployment [illegible]

events are not mechanically simulated, but are accomplished [illegible]

actual live firing [illegible]

impact tests [illegible]

systems. [illegible]

the SRV [illegible]

fication tests.

S-3.1.1.5 [illegible]

[illegible]

equipment [illegible]

wiring [illegible]

[illegible]

S-3.1.1.6 [illegible]

[illegible]

In conjunction [illegible]

routinely [illegible]

system [illegible]

C and T [illegible]

S-3.1.1.7 [illegible]

[illegible]

ference) testing [illegible]

S-3.1.1.8 [illegible]

[illegible]

S-3.2 Environmental Tests, OPE Systems

S-3.2.1 Environmental Tests Completed on OPE Before Arrival at A/P

Qualification of OPE subsystems and components [illegible] formed to the [illegible] environmental [illegible] previously [illegible] device for obtaining uniformity of qu[illegible] General Environmental Specification for [illegible] Acceptan[illegible] to this document, which is a part of the program contract.

S-3.2.2 Environmental [illegible]

[illegible]

S-3.3.2.1 Systems Vibration Test

This is the primary mechanical qualification test of the complete vehicle system. It consists of a sinusoidal excitation through a frequency range extending from 5 to 400 cps.

All significant elements of the system and the input at the shaker are instrumented and monitored throughout the test.

The forces imposed (g level) are maximum through the POGO range (5 to 20 cps), and there is no input limiting in this range. With the exception of the POGO range, the shaker input is limited to preclude the imposition of forces upon various elements of the system excessive of the levels to which they had been qualified as components or subsystems. The line of action of the excitation is along the vehicle longitudinal axis, and the input crosstalk is limited to 100 percent of the primary input.

The system is exercised before and after the test, and a light leak test is performed after the test. The system performance must satisfy the criteria published in various detail specifications in order to qualify the design. Also, resonance in the POGO frequency range is cause for a review of the design.

S-3.3.2.2 Systems Thermal-Altitude Simulation

A system design adequacy test provides the primary and most comprehensive measure of system total design adequacy. Its objective is to monitor system and subsystem performance and temperature and pressure response in all modes of operation while the system is experiencing the mission operational environment. The system is considered qualified when an analysis of the data, including evaluation of payload, has provided a permanent record of in-specification performance. The HIVOS chamber is a heat flux simulator, rather than a solar simulator. In consideration of the heat transfer properties of both the chamber and the vehicle, the chamber heat flux is programmed so that the vehicle will obtain that amount and distribution of energy absorbed which has been predicted by the system math model.

The complete payload system is subjected to an orbital simulation during which dynamic thermal programming reproduces the effects of various orbit solar incidence angles (Beta) and a vacuum representative of typical orbits. The system is in orbital configuration with all thermal masses installed or simulated, and the vehicle external surface is painted to the design pattern. Pressure and extensive temperature instrumentation are installed.

The test is of fourteen days duration, during which the system is exposed to five periods of dynamic heating (corresponding to orbits of five different solar incidence angles) and two operational soak periods. The system is operated in all modes at least once during each simulated orbit and soak period, and during one of the simulated orbits the system is operated for the maximum design duty cycle.

S-3.3.3 Compatibility Test

A compatibility test is performed on the Qualification system wherein the payload system and the Agena are mated mechanically and electrically. During the course of this test, all Agena payload functions are programmed in order to reveal possible anomalies in compatibility.

S-3.3.4 Road Transportation Environments

No test environments are imposed to simulate road transportation environments. The vehicle transport is maintained at $70 \pm 5^{\circ}F$; measurements taken during a test trip to the base showed that transport environments were within limits. The present transporter has been designed to carry explosives. All electrical wiring is shielded by conduit.

S-3.3.5 Launch Pad Environment

Temperature and humidity on the pad are controlled, respectively, by a frangible sheath which covers the entire payload vehicle, and through which heated air is circulated, and by circulation of dry nitrogen internally through the vehicle. The sheath, which falls away at launch, protects the vehicle external surface against the weather and airborne salt spray and dust.

SECTION T

FACTORY-TO-LAUNCH TESTING PHILOSOPHY AND SEQUENCE

T-1.0 PURPOSE

The purpose of the factory-to-launch test sequence is to insure that test methods and operations produce maximum system reliability with minimum handling and redundant testing, thereby assuring maximum confidence from factory to launch.

T-2.0 BASIC TEST PHILOSOPHY

The basic philosophy in test methods and operations is oriented toward producing maximum reliability with a minimum of redundant or recycle tests. The test sequence is governed by the objectives of the factory-to-launch concept, wherein system integration, assembly, and acceptance tests are performed to ready the payload system at the factory for shipping and mating with the launch vehicle. The requirements for component and subsystem tests are directed to obtain maximum confidence prior to integration into the system. It is intended that no tests performed at the subsystem level need be directly repeated at the system level. The test sequence is arranged to minimize handling, retest, and mating/demating, and is oriented toward final acceptance based on the successful completion of the thermal/altitude test.

T-3.0 TEST SEQUENCE

The testing sequence is as shown in the J-3 Test Flow Diagrams (Figures T-1 and T-2). This test flow minimizes handling and retest from manufacturing to launch, and is arranged as follows:

a. GFE acceptance tests

[redacted]

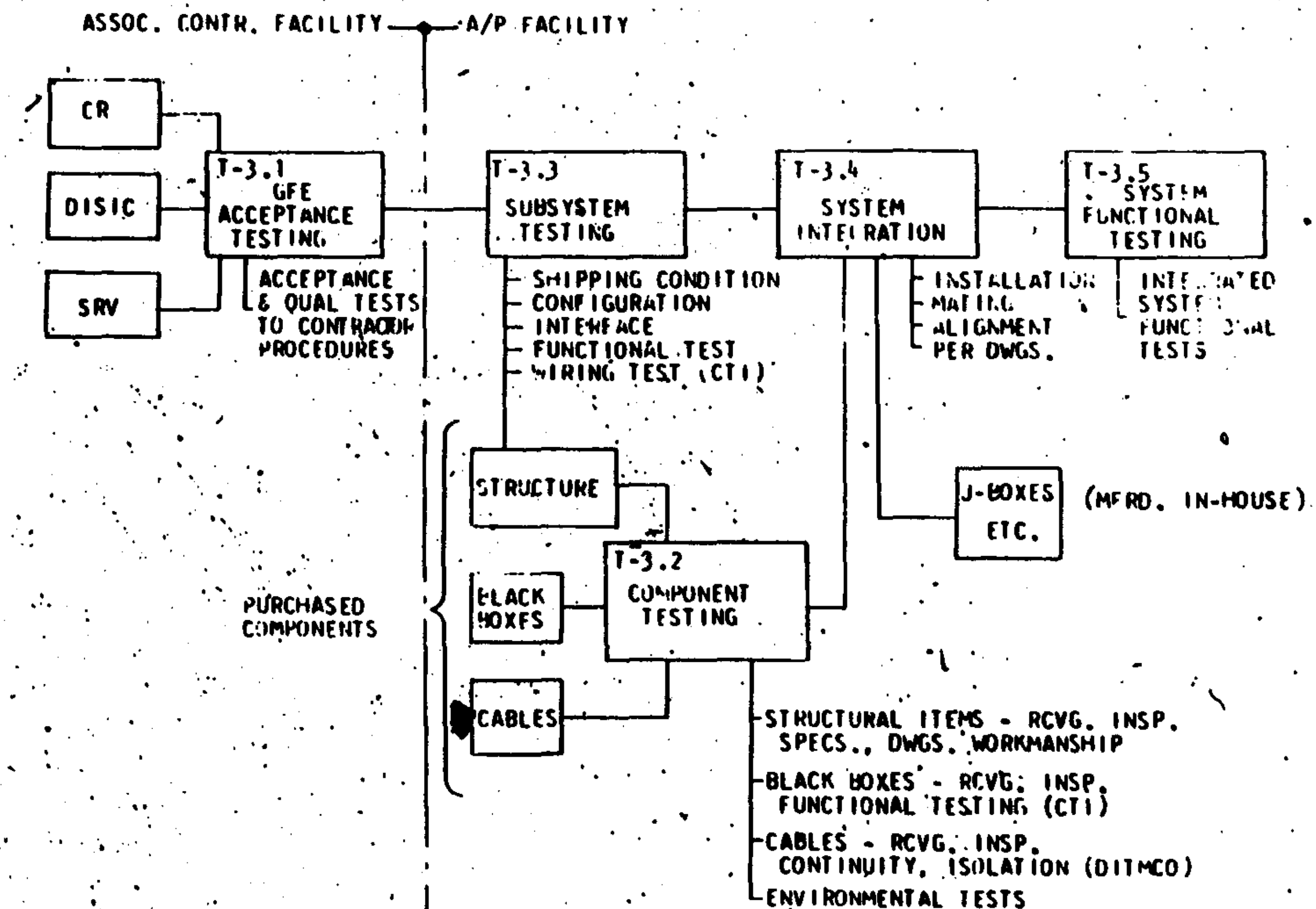


Figure T-1 Test Flow - Manufacturing-to-System Test

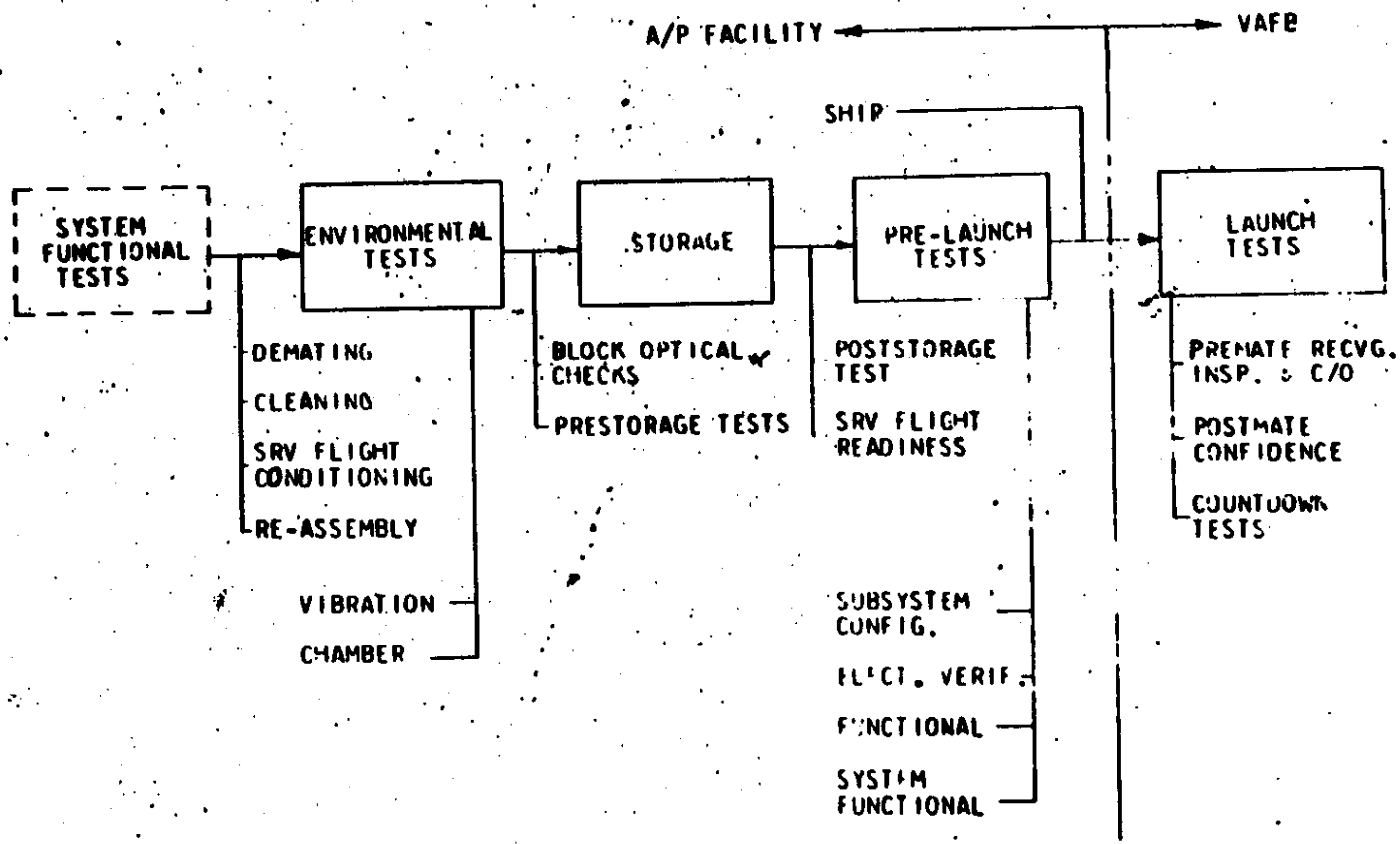


Figure T-2 Test Flow - System Test-to Launch

[redacted]

b. Component tests

c. Subsystem tests

d. System integration

e. System functional tests

f. Environmental tests

g. Prelaunch tests

h. Launch tests

T-3.1 GFE Acceptance Tests

GFE acceptance tests are accomplished at the following associate contractor facilities.

a. CR camera system -- Boston

b. DISIC camera system -- New York

c. SRV system -- Philadelphia

Each associate has established a logical sequence of testing from component acceptance through subsystem assembly and functional verification. Final acceptance criteria are established to prove that the subsystem meets operational design requirements.

T-3.2 Component Tests

Component testing includes those tests required to establish that A/P-furnished hardware is ready for system integration. Structural components are inspected for conformance to drawings, specifications, and workmanship. Electrical cabling is subjected to continuity and isolation DITMCO testing. Black box components are functionally tested by automatic testing devices (CTI) to verify proper wiring and mode responses. Operational capability is proven at designed environmental and functional levels.

T-3.3 Subsystem Tests

Subsystem testing is accomplished on all GFE equipment after arrival at A/P. Each subsystem is inspected for compliance with shipping conditions, configuration, and interface requirements. The operational integrity is verified by functional testing prior to integration into the system. All structural wiring installations are verified by CTI testing.

T-3.4 <u>System Integration</u>

System integration provides for the installation of all GFE and A/P subsystems into the structural components. Proper mating alignments and locations are verified for compliance with appropriate installation drawings and block diagrams (ref. T33-6000 and T33-3000).

T33-6000

Installation Summary Drawing

T33-3000

Electrical Block Diagram

T-3.5 <u>System Functional Tests</u>

The system functional tests determine that the integrated system is operating properly and meets all functional requirements. After assembly as a system, interface resistances are measured and verified. DISIC tracking is verified by visual observation of the film path between DISIC components, TUNA, forward roller box, and both take-up units. The CR camera system is operated to provide roller alignments and tracking verification. Both camera systems are operated sufficiently to establish proper stacking on each take-up unit.

Special test harnesses are installed to facilitate the functional checkout of the complete system. In this configuration, the following tests are conducted:

a. All interface commands are exercised and proper responses checked.

b. Compatibility of ancillary equipment such as the slope programmer, exposure control and clock are verified with the camera subsystems.

c. Operational modes and cycle rates of the DISIC are established.

d. A check is made of high, low, and three intermediate cycle rates of the CR instruments when controlled by the slope programmer.

e. The cut-and-splice and the cut-and-wrap operations are verified.

f. The system is operated at expected flight voltage extremes and proper dynamic operation verified.

g. Power consumption and AC voltage distortion are verified.

h. A pyro load test, stray voltage, and continuity test are performed.

i. System instrumentation and calibrations are verified.

j. A live film run is conducted and all auxiliary data are reviewed for the DISIC and the CR instruments.

T-3.6 <u>Environmental Tests</u>

At the completion of the above tests, the system is demated and cleaned in preparation for the environmental acceptance tests. The SRV's are returned to the SRV lab for film retrieval and buildup to a simulated flight condition.

T-3.6.1 Light Leak

After system assembly, a light leak search is conducted using photomultipliers. This test assures light leak integrity for the chamber operations.

T-3.6.2 Vibration

The system is completely assembled in near-flight configuration for acceptance vibration. This test provides low-level vibration of the system to prove manufacturing integrity. The system is operated prior to and after the vibration test to verify operational status.

T-3.6.3 Thermal Altitude Test

Following postvibration inspection, the system is prepared for the thermal-altitude test with installation of special instrumentation. Test cables are installed to provide automatic cycle rate data, diagnostic data for operational evaluation, thermocouples for auxiliary temperature data, and vacuum gages to record system pressure.

T-3.6.3.1 A prechamber confidence test is conducted at A/P prior to shipment of the system to the chamber. This test verifies that all subsystems are operational and that performance is normal. The system is then shipped to the HIVOS thermal-altitude chamber where it is installed on the chamber door. All AGE cables are verified and connected to the system. Fogging lamps are installed in place of the optic doors. All thermocouples are connected and verified with the chamber recorders. A confidence run is conducted to verify the system prior to closing the chamber for pumpdown.

T-3.6.3.2 The thermal-altitude test provides a complete mission simulation for payload system acceptance. During the test, all command functions are exercised and all modes of operations are verified. Programming of system operations is accomplished either

[redacted]

manually or by an automatic tape programmer. All data from the thermal-altitude test are reviewed for the following:

a. Cycle rates
b. Power summary
c. Dynamic performance
d. Proper cut and wrap
e. Proper cut and splice
f. PMU performance
g. Command system performance
h. System instrumentation
i. Thermal paint pattern

The processed film is reviewed for corona marking, presence of auxiliary data, and proper camera operation.

After the chamber test, the system is placed on the block for photo optical testing. The panoramic instrument resolution capabilities are verified and theodolite calibrations are obtained for the horizon cameras.

CR-1 thru CR-4 only: Prior to starting the prelaunch tests, the system is assembled and loaded with fast film for a light leak soak test under high-intensity light levels. The film is processed and reviewed for evidence of light leaks.

T-3.7 Prelaunch Tests

Prelaunch tests are those tests performed at A/P during the period between the completion of system acceptance tests and the shipping of the payload system to the launch base. Prelaunch testing and limitations are defined in the prelaunch and launch requirements specification for J-3 systems [redacted].

T-3.7.1 Subsystem Configuration Verification

At the start of prelaunch testing, the configurations of all subsystems in the structure are examined and verified with the system drawing list to be in accordance with mission requirements.

T-3.7.2 Subsystem Electrical Verification

Continuity of subsystem wiring is verified by testing all pins on the payload/Agena interface connectors with a CTI analyzer. The CTI test is automatic by means of a punched tape. In prelaunch testing the CTI test is performed on the payload after environmental tests and final cleaning, after storage, and, to a limited extent, after final system assembly.

T-3.7.3 Subsystem Operation Verification

The SRV, DISIC, and CR camera subsystems are verified by a functional test. The flight readiness of the DISIC and CR subsystems is proven by exposing film during the functional tests and analyzing the processed film.

T-3.7.4 Flight Readiness

In addition to the functional tests of the subsystems and the system, there are several other operations required to ready the payload for flight. After the configuration verification described in para. T-3.7.1 and the final cleaning, pyros are installed, DRCG "offset" is determined, pressure vessels are pressurized, the supply cassettes are loaded with flight film, and the system is closed up in flight configuration, given a light leak test, and weighed.

T-3.7.5 System Operation

The assembled system is verified by functional tests of tracking, shutter operations, command response, T/M monitors, and SRV transmissions.

T-3.7.6 Loading and Shipping

After the completion of the flight readiness and prelaunch tests, the system is secured, loaded onto a transport van with required AGE, and shipped to VAFB on R-4 day.

T-3.8 Launch Tests

Launch tests are those tests performed at the launch base during the period between the unloading of the payload from the transportation van and the launching of the payload with its boosters. Launch testing and limitations are defined in the prelaunch and launch requirement specification for J-3 systems (T3-7-018).

T-3.8.1 Pre-Mate Receiving Inspection and Checkout

After arrival at the launch base, the payload system is transferred from the transportation van to the payload trailer where it is given a receiving inspection and checkout to verify that the payload is ready for mating with the Agena. This test, conducted on R-3 day, includes a visual inspection, functional checkout, and a light leak check.

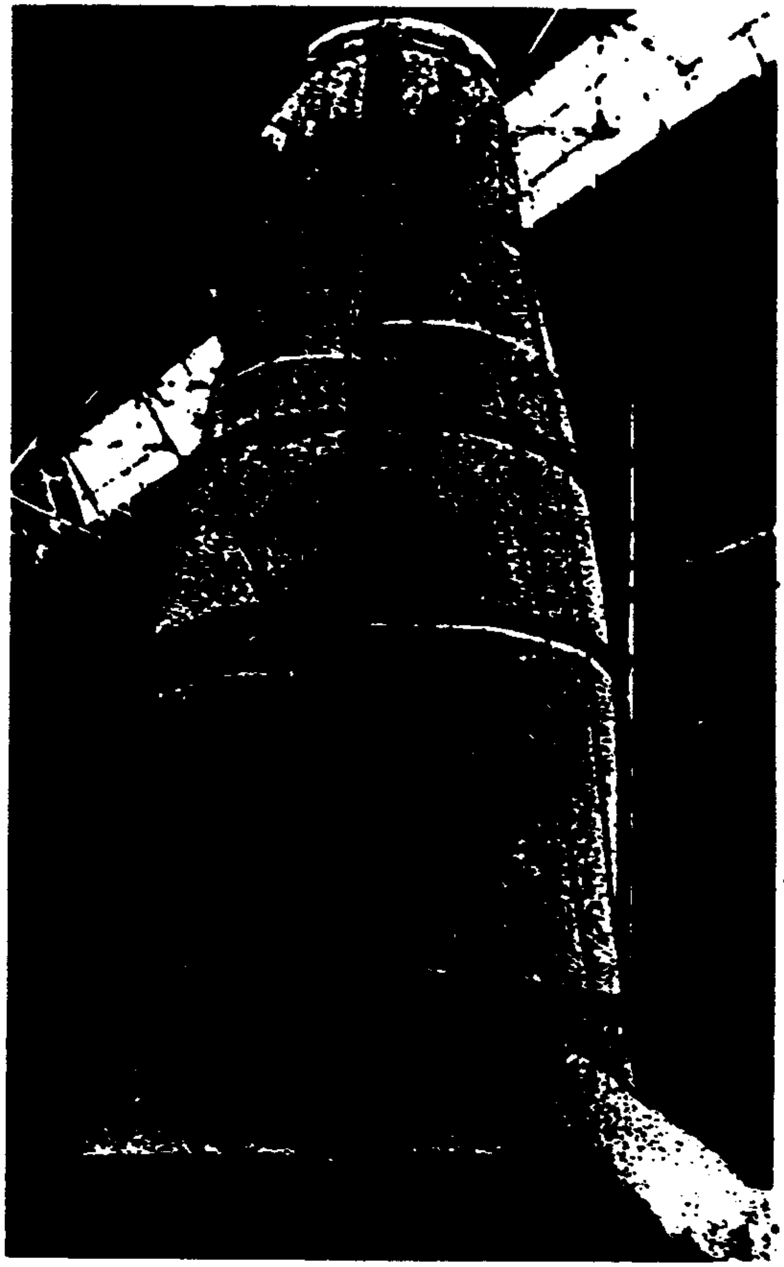
T-3.8.2 Mating

On R-2 day the system is mated to the Agena after being transferred from the trailer to the launch pad. Retro rockets are connected, and the Agena electrical interface is verified. After verification of the interface, the payload is mechanically and electrically mated to the Agena and the environmental sheath is installed. See Figure T-3. This completes the mating.

T-3.8.3 Post-Mate Confidence Tests

The post-mate confidence tests are conducted to verify the launch readiness of the payload/Agena system. These tests include the following:

[redacted]



PICTURED DURING DEVELOPMENTAL TESTS

Figure T-3. Environmental Control Sheath

a. Alpha test to verify camera operations.

b. Bravo test to measure recovery transmitter frequencies and verify tape recorder playback to start of tape.

c. Verification of payload response to real time commands.

d. Negative check and positive verification of stored program commands.

e. Verification of slope, OSFG, and switch programmer operation.

f. Verification of independent and slave operation of the DISIC.

g. Functional verification of CR instrument operation.

T-3.8.4 Countdown Tests

During countdown to launch on R-0 day, the system operation is again verified by repeating the Alpha and Bravo tests (para. T-3.8.3).

SECTION U

AEROSPACE GROUND EQUIPMENT ELECTRICAL AND MECHANICAL

U-1.0 PURPOSE

The electrical and mechanical aerospace ground equipment is used to test, control, and handle the payload at the component, subsystem, and system levels during manufacture, checkout and launch.

U-2.0 CHECKOUT EQUIPMENT

This section provides a detailed description of the major test consoles and test aids required to test and qualify the J-3 flight components, subsystems, and complete payload system.

Note: Each item of electrical test equipment which contains measurement equipment is stamped or sealed with a calibration sticker validated for the using period.

U-2.1 <u>Component Qualification and Acceptance Test Panels</u>

U-2.1.1 Introduction

The purpose of the test panels is to provide power and commands for the component J boxes, measure component voltages and currents, and verify component circuit continuity during qualification and acceptance tests.

U-2.1.2 Description

The component qualification and acceptance panels consist of eight pieces of equipment, each for testing a particular flight component. Part numbers are given below for each panel. This allows reference to drawings for greater detail.

Pyro Box

Command Box

Cycle Counter

Switch Programmer

A/T/M Box

Slope Programmer

SLP Controller

PMU Panel

U-2.1.3 Capabilities

The test panels have the capability for the following:

a. Qualification of the component boxes during the environmental test phase.

b. Power and manual commands to operate the component boxes during test.

c. Measurement of voltage and current during environmental testing of component boxes.

d. Verifies that component circuit wiring is in conformance with the design requirements.

e. Assurance that circuits function and respond properly.

Recorders can be patched into the breakout banana jacks on the panel.

U-2.2 SRV Pyro Load Flight/Assembly Console

U-2.2.1 Purpose

The console is used to perform [illegible] installing the live pyro devices in the [illegible] prior to [illegible]

U-2.2.2 Description

The console [illegible] containing [illegible]

U-2

of the console are 52 in. high x 24 in. wide x 20 in. deep.

U-2.2.3 Capabilities

The SRV-Pyro Load Flight/Assembly Console provides the following:

a. A breakout point for all interface connectors which can be used for troubleshooting faulty circuits.

b. A voltmeter, ohmmeter, and an ignition circuit meter which measure the continuity and resistance of each SRV circuit and the resistance of each pyro circuit and fusistor.

c. A continuity and resistance test of each squib at installation.

d. A test for stray voltage prior to final harness connection.

U-2.2.4 Reference Document

a. Top Assembly Drawing T8-2[illegible]

U-2.3 Automatic Programmer Console

U-2.3.1 Purpose

The automatic programmer console uses a taped program checkout sequence to automatically supply the [illegible] console with simulated Agena commands. It also controls the speed of the Sanborn recorders. A block diagram is shown in Figure U-[illegible].

U-2.3.2 Description

The console consists of a single-bay, floor-mounted enclosure containing a GT tape reader, command control unit, GT tape handling unit, recorder speed control unit, and a 28 VDC power supply. The dimensions of the console are 72 in. high x 24 in. wide x 24 in. deep.

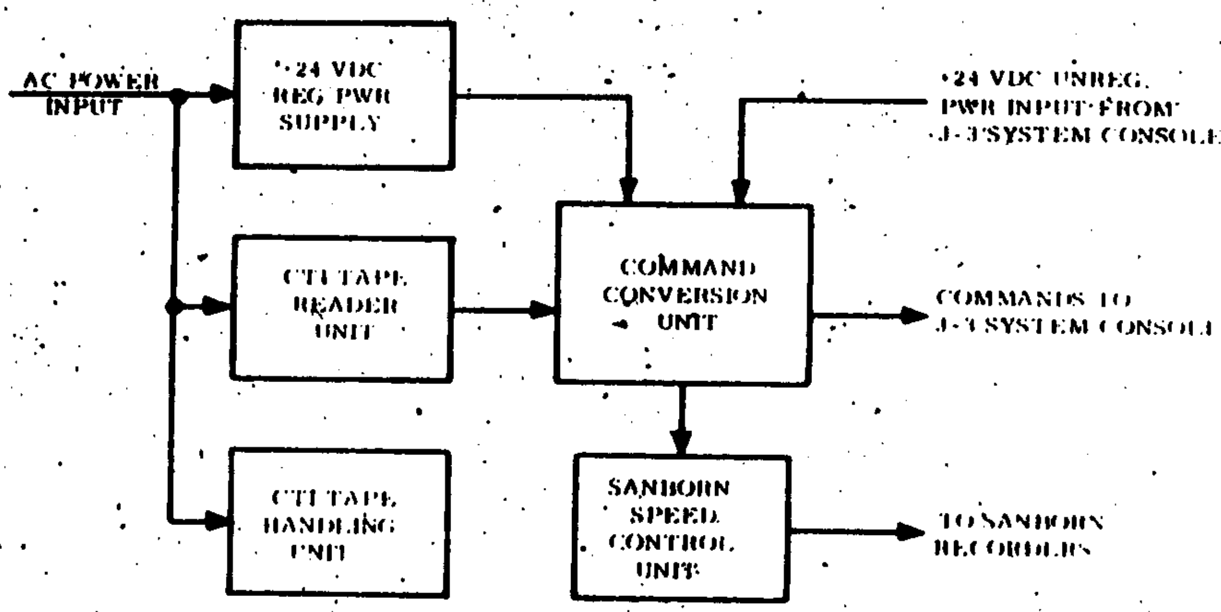


Figure U-1 Automatic Program Console - Block Diagram

C TOP SECRET

U-2.3.3 Capabilities and Operation

U-2.3.3.1 Tape Reader

The console uses a CTI tape reader and tape handli for the command generating source.

U-2.3.3.2 Command Conversion

A brush closure on the tape reader energizes a con relay in the console. The contacts of the conversion relay payload command to the J-3 console.

U-2.3.3.3 Automatic Program.

An automatic program is defined as any program w exists on a punched tape. The tape is passed through the re one frame at a time by manually depressing the step switch reader panel once for each frame, or setting the A.P.C. to automatic mode causing the tape to automatically step.

U-2.3.3.4 Power Source

The console has an internal +24 VDC power supply is used to actuate the conversion relays. It is supplied +24 unregulated and unregulated return from the J-3 console thr external cabling. This power is used for all commands sup the J-3 console.

U-2.3.3.5 Safety Circuits

The control circuitry in the console prevents any c from being sent to the J-3 console unless the tape is indexe perly in the CTI reader head. Improper indexing of the tap prevents the tape from transporting when the step switch is pressed. No commands are sent if the brushes are placed c head without a tape being present. A reset switch on the co unit establishes a Start Test configuration.

U-2.3.3.6 Sequence of Operation

Normal operation results in the following sequence: The step switch is depressed manually to initiate a step to the next frame: The tape reader advances the tape to the next frame. When proper indexing is established, +24 VDC console power is applied to all conversion relays for a period of one second (this time duration is variable from 0 to 10 seconds). Those relays which are returned to the tape reader head through their respective brushes are energized for this period of time.

At the end of one second, +24 VDC power is removed from all conversion relays. Commands requiring time duration longer than one second are supplied by a latching relay and two brushes. The reader is now ready to be stepped to the next frame by repeating the cycle outlined above.

U-2.3.3.7 Visual

An amber Adjust Lamp on the reader panel is programmed to light when an adjustment or reading is required by the test personnel. Completion of a test is indicated by a White Complete light on the reader panel.

U-2.3.3.8 Sanborn Recorder Control

The automatic program console uses six brushes exclusively for controlling a maximum of four eight-channel Sanborn recorders. Proper selection of these brushes selects one of nine paper drive running speeds. All recorders operate at the same speed.

Speed Control Programming:

Speed (mm/sec.)	Brushes
100	9D, 9F, 10A, 10B, 10C
50	9D, 10A, 10B, 10C

Speed (mm/sec.)	Brushes			
25	9D,	10A,	10B,	
10	9D, 9F,		10B,	10C
5	9D,		10B,	10C
2.5	9D,		10B	
1.0	9D, 9F,			10C
0.5	9D,			10C
0.25*	9C,			

*Brush 9C (Recorder Control Reset) must be sent before programming another speed.

U-2.3.4 Reference Documents

a. Top Assembly Drawing T8-1470

b. Console Schematic Diagram T8-1471

c. Tape Reader Schematic Diagram FT-12295-1

U-2.4 J-3 System Test Console

U-2.4.1 Purpose

The console is used at A/P in Systems Test and at the launch base in the payload checkout trailer. The console simulates the Agena orbital vehicle for performing the system functional test of the J-3 payload system. The console can be operated manually or automatically programmed with the aid of the automatic program console as shown in Figure U-2.

U-2.4.2 Description

The J-3 system test console is a three-bay console, 60 inches long, 48 inches high, and 24 inches deep. It is mounted on a rigid, steel plate chassis equipped with two reinforced fork lift channels and heavy-duty, rubber-tired ball bearing casters with brakes. The console contains one digital voltmeter, five panel

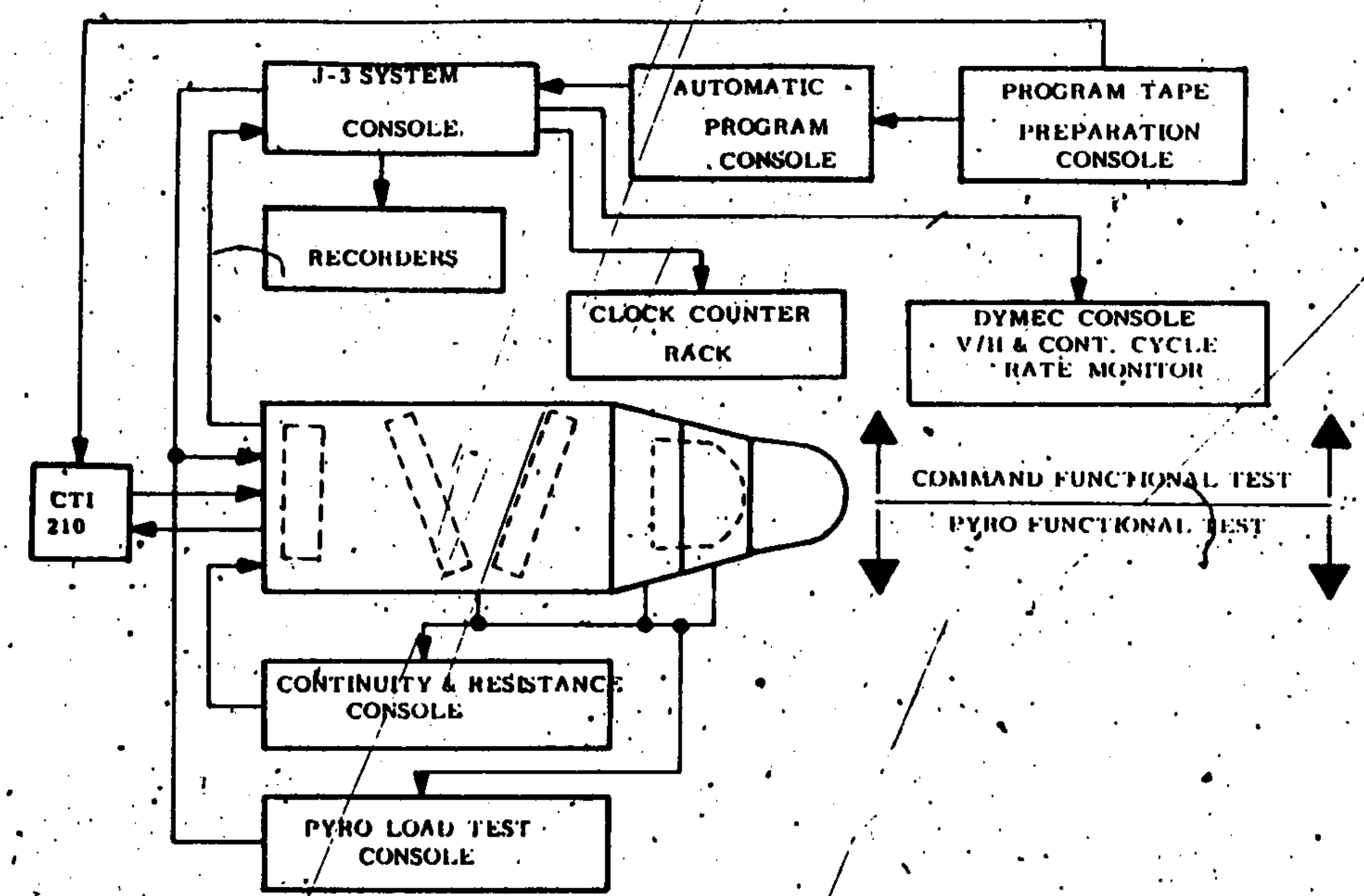


Figure U-2 System Test Configuration for Functional Test - Block Diagram assemblies for power and command control, T/M patching and monitoring, and an interface test panel. A block diagram is shown in Figure U-3.

U-2.4.2.1 Left Bay

The left bay contains the power control panel assembly, the digital voltmeter, the digital range selector, the AC/DC converter, the 400-cycle 115 VAC power supply, and the -28 VDC regulated power supply.

U-2.4.2.2 Center Bay

The center bay contains the command control panel, a supply drawer, and the +24 VDC unregulated power supply.

U-2.4.2.3 Right Bay

The right bay contains the T/M monitor panel assembly, the interface test and distribution panel assembly, and the patch panel assembly.

U-2.4.2.4 Rear of Console

All system interface and test connectors are located in the rear of the console.

U-2.4.3 Capabilities

U-2.4.3.1 Power Systems

Three commercial power supplies in the console furnish the voltages required to test and operate the complete J-3 payload system for all acceptance, qualification, and flight-readiness testing.

U-2.4.3.1.1 Unregulated Power Supply

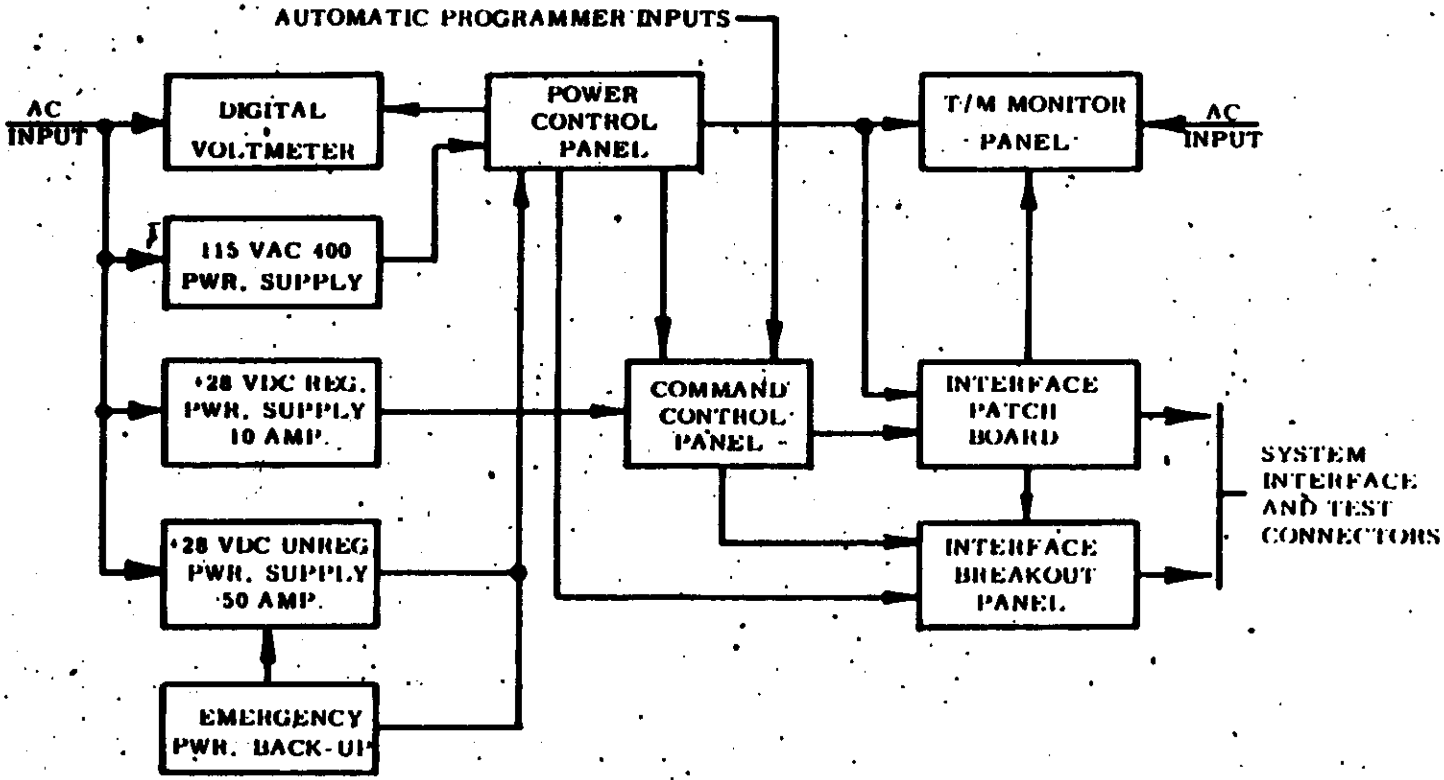


Figure U-3 J-3 System Console - Block Diagram

This supply is a [redacted] Model TVR28-50, 50 amps @ 22 to 32 VDC output, requiring 60-cycle, 3 phase input 208/230 VAC. It simulates Agena battery power to the payload interface and provides power for the consoles. The unregulated power is divided off within the power control panel to the following three main buses, which are protected by circuit breakers (1) unregulated power bus (2) pyro power bus, and (3) console power bus.

U-2.4.3.1.2 400-Cycle, 115 VAC Power Supply

This supply is a [redacted] Model 161A-OSC-1, 400-cycle ± 0.1 percent, 115 VAC, 400-cycle, single-phase output unit requiring 60-cycle, single-phase input 115 VAC. The supply simulates the Agena 400-cycle inverter power to the payload interface. The single phase is divided into two buses for the convenience of interface terminology, thus simulating A phase, B phase and C phase.

U-2.4.3.1.3 +28 VDC Regulated Power Supply

This unit is a [redacted] +28 VDC Model SC-32-10A, 10 ampere, +28 VDC regulated output. It requires 60 cycle, single-phase input 105/125 VAC. This power supply only supplies power for the fogging film tests. It does not support power to the payload system interface. Fogging film test control is located on the command and control panel.

U-2.4.3.1.4 Emergency Power Supply

Provision is included in the console to connect an emergency power back-up system. This provides unregulated voltage to the payload system in case the commercial unregulated power supply fails and allows the operator to shut down the payload in a normal way.

[redacted]

U-2.4.3.1.5 Power Control Panel

The power control panel represents the power interface between the Agena and the payload system. It provides voltmeters and ammeters for readout of voltage and current levels in each power bus, and provides switches from each power bus into the payload system. The meters and switches are arranged in three rows with the voltmeters in the top row, the ammeters in the middle row and the switches pertaining to that power supply below the meters. The fail-safe indicator lights and reset switch are located on the right-center side of the panel. Jack connectors are provided for precise measurement of power loads for each voltage.

U-2.4.3.2 Command

The command control panel provides two modes of operation:

a. The Manual mode, in which all commands are set up and executed by the operator.

b. The Automatic mode, in which all brush commands and real time commands are supplied by a tape in the automatic programmer console.

U-2.4.3.2.1 Control

a. Operational Commands

(1) 8 UHF real time commands (RTC)

(2) 8 analog S-Band real time commands (RTC)

(3) 2 S-band secure real time commands (SRTC)

(4) 28 stored program commands (SPC)

b. Recovery Commands

(1) Arm

(2) Transfer

(3) Disconnect

(4) Separation

[redacted]

c. Special-Purpose Commands

(1) In-Flight reset

(2) A/P Orbit mode

(3) A/P Data enable

(4) A/P Recovery enable

(5) T/M ON

d. Umbilical Commands

(1) A/P Command #1 - Continuity Loop Power

(2) A/P Command #2 - Arm By-Pass #2

(3) A/P Command #3 - Instrument Operate

(4) A/P Command #4 - Arm By-Pass #1

(5) A/P Command #5 - Orbit Mode Control

(6) A/P Relay reset

e. AGE Commands

(1) SRV reset

(2) Two slope programmer commands

(3) Digital tape recorder command.

(4) Two PMU commands

(5) F/L command

(6) All ones command

(7) T/U and B/U command

(8) Automatic Mode/Manual Mode-Select

U-2.4.3.3 Monitor

The console provides a test point for each pin of the interface plugs to allow trouble shooting or monitoring. Command status is indicated by individual lights plus meters to indicate the command given. A patch panel is also provided which allows all points to be patched to recorders. The Dymec console can be patched in to monitor voltages and time periods. Current shunts are connected to remove recorders through the patch panel to record current wave forms.

U-2.4.4 Reference Documents

a. Acceptance and Qualification Test Specification T3-6-063

b. Engineering Analysis T9-7-004

c. Top Assembly Drawing T8-2620

U-2.5 Thermal Altitude Chamber (HIVOS) Console

U-2.5.1 Purpose

The console is used during the HIVOS chamber environmental test to simulate Agena commands for flight simulation testing, and also provides precise measurement of voltage and current levels during dynamic and/or static tests. The console can be operated manually or automatically programmed with the use of the H-timer.

U-2.5.2 Description

The HIVOS chamber console is a six-bay console, 10 ft. long, 48 in. high, and 24 in. deep, as shown in Figure U-4. It is mounted on a rigid steel plate chassis equipped with a tow bar and heavy rubber-tired ball bearing casters with brakes. The console contains three commercial power supplies and one 115 VAC, 400 cycle, 3-phase vehicle power supply, eleven panel assemblies for power and command control, T/M patching and monitoring, pressure monitoring, and an interface test panel. A block diagram is shown in Figure U-5.

U-2.5.2.1 Bay 1 contains

a. H-timer

b. H-timer control panel

c. H-timer sequence panel

d. Interface break-out panel

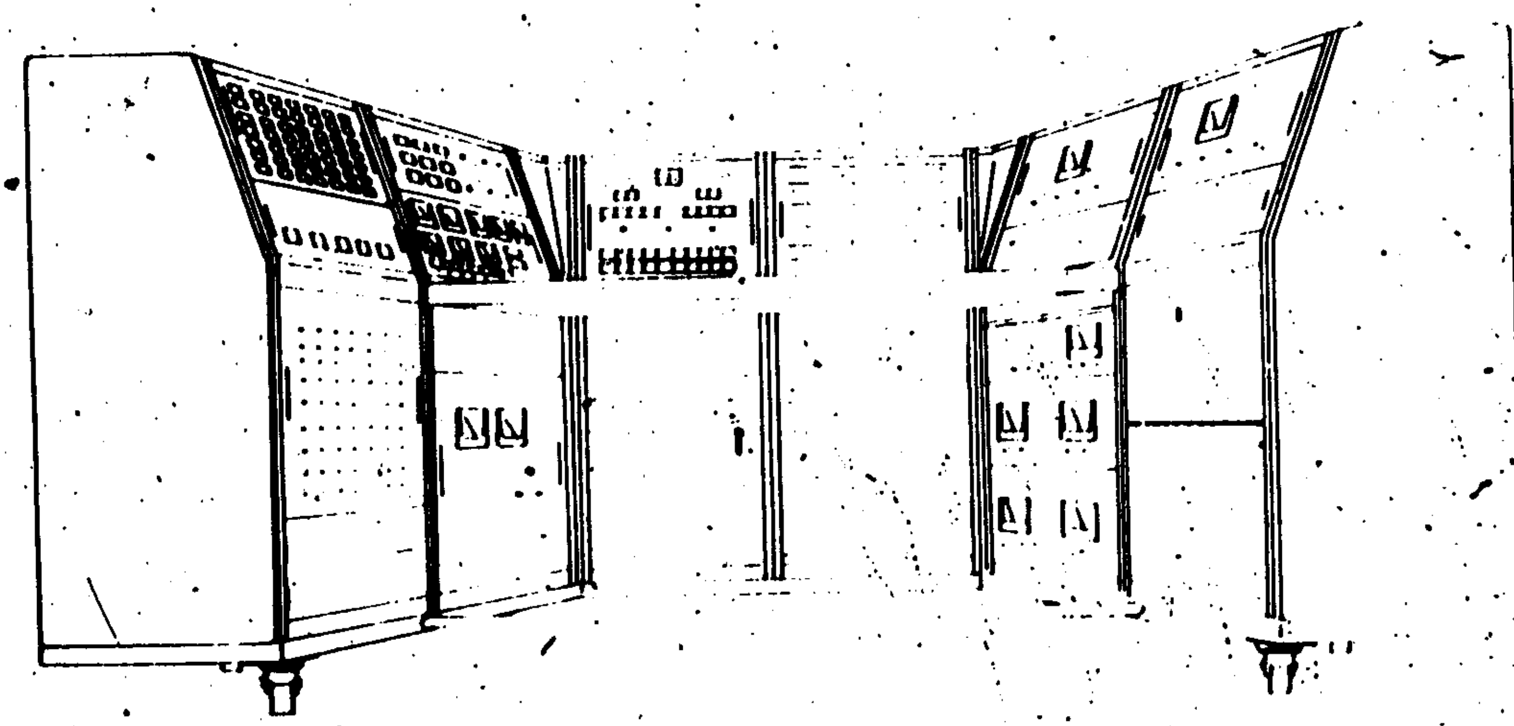


Figure U-4 Thermal Altitude Chamber Console

TOP SECRET [redacted]

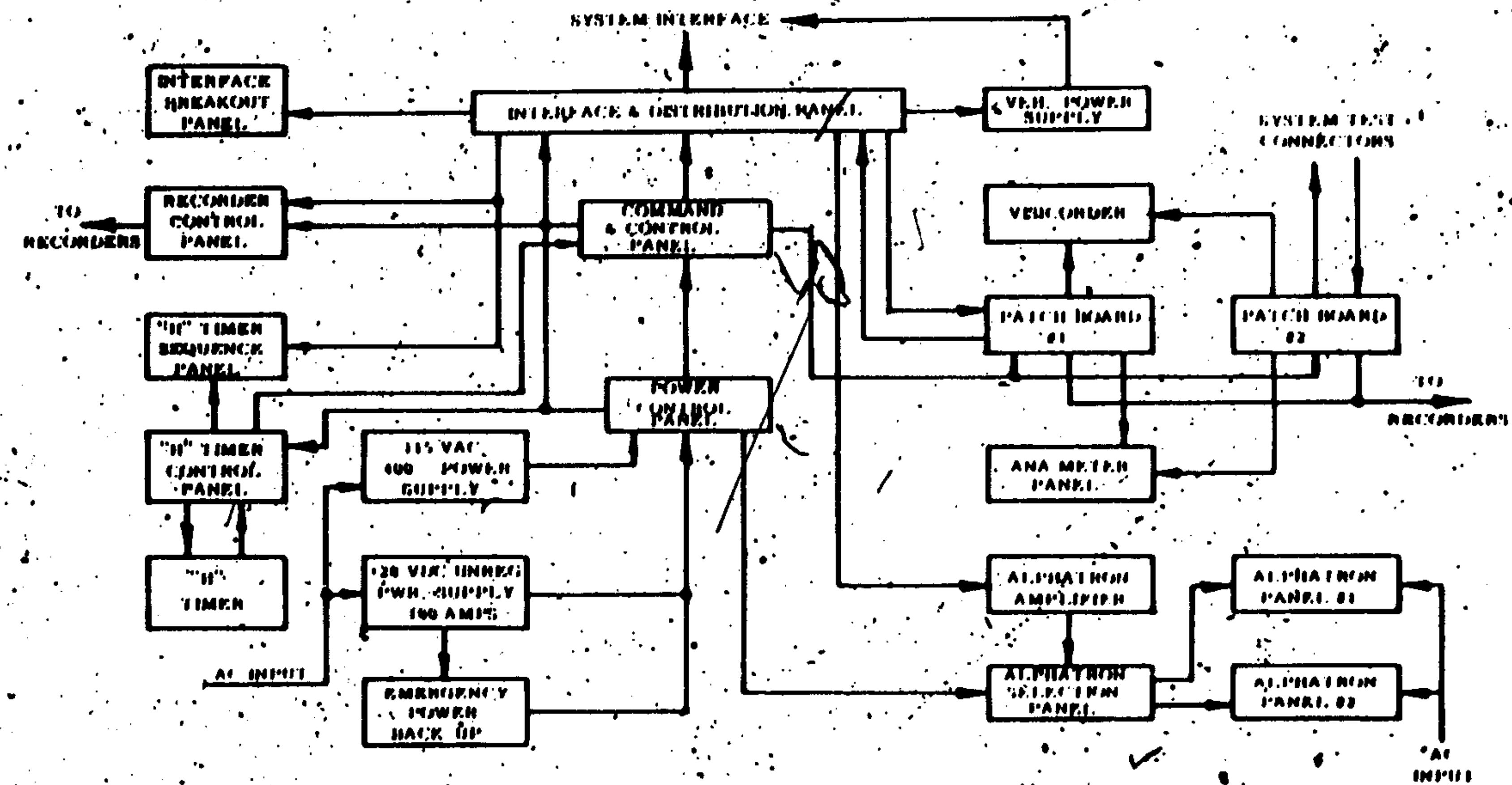


Figure II-5. Thermal Altitude Chamber Console - Block Diagram

TOP SECRET [redacted]

II-2.5.2.2 Bay 2 contains

a. 100 amp., unregulated, 24 VDC power supp

b. Power control panel

c. Recorder control panel

II-2.5.2.3 Bay 3 contains

a. Command panel

b. Interface patch and distribution panel

II-2.5.2.4 Bay 4 contains

a. RTC monitor panel

b. T/M distribution and patch panel

II-2.5.2.5 Bay 5 contains

a. Alphatron panel

b. 28 VDC, 10 amp. power supply

c. 400 cycle, 115 VAC power supply

II-2.5.2.6 Bay 6 contains

a. Alphatron panel

b. Visicorder

c. Emergency power back up battery

d. 115 VAC, 400 cycle, 3 phase vehicle power

II-2.5.2.7 Rear of Console

All system interface and test connectors are locat
rear of the console.

II-2.5.3 Capabilities

II-2.5.3.1 Power

Three commercial power supplies and one 115 VA
cycle vehicle power supply in the console furnish the voltag

required to test and operate the complete J-3 payload system for flight simulation tests.

U-2.5.3.1.1 Unregulated Power Supply

This supply is a [redacted] Model TVR28-100, 100 amps, @ 22 to 32 VDC output, requiring 60-cycle, 3-phase input 208/230 VAC. It simulates Agena battery power to the payload interface and provides power for the consoles. The unregulated power is divided off within the power control panel to the following three main buses, which are each protected by circuit breakers: (1) unregulated power bus, (2) pyro power bus, (3) console power bus.

U-2.5.3.1.2 400-cycle, 115 VAC Power Supplies

a. The 400-cycle, 115 VAC vehicle power supply (Lockheed Part No. 1464420) is a 3-phase inverter requiring 24 VDC unregulated input. It provides A phase, B phase, and C phase to the payload interface.

b. A [redacted] Model, 161A-OSC-1, 400-cycle $\pm$ 0.1 percent, 115 VAC, 400-cycle, single-phase output unit requiring 60-cycle, single-phase, 115 VAC. The supply is a back-up for the Agena 400 cycle inverter power to the payload interface. The single phase is divided into two buses for the convenience of interface terminology, thus simulating A phase, B phase, and C phase.

U-2.5.3.1.3 +28 VDC Regulated Power Supply

This unit is a [redacted] +28 VDC Model SM36-10M, 10 ampere, +28 VDC regulated output. It requires 60-cycle, single-phase input, 105/125 VAC. This unit only supplies power for the fogging film tests.

It does not supply power to the payload system.

U-2.5.3.1.4 Emergency Power Supply

An emergency power back-up system is included in the console. This provides unregulated voltage to the payload system in case the commercial unregulated power supply fails and allows the operator to shut down the payload in a normal way.

U-2.5.3.1.5 Power Control Panel

The power control panel represents the power interface between the Agena and the payload system. It provides voltmeters and ammeters for readout of voltage and current levels in each power bus, and provides switches from each power bus into the payload system. The meters and switches are arranged in three rows, with the voltmeters in the top row, the ammeters in the middle row, and the switches pertaining to that power supply below the meters. The fail-safe indicator lights and reset switch are located on the right-center side of the panel. Jack connectors are provided for precise measurement of power loads for each voltage.

U-2.5.3.2 Command

The command control panel provides two modes of operation:

a. The Manual mode, in which all commands are set up and executed by the operator.

b. The Automatic mode, in which all brush commands and real time commands are supplied by a tape in the H-timer.

U-2.5.3.2.1 H-timer

To accomplish the automatic operation mode, the console uses a Fairchild "H", two-deck timer (LMSC 1461895-37) for command generation.

The test tape program is prepared at A/P. The program and the timer are sent to VAFB SS/L, where the test tape is punched and installed into the timer. The timer is tested, sealed, and returned to A/P for installation into the console. The timer runs a payload system simulator for final verification prior to a flight simulation with the flight payload.

The timer is controlled by the H-timer control panel which supplies switched +24 VDC, unregulated power, and 115 VAC, 400-cycle power to it. In addition to a Start and Stop switch, the panel also has a reset switch to rewind the tape.

A brush closure in the H-timer energizes a conversion relay in the console. The contacts of that conversion relay send a payload command to the J-3 system or to a recorder for automatic control, if so programmed.

U-2.5.3.2.2 Panel Commands

a. Operation Commands
   (1) 8 UHF real time commands (RTC)
   (2) 8 analog S-band real time commands (RTC)
   (3) 2 S-band secure real time commands (SRTC)
   (4) 28 stored program commands (SPC)

b. Recovery Commands
   (1) Arm
   (2) Transfer
   (3) Disconnect
   (4) Separation

c. Special purpose commands
   (1) In-Flight reset
   (2) A/R Orbit mode
   (3) A/P Data enable
   (4) A/P Recovery enable
   (5) T/M ON

[redacted]

d. Umbilical Commands

(1) A/P Command #1 - Continuity Loop Power

(2) A/P Command #2 - Arm By-Pass #2

(3) A/P Command #3 - Instrument Operate

(4) A/P Command #4 - Arm By-Pass #1

(5) A/P Command #5 - Orbit Mode Control

(6) A/P Relay Reset

e. AGE Commands

(1) SRV Reset

(2) Two slope programmer commands

(3) Digital tape recorder commands

(4) Two PMU commands

(5) F/L command

(6) All Ones command

(7) Automatic Mode/Manual Mode Select

(8) T/U and B/U commands

U-2.5.3.3 Recorder Control Panel

The recorder control panel provides the following two modes of operation for controlling three eight-channel Sanborn recorders:

a. The Manual mode, in which the speeds of all three recorders can be controlled individually.

b. The Automatic mode, in which the speeds of all three recorders can be controlled individually by brush commands supplied by a tape in the H-timer.

U-2.5.3.4 Monitor

The console provides a test point for each pin of the interface plugs to allow trouble-shooting or monitoring. Command status is indicated by individual lights plus meters to indicate the command given. Two patch panels are provided which allow all points to be patched to recorders. The Dymec console can be patched in to monitor voltages and time periods. Current shunts are connected to remote recorders through the patch panel to record current wave forms.

U-2.5.4 Reference Documents

a. Acceptance and Qualification Test Specification [redacted]

b. Engineering Analysis [redacted]

c. Top Assembly Drawing [redacted]

U-2.6 Payload Simulator

U-2.6.1 Purpose

The payload simulator serves as a substitute for a payload, for payload checkout console validation, for environmental laboratory equipment validation, and for Agena systems test and pad systems runs.

U-2.6.2 Description

The payload simulator consists of a single-bay, tilt-front console which is readily transportable. It has three panels which are described in detail below.

U-2.6.3 Capabilities

U-2.6.3.1 Control and Monitor

The control and monitor panel provides visual indicators which monitor all commands and power by individual plug and pins across the Agena interface. The power monitors are interlocked to an audio alarm which sounds when a power failure occurs. The panel provides test mode switches which allow the operator to select manual or automatic load testing. The automatic load testing is accomplished by discrete commands from the Agena. Manual operation is by use of the enable and load command switches located on the panel.

U-2.6.3.2. Telemetry

The front of the T/M and distribution panel has test points for fault isolation or special tests at the Agena interface. The individual power and commands are conditioned by T/M circuits to give a status signal of 0 to 5 VDC. The T/M signals generated by power and commands from the Agena are sent to a 0.4 x 60 commutator. The commutator's output is sent to the Agena T/M System. The Agena T/M is recorded by AGE support equipment for later data reduction. Ring A of the commutator is used for primary data and ring B is used for diagnostic data.

U-2.6.3.3. Resistor Load.

The resistor load panel provides dynamic load testing of the Agena power supplies. The panel demands average power which is equivalent to normal payload power consumption, and peak power loads in a cycling method. The voltage of the power supplies is monitored for drop under load condition to verify that interface and power supply capability are adequate for flight requirements.

U-2.6.4 Reference Documents

a. Top Assembly Drawing [redacted]

b. Engineering Analysis [redacted]

U-2.7 <u>Block Test Equipment</u>

U-2.7.1 Purpose

The block test equipment permits measurement of the dynamic resolving power of the CR cameras while in the flight configuration. The measurement is performed by photographing a moving target pattern through optical collimation equipment, which transforms the target to an object at infinity. The targets (USAF 1951) are on a film strip which is mounted on the outer diameter of the film drive wheel. Each film strip contains 157 serialized high-contrast and 157 low-contrast identical targets. The targets are illuminated, and the image thus formed is directed to the main instruments by the collimating system. The velocity of the target drive wheel is variable between the limits which correspond to the FMC direction image velocity which the CR cameras produce while nodding during test operation. A servo system is provided to drive and maintain the target drive wheel velocity. A console containing much of the servo drive and measurement portion completes the block test equipment.

U-2.7.2 Target Drive

The target drive consists of the target wheel, drive mechanism, encoder, and a servo control system. The target wheels as described are driven by machine elements having high polar inertia and low friction torque. These considerations aid in the drive system accurately maintaining a constant velocity of 0.1 percent over a range of 0.31 to 0.93 radians per second. The servo system which maintains the constant velocity is digital operating on a phase-lock principle. An optical encoder coupled to the target wheel shaft generates a pulse output which is proportional to the target wheel velocity. The output of the encoder is differentially compared (by means of an error detector) with a preselected pulse rate from the counter in the console (this corresponds to the desired velocity of the target wheel). The resultant error signal is amplified and drives a dc torque motor which drives the target wheel, completing the feed-back loop.

U-2.7.3 Optical System

The optical components which make up the block test equipment are dual 60 inch refractive collimators, dual 120 inch reflective collimators, and light sources and target drives, all of which are mounted on a seismic block. The seismic block isolates the optical equipment and the cameras from vibration which would degrade the resolution measurements. The block supports a platform upon which the CR system is mounted such that the cameras have their optical axes parallel to the collimator beams.

The collimators project the target into the camera lens as if the target was located at infinity when set to the zero or infinity focal position. (The targets may be moved away from the zero collimator focus so as to verify the location of peak focus in the camera system.) The targets are illuminated by a tungsten projection lamp operated on dc and diffused to provide a uniform noncoherent light.

U-2.7.4 Console

The console contains the servo components, power supplies, a digital counter, and a printer. Internal to the console are all of the switching, electronics, and interconnections between the servo, optical, and supply systems. In addition, the console panel has provisions for selection of target velocity, lamp intensity, and printout of target velocity. The printout is a measurement of the time lapse between the shaft encoder pulse as compared with a pulse train developed by the digital counter.

U-3.0 GROUND HANDLING EQUIPMENT (GHE)

U-3.1 Introduction

This section discusses the major ground handling procedures and equipment used to handle the payload or its components during manufacture, test, storage, shipping, Agena mating, and launch.

Since, for training purposes, an understanding of handling procedures is considered more important than an understanding of physical details of the equipment, the discussion to follow will be arranged according to procedure rather than equipment.

A part number is given for every piece of GHE referred to. This allows reference to the drawings to be made if greater detail is required regarding each apparatus. A/P drawing T7-1005 shows the major dollies and slings used on the J-3 program.

Items used in such a way that their failure might cause personal injury or serious vehicle damage are subjected to proof load testing and periodic retesting.

Note: Each item of load-rated handling equipment is periodically retested and carries a validation sticker showing evidence of satisfactory proof test.

U-3.2 Barrel Handling Sequence

Figure U-6 shows the barrel handling sequence and the GHE used from the time the barrel is received in its crate until it is ready for mating with the recovery system.

U-3.3 Conic Handling Sequence

Figure U-7 shows the conic handling sequence and the GHE used from the time the conic is received in its crate at A/P until it is ready for mating with the fairing.

U-3.4 Fairing Handling Sequence

Figure U-8 shows the fairing handling sequence and the GHE used from the time the fairing is received in its crate at A/P until it is ready for recovery system mating.

U-3.5 SRV Handling Sequence

Figure U-9 shows the SRV handling sequence and the GHE

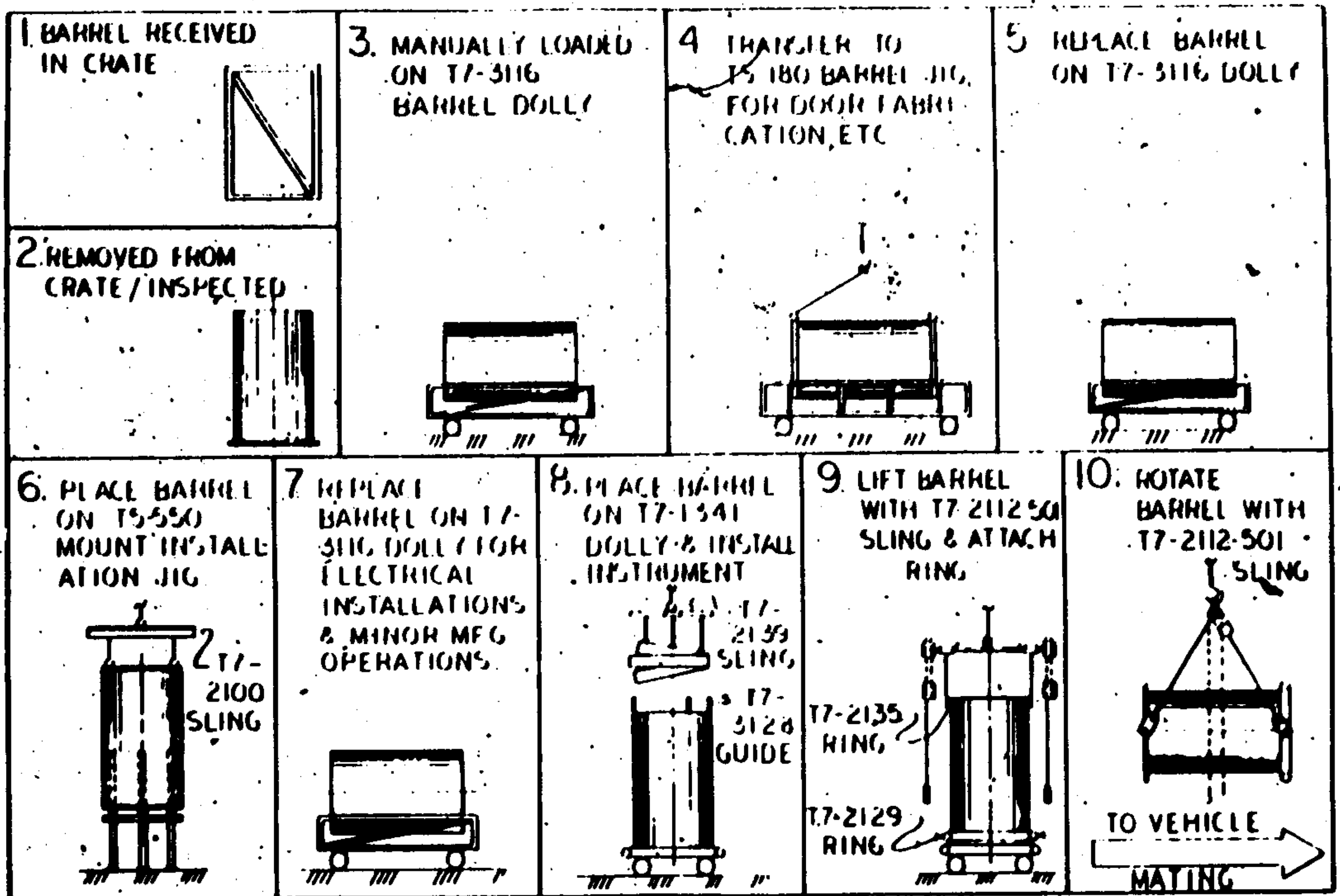


Figure II-6 Barrel Handling Sequence

[redacted]

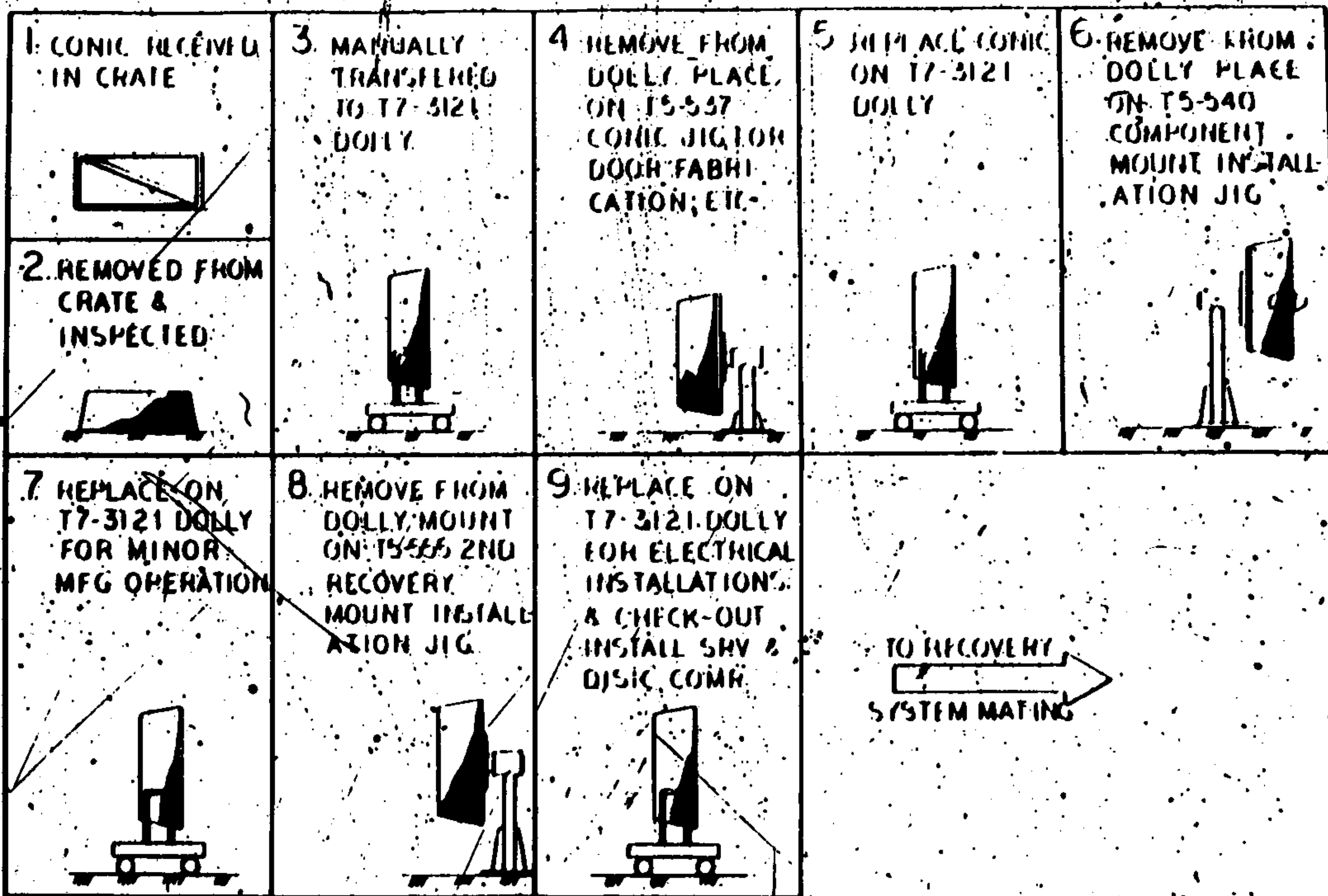


Figure II-7 Conic Handling Sequence

[redacted]

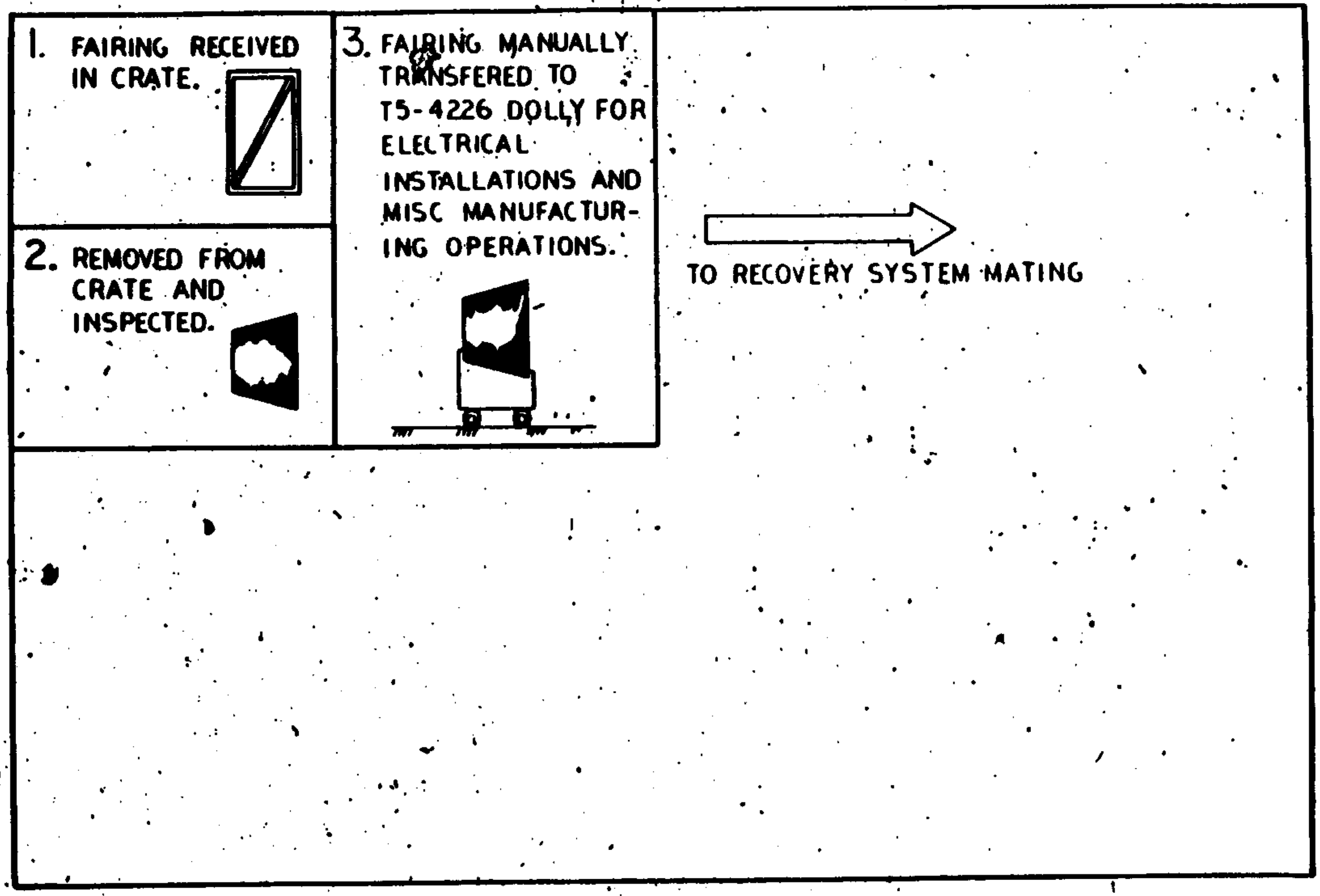


Figure U-8 Fairing Handling Sequence

[redacted]

used from the time the SRV is received in its case at A/P until it is ready for recovery system mating.

U-3.6 Supply Cassette Handling Sequence

Figure U-10 shows the supply cassette handling sequence and the GHE used from the time the S/C is received in its case at A/P until it is ready for vehicle mating.

U-3.7 Painting Sequence

Figure U-11 shows the painting sequence and GHE used to apply the thermal pattern paint.

U-3.8 Recovery System Mating

Figure U-12 shows the mating sequence of the fairing, A SRV, B SRV, and the conic.

U-3.9 Vehicle Mating Sequence

Figure U-13 shows the mating of the recovery system to the barrel and the installation of the supply cassette.

U-3.10 Vibration Test Loading

Figure U-14 shows the procedure and GHE required to place the P/L vehicle on the vibration test fixture.

U-3.11 Vehicle Collimation Loading

Figure U-15 shows the procedure and GHE required to place the P/L vehicle on the collimator turntable.

U-3.12 P/L Vehicle Light Leak Test

Figure U-16 shows the procedure and the GHE required to conduct the light leak test.

[redacted]

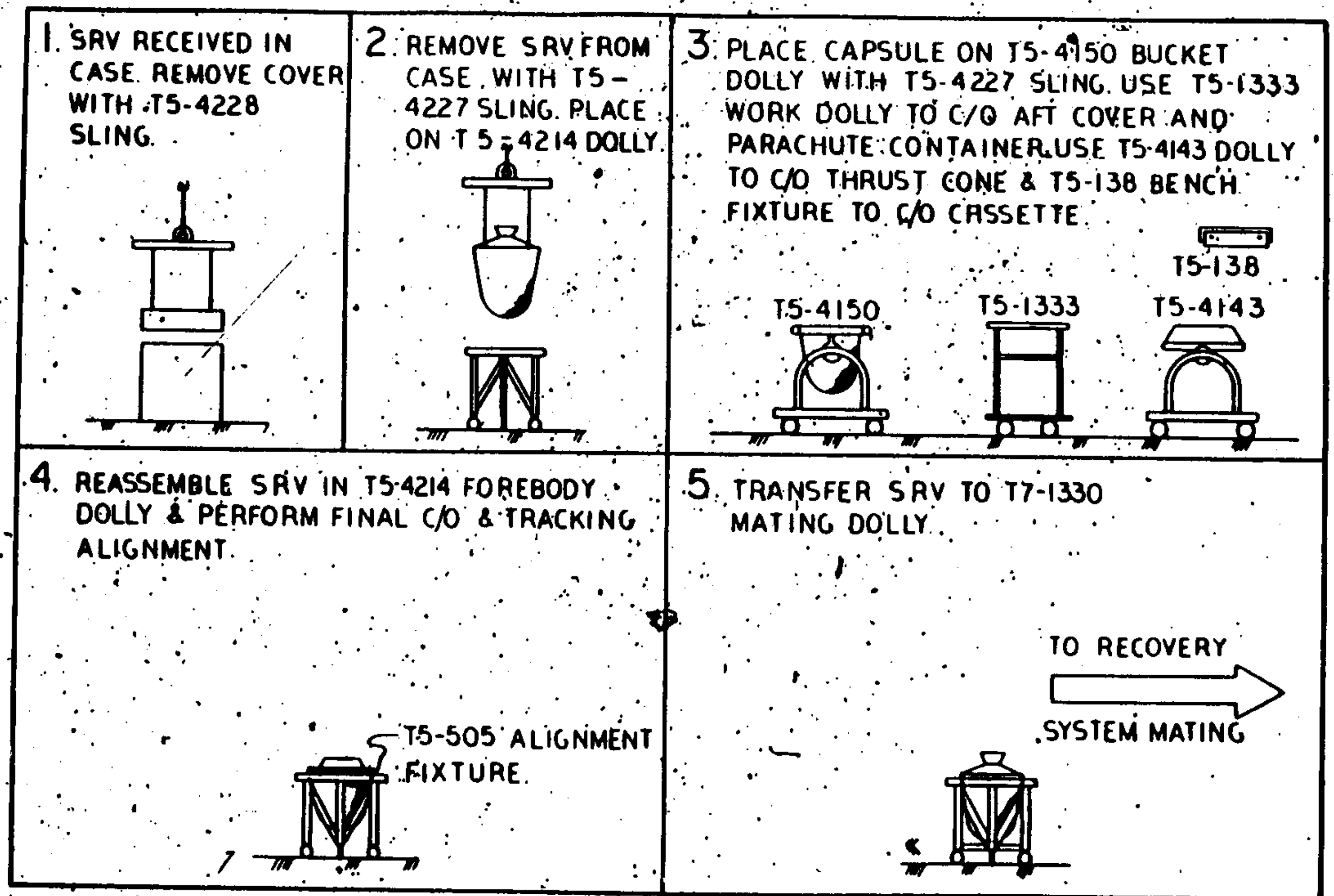


Figure U-9 S R V Handling Sequence

[redacted]

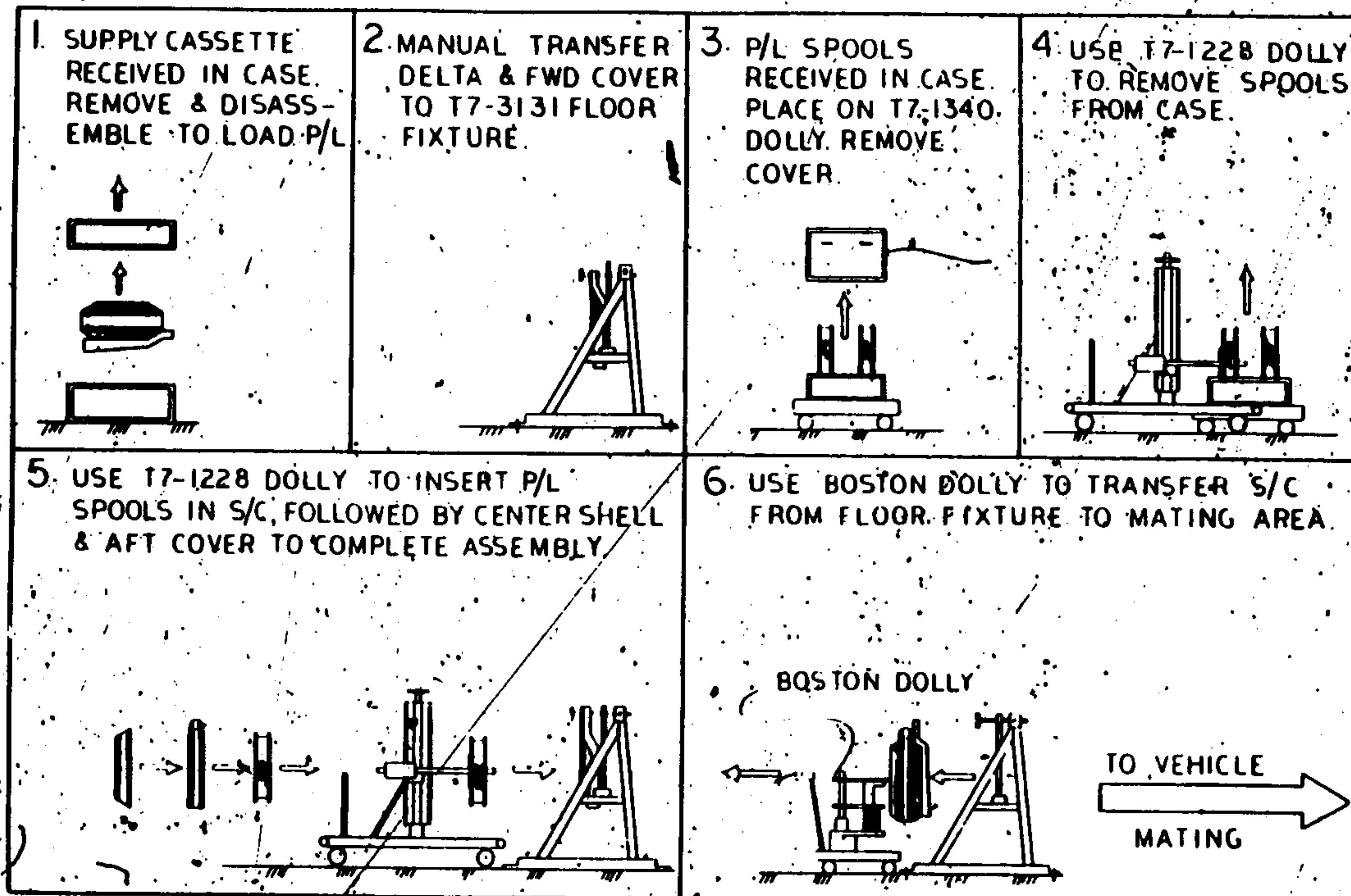


Figure U-10. S/C Handling Sequence

[redacted]

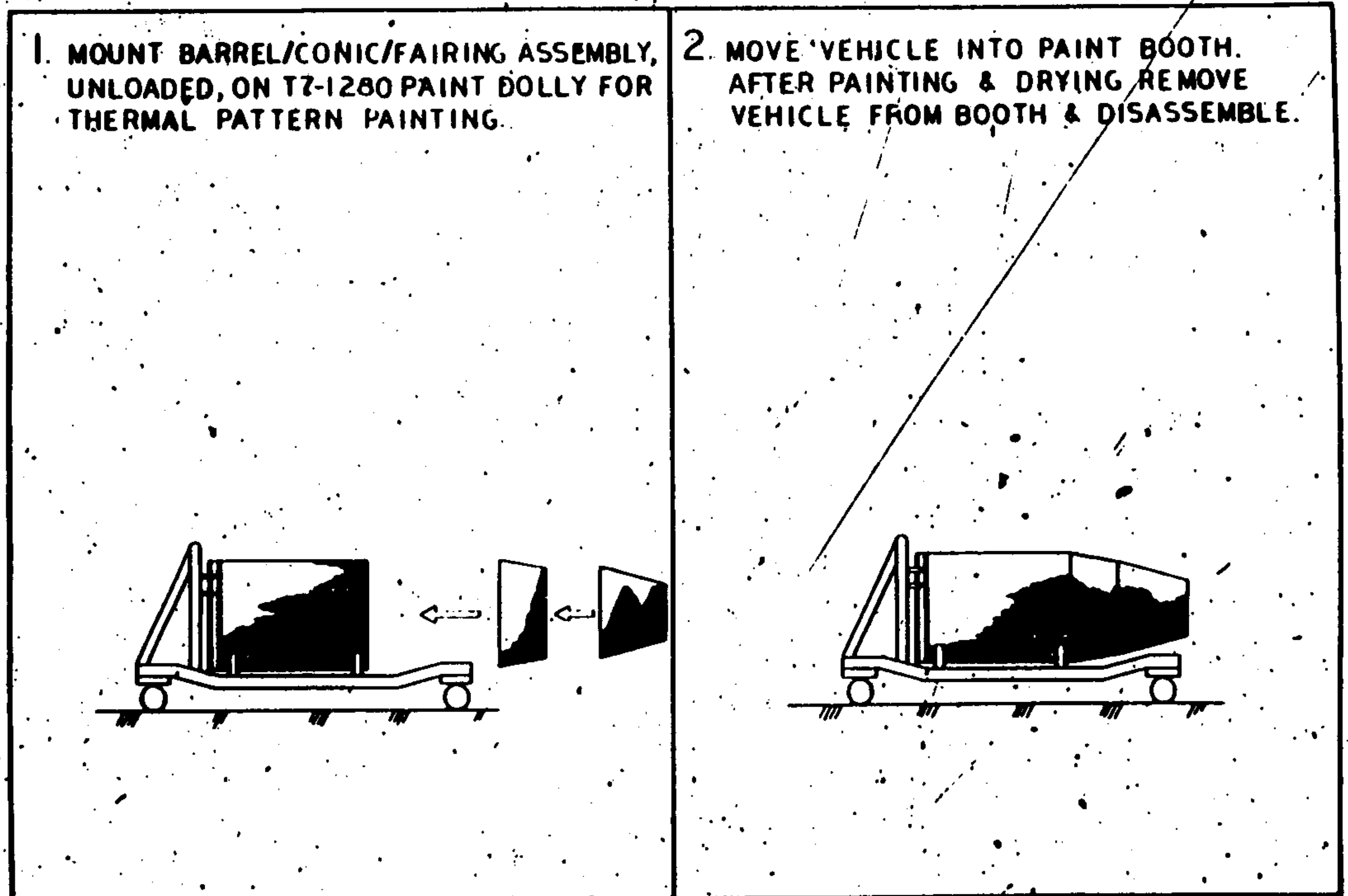


Figure U-11 Painting Sequence

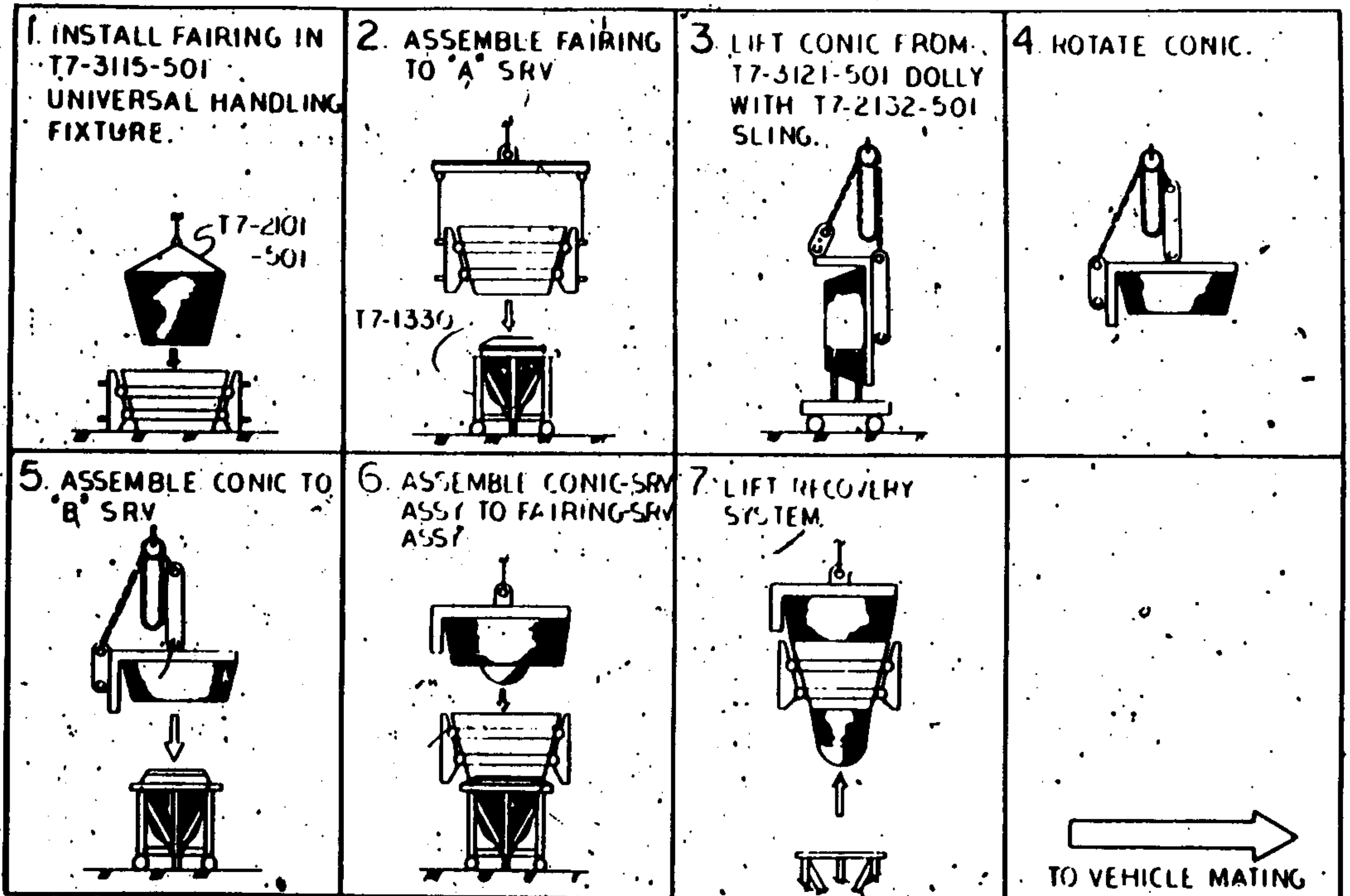


Figure U-12. Recovery System Mating

[redacted]

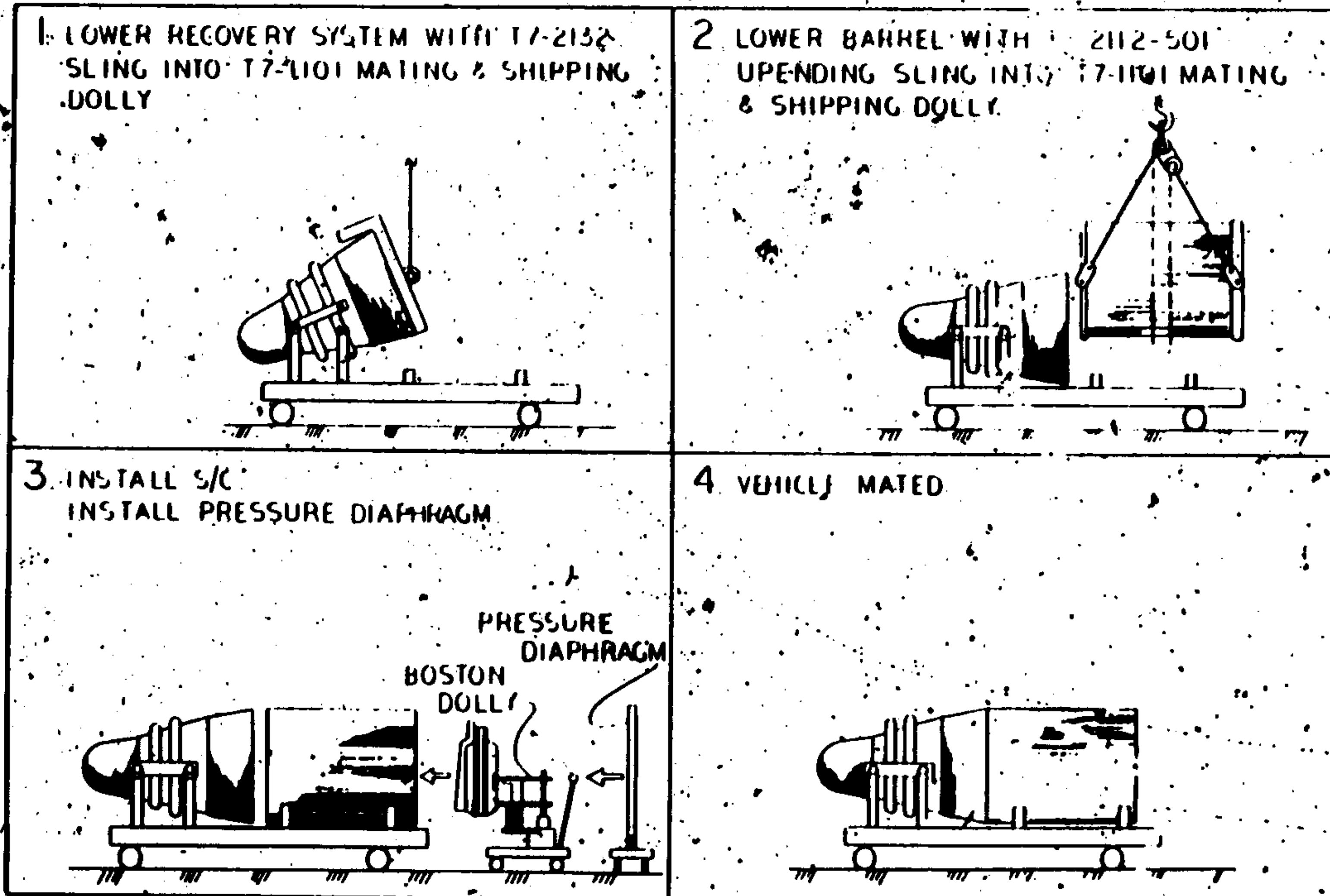


Figure U-13 Vehicle Mating Sequence

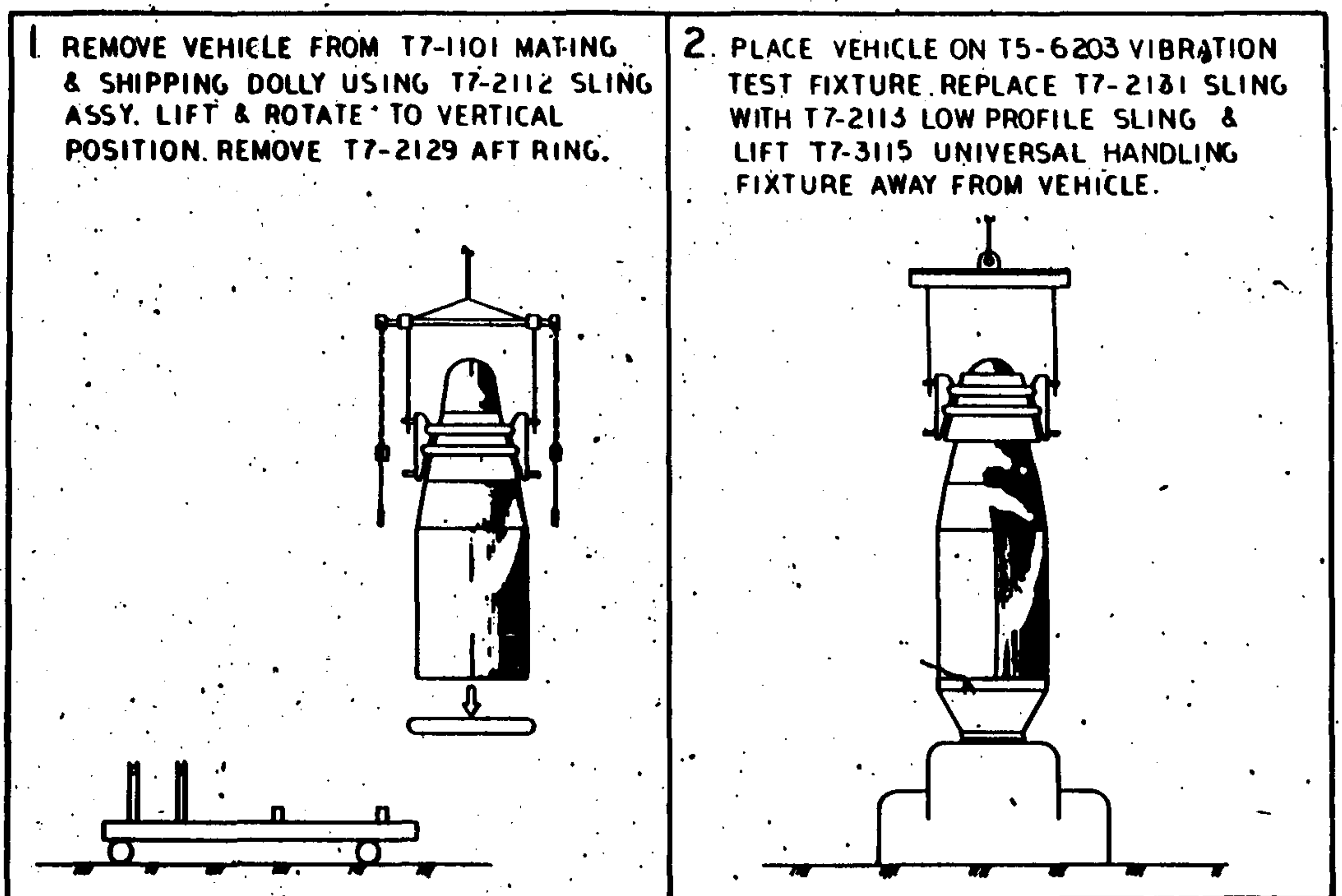


Figure U-14 Vibration Test Loading

[redacted]

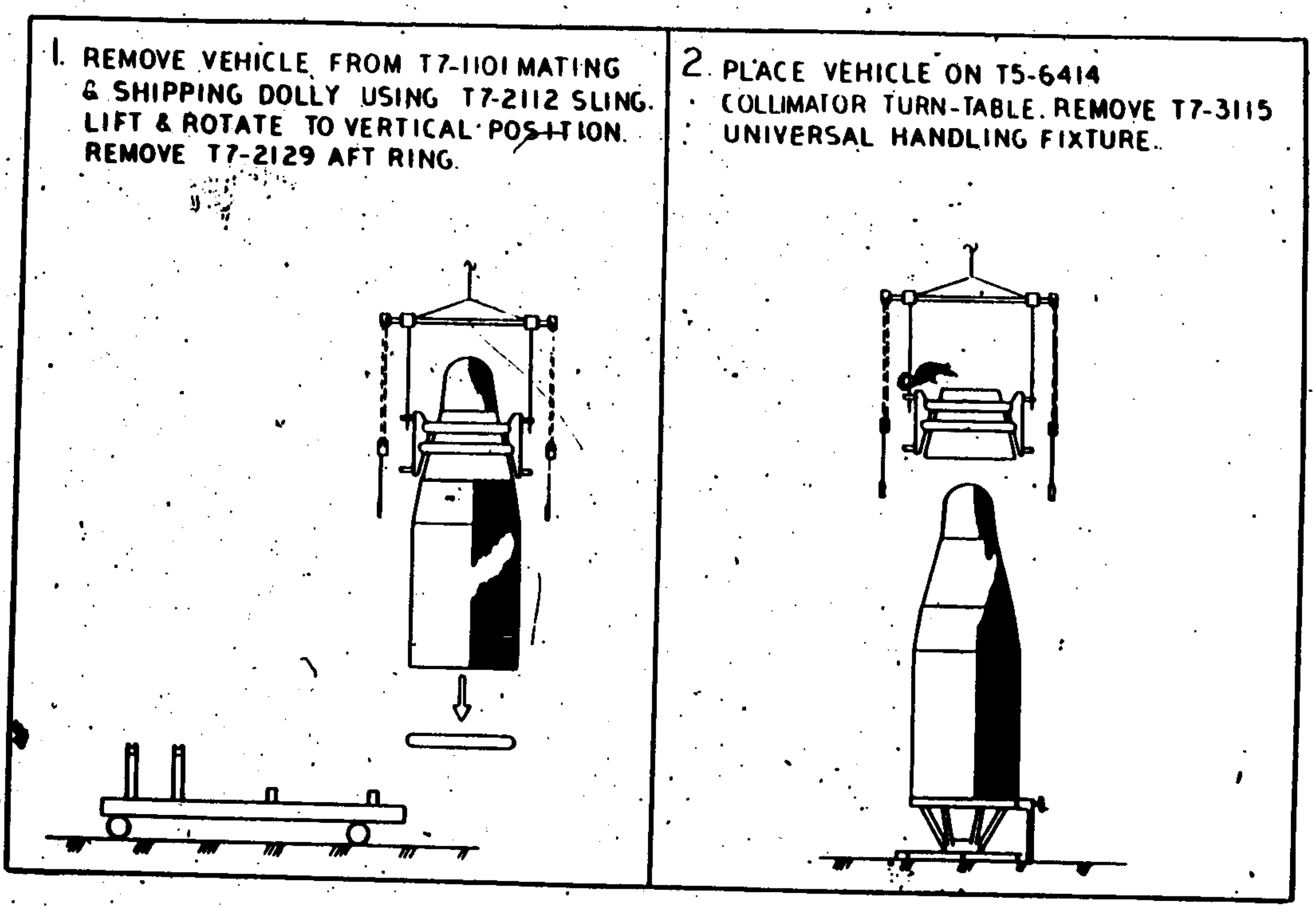
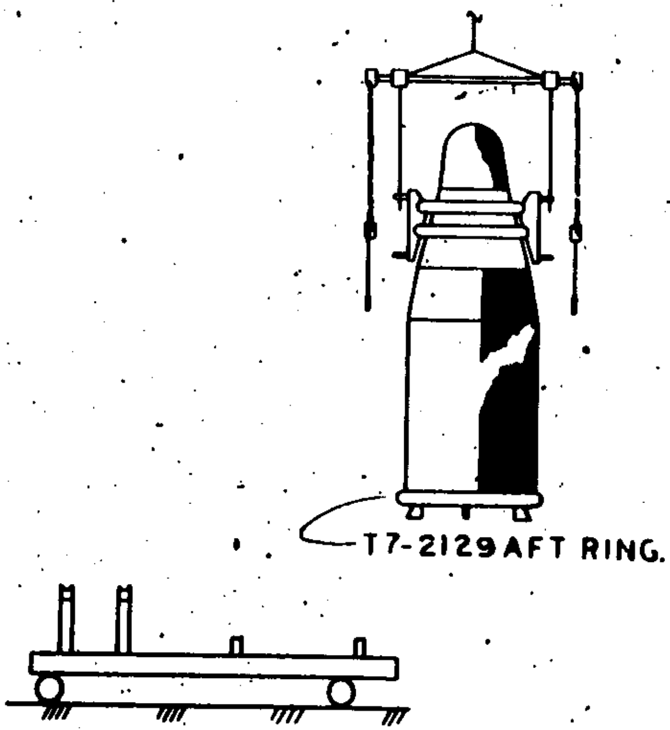


Figure U-15 Vehicle Collimation Loading

1. REMOVE VEHICLE FROM T7-1101 MATING & SHIPPING DOLLY USING T7-2112 SLING. LIFT & ROTATE TO VERTICAL POSITION.



2. PLACE VEHICLE ON FLOOR & POSITION T5-6477 LIGHT BOARD. LIFT T7-3115 UNIVERSAL HANDLING FIXTURE AWAY FROM VEHICLE.

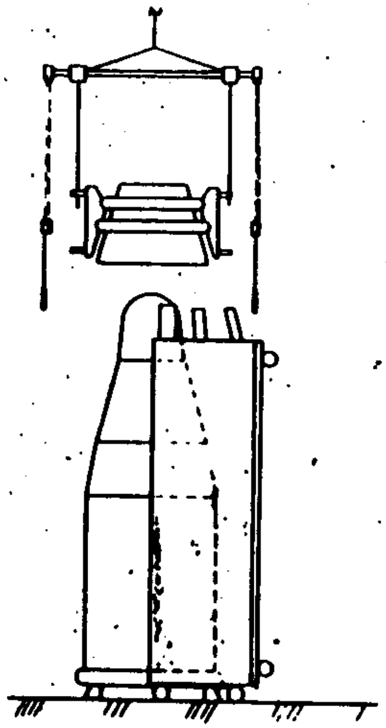


Figure U-16 Light Leak Test

U-3.13 HIVOS Test Loading

Figure U-17 shows the procedure and the GHE required to place the P/L vehicle in the HIVOS test chamber.

U-3.14 Storage Loading

Figure U-18 shows the procedure and the GHE required to place the P/L vehicle in storage to wait for its launch date.

U-3.15 Shipping Sequence

Figure U-19 shows the procedure and the GHE required to transport the P/L vehicle from base for launch.

U-3.16 Vertical Agena Mating

Figure U-20 shows the procedure and the GHE required for vertical mating of the P/L vehicle and the Agena.

U-3.17 Horizontal Agena Mating

Figure U-21 shows the procedure and the GHE required for horizontal mating of the P/L vehicle and the Agena.

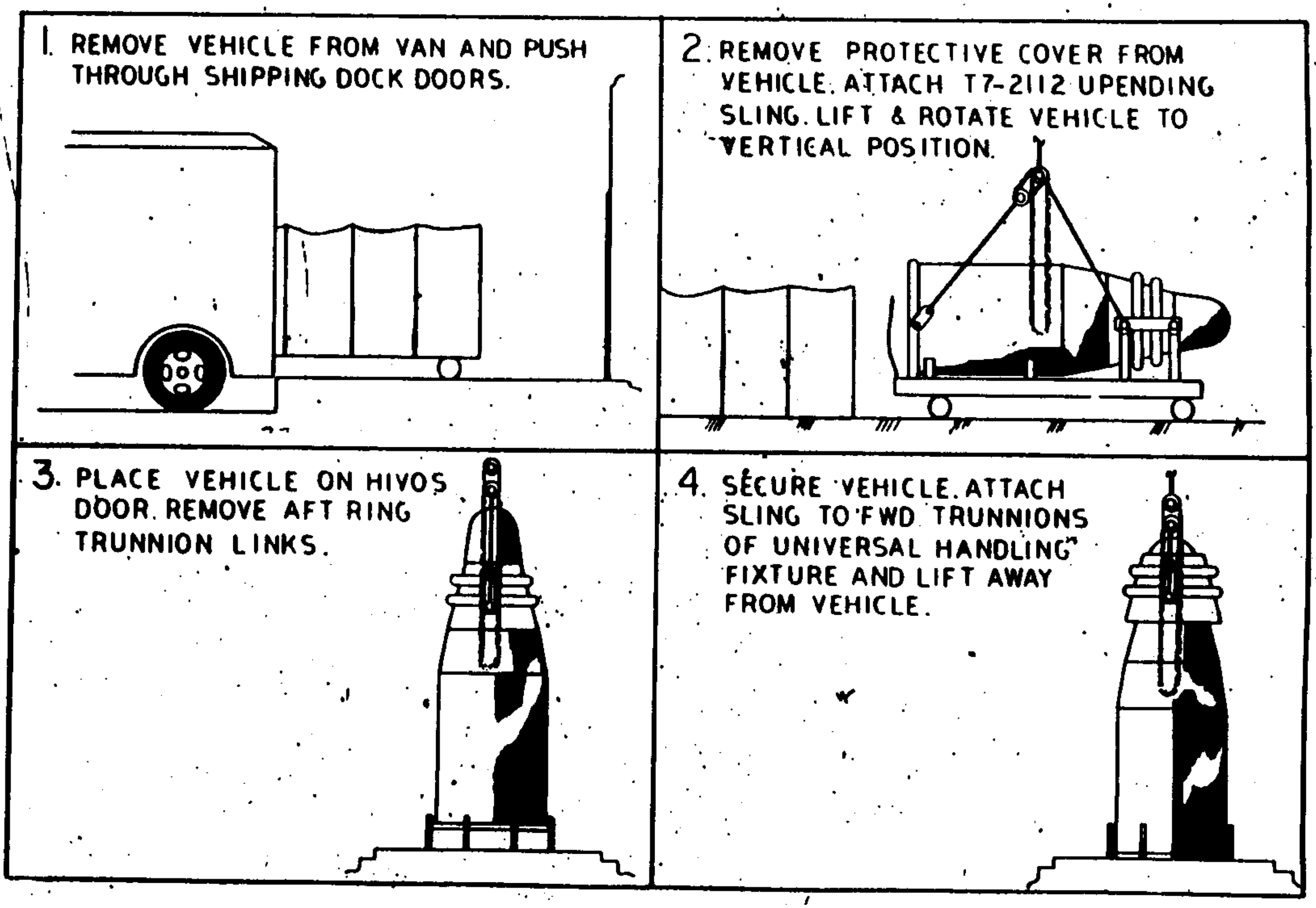


Figure U-17 HIVOS Test Loading

[redacted]

1. WITH VEHICLE ON MATING & SHIPPING DOLLY, DEMATE RETURN RECOVERY SYSTEM TO FOREBODY MATING DOLLY AND REMOVE SRV B & A TO T7-1339 SRV STORAGE DOLLY. RE-ASSEMBLE AND TRANSFER VEHICLE TO T7-1319 VEHICLE STORAGE DOLLY.

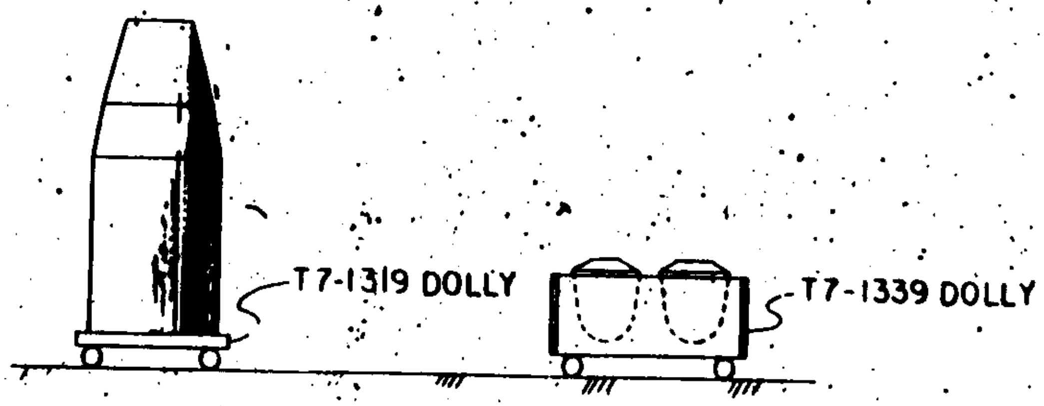


Figure U-18 Storage Loading

[redacted]

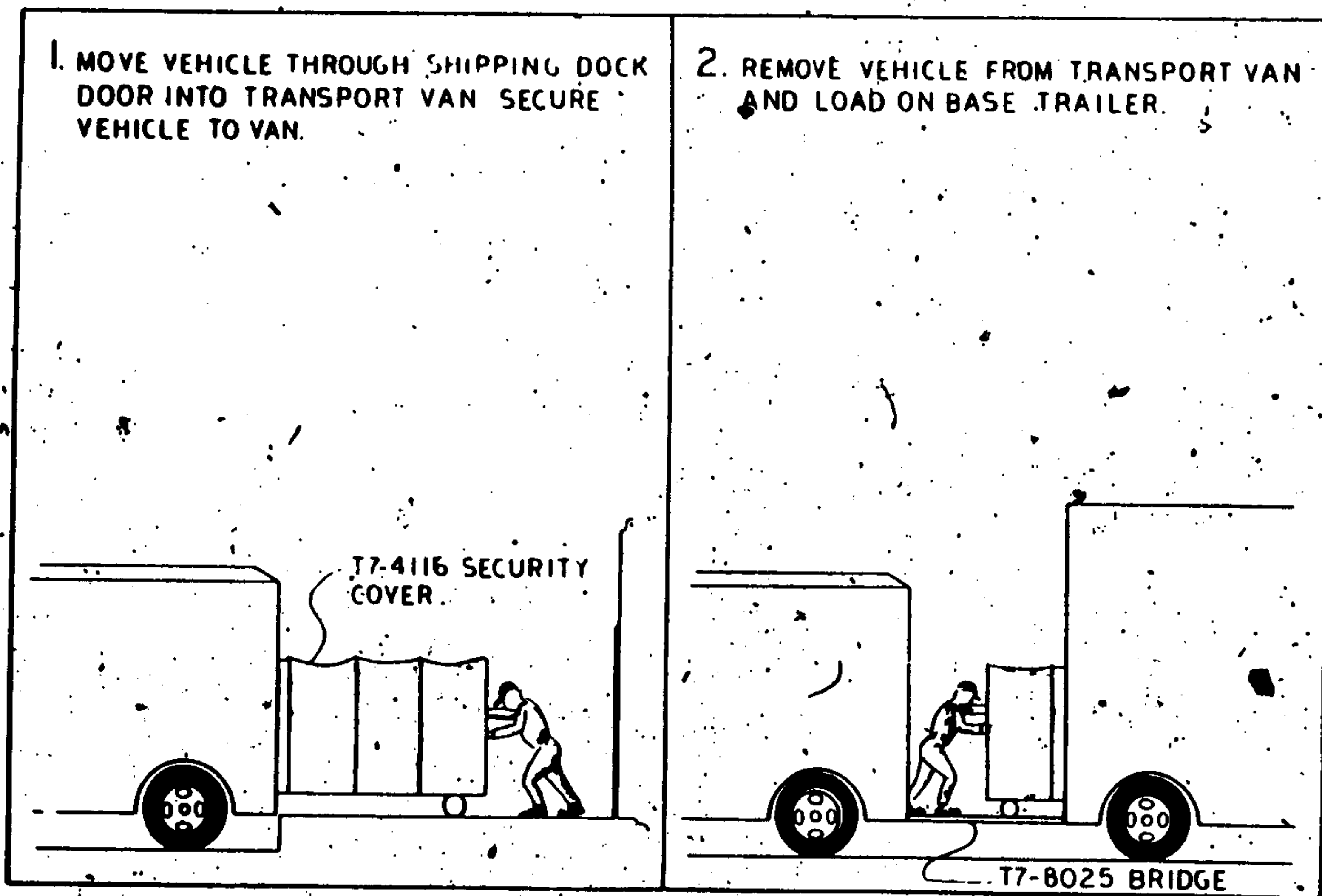


Figure U-19 Shipping Sequence

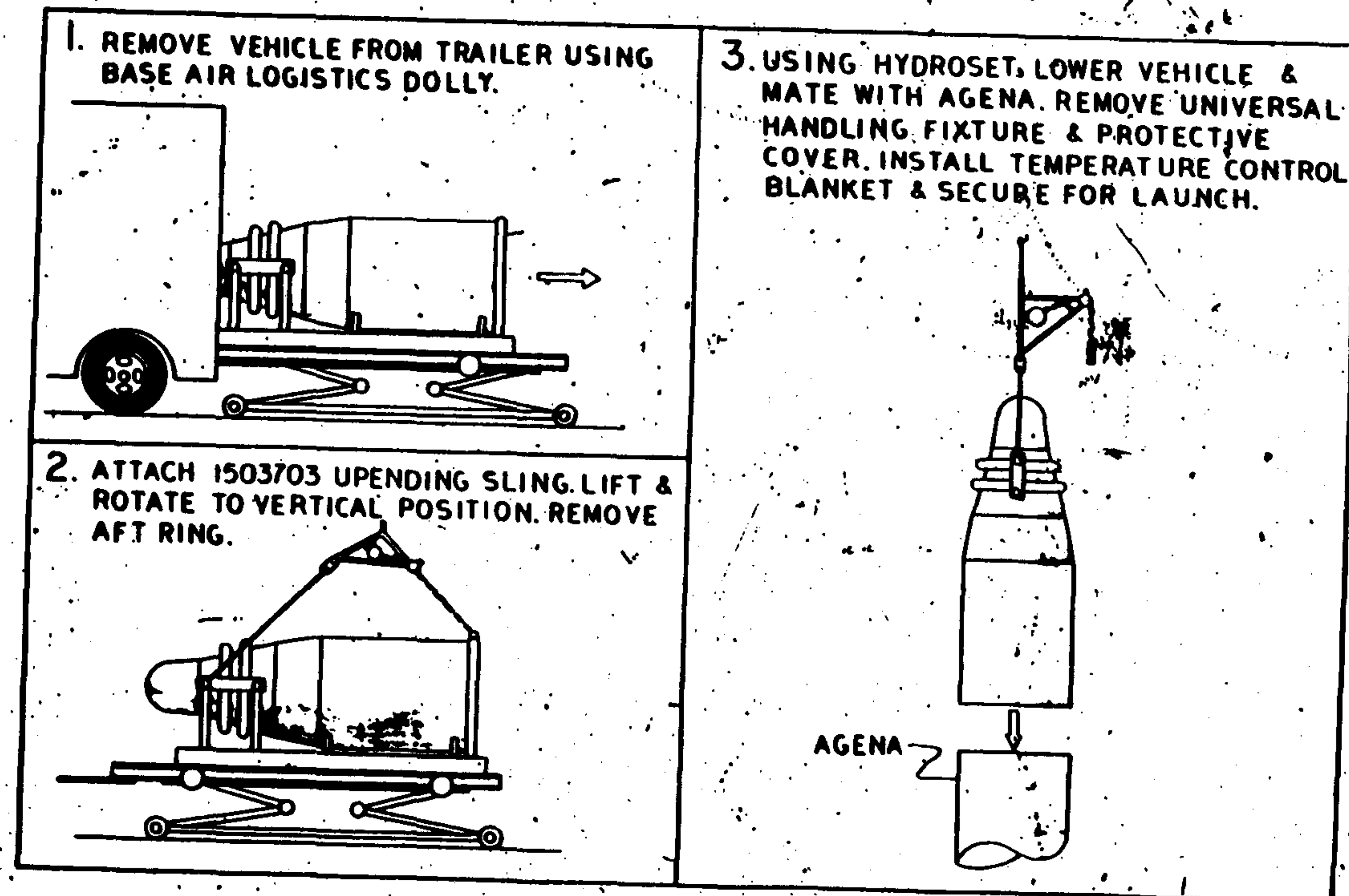


Figure U-20 Vertical Mate

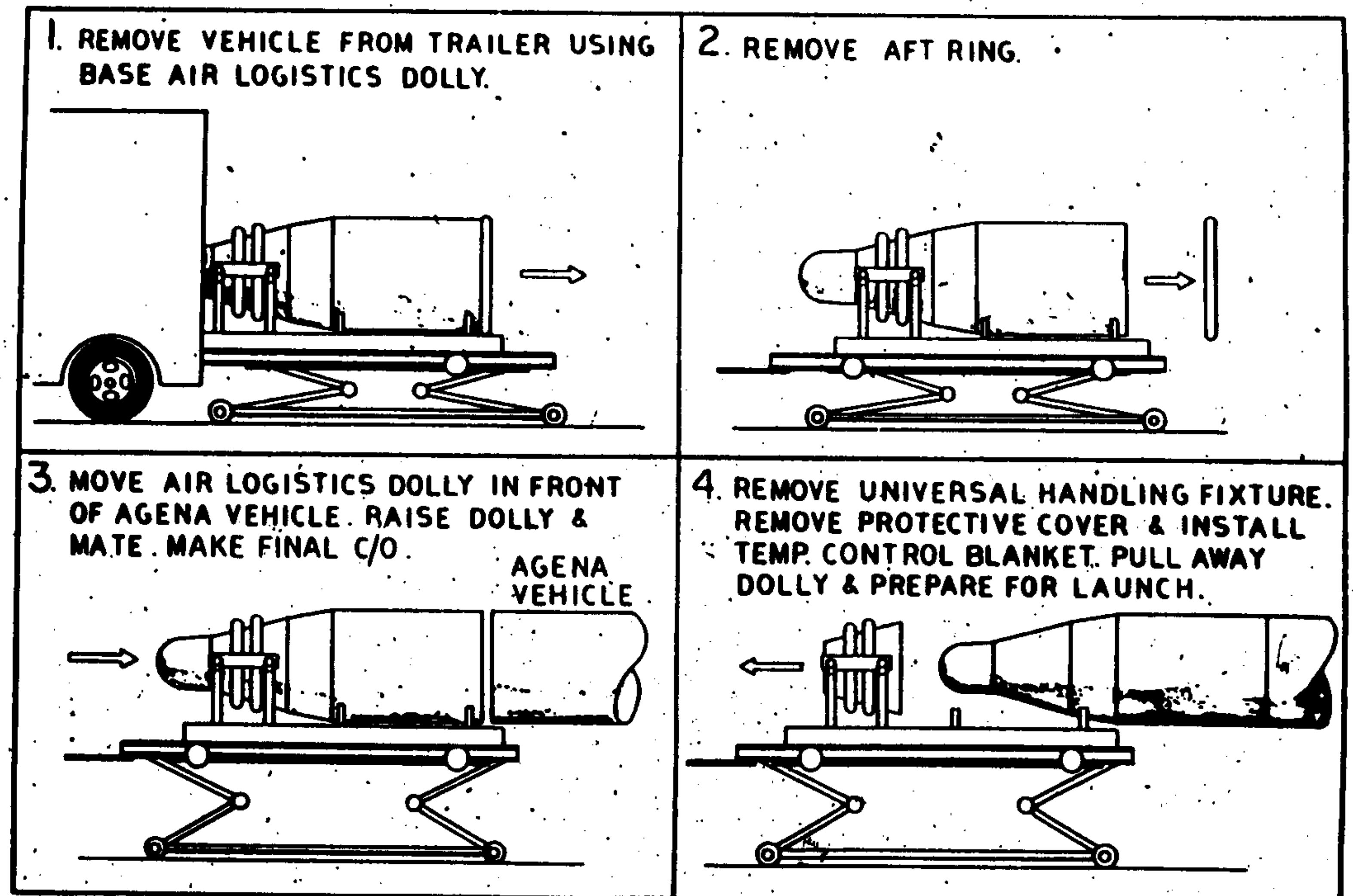


Figure U-21 Horizontal Mate

[redacted]

SECTION V

TEST EVALUATION

V-1.0 PURPOSE

The purpose of test evaluation is as follows:

a. To provide the administrative and technical operations and analysis functions as required to support the preflight testing and performance evaluation activities of the Advanced Projects payloads.

b. To develop and maintain computer software necessary to support test.

V-2.0 LOCATION

These functions are performed at A/P and at VAFB.

V-3.0 DESCRIPTION

V-3.1 Mechanical-Electrical-Optical Tests

V-3.1.1 Data Analysis

As each system flows through checkout and test it is monitored (via test data) by Data Analysis personnel for support of payload engineers in system checkout, adjustment, calibration, and preparation for launch. This monitoring of system performance starts with Component Receiving Inspection, continues through launch countdown, and includes the following:

a. Subsystem acceptance
b. System compatibility
c. System functional
d. Environmental
e. Pre-ship/storage

f. SRV test

g. Pre-ship/base

h. Base receiving

i. Payload/Agena mate

The monitoring ends with launch countdown analysis. During the entire monitoring, Data Analysis personnel familiar with the characteristics and individualities of the system validate the flight readiness of Advanced Projects payloads through analysis of ground systems test data, and provide Advanced Projects management, customer representatives, and Engineering Design the results of system performance analysis.

Figure V-1 shows a typical test record. During all testing, the following items are checked whenever applicable.

a. Panoramic camera subsystem performance
   (1) Cycle rate
   (2) Film transport
   (3) Exposure control
   (4) Internal camera commands
   (5) Auxiliary cameras
   (6) Film consumption
   (7) Response to commands
   (8) SRV tape recorder

b. DISIC Performance
   (1) Slave/Independent mode
   (2) Film transport
   (3) Exposure control
   (4) Internal camera commands
   (5) Film consumption
   (6) Response to commands

c. Command System Performance
   (1) Exposure control

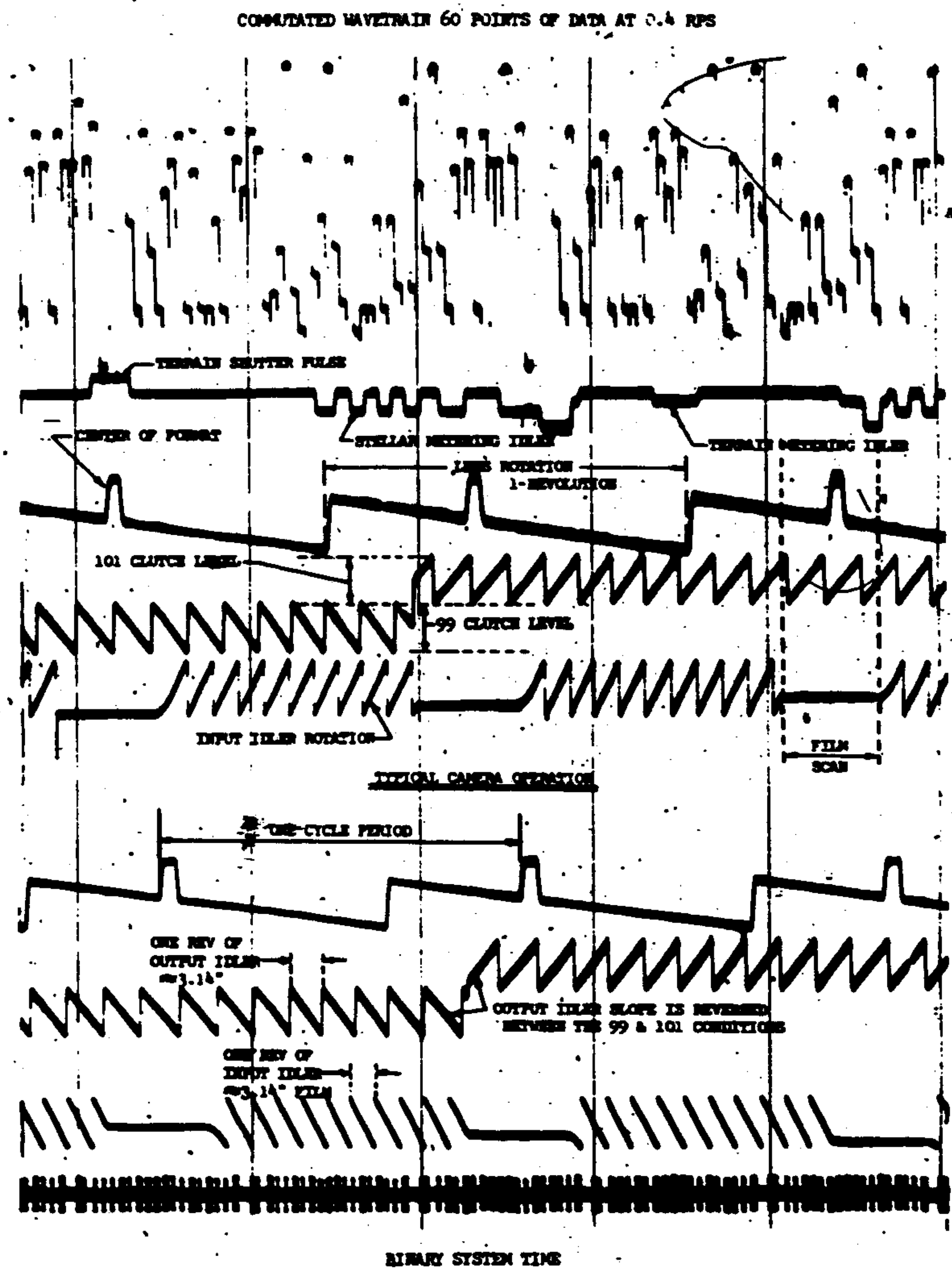


Figure V-1   Typical Camera Operation

(2) Slope programmer

(3) Yaw and oblateness programmer

(4) Stored and real time pan and DISIC camera control

(5) A to B transfer

(6) Recovery

(7) Blockhouse

(8) Instrumentation system control

d. Instrumentation System Performance

(1) Command monitoring

(2) Payload system status

(3) Payload dynamics

(4) Payload diagnostic

(5) Thermal status

(6) Calibration verification

(7) SRV tape recorders

e. Pressure Make-Up (PMU)

(1) Total operate time

(2) Total number of operations

(3) Gas consumption rate

(4) Payload internal pressure

f. Clock Performance

(1) Telemetry readout

(2) Accuracy

(3) SRV tape recorder

g. SRV System Performance

(1) Film stacking

(2) A to B transfer events

(3) Telemetry and beacon

(4) Re-entry events

h. Pyro System

(1) Proper timing

(2) Stray voltage

(3) Response to commands

V-3.1.1.1 Component Receiving Inspection

As the components are being received, all vendor calibration data are collected, assembled, and analyzed, and the necessary calibration curves and/or tables are generated.

V-3.1.1.2 Subsystem Acceptance

During system acceptance, all A/P subsystem calibration data are obtained and the necessary calibration curves and/or tables are generated, analyzed, and distributed to the using organizations.

V-3.1.1.3 System Compatibility

After payload system assembly, the command system, pyro system, and instrumentation system are checked out and verified. These data are analyzed for system compatibility.

V-3.1.1.4 System Functional

A system functional test is made, which is the first opportunity to monitor the complete payload system in operation. These data are analyzed in accordance with applicable test procedures and operational specifications. The necessary reports on results are issued.

V-3.1.1.5 Environmental Testing

The environmental test data from vibration and HIVOS (high vacuum orbital simulator) are analyzed to detect any system functional changes which may be a result of the environment. These tests serve as a shake-down of the system and enable a thorough checkout of all subsystems. Corona marking of the film under low-pressure environment is an important function of the test, but subsystem shake-down is equally important.

The HIVOS test is the most comprehensive test performed on the payload system. This test is programmed to simulate on-orbit environmental and operational conditions. Data from this test are used to give a Go-No-Go decision of system flight worthiness from a hardware and corona marking standpoint.

V-3.1.1.6 Pre-Ship Storage

Prior to placing a payload system into storage, a system functional test is performed. Results of this test are analyzed to validate flight worthiness.

V-3.1.1.7 Pre-Ship (Base)

Prior to shipment to the Base, the pre-ship functional is used to check for final verification of all subsystems. Functional validation of pan camera, DISIC, clock, slope programmer, switch programmer, pressure transducer, Pirani gauges, command system, instrumentation system, SRV tape recorder, and all associated functions is performed for the final checkout of a complete system. Data from this test are analyzed to certify the system is flight-worthy and ready for shipment.

V-3.1.1.8 Base Receiving

After arriving at the base the payload system is subjected to a receiving functional test to assure that no damage has occurred to any subsystems as a result of the environment experienced during shipment. Data from this test are analyzed to assure that the system is still flight-worthy.

V-3.1.1.9 Payload/Agena Mate

A system run is performed after the payload and Agena are mated. This test is used to certify payload/Agena interface compatibility. All SPC's and RTC's, with the exception of destructive-type commands, are both negatively and positively verified.

V-3.1.1.10 Launch Countdown

During the launch countdown, a functional verification of the camera systems, the recovery beacon and telemetry systems, the real time command system, and the primary instrumentation is made. These data provide the final ready-to-launch decision.

V-3.1.1.11 Reporting

Reporting on test results is performed in several ways, as follows:

a. Verbal reports are made with the test engineers and other organizations concerning discrepancies and anomalies.

b. A Data Analysis Evaluation Summary is issued on each test. An example form is included as Figure V-2.

c. A formal report is issued on the environment test conducted in the HIVOS chamber. This report contains test objectives, test results, a summary of the performance of each subsystem, thermal data, presure data, cycle rate data, and any other data pertinent to the test.

V-3.1.1.12 Additional Functions and Responsibilities

Additional functions and responsibilities are as follows:

DATA ANALYSIS EVALUATION - SYSTEM NO. ____________ PAGE ____ OF ____

PREPARED BY: ____________

TEST ____________ T/P NO. ____________ RUN DATE ____________

ORGN. ____________

ITEM NO.	EVALUATION	FURTHER ACTION REQUIRED
	(This form is used to itemize discrepancies, which are present during systems tests and are discovered by post-test data evaluation.)	

cc: Payload Integration, 60-61
Test, 60-64
System Test Log, 60-64
Quality Assurance, 75-20
Data Analysis File, 60-62
Boston (When affected)
New York (When affected)
Philadelphia (When affected)

Figure V-2 Evaluation Data Form

a. Coordinate and establish Advanced Projects payload instrumentation requirements and command system requirements.

b. Publish and maintain the telemetry and command system specification documents for Advanced Projects payloads.

c. Establish and document the command sequence for the thermal/altitude system tests of Advanced Projects payloads.

d. Establish, coordinate, and document command requirements for Automatic Ground Equipment (AGE) which controls Advanced Projects payloads during ground test and launch operations.

e. Coordinate, establish, and document requirements for and monitor the development of data acquisition systems associated with Advanced Projects payloads.

f. Establish instrumentation calibration standards; coordinate and verify flight equipment instrumentation calibrations.

g. Develop data reduction and analysis techniques as required.

V-3.2 Film Evaluation and System Performance

As the sole purpose of the J-3 system is the acquisition of aerial photography, many tests are conducted to assure that the system is operating in a manner that will maximize the information recorded on the film. These tests are designed to provide a basis to measure the quality of the ground scene that can be expected in flight, as well as the satisfactory recording of ancillary data that are required to fully exploit the recovered mission film.

V-3.2.1 Ancillary Data

A brief description of the purpose of the ancillary data on the film is necessary to appreciate the requirements for certain test phases. A sketch of the panoramic camera format is shown in Figure V-3. In general, all of these data are used to determine the precise geographic location at which the camera axis is pointed along each frame.

All cameras will contain rail holes which, through pre-flight calibration, accurately locate positions along the major axis of the film as a function of lens scan angle. The center of format is located by a set of two rail holes on each side of the film format.

The 200-cycle time track is very similar to the display used in previous systems. There will be no indication of stellar or terrain frame camera operation, as this unit is now completely separate from the panoramic cameras. The time word displayed in the data block is keyed to the format by an extension, slur pulse, of one time track bit.

System time from the clock is exposed on the film by the data block. The time word on each frame can be correlated with vehicle and ground time. The vehicle orbital position can also be correlated with ground time, hence the location of the camera station can be calculated as a function of the data block time word. The 200-cycle time track then permits the determination of the time of photography for any point in the camera format. This, in turn, will provide the data required to calculate the actual camera station for all points of photography.

There is no assurance that the film position in the platen is exactly the same for each frame of photography. If this position does change, there is no way to accurately determine the true path that the lens axis made during scan. Two small, illuminated apertures are located at each end of the scan head which expose a

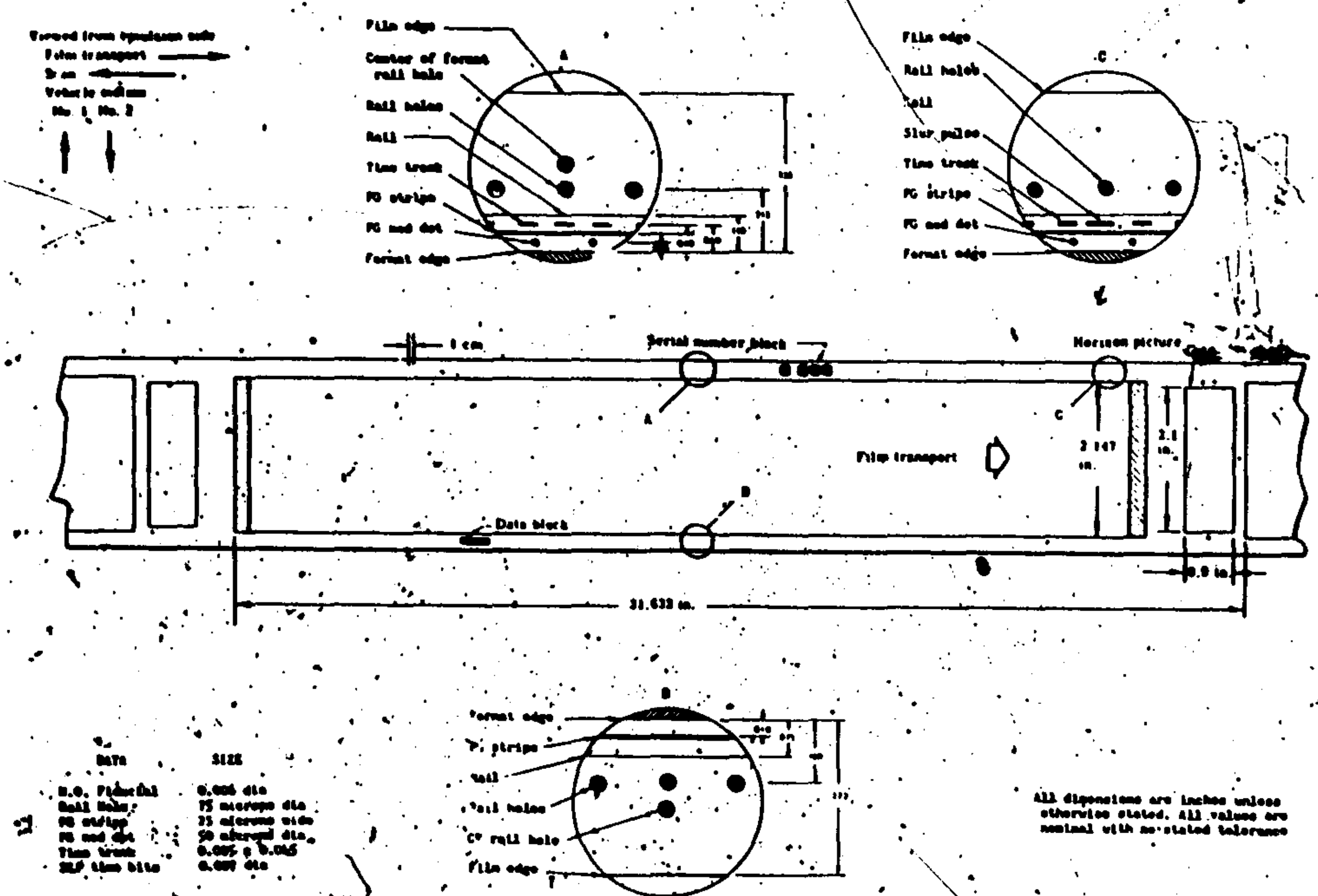


Figure V-3 Original Negative Format Drawing.

continuous stripe (termed the PG stripe) along both margins of the format. The location of these holes can be accurately calibrated to the lens axis prior to flight, thus the actual axis path can be determined on flight film regardless of slight variations in film position.

The entire camera rocks during operation to compensate for the forward motion of the vehicle during flight. A shaft rotation encoder has been incorporated into the rocking mechanism that produces a pulse for each 19.78 arc seconds of rotation. This pulse triggers a light source which exposes the PG nod dot along the margin of the format.

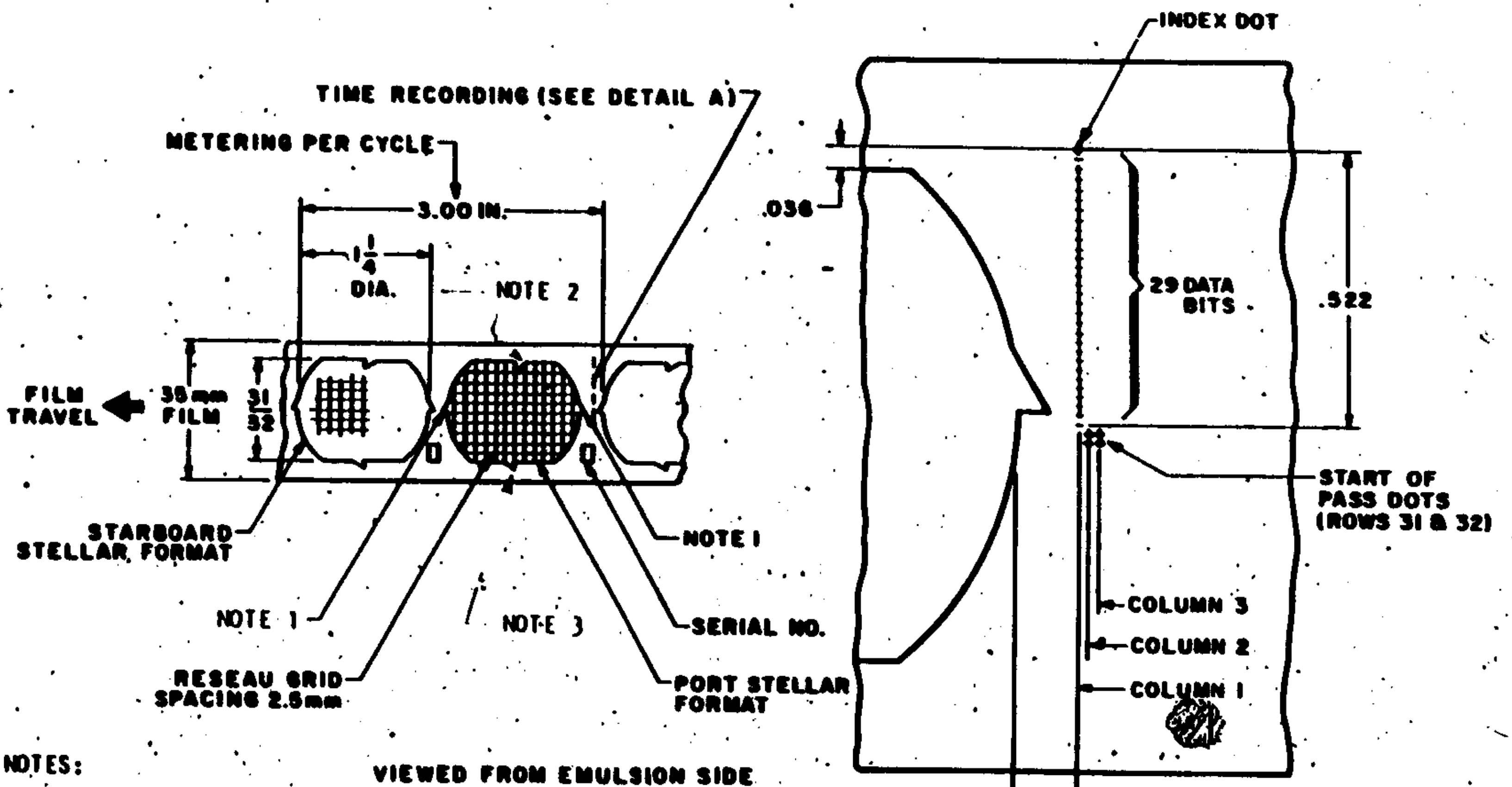
A sketch of stellar and terrain formats of the DISIC is shown in Figures V-4 and V-5, respectively. Both formats contain essentially the same ancillary data; time data block, serial number, and fiducials.

The time data block indicates the time of exposure of the appropriate camera. The data block on the stellar film is exposed by the port stellar camera. The operation of the DISIC unit is independent of panoramic cameras. Correlation of the photography of the panoramic cameras and DISIC is achieved through the respective time words.

The serial number of each unit is exposed on the film, with a P indicating the port stellar camera. The fiducials, as shown in the figures, denote flight direction, direction of film metering, and time word that is associated with the respective frame.

V-3.2.2 Resolution-Theodolite Test

A dynamic photographic resolution test is performed on each assembled system at A/P. The primary purpose of this test is to determine that the panoramic cameras are adjusted to the position of peak focus, thus maximum resolution. This position is determined



NOTES:

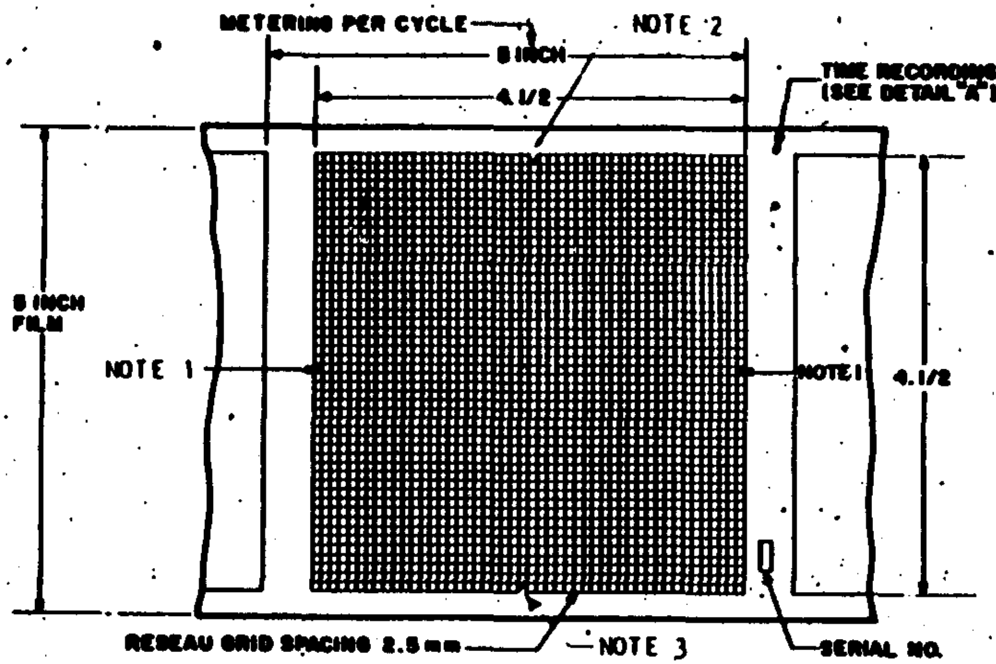
1. THESE FIDUCIALS INDICATE DIRECTION OF FLIGHT WITH RESPECT TO STELLAR CAMERA CONFIGURATION.
2. THIS FIDUCIAL POINTS TO SLP TIME WORD ASSOCIATED WITH THIS FRAME.
3. THIS FIDUCIAL INDICATES DIRECTION OF FILM METERING (TRAVEL).

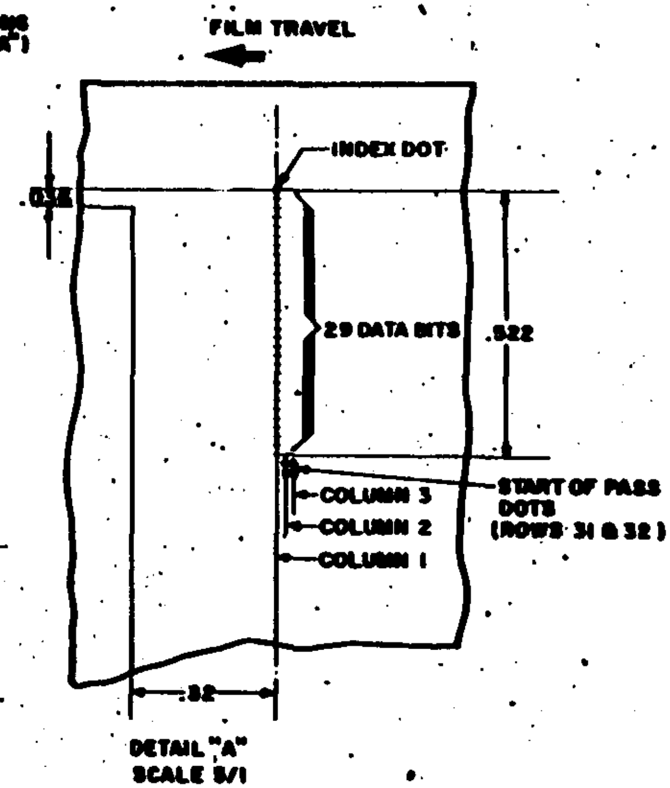
Figure V-4 Stellar Camera Format

C TOP SECRET [redacted]

[redacted]

[redacted]





VIEW FROM EMULSION SIDE

NOTES:

1. THESE FIDUCIALS INDICATE DIRECTION OF FLIGHT WITH RESPECT TO TERRAIN CAMERA CONFIGURATION.
2. THIS FIDUCIAL POINTS TO SLP TIME WORD RECORDING ASSOCIATED WITH THIS FRAME.
3. THIS FIDUCIAL INDICATES DIRECTION OF FILM METERING (TRAVEL).

Figure V-5 Terrain Camera Format

[redacted]

by visually reading the resolution of a standard test target as the position of this target is varied. The effect of changing target position from nominal is shown schematically in Figure V-6. If the maximum resolution occurs at the 0.000 inch target position, then the camera is adjusted for proper focus. In practice, the peak focus is usually shifted slightly from the nominal zero position to allow for certain flight conditions.

The secondary purpose of the resolution test is the determination of the performance capability of each panoramic camera. The absolute level of the resolution reading is not of major concern as long as this value is not less than the required 110 lines per millimeter.

A theodolite test is run in conjunction with the resolution test. A series of six theodolites is located in front of the system; one near the principle axis of each horizon camera and one near the center of format position of each panoramic camera. Each theodolite projects a crosshair image that is photographed by the respective camera. The angles between the axes of the theodolite projections are known to a high degree of accuracy, thus the angular relationship between the crosshair images on the system film is known.

A sketch of a section of a typical theodolite test format is shown in Figure V-7. As the location of the lens axis has been determined across the camera format by previous calibration, it is possible to measure the crosshair position and transfer this position to the center of format to determine the absolute stereo angle between the panoramic cameras. The absolute angular relationship between the centers of the horizon camera formats and any position in the panoramic camera format can then be ascertained by established measurement techniques.

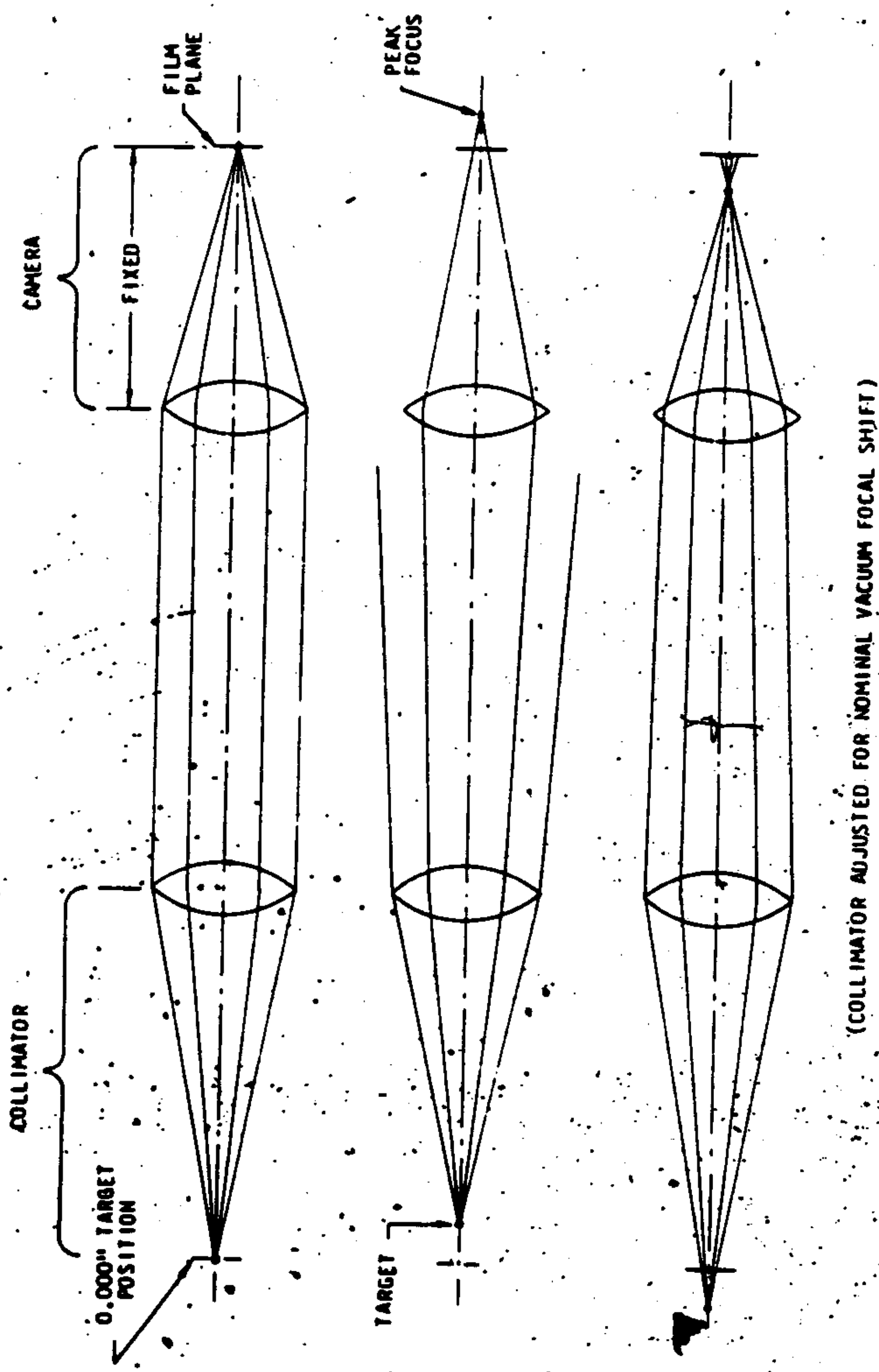


Figure V-6 Through Focus Resolution Test

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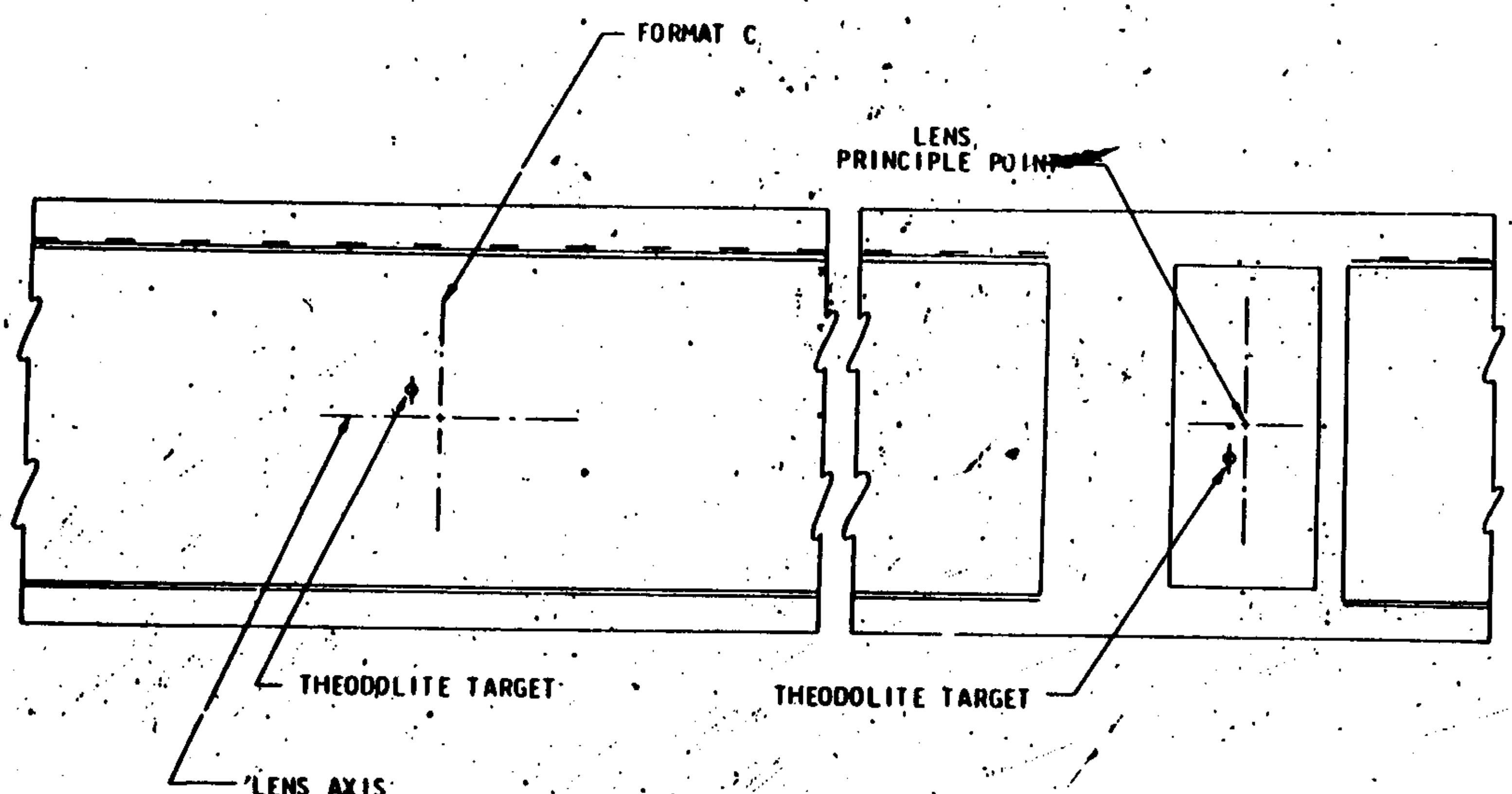

Figure V-7 Typical Theodolite Test Format

Resolution and theodolite calibration testing of the DISIC are done prior to systems test.

V-3.2.3 Environmental Test

Each complete system is subjected to an environmental test that simulates the thermal and pressure conditions that are encountered on orbit. A complete film supply spool is metered through each camera in a duty cycle representative of operational programming. This test is designed to assure satisfactory system operations during a complete mission simulation. A major consideration is the effect of the system on the film that is passed through the system.

The evaluation and analysis of the processed film from this test falls into three categories; photographic anomalies, physical defects, and equipment functions.

The major photographic anomalies are in the area of electrostatic phenomena that have been found to occur at pressures between 1 and 50 microns of mercury. These anomalies, termed corona discharge and dendritic static, cause illumination sources within the camera system. The level of illumination is sufficient to produce fogging on the film of a level that degrades operational photography. All camera systems are required to operate without producing any film fog from these types of discharge.

The physical defects that the film can encounter are normally in the broad category of scratches. The platen rails have historically scratched the film; however, in this case the magnitude of scratching is of primary concern. Severe rail scratches will result in flakes of emulsion falling onto the camera filter or rear lens. These flakes are opaque, thus the illumination through the camera is reduced in these areas causing minus density streaks on the film. Scratches and abrasions have been caused by many other components. Generally they are the result of marginal film path alignment.

All of the test film is examined to assure that the camera functions operated in a normal manner. This includes the proper shutter operation of all cameras, as well as the correct display of the previously discussed ancillary data.

V-3.2.4 Light Leak Testing

The panoramic camera film path is shielded from extraneous light by the space structure from the supply spool to the take-up spools. This design requires that the structure and portions of the camera must be sufficiently light-tight to prevent film fogging. A specific test has been developed to assure that the system meets the requirement of complete light-tightness.

The complete system, threaded with high-speed film, is exposed to a bank of lights. The combination of the film speed, lamp output, and test duration is equal to the energy recorded in an operational system that is not programmed during four consecutive orbits.

Following the test, the film is removed from the system, processed, and analyzed. The ancillary data exposed by the camera give a reference point to ascertain the position of the film in the system during the test. The location of any fog marks can therefore be correlated in the system and thus aid in the source of the light leak.

V-3.2.5 Readiness and Final Loading

A final test of system operation is conducted immediately prior to loading the flight film into the cameras. Fogging lamps are placed in front of each camera to show shutter operation.

The processed test film is evaluated to assure satisfactory operation of each camera and the associated ancillary data. The fogging lamps provide the means to examine the cleanliness of the lens, as minus density streaks are readily apparent.

Film samples are removed from the flight supply spools prior to loading into the supply cassette. A portion of this sample is examined without processing, to assure that there are no physical or manufacturing defects. A second portion is processed to establish that the photographic characteristics of each film emulsion are within the manufacturer's tolerance.

APPENDIX AA

PROGRAM PERFORMANCE HISTORY

AA-1.0 HISTORY OF SRV'S AND THE A/P PROGRAM

AA-1.1 SRV's were first flown by A/P in 1959. A total of eight different types of systems have been flown to date, with SRV's in different configurations. A summary of the flights and recoveries is shown in Figure AA-1. The first SRV's flown were two BIO (biological) capsules which were orbited in 1959. Neither SRV was recovered, although the first capsule was ejected over Spitzenbergen.

AA-1.2 The C system was the first camera system to be flown by A/P. It was conceived in 1958 and first flights were in 1959. The camera system was built by Fairchild with an Itek lens system. Five C systems were flown in 1959 with no recoveries, and five systems were flown in 1960 with one recovery. The tenth flight was a partial success, since the camera operated properly but an improper Agena pitchdown aborted recovery. The capsule was water-impacted 1000 miles down range and sank.

Two diagnostic flights were flown in 1960 during the C program, after the Atlantic recovery rocket failed on C-8. The second diagnostic flight produced the first recovery of a space capsule. The capsule water-impacted and was picked up. The spin system was changed from rockets to the present spin gas system on the diagnostic capsules.

AA-1.3 The C' system, an improved C system which utilized the Agena B vehicle, was developed in 1960. Three flights were made in 1960 with two successful recoveries. Seven C' systems were launched in 1961 with three successful recoveries.

[redacted]

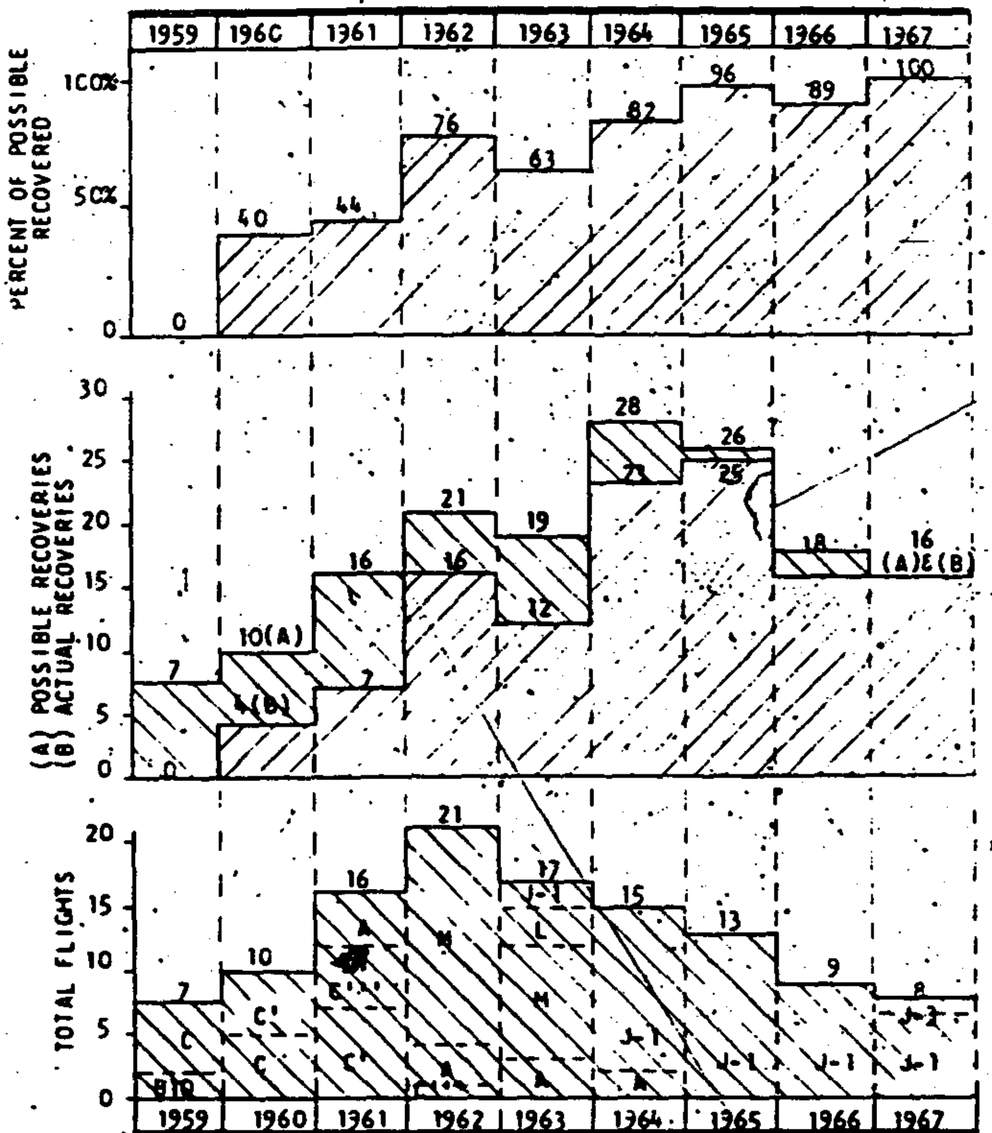

Figure AA-1 Recovery Results by Year

AA-1.4 The A system was introduced in 1960 with flights intermixed with the C' system. The A system was a high-altitude mapping system. Four systems were launched in 1961 with no recoveries. Three systems each were flown in 1962 and 1963 with two recoveries.

AA-1.5 The C''' System was introduced in 1961 and consisted of an Itek-supplied camera. Five flights were made in 1961 with four recoveries and one flight was made in 1962 with no recovery.

AA-1.6 The M system followed the C''' configuration, and consisted of a pair of C''' cameras juxtapositioned at 30 degrees to provide for stereo photography. Seventeen flights were made in 1962 with fourteen recoveries, and nine flights were made in 1963 with six recoveries.

AA-1.7 An L system was introduced in 1963. It was a larger and more sophisticated system than those previously flown. Due to the many problems encountered with the camera system, only three L systems were flown with two recoveries.

The J system was developed to obtain a longer on-orbit capability utilizing two SRV's per flight system. Two flights were made in 1963 with two recoveries out of four capsules. The first J-3 system was flown in September, 1967. The one flight to date was successful and both capsules were recovered. The J system recovery statistics are: 1964 - 13 flights with 26 capsules and 21 recoveries; 1965 - 13 flights with 26 capsules and 25 recoveries; 1966 - 9 flights with 18 capsules and 16 recoveries; 1967 to date - 8 flights with 16 capsules and 16 recoveries.

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APPENDIX BB

SIMILARITIES AND DIFFERENCES BETWEEN J-1 AND J-3

BB-1.0 PAYLOAD SUBSYSTEMS

BB-1.1 A/P Structure

		J-3	J-1
a.	Conic Adapter	None	(One) 60.00" to 50.56" dia. 17.60" long, mounting the supply cassette, DRCG, T/M and power J-box, aft pyro box, interface plug panel, yaw programmer, humidity sensor, and Pirani gauge.
b.	Camera barrel	(One) 60.00" dia. 66.00" long, mounting supply cassette, pan cameras (on 3-point deltas), IMC programmer, exposure control, aft power box, SI.P conditioner, humidity sensor, DRCG, aft T/M J-box, pyro current monitor, nitrogen purge valve.	
c.	Recovery barrel	None	(One) 50.56" dia. 24.00" long mounting the transfer box, fwd. pyro box, SI control box, felt door, PMU, nitrogen purge valve, hot wire cutter, SRV and fairing ejection equipment, "B" SI and B SRV.
d.	DISIC conic	(One) 60.00" to 50.56" dia., 26.00" long, mounting the DISIC system, intermediate roller, DISIC cycle counter, fwd. power J-box, transfer J-box, pyro J-box, SRV and fairing ejection devices, PMU, cut and splice assy., DISIC, and main seal assys. (felt doors)	None

[redacted]

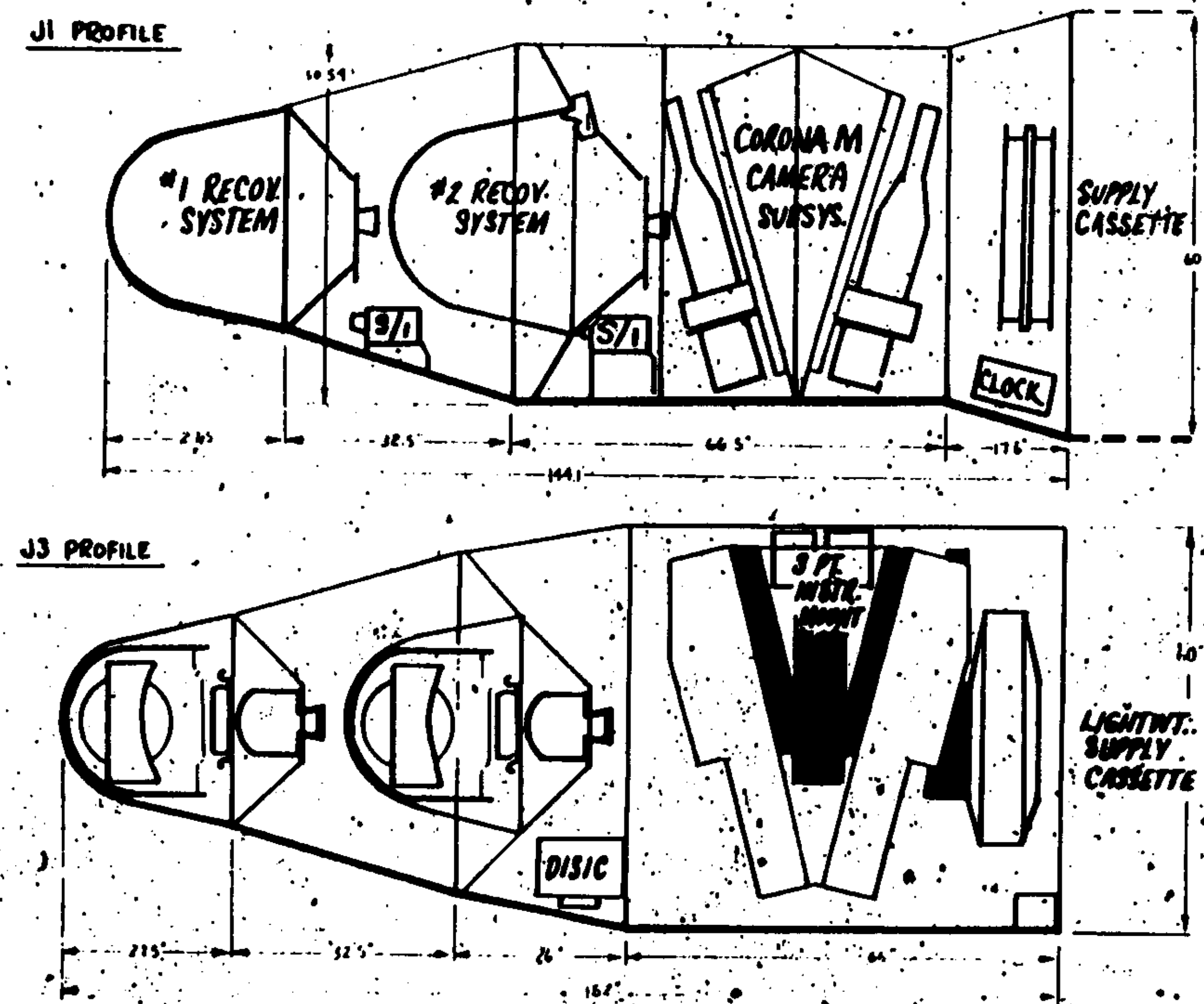

Figure BB-1 Inboard Profile Differences J-1 and J-3

e.	Fairing	(One) 50.56" to 33.17" dia., 32.55" long, mounting fwd. T/M J-box, DISIC chutes, and ejection equipment plus A SRV	Same as J-3, except mounting "A" SI plus A SRV, fairing J-box, temp. sensor J-box, SI control box, and ejection equipment.
f.	Ejectable photo doors	(1) One door for both main cameras (2) One (each) door for horizon optics (3) Three doors for DISIC	(1) One (each) door for main cameras. (2) One (each) door for horizon optics. (3) Two (each) doors for each SI camera.

BB-1.2	A/P Equipment	J-3	J-1
a.	Tape recorder	New -- (One each) system per SRV	None
b.	Film data recorders	New - Silicon light pulser data heads	Incandescent data heads.
c.	Exposure and filter control	New -- Inflight variable	Preflight fixed set -- Invariable in flight --
d.	DRCG	Outputs for two pan cameras, T/M, and DISIC, plus automatic serial readout every 20 seconds for T/M	Outputs for two pan cameras and T/M.
e.	PMC	3200 psi load of gas	3000 psi load of gas
f.	Command and control	19 real time commands 26 stored commands	9 real time commands 26 stored commands
g.	T/M	183 monitors	114 monitors
h.	Power distribution	28 VDC unregulated and 115 VAC 400 cycle power	+26 VDC unregulated, +24 unregulated, and 115 VAC, 400 cycle power
j.	Image motion compensation	Image motion compensation generated by single A/P programmer	Image motion compensation generated within the camera
k.	Cut and splice	DISIC cut and splice	None
l.	DISIC cycle counter	New	None
m.	DISIC chutes	New	None
n.	Yaw programmer	Integrated into slope programmer	Independent Unit

BB-1.3 Panoramic Camera	J-3	J-1
a. Scan system	Constant-rotating	Oscillating
b. Lens system	Second generation	First generation
c. Image motion compensation	By nodding entire camera system. Voltage generated by A/P (operates at lower altitude than J-1)	Bi-axial translation of each lens system. Voltage generated by camera subsystem
d. Exposure and filter control	Inflight variable	Preflight selectable
e. Splice sensor	New - (Provides capability to intermix film types)	None
f. Data recording	New - Silicon light pulser data block	Incandescent data block

BB-1.4 DISIC Subsystem	J-3	J-1
	New - DISIC subsystem. Replaces SI subsystem.	SI camera - (Positioned for East or West looking stellar capability as required.)

BB-1.5 Interface	J-3	J-1
a. Interface Connectors	Six Additional connector to separate pyro power from pyro commands	Five

BB-2.0 SRV	J-3	J-1
BB-2.1 Forebody		
a. Thermal paint	Paint added to adjust emissivity to 0.62	None
b. Internal aluminum thermal blanket	New	None
c. Thrust cone release	New - Guillotine cable cutters	Explosive bolts

BB-2.2 Recovery Capsule and Parachute

BB-2.2.1 External Capsule	J-3	J-1
a. Capsule cover	(1) New - Aluminum plus ESM coating.	(1) Fiberglass
	(2) New - 61-pin connector tension release (FD)	(2) 55-pin blow-off connector
	(3) New - Cutter relocated 90° clockwise from J-1 for DISIC	(3) SI cutters
	(4) Accessible test connector	(4) None

b. Flotation ballast	Fixed - Welded to nose of capsule	Swingdown pyro activated.
c. Parachute	MK5C with increased suspended load limit due to new swivel	MK5C with old swivel
d. Film chute	For DISIC	For SI
BB-2.2.2 Internal Capsule	J-3	J-1
a. Cartographic camera take-up	DISIC	SI
b. Blossom T/M	Repackaged and relocated. Despin event not monitored.	All components on T/M tray.
c. Recovery battery	Pyro-activated	Preflight-activated
d. Recovery programmer	New - With 26 sec. time delay	34 sec. time delay
e. Data recording	New - Tape recorder	None
BB-2.3 Thrust cone	J-3	J-1
a. Structure	DISIC film chute	None
b. Interface connectors	New - 61 pin	55 pin
c. Temp sensors	One retro	One retro One thrust cone skin

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TOP SECRET [redacted]

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APPENDIX CC

ADDENDUM A
OF
COMMAND FUNCTION LIST
(T3-7-024)

TOP SECRET [redacted]

******************* J-3 REAL TIME COMMAND DESCRIPTION *******************

ANAL-6/UHF-116 PROGRAM SELECTION

THIS IS A 11 POSITION STEPPER SWITCH TO SELECT ANY ONE OF NINE INDIVIDUAL STORED PROGRAMS.

NOTE 1 - UHF-109 (EMERGENCY BY-PASS ENABLE/DISABLE) IS USED IN CONJUNCTION WITH ANAL-6. WHEN UHF-109 IS IN THE 'ENABLE' CONDITION, PROGRAM SELECTION POSITIONS 10 AND 11 ARE REPEATS OF POSITIONS 1 AND 4 RESPECTIVELY.
- WHEN UHF-109 IS IN THE 'DISABLE' CONDITION PROGRAM SELECTION POSITIONS 1 THRU 9 SELECT PROGRAMS 1 THRU 9 AND POSITIONS 10 AND 11 ARE PANORAMIC CAMERA OFF POSITIONS.

************************* TELEMETRY VERIFICATION *************************

POS	VOLTAGE		PROGRAM		CONTROL SPC'S
	FIVES	UNITS	EMER BY-PASS ENA	EMER BY-PASS DIS	ON-OFF
1	1	1	1	1	30-31
2	1	2	2	2	32-33
3	1	3	3	3	34-35
4	1	4	4	4	36-37
5	1	5	5	5	38-39
6	2	1	6	6	40-41
7	2	2	7	7	42-43
8	2	3	8	8	44-45
9	2	4	9	9	46-47
10	2	5	1	OFF	30-31
11	3	1	4	OFF	36-37

[redacted]

ANAL-8/UHF-118 OPERATIONS SELECT NO. 1

THIS IS A 16 POSITION STEPPER SWITCH FOR CONTROLLING THE PANORAMIC CAMERAS OPERATIONS. THE POSITION OF THIS SWITCH DETERMINES IF THE 'ON' SPC FROM THE SELECTED PROGRAM SHALL BE RECEIVED AT THE PANORAMIC CAMERAS AS AN OPERATE COMMAND OR AS A SHUT DOWN COMMAND.

THIS STEPPER SWITCH, IN ADDITION TO BEING CONTROLLED BY ANAL-8, IS ADVANCED BY ONE OF TWO INTERNAL SOURCES. THE TWO (2) INTERNAL SOURCES ARE THE SELECTED PROGRAM 'ON' SPC OR SPC - 29 AS DETERMINED BY ANAL-10.

AFTER FOUR INTERNAL ADVANCE COMMANDS ARE RECEIVED BY OPERATE SELECT NO. 1, CONTROL OF THE PANORAMIC CAMERAS OPERATION IS SWITCHED TO OPERATE SELECT NO. 2. CAMERA CONTROL IS RETURNED TO OPERATE SELECT NO. 1 ONLY BY RECEIVING AN ANAL-8.

POSITION 16 OF THIS STEPPER SWITCH IS REFERED TO AS 'HOME' BECAUSE THE INTERNAL ADVANCE COMMANDS WILL NOT STEP THE SWITCH BEYOND THIS POSITION. ANAL-8 COMMANDS ARE REQUIRED TO MOVE THE STEPPER SWITCH FROM POSITION 16.

THE CONTROL LOGIC FOR THE SIXTEEN (16) POSITIONS IS SHOWN IN THE TELEMETRY VERIFICATION. A (1) IN THE CONTROL LOGIC MEANS THAT AN 'ON' SPC WILL OPERATE THE CAMERAS. A (0) IN THE CONTROL LOGIC MEANS THAT AN 'ON' SPC WILL SHUT DOWN THE CAMERAS. THE 'OFF' SPC'S ONLY TURN THE CAMERAS OFF.

ANAL-9/UHF-119 OPERATIONS SELECT NO. 2

THIS IS A 16 POSITION STEPPER SWITCH FOR CONTROLLING THE PANORAMIC CAMERAS OPERATIONS. THE POSITION OF THIS SWITCH DETERMINES IF THE 'ON' SPC FROM THE SELECTED PROGRAM SHALL BE RECEIVED AT THE PANORAMIC CAMERAS AS AN OPERATE COMMAND OR AS A SHUT DOWN COMMAND. THIS COMMAND TAKES CONTROL AFTER OPS SELECT NO. 1 HAS CONTROLLED FOUR (4) OPERATIONS. THIS COMMAND WILL ADVANCE TO POSITION 16 AND REMAIN IN CONTROL UNTIL AN ANAL-8/UHF-118 IS GIVEN.

THIS STEPPER SWITCH, IN ADDITION TO BEING CONTROLLED BY ANAL-9, IS ADVANCED BY ONE OF TWO INTERNAL SOURCES. THE TWO (2) INTERNAL SOURCES ARE THE SELECTED PROGRAM 'ON' SPC OR SPC - 29 AS DETERMINED BY ANAL-10.

POSITION 16 OF THIS STEPPER SWITCH IS REFERED TO AS 'HOME' BECAUSE THE INTERNAL ADVANCE COMMANDS WILL NOT STEP THE SWITCH BEYOND THIS POSITION. ANAL-9 COMMANDS ARE REQUIRED TO MOVE THE STEPPER SWITCH FROM POSITION 16.

THE CONTROL LOGIC FOR THE SIXTEEN (16) POSITIONS IS SHOWN IN THE TELEMETRY VERIFICATION. A (1) IN THE CONTROL LOGIC MEANS THAT AN 'ON' SPC WILL OPERATE THE CAMERAS. A (0) IN THE CONTROL LOGIC MEANS THAT AN 'ON' SPC WILL SHUT DOWN THE CAMERAS. THE 'OFF' SPC'S ONLY TURN THE CAMERAS OFF.

[redacted]

•••••••••••••••••••••• TELEMETRY VERIFICATION ••••••••••••••••••••••

ANAL-8/UHF-118 AND ANAL-9/UHF-119

POSITION	VOLTAGE FIVES	VOLTAGE UNITS	CONTROL (EDG)
1	1	[illegible]	1
2	1	[illegible]	1
3	1	3	1
4	1	4	0
5	1	5	0
6	2	1	1
7	2	2	0
8	2	3	1
9	2	[illegible]	0
10	2	5	0
11	3	1	0
12	3	2	0
13	3	[illegible]	1
14	3	[illegible]	1
15	3	5	0
16	4	1	0

ANAL-10/UHF-120 PANORAMIC CAMERA MODE SELECT

FUNCTION: THIS IS AN 11 POSITION STEPPER SWITCH FOR SELECTING STEREO OR MONO OPERATIONS, OPERATION SELECTS ADVANCE SOURCE ... PANORAMIC CAMERA OFF.

•••••••••••••••••••••• TELEMETRY VERIFICATION ••••••••••••••••••••••

POSITION NO.	VOLTAGE FIVES	VOLTAGE UNITS	FUNCTIONS: CAMERA MODE	OPS SELECT ADV. SOURCE
1	1	1	STEREO	CON. SE
2	1	2	MONO No. 1	"
3	1	3	MONO No. 2	"
4	1	4	No. 1 INDEPENDENT, No. 2	"
5	1	5	NO. 2 INDEPENDENT, NO. 1	"
6	2	1	STEREO	[illegible]
7	2	2	MONO No. 1	"
8	2	3	MONO No. 2	"
9	2	4	NO. 1 INDEPENDENT, No. 2	"
10	2	5	NO. 2 INDEPENDENT, No. 1	"
11	3	1	OFF	[illegible]

ANAL-11/UHF-121 ECCENTRICITY START-LEVEL SELECTOR

THIS IS A TWENTY (20) POSITION STEPPER MOTOR FOR SELECTION OF ANY ONE OF 20 PRE-SET START AND END VOLTAGES FOR THE ECCENTRICITY SINE FUNCTION.

ANAL-12/UHF-122 ECCENTRICITY HALF CYCLE LEVEL SELECTOR

THIS IS A TWENTY (20) POSITION STEPPER MOTOR FOR SELECTION OF ANY ONE OF 20 PRE-SET VOLTAGES FOR THE ECCENTRICITY SINE FUNCTION AT THE ONE-HALF CYCLE POINT.

************************* TELEMETRY VERIFICATION *************************

ANAL-11/UHF-121 AND ANAL-12/UHF-122

POSITION NO	VOLTAGE FIVES	VOLTAGE UNITS	FUNCTION
1	1	1	LOWEST VOLTAGE
2	1	2	
3	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
9	[illegible]	[illegible]	
10	[illegible]	[illegible]	
11	[illegible]	[illegible]	
12	[illegible]	[illegible]	
13	[illegible]	[illegible]	
14	[illegible]	[illegible]	
15	[illegible]	5	
16	[illegible]	[illegible]	
17	[illegible]	[illegible]	
18	[illegible]	[illegible]	
19	[illegible]	[illegible]	
20	[illegible]	[illegible]	HIGHEST VOLTAGE

ANAL-14/UHF-124 DISIC MODE SELECTOR

THIS IS A TWO (2) POSITION SELECTOR FOR SELECTING SLAVE OR INDEPENDENT MODE FOR THE DISIC INSTRUMENT. THE INDEPENDENT MODE IS OVERRIDDEN DURING PANORAMIC CAMERA OPERATION CAUSING THE DISIC TO OPERATE IN THE SLAVE MODE.

************************* TELEMETRY VERIFICATION *************************

POSITION NO	VOLTAGE UNITS	FUNCTION
1	1	INDEPENDENT [illegible]
2	2	SLAVE [illegible]

TOP SECRET

ANAC-15/UHF-125 ECCENTRICITY START DELAY SELECTOR

THIS IS A [illegible] 20 POSITION STEPPER MOTOR TO CONTROL THE TIME BETWEEN RECEIPT OF A SPC-2 [illegible] AND THE START OF THE ECCENTRICITY PORTION OF THE PMG FUNCTION. THE TIME PER STEP IS PRE-FLIGHT SELECTABLE FOR EITHER 25, 50 OR 200 SECONDS PER STEP.

TELEMETRY VERIFICATION

POSITION NO.	VOLTAGE FIVES	VOLTAGE UNITS	DELAY 25	DELAY 50	DELAY 200
1	1	1	25	50	200
2	1	2	50	100	400
3	1	3	75	150	600
4	1	4	100	200	800
5	1	5	125	250	1000
6	2	1	150	300	1200
7	2	2	175	[illegible]	1400
8	2	3	200	400	1600
9	2	4	225	450	1800
10	2	5	250	500	2000
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	300	600	3200
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	900	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	3800
20	[illegible]	[illegible]	500	1000	4000

UHF-101 PANORAMIC CAMERA EXPOSURE CONTROL

THIS IS AN ELEVEN STEP POSITION STEPPER SWITCH THAT PROVIDES AUTOMATIC SEQUENCING OR INDIVIDUAL SELECTION OF [illegible] OF FOUR (4) SLIT WIDTHS ON THE [illegible] INSTRUMENT, [illegible] FOR A FAIL-SAFE POSITION FOR BOTH INSTRUMENTS.

NOTE: UHF-102 IS USED IN CONJUNCTION [illegible] EITHER INSTRUMENT TO THE FAIL-SAFE POSITION WHILE THE OTHER INSTRUMENT IS ON AUTOMATIC CONTROL OR ONE OF THE FIXED SLIT POSITIONS.

TELEMETRY VERIFICATION

UHF-101

POSITION NO.	VOLTAGE FIVES	VOLTAGE UNITS	FUNCTION UHF-102 POS 1	FUNCTION UHF-102 POS 2
1	1	1	PAN 1 & 2 AUTO CONTROL	PAN 1 & 2 AUTO CONTROL
2	1	2	PAN 1 & 2 FIXED SLIT POS. 1	PAN 1 & 2 FIXED SLIT POS. 1
3	1	3	PAN 1 & 2 FIXED SLIT POS. 2	PAN 1 & 2 FIXED SLIT POS. 2
4	1	4	PAN 1 & 2 FIXED SLIT POS. [illegible]	PAN 1 & 2 FIXED SLIT POS. [illegible]
5	1	5	PAN 1 & 2 FIXED SLIT POS. [illegible]	PAN 1 & 2 FIXED SLIT POS. [illegible]
6	2	1	PAN 2 AUTO CONTROL	PAN 1 AUTO CONTROL
			PAN 1 FAIL SAFE	PAN 2 FAIL SAFE
7	2	2	PAN 2 FIXED SLIT NO. [illegible]	PAN 1 FIXED SLIT NO. [illegible]
			PAN 1 FAIL SAFE	PAN 2 FAIL SAFE
8	2	3	PAN 2 FIXED SLIT NO. [illegible]	PAN 1 FIXED SLIT NO. [illegible]
			PAN 1 FAIL SAFE	PAN 2 FAIL SAFE
9	2	4	PAN 2 FIXED SLIT NO. [illegible]	PAN 1 FIXED SLIT NO. [illegible]
			PAN 1 FAIL SAFE	PAN 2 FAIL SAFE
10	2	5	PAN 2 FIXED SLIT NO. [illegible]	PAN 1 FIXED SLIT NO. [illegible]
			PAN 1 FAIL SAFE	PAN 2 FAIL SAFE
11	3	1	PAN 1 & 2 FAIL SAFE	PAN 1 & 2 FAIL SAFE

UHF-102 PANORAMIC CAMERA FAIL-SAFE CONTROL

THIS IS A 2-POSITION SELECTOR [illegible] USED IN CONJUNCTION WITH UHF-101 TO PLACE EITHER [illegible] IN ITS FAIL-SAFE POSITION WHILE THE OTHER INSTRUMENT IS IN AUTOMATIC CONTROL OR ONE OF THE FIXED SLIT POSITIONS.

TELEMETRY VERIFICATION

POSITION NO.	VOLTAGE		FUNCTION
1	2	1	PAN 1 IN FAIL-SAFE POSITION
			PAN 2 UHF-101 CONTROL
2	2	2	PAN 2 IN FAIL-SAFE POSITION
			PAN 1 UHF-101 CONTROL

UHF-103 PANORAMIC CAMERA NO. 1 FILTER CHANGE

THIS IS A TEN (10) POSITION SELECTOR FOR SELECTING [illegible] ONE OF TWO FILTER TYPES. FIVE (5) COMMANDS ARE REQUIRED TO COMPLETE A FILTER CHANGE.

UHF-104 PANORAMIC CAMERA NO. 2 FILTER CHANGE

THIS SELECTOR IS IDENTICAL TO UHF-103 EXCEPT IT CONTROLS FILTERS FOR PANORAMIC CAMERA NO. 2.

[redacted]

TOP SECRET

TELEMETRY VERIFICATION
UHF-1[illegible] AND UHF-10[illegible]

POSITION NO	VOLTAGE UNITS	FUNCTION
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	NORMAL
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	[illegible]

UHF-105 - EXPOSURE CONTROL DELAY

A. THIS IS A 20 POSITION STEPPER MOTOR FOR CONTROLLING [illegible] ING TIME DELAY OF AN AUTOMATIC NIGHT TO DAY EXPOSURE CONTROL SEQUENCE AFTER RECEIPT OF A SPC-[illegible] [illegible] NIGHT [illegible] AFTER SPC-32 [illegible] ARE 20 DELAY INCREMENTS OF [illegible] SECONDS PER INCREMENT. [illegible] PRE-FLIGHT.

TELEMETRY VERIFICATION

POSITION NO	VOLTAGE FIVES	VOLTAGE UNITS	DELAY SEC	DELAY SEC	REMARKS
1	1	[illegible]	10	[illegible]	
2	1	[illegible]	[illegible]	[illegible]	
3	1	[illegible]	[illegible]	[illegible]	
4	1	[illegible]	[illegible]	[illegible]	
5	[illegible]	[illegible]	[illegible]	[illegible]	
6	2	[illegible]	[illegible]	[illegible]	
7	2	[illegible]	[illegible]	[illegible]	
8	2	[illegible]	[illegible]	[illegible]	
9	2	[illegible]	[illegible]	[illegible]	[illegible]
10	2	[illegible]	100	[illegible]	[illegible]
11	3	[illegible]	[illegible]	[illegible]	[illegible]
12	3	[illegible]	120	[illegible]	[illegible]
13	3	[illegible]	[illegible]	[illegible]	DELAY
14	3	[illegible]	[illegible]	[illegible]	
15	3	[illegible]	[illegible]	[illegible]	
16	[illegible]	[illegible]	[illegible]	[illegible]	
17	[illegible]	[illegible]	[illegible]	[illegible]	
18	[illegible]	[illegible]	[illegible]	[illegible]	
19	[illegible]	[illegible]	[illegible]	[illegible]	
20	[illegible]	[illegible]	200	[illegible]	

TOP SECRET

UHF-106 YAW FUNCTION ENABLE/DISABLE

THIS IS A 2 POSITION SELECTOR FOR ENABLING OR DISABLING YAW PROGRAMMER OUTPUT TO VEHICLE.

TELEMETRY VERIFICATION

POSITION NO.	VOLTAGE UNITS	FUNCTION
1	[illegible]	[illegible]
2	[illegible]	[illegible]

UHF 107 DISIC CONTROL

THIS IS A [illegible] POSITION SELECTOR FOR CONTROLLING THE [illegible] SHUTTERS OF THE DISIC STELLAR [illegible] TO PERMIT [illegible] RIGHT LOOKING OR BOTH [illegible]. A DISIC CAMERA [illegible] POSITION IS ALSO PROVIDED.

TELEMETRY VERIFICATION

POSITION NO.	VOLTAGE UNITS	FUNCTION
1	[illegible]	DISIC OFF
2	[illegible]	RIGHT [illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

UHF-109 EMERGENCY BYPASS

THIS IS A TWO POSITION SELECTOR WHICH CONTROLS THE OUTPUT OF THE PROGRAM SELECT SWITCH. IN THE EMERGENCY BYPASS ENABLE POSITION THE ON/OFF COMMANDS FROM THE SELECTED PROGRAM [illegible] 10 AND 11 ARE SENT DIRECTLY TO THE CAMERAS BYPASSING THE OPERATIONS SELECTION AND CAMERA CONTROL SELECTORS. IN THE DISABLE POSITION CAMERA CONTROL IS THRU THE OPERATIONS SELECTION AND CAMERA CONTROL SELECTORS. [illegible] IS ALSO [illegible] RESET TO THE KZ-[illegible] AND KZ-[illegible] TIMERS AND [illegible] COMMAND FOR ORBIT MODE.

[redacted]

POSITION VOLTAGE

UHF-110 ... ENABLE/DISABLE

OF ENABLING OR DISABLING ...

POSITION VOLTAGE

KIR-20PPG-3A ...

POINT

CH1S PT

CH1S PT

CH1S PT

CH1S PT

KIK-ZORRO-3 [illegible]

THIS IS A SECURE COMMAND [illegible] SEQUENCE [illegible] THE CRV-[illegible] COMMAND [illegible] CONTINUOUS [illegible]

TELEMETRY VERIFICATION

POINT	BEFORE	AFTER
CHLS HE55S50	[illegible]	[illegible]
LINK L/CS1.00	[illegible]	[illegible]

AP RECOVERY ENABLE

THIS SIGNAL IS [illegible] EXECUTING [illegible] RECOVERY [illegible] ACTIVATES [illegible]

[illegible]

STORED PROGRAM COMMAND [illegible]

SPC NO. FUNCTION

14• A. ECCENTRICITY FUNCTION [illegible]
B. YAW FUNCTION START
C. OBLATENESS FUNCTION START

17• CONTINUOUS T/M CHANNEL [illegible]

20 AGENA CHANNEL SWITCH [illegible]
INTERFACE [illegible]

21 A/P CHANNEL SWITCH [illegible]
A/P COMMUTATOR [illegible] INTERFACE [illegible]

27 ECCENTRICITY START DELAY

28• PAN CAMERA(S) [illegible] PROGRAM

29• OPERATION(S) SELECT ADVANCE

30/46 (EVEN) PAN CAMERA PROGRAM [illegible]

31/47 (ODD) PAN CAMERA PROGRAM [illegible]

48• DISIC ON

49• DISIC OFF

50• EXPOSURE PROGRAMMER POWER OFF

51•• EXPOSURE PROGRAMMER NIGHT TO DAY SEQUENCE START

52•• EXPOSURE PROGRAMMER DAY TO NIGHT SEQUENCE START

[illegible] T/M ON (AGENA INTERFACE) [illegible]
[illegible]

[illegible] AP DATA ENABLE [illegible] INITIATED BY VEHICLE [illegible] TAPE RECORDER [illegible] TELEMETRY [illegible]

NOTE (•) THESE SPC COMMANDS CAN BE ISSUED FROM THE [illegible] THROUGH UMBILICAL PLUG [illegible]

NOTE (••) THESE SPC COMMANDS CAN BE ISSUED FROM THE [illegible] THROUGH UMBILICAL PLUG [illegible]

[illegible]

COMMAND [illegible]

AP-1 [illegible]

AP-2 ARM BY-PASS [illegible]
SRV-STAR [illegible]

AP-3 SAFE [illegible] OPERATION [illegible]

AP-4 ARM BY-PASS [illegible]
SRV-STAR [illegible]

AP-5 [illegible]

[illegible]

IN-FLIGHT [illegible]

[illegible]

[illegible] INITIATES [illegible]

********************** STORED PROGRAM COMMANDS *************************

SPC NO.	FUNCTION
14*	A. ECCENTRICITY FUNCTION RESET B. YAW FUNCTION START C. OBLATENESS FUNCTION START
17*	CONTINUOUS T/M CHANNEL ENABLE
20	AGENA CHANNEL SWITCH TO T/R, - A/P COMMUTATORS OFF (NOT THROUGH INTERFACE)
21	A/P CHANNEL SWITCH TO T/R A/P COMMUTATORS ON (NOT THROUGH INTERFACE)
27	ECCENTRICITY START DELAY
28*	PAN CAMERA'S REDUNDANT OFF; ALL PROGRAMS
29*	OPERATIONS SELECT ADVANCE
30/46	(EVEN) PAN CAMERA PROGRAM 1-9 ON
31/47	(ODD) PAN CAMERA PROGRAM 1-9 OFF
48*	DISIC ON
49*	DISIC OFF
50*	EXPOSURE PROGRAMMER POWER OFF
51**	EXPOSURE PROGRAMMER NIGHT TO DAY SEQUENCE START
52**	EXPOSURE PROGRAMMER DAY TO NIGHT SEQUENCE START

T/M ON (AGENA INTERFACE) - ENERGIZES ALL A/P TELEMETRY CIRCUITS AND RESETS A/P CONTINUOUS T/M.

AP DATA ENABLE - INITIATED BY VEHICLE EACH TIME PAYLOAD FUNCTIONS ARE TO BE TAPE RECORDED (SEE SPC-20 AND SPC-21). ENERGIZES ALL TELEMETRY CIRCUITS.

NOTE (*) THESE SPC COMMANDS CAN BE ISSUED FROM THE BLOCKHOUSE THROUGH UMB. PLUG J-100 OR J-101.

NOTE (**) THESE SPC COMMANDS CAN BE ISSUED FROM THE BLOCKHOUSE THROUGH UMB. PLUG P200.

******************************** BLOCKHOUSE COMMANDS ********************************

COMMAND	FUNCTION
AP-1	COMMANDS POWER ON FOR CONTINUITY LOOP
AP-2	ARM BY-PASS 2 (ENABLES SRV-B BEACON AND T/M) (REVERSE PLAYBACK SRV-B TAPE RECORDER)
AP-3	SAFE (STEREO OPERATE) (BOTH SRV RECORDERS-RECORD)
AP-4	ARM BY-PASS 1 (ENABLES SRV-A BEACON AND T/M) (REVERSE PLAYBACK SRV-A TAPE RECORDER)
AP-5	A/P ORBIT MODE
----	A/P RELAY RESET (CONDITIONS PAYLOAD TO ASCENT MODE)

******************************** ASCENT EVENTS ********************************

IN-FLIGHT RESET

THIS SIGNAL IS INITIATED BY THE PHYSICAL SEPARATION OF THE VEHICLE AND THE BOOSTER ADAPTER. IN-FLIGHT RESET INITIATES EJECTION OF THE MAIN DOOR, DISIC TERRAIN DOOR, AND DISIC STELLAR NO. 1 DOOR (R.H. LOOKING FOWARD).

IN-FLIGHT RESET PLUS 100 M/S (ORBIT MODE SIGNAL BACKUP) INITIATES EJECTION OF THE FOUR (4) HORIZON DOORS, AND DISIC STELLAR NO. 2 DOOR (L.H. LOOKING FORWARD).

SEQUENCE TIMER EVENTS

AP ORBIT MODE

THIS SIGNAL IS INIATED BY THE ASCENT TIMER AND TRANSFERS THE PAYLOAD TO ORBIT MODE. IT IS ALSO A BACKUP FOR IN-FLIGHT RESET. UHF-109 IS BACK-UP FOR A/P ORBIT MODE.

ARM SIGNAL

SRV-A THIS IS THE INITIAL SIGNAL OF THE RECOVERY SEQUENCE. UPON RECEIPT OF THE ARM COMMAND THE SRV-A T/M BATTERY, SRV-A RECOVERY BATTERY, AND T/M CONTINUOUS ENABLE ARE ACTIVATED. THIS SIGNAL IS ALSO A BACKUP FOR KZ-38 AND/OR KZ-39 IF NOT ALREADY ACTUATED.

SRV-B UPON RECEIPT OF THE ARM COMMAND THE FAIRING DISCONNECT PLUGS ARE SPUN OFF, THE SRV-B T/M BATTERY, RECOVERY PROGRAMMER BATTERY, AND T/M CONTINUOUS ENABLE ARE ACTIVATED. THIS SIGNAL IS ALSO A BACKUP FOR THE DISIC CUTTER.

ARM PLUS 100 M/S INITIATES THE FAIRING SEPARATE PIN PULLERS AND SRV-B MAIN WATER SEAL.

TRANSFER SIGNAL

SRV-A THIS SIGNAL IS THE SECOND SIGNAL OF THE RECOVERY SEQUENCE. IT ACTIVATES THE DISIC LIGHT SEAL (FELT DOOR), SRV-A THRUST CONE THERMAL BATTERIES AND SRV-A DISIC WATER SEAL.

SRV-B THIS SIGNAL ACTIVATES THE SRV-B THRUST CONE THERMAL BATTERIES AND SRV-B DISIC WATER SEAL.

DISCONNECT SIGNAL

THIS IS THE THIRD SIGNAL IN THE RECOVERY SEQUENCE. RECEIPT OF THIS SIGNAL ACTIVATES THE SPIN OFF OF THE P28A OR P28B INTERFACE CONNECTOR.

SEPARATION SIGNAL

THIS IS THE FOURTH SIGNAL OF THE RECOVERY SEQUENCE. UPON RECEIPT OF THE SEPARATE SIGNAL, PHYSICAL SEPARATION (PIN PULLERS) OF THE PAYLOAD AND SRV IS INIATED.

NOTE - TEN SECONDS AFTER REMOVAL OF THE SRV-A SEPARATE SIGNAL THE A/P RECOVERY SWITCH-OVER CIRCUIT TRANSFERS THE RECOVERY COMMAND CAPABILITY TO THE SRV-B.

APPENDIX DD

ABBREVIATIONS

ADAPS	Automated Digital and Analog Processing System
ADP	Automatic Data Processing
AFSSD	Air Force Satellite Systems Division
AGE	Aerospace Ground Equipment
ANA	Analog Command Link
A/C	Aircraft
AO	Auxillary Optics
A/P	Advanced Projects, Agena/Payload (Interface)
AUGGIE	Augmented Tracking Station Data Handling System
AWAR	Area Weighted Average Resolution
B/U	Back-Up
BTL	Bell Telephone Laboratory
C_DA	Drag Area
CPS	Cycles Per Second
CR	Constant Rotating
[redacted]	[redacted]
CW	Continuous Wave
DF	Direction Finding (Antenna)
DISIC	Double Improved Stellar Index Camera
DMU	Drag Make-Up Unit
DRCG	Digital Recording Clock Generator
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPS	Electrical Power System
ESM	Elastomeric Shield Material
FCD	Film Change Detector
FMC	Forward Motion Compensation
FMSL	Feet Above Mean Sea Level
FPS	Feet Per Second

F/L	Flight Loaded
GFE	Government-Furnished Equipment
GHE	Ground Handling Equipment
HIC	Hickam Field
HIG	Hermetic Integrating Gyro
HIVOS	High Vacuum Orbital Simulator
H/O	Horizon Optics (In A/P Payload)
H/S	Horizon Sensor (In Agena)
[redacted]	[redacted]
HZ	Hertz (Cycles Per Second)
IFD	In-Flight Disconnect
IMC	Image Motion Compensation
IPS	Inches Per Second
IR	Infrared
IRFNA	Inhibited Red-Fuming Nitric Acid
IRIG	Inter Range Instrumentation Group
IRP	Inertial Reference Package
KIAS	Knots Indicated Air Speed
[redacted]	[redacted]
LBNO	Lifeboat Next Orbit
LMSC	Lockheed Missiles and Space Company
L/B	Lifeboat
MDF	Mild Detonating Fuse
MIG	Miniature Integrating Gryo
NM	Nautical Miles
NRZ	Nonreturn to Zero
OSFG	Orbital Sine Function Generator
PAM	Pulse-Amplitude Modulation
PCM	Pulse Code Modulation
PMU	Pressure Make-Up Unit
PNO	Primary Next Orbit
POHCV	Pyro-Operated Helium Control Valve

PPM	Parts Per Million
PPS	Primary Propulsion System
PPS	Pulses Per Second
PRF	Pulse Repetition Frequency
PRR	Pulse Repetition Rate
P/L	Payload
P/LV	Payload Vehicle
PSI	Pounds/Square Inch
PSIA	Pounds/Square Inch Absolute
RC	Radio Command, Rate of Change, Resistor-Capacitor
RF	Radio Frequency
RFI	Radio Frequency Interference
RPC	Revolutions Per Cycle
RPM	Revolutions Per Minute
RPS	Revolutions Per Second
R/E	Re-Entry
RTC	Real Time Command
RV	Recovery Vehicle (Re-Entry Vehicle)
SCR	Silicon Controller Rectifier
SHEMYA	Aleutian Island
SLP	Silicon Light Pulser
SPC	Stored Program Command
SRTC	Secure or S-Band Real Time Command
SRV	Satellite Recovery Vehicle
S/C	Supply Cassette
S/I	Stellar and Indexing
SS	Subsystem
SS/A	Spaceframe Subsystem
SS/B	Propulsion Subsystem
SS/C	Electrical
SS/C C	Communications and Control
SS/D	Guidance and Control

[redacted]

SS/L	Subsystem L (Payload)
STC	Satellite Test Center
SV	Sunnyvale, Satellite Vehicle
TDR	Timing and Data Recording
TRL	Transistor/Resistor Logic
T/C	Thrust Cone
T/M	Telemetry (And Instrumentation)
T/R	Tape Recorder
UDMH	Unsymmetrical Dimethylhdrazine
UHF	Ultrahigh Frequency
VAC	Volts Alternating Current
VAFB	Vandenberg Air Force Base
VCO	Voltage-Controlled Oscillator
VDC	Volts Direct Current
VHF	Very High Frequency
V/H	Velocity/Height Ratio
[redacted]	[redacted]
W/S	Water Seal (And Cutter)
WTR	Western Test Range

APPENDIX EE

GLOSSARY

Term	Definition
Ablation (ablative)	In areospace usage, the removal and carrying away of surface materials (usually as a means of dissipating and dispersing intense concentrations of heat). The erosion of the lining of a rocket nozzle or the exterior layers of an ablative heat shield on the SRV, as it chars and flakes off in the form of glowing incadescent particles in the air stream or rocket blast (to carry away the accumulated surface heat before it can penetrate to the interior layers, which thus remain relatively cool).
Absorptivity-to-Emissivity ratios (of thermal radiation)	Absorptivity is the ratio between the radiant energy absorbed by a particular surface or body (most of which is re-radiated), divided by the total energy reaching the surface or body. That energy which is transmitted by re-radiation usually emerges in a changed range of frequencies. Emissivity is the ratio between the energy input absorbed by the surface or body and the IR energy emitted or re-radiated as an output from the surface or body. The relative balance between the thermal input ratio and the output ratio is still another ratio (a ratio between quantities that are themselves ratios), which determines the portion of the total energy input retained for internal use of the satellite in order to maintain the desired temperature range. Because the J-3 satellite is in the earth's shadow during approximately half of each orbit, and is in direct sunlight the other half, a cyclic pattern of heat ebb and flow occurs during each orbit. The choice of thermal materials and the patterns of their application in different parts of the vehicle are two of the methods used to control the temperature within desired limits in different parts of the satellite vehicle.
Acquisition (data acquisition or vehicle acquisition)	The act of acquiring or gaining possession of (some item or object). In data acquisition, the act of accumulating or taking possession of data or monitored status and operational information, usually by means of a T/M signal. Vehicle acquisition is the act of taking command of a satellite vehicle by locking onto the vehicle with the tracking radar as it comes over the horizon, and by means of appropriate electronic signals (which are usually peculiar to a particular vehicle for protection against unauthorized commanding of

Term	Definition
	the satellite) opening up two-way communication with the satellite until the vehicle "fades" over the horizon. The means of re-opening communication are then locked out or disabled until an interval command re-enables the means of real time communication for the next pass over the ground station.
ANA (commands)	Analog or "picture" (graphic-type) commands transmitted to the Agena via the VHF command link, operating at radio/radar frequencies lower than the UHF bandwidth.
Analog command (or signal)	A continuously variable signal or command, the output of which corresponds closely to the applied input. A "picture" type of signal (e.g., a sine wave-function), rather than one in which discrete step levels are used. A step-function signal is usually converted in computerized data handling to a binary code signal. An analog signal is usually processed without converting it to a formal machine language, ~~but requires an~~ analog-type computer to do so.
Ancillary (equipment data, etc.)	Subordinate, or auxiliary (accessory equipment). Playing a supporting role or function.
Apogee	That point in the orbit of an earth satellite which is farthest from earth.
Argument of perigee	The angle measured in the orbit plane from the ascending node to perigee in the direction of satellite motion. NOTE: The ascending node of an orbit is the point where the satellite crosses the fundamental plane (the equatorial plane of the earth) moving northward.
Arm (an electronic command to the pyrotechnic subsystem and the SRV)	One of a sequence of commands (ARM, TRANSFER, DISCONNECT, SEPARATE) required to prepare the SRV for de-orbiting and recovery. It is preceded (in the Agena orbital timer) by the Recovery Enable command, and is the enabling command to start the recovery timer, which then sends signals to the SRV and the payload system to make preparations for SRV departure from the satellite vehicle.
Ballpark (in SRV Recovery)	The outer limits of the expected area for recovery of the SRV. Also used as slang for any such arbitrary approximation of the working area or similar allegorical limitations on a process or procedure.
Beacon (radar, acquisition, and tracking or homing types)	Beacon, general: A signal station or device producing a guidance signal. The Agena carries a radar beacon (actually a transponder) capable of sending and receiving radar signals to aid the tracking radar systems to "lock on" and adjust the radar signals to and from

Term	Definition
	the Agena for maximum effective information flow. Each SRV carries a pulse repetition-type beacon (each beacon with an individual "signature") for tracking the SRV during recovery operations. The beacon (or the beacon-transponder) is an essential part of the Agena Command and Communications link.
Binary	Double, or consisting of two parts: a. In electronics logic, a two-state device capable of ON/OFF, YES/NO, First Level/Second Level, One/Zero types of choices. b. In binary computations, counting in sets of two or to the base two. Such numbers are expressed as exponents of two (e.g., $2 \times 1/2 = 1$, $2 \times 1 = 2$, $2 \times 2 = 2^2 = 4$, $2 \times 2 \times 2 = 2^3 = 8$. Powers of two (quatral, octal, or higher powers) may be substituted in such calculations to shorten the computer programming time or computer subroutines.
Bit (bit of data or information)	The separate elements (pulses, voltage levels, etc.) from which electronic data words or functions are constructed in electronic logic systems. Also, the separate binary bits of data or symbolic logic elements by which the data are transmitted. A basic unit in any machine language by which computers and similar electronic devices can be programmed for communication or computation logic.
Blackout zone (in telemetry communication, beacon tracking, etc.)	The "communications blackout" or fading of RF transmission during the interval a space vehicle or re-entry body (e.g., an SRV) is passing through the ionosphere, or where an ionization layer has built up on an antenna or other radiator of RF energy during re-entry, which blocks radiation of energy from the radiator.
Booster	The THORAD first-stage rocket booster plus the booster adapter collar.
Boot (optical boot)	A flexible, light-tight membrane around the lens opening for each camera lens (except the DISIC terrain lens, which has a rigid, recessed mount required for precise alignment with the satellite vehicle). The boot allows the camera system and space frame structure to flex in relation to each other, without leaking unwanted light into the film path cavities as the lens looks out through the uncovered optical ports after the doors (or cover) over them are ejected during ascent.
Cartographic camera	A precision framing-type camera having a carefully calibrated low-distortion lens, a calibrated flat-field focal plane, and wide field angle (covering 70 to 90 degrees across the fiducial marks, and up to

[redacted]

C TOP SECRET [redacted]

Term	Definition
	120 degrees in a few advanced lens designs) designed specifically for photographic/photogrammetric mapping techniques.
Cartographic/ geodetic camera	A camera that takes simultaneous terrain and stellar photographs for photogrammetric mapping. The stellar lens (two stellar lenses on the DISIC camera) has a calibrated locking angle between the stellar optical axis and the optical axis of the terrain lens (also calibrated for photogrammetric mapping). The stellar photography is used for geodetic control in much the same way as stellar photography made with a surveyor's phototheodolite on earth.
Cartography (cartographic)	The art and science of making maps, or pertaining to the making of such maps or charts.
Cassette (supply cassette or take-up cassette)	A container for holding the film supply before exposure and the exposed film taken up after exposure in the cameras. The film is usually stored on spools within the cassettes, except while passing from the supply cassette through the camera to the take-up cassette.
Char (on the ablative heat shield of the SRV)	Partial combustion or carbonization of the outer layers of ablative material on the outside of the SRV heat shield during the heat of supersonic re-entry into the atmosphere. The charred portions flake off in the airstream, carrying away most of the heat from the inner capsule.
Chuted film path (DISIC)	Rectangular, box-like structures enclosing the DISIC film paths to the SRV's, to protect the fast films used in the DISIC from extraneous light and radiation exposure. The DISIC films advance more slowly along the paths to the take-up cassettes than do the CR films, so need greater protection.
Clutch, 99/101%	A two-position, variable-drive, geared clutch in the panoramic camera to adjust the rate of film input/output to compensate for manufacturing tolerances necessary in the film metering rollers and other parts of the film metering equipment of the panoramic cameras.
Commutated (telemetry)	A technique in telemetry by which a rotary sampling switch (commutator) is used to sample data from many instrumentation points or sensors and convert them to a variable voltage pulse train (or square wave train) feeding into the VCO (Voltage-Controlled Oscillator) of the telemetry transmitter. The length of time each point is sampled (pulse width) depends on the number of points on the rotary switch and the speed of rotation.

[redacted]

C-TOP SECRET [redacted]

[redacted]

Term	Definition
Converter (DC to DC)	A device which changes direct current from one voltage to another.
Corona (corona effect)	In electricity, the crown-like electrostatic discharge which envelopes the surface of a wire or component under high-voltage (or lower voltages in the presence of high vacuum) once the dielectric strength of insulating materials has been exceeded or broken down.
DD 250 (form)	A formal document prescribed by the Department of Defense (DOD) for the acceptance of major items of procurement on US Government or DOD contracts. It transfers title to the property from the manufacturer to the US Government, so that the vendor can be paid on an increment of the contract.
Delta-connected (delta connection)	A three-phase electrical system connected in such a way that the corresponding windings of the three transformers form a triangle (or delta).
Detent	That which locks or unlocks a movement or mechanism (e.g., a catch, dog, pawl, or ratchet). In J-system terminology, the mechanisms by which the rotating lens and oscillating drum were locked together during scan of the J-1 cameras, and the engagement/disengagement of the yaw function generator and the oblateness function generator to the same drive system in the IMC slope programmer.
Digital (data) (computations) (computers)	Pertaining to numbers in the digital system (1's, 2's, etc. through 9's, plus the zero symbol), or to data expressed as such numbers, including the binary logic used in electronic digital computers. Such computers operate with numbers expressed directly as digits (1's and 0's), and require a formal machine language (as compared to analog computers, which operate on a graphical principle).
Disable (as electronic command)	To open a lockout circuit or device which prevents the receipt or action of another command or function.
Discrete	Composed of separate and distinct units or elements.
Eccentricity (of an orbit) (Also see elliptical or ellipticity).	State or degree of being eccentric (as a planet's orbit, which is usually elliptical), and containing portions of two or more circles not having the same center. Also deviation from the center, or having a nonconcentric location within an ellipse.

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TOP SECRET [redacted]

Term	Definition
Fiducial marks (in a camera)	Sets of collimating marks (or similar devices) built into aerial cameras and registering calibrated images on the photograph as a set of fixed reference points. The usual purpose of such marks is to locate the principal ray or point at the geometrical center of projection, as the initial reference point from which angular distances and directions to other image points are measured by photogrammetry
Ephemeris	Tabulated data showing the assigned or anticipated location of a celestial body for regular intervals of time, distance, or angular velocity. Specifically, for a man-made earth satellite or space probe, the calculated or observed position from a table of tracking data at regularly spaced increments of time, distance, or velocity
Enable (as an electronic command)	To close a lockout circuit or other controlling device by a preliminary command which must be received and executed to "enable" or close an otherwise open (lockout) circuit path before the primary command or signal is given for execution of some function or event, usually of a critical nature.
Electrostatic phenomena (corona markings on film)	The usual problem encountered in passing film through unpressurized camera systems in a vacuum is the corona discharge, or electrostatic discharge, between layers of film. The markings on the film take several forms, but the dendritic lightning (forked or branched black lines exposed by a lightning-like flash) is the most common. Next is the "heat lightning" type of mark, where the electrostatic path is diffused over an area that may be several millimeters wide across the width of the film. These are usually "negative-density" marks, where exposed silver appears to have been removed from the emulsion and is lighter than an adjacent exposed area. Positive-density (darker) markings also occur.
Flip-flop (and magnetic flip-flop)	An electronic device having two stable states and two input terminals corresponding to these states. The device remains in either state until caused to change to the other by application of the appropriate signal. It serves as a switch in some electronic applications. A magnetic flip-flop is such a bistable device, with an input which allows it to function as a single-state binary counter. (Also see multivibrator.)
Format (literally, shape or layout)	The frame of exposure, or limits of optical coverage, in each picture taken.

Term	Definition
Geodesy (geodetic)	The art and science of measuring the size and shape of the geoid, or planet Earth, and determining precise celestial and geographic co-ordinates for objects or points of interest on the geoid. Geodetic: Pertaining to the science of geodesy.
Hardlined (command or T/M signal)	A command, signal, or T/M monitor transmitted over a wire in the umbilical cable (or a test cable during test operations), rather than by usual means of RF (radio frequency) transmission for remote control.
Hermetic integrating gyro	A rate gyro in a hermetically sealed container, used to sense differences between the inertial reference attitude of the gyro and the attitude of the vehicle. Generates a signal proportional to the difference or rate of change.
Hertz (Hz) (Hertzian waves)	Wavelengths in the radio frequency bandwidth of the total electro-magnetic spectrum. Also, the unit of frequency equal to one cycle per second, now used in lieu of cycles per second (cps). (A notation of 400 Hz for electrical power to the Agena guidance system is equivalent to 400 cps.)
Honeycomb (structure)	Two thin sheets of metal, bonded sandwich fashion across the open ends of a metallic (or resin-impregnated fiberglas) honeycomb structure. It is a pure monocoque design, in that the entire shear, compressive, and bending stress loads are distributed throughout the walls of the cells and the end plates in all directions from an applied load. It has exceptional rigidity and strength-to-weight ratio when properly bonded.
Horizon optics	Auxiliary horizon cameras, mounted one on each side of each pan-oramic camera, to photograph the horizon on either side of the satellite track and provide quick attitude reference for the panoramic formats on the same panoramic film.
Hypergolic (ignition)	A chemical combustion reaction in which ignition occurs on contact of the chemicals involved, with no external source of heat to kindle the reaction.
Image plane (of a lens)	The focal plane at which the images formed by the lens are brought to the sharpest average focus in a camera system.
Impulse	A force communicated suddenly, causing motion. In mechanics, the effect of a force in changing the motion of a body, and measured by the product of the average force applied multiplied by the time during which it acts; most frequently applied to forces of brief duration.

Term	Definition
Infrared (IR) (Infrared absorptance and emission)	The portion of the electromagnetic spectrum just below the red end of visible spectrum, in the wave lengths from approximately 1/2 micron to 24 microns. Also, the energy emitted within this spectrum of frequencies as a result of the conversion of solar energy striking a surface and being absorbed and transmitted (re-radiated) or emitted after absorption (particularly the absorption of ultraviolet and optical frequency radiation and its emission or re-radiation in the infrared frequencies, such as occurs with optically transparent and/or opaque materials).
Inhibited red-fuming nitric acid (IRFNA)	A highly corrosive, poisonous, and volatile liquid which unites hypergolically (on contact, without an external heat source or catalyst to initiate the chemical reaction) with various organic hydrocarbon fuels. It is used as an oxidizer in a bipropellant rocket engine system. In the Agena rocket engine, the other propellant for the bipropellant rocket is UDMH (Unsymmetrical Dimethylene Hydrazine).
Integrate (integrating) (integrator)	To sum up or make whole, as by use of integers (integrals), as in mathematical calculations or the algebraic summing of voltages in electronics equipment (e.g., the OSFG slope programmer voltages in the sine wave potentiometers) to obtain the desired output or voltage level.
Interface (noun, as the mechanical or electrical boundary or mating surface(s) of a system or subsystem)	A surface (especially a plane surface) forming a common boundary between two bodies or spaces. In general aerospace usage, it is also commonly used to denote the physical boundaries (mechanical or electrical) at which systems and subsystems are mated or joined into larger or more complex elements (e.g., the satellite vehicle, which comprises the Agena and the payload section; each containing various systems or subsystems designed to perform specific tasks or functions, and which are integrated at their interfaces into larger and more complex systems utilizing the functions performed by the smaller systems and subsystems).
Interface (verb, as the action of an integrated joint effort)	The term used allegorically to denote the boundaries of areas of responsibility (and necessary intercommunication at those boundaries) between individuals, departments, companies, vendors, and customers to integrate ideas, software, and hardware into a unified complex system and the separate subsystems thereof.
Invertor (DC to AC)	A device which converts DC into AC, either by a rotating device or an amplifier which inverts the polarity of a circuit.

Term	Definition
KIK-ZORRO and KIK-ZEKE	Secure commands in the UHF (ZORRO) and VHF (ZEKE) command links, designed to prevent unauthorized commanding of certain critical functions in the satellite vehicle (also see Secure commands)
Labyrinth (Labyrinth vents or valves, and instrument or CR camera labyrinth)	An intricate maze of passages. As used in J-3, air passages or vents to drain off internal air pressure in the camera section during ascent, so constructed as to block the passage of light through the maze.
Launch window	The time slot or interval during which optimum conditions for launching a satellite or space probe exist. The relative position of the earth and sun for maximum photographic effectiveness (mainly in the northern hemisphere) is one important consideration in determining the optimum launch time for J-3 satellites; clear weather for optical tracking in daylight after liftoff is another.
Matrix	That which gives form, origin, or foundation to something enclosed or embedded within it, as a mold for casting. In electronic logic circuits, the array of binary steps or logic elements required to develop the range of discrete points (voltage, current, resistance, etc.) necessary for the electronic logic to perform the computations or range of step functions required as the output. The logic matrix often uses combinations of transistors, resistors, diodes, and relays to do this.
Microsecond	See "Prefixes"
Millisecond	See "Prefixes"
Modulate (as in radio or electronics) (Frequency or amplitude modulation)	The process of producing a wave, some characteristic of which varies as the instantaneous value of another wave called the modulating wave or modulator. Waves in RF electronics for satellites may be modulated by imposing a modulating frequency wave on the signal carrier, or by amplitude modulation in which the voltage amplitude is varied.
Monocoque (structure)	A stiffened, lightweight structure in which the outer skin is the principal load-bearing member for compressive, shear, and bending loads.
Motor, hysteresis syncronous	A type of synchronous electric motor which starts by virtue of the hysteresis losses induced in the hardened-steel secondary member by the revolving field of the primary. An induction-type motor that synchronizes the speed of rotation with the rate at which the rotating

Term	Definition
	field in the windings revolves, induced by and directly proportional to the frequency of the alternating current fed into the machine.
Multiplex (Multiplexed or multiplexing of radio or T/M signals. Also, multiplex operation)	The simultaneous transmission of several functions, such as frequency, amplitude, or waveshape, over one path without any loss of identity of each function. Also, the stacking of T/M signals having different characteristics for such simultaneous transmission over a single path.
Nanosecond	See "Prefixes"
Nodal point (of a lens).	Either of two points on the axis of a lens, such that a ray entering the lens in the direction of one leaves as if from the other and parallel to the original direction. Rotation of the lens about the rear nodal point permits rapid movement of the lens through large angles without image distortion. It is also fairly close to the center of mass (or balance point) of the lens, so a minimum counterbalance momentum is required to avoid upsetting the satellite under weightless conditions.
Nod angle	The angle through which each of the panoramic cameras rocks during scan to compensate for forward image motion. The rocking or nodding action puts the image motion compensation into "object space" (tracks the object during the forward motion of the satellite), rather than having the lens translate in line of flight on a cam to track the image as it moves during exposure ("image space" IMC).
Nod axis	The shaft about which each camera rotates during each scan to "nod" the cameras. This "tracks" the object as the camera moves forward during the exposure interval for each increment of film as the slit aperture exposes it.
Nomograph	A graph that enables one by use of a straightedge to read off the value of a dependent variable when the value of the independent variable is given. Also, a graphic representation of numerical relations by any of various systems.
Oblate (oblateness)	The flattening at the poles of a spheroid or flattened sphere; typical of the shape of the earth.
Orbital sine function generator	The image motion compensation sine function generator.
Panoramic camera	A camera that covers a wide field of view (in one direction only), with a lens having a relatively narrow field angle of coverage, by sweeping the lens through an arc during the exposure cycle. The format is long

Term	Definition
	and narrow, and is usually exposed by means of a travelling slit aperture coordinated with the travel of the lens through the arc to cover the desired field of view.
Panoramic geometry system	A system of geometrically located, accurately calibrated holes located in the film path (on the guide rails) used to compute and correct shrinkage and positional errors of images on the panoramic films.
Passive thermo-dynamic control	A method of heat energy control in space in which heat absorbed from the sun or from the earth's albedo (reflected sunlight from earth) is either absorbed or re-radiated to maintain desired temperature control in the vicinity of specific elements of the orbital payload system.
Perigee	That point in the orbit of an earth satellite which is nearest the earth.
Petzval lens (Design)	A lens design featuring high resolution over a relatively narrow field of view and moderately long focal lengths, named after its originator.
Picosecond	See "Prefixes"
Pirani Gauge	A vacuum-measuring gauge reading in microns of mercury above an absolute vacuum, which measures the amount of vacuum by means of the electron density between an anode and a cathode in the vacuum environment. The flow of electrons in the electron path is proportional to the vacuum or lack of air molecules.
Prefixes:	
Millisecond	One thousandth of a second (1×10^{-3})
Microsecond	One ten-thousandth of a second (1×10^{-4})
Nanosecond	One millionth of a second (1×10^{-6})
Picosecond	One billionth of a second (1×10^{-12})
	NOTE: The same prefixes also apply to electrical units, such as milliamperes, microwatts, millivolts, microfarads, etc.
Primary battery (flight)	A high-energy battery, usually not recharged (though some will accept limited recharging for ground test purposes), and used as a primary electrical power source during flight. Nickel/cadmium or silver/zinc voltaic cells with a caustic alkaline electrolyte are the most common types.
R-days (R-1, 2, 3, 6, etc.)	Readiness days, counting in reverse (or countdown fashion) to launch. R-6 is usually the sixth normal work day before launch without overtime or multiple shifts.

Term	Definition
Ramp-down (in the CR cameras)	The reduction of speed or rotational velocity under controlled power. or voltage, as opposed to coasting to a random stop without power Also, the recorded shape of the voltage-level wave as the cameras are brought to a controlled stop in a homed position after each operation.
Real time (e.g., real time data transmission)	The natural time at the actual time of an event, as measured second after second by the rotation of the earth and apparent position of the sun. A clock measures real time.
Real time operation	Operation of a device (e.g., a T/M system or computer) during the actual time that the related physical processes occur.
Recovery capsule	Recovery vehicle. That part of the SRV which is actually recovered, composed of the capsule assembly suspended from the deployed parachute assembly. This subsystem is involved in the recovery function.
Reef (as a sail, or parachute) (Also disreef)	To reduce the area, or restrain a part of a sail (or parachute), to control the pull (or drag) in a wind or airstream. Also, the area gathered in and held in restraint, and the means used to restrain the unwanted area (e.g., a reefing line). Disreef is the release of the restraining devices to allow full use of the added open area in the airstream.
Regenerative cooling (or heating)	The absorption of heat energy into a fluid (e.g., the oxidizer for the Agena rocket engine) to increase its energy content (specific heat) from heat sources that would otherwise be wasted. In the case of the Agena rocket engine, the oxidizer is passed through external coils to cool the combustion chamber and nozzle throat, and the latent heat absorbed by the IRFNA, enroute to the head of the chamber, increases the energy of the reaction with the fuel. Thus, the heat passes back up to the head of the combustion chamber in the IRFNA and is re-generated and re-used.
Resolution (or re-solving power, of a photographic lens)	The ability of a lens to image closely spaced objects so that they are recognizable as individual objects. It is usually expressed in the metric system as "n lines/mm," and varies both radially and tangentially with the angular distance out from the optical axis or center of the lens. A single value to express the overall resolution performance required within the entire field of view of a lens is the Area Weighted Average Resolution (AWAR) value. This is generally somewhat lower than the critical focus resolution at any one point of the

[redacted]

Term	Definition
	lens. The AWAR resolution is usually measured at the optimum plane of critical focus for the entire lens field, and is the implied performance unless otherwise stated.
[redacted] recorder	An oscillographic recorder made by [redacted], used extensively in aerospace systems testing to record electrical/electronic data for analysis of simultaneous functions or events.
Sear latch (or sear)	In mechanical devices: a latch to hold a mechanism in a cocked position, such as the sear which releases the hammer of a gun when the trigger is pulled. The dimple motors in the waterseal assemblies, and the film aperture doors on the DISIC conic bulkhead, release sear-type latches which hold the spring-powered devices in a cocked or open position until the sear is tripped.
Secondary battery (flight)	Batteries built for long life and frequent recharging at lower rated output/lb of active materials. These batteries are usually recharged just prior to flight, or a means of recharging in flight (such as solar panels, etc.) is necessary for long-duration flights where power must be conserved for long periods of operation. Nickel hydroxide/cadmium hydroxide with a caustic alkaline electrolyte is the usual construction.
Secure commands	Special-purpose commands that remain "locked out" except when some type of unlocking code (e.g., a particular pulse sequence or similar type of device) is present in the signal. This requires a decoding device to unlock only the coded signal and reject all other signals not having the proper code.
Slew (as in camera operation, or in IMC subsystem operation)	To twist or turn about a fixed point or axis. As used in J-3 system terminology, to move ahead (or back) rapidly out of the normal timed sequence, as with rapid take-up of film before waterseal operation in preparation for SRV recovery, or the rapid return to a null voltage on the sine-function potentiometers of the IMC slope programmer between operational runs.
Slit width	The width of the slit aperture in front of the focal plane of the panoramic camera, through which the film is exposed. The total exposure is determined by the width of the slit and the angular velocity of rotation.

[redacted]

Term	Definition
Slope programmer (or orbital sine function generator)	The compound sine-function signal generator (also called orbital sine function generator) used to generate the IMC rate control voltages for the panoramic camera system and the yaw signal to the Agena guidance system.
Specific impulse (propellant)	The thrust per unit weight-rate of flow, or the total impulse (in lb.-seconds) divided by the weight of propellant (in lbs.) as expressed by the ratio $\frac{\text{lb.-sec.}}{\text{lb.}}$. In overall specific impulse, the total weight of the rocket is used rather than the weight of the propellant.
Squib (pyrotechnic)	A small, electrically or mechanically fired explosive charge, generating large amounts of gases and/or heat, and used as a single-function, nonrepeating propulsion device to actuate piston-type mechanical devices, or to ignite another larger element in an explosive train, such as firing a solid-propellant grain in a rocket motor. Pin pullers, door ejectors, and dimple motors (in which the dimpled end of the squib case itself becomes the actuating piston) are all examples of piston-actuated, one-shot propulsion devices.
Start, Half-Cycle, and Delay Start positions (on the V/h transducer, or slope programmer, and the calibration of these for T/M read-out in orbit)	The IMC subsystem is capable of generating a family of 8000 curves to fit a wide assortment of orbital parameters. The starting level, half-cycle (or peak) voltages, and the angular velocity of the V/h sine function generator (a motor-driven potentiometer), determine the amplitude and the period of the basic V/h curve, and together these determine the slope of the curve. The Delay Start capability allows synchronization between the V/h ratio curve (cycle rate control of the CR cameras) and any segment of the ellipsoid formed by the orbit. The purpose is to correct or adjust the slope of the V/h curve generated to coincide with the true orbit generated by the satellite, rather than the nominal planned orbit on which the orbital programmer tapes were cut for the stored programs. It is not feasible to test all 8000 curves for the slope programmer during systems tests, so a representative family of the most frequently used curves are calibrated in test as baseline data for flight operations. The T/M output of these curves (or of curves nearest them in flight) are compared with the baseline curve data from systems tests to check on the operation of the CR camera system in flight.
Stepper Motor	An electromagnetic device for moving a mechanical part through discrete steps of operation or rotation by use of discrete voltage steps or rotational increments.

Term	Definition
(1) Sun angle (photographic)	The local elevation of the sun above the horizon (hour angle) at the target area being photographed, as it affects the general illumination of the scene (shadows, etc.).
(2) Sun angle (beta angle)	The angle formed by the intersection of the earth/sun line and the plane of the satellite's orbit at the center of the earth. It is used in thermodynamic heat transfer calculations to represent the variations in total radiant flux falling on the satellite (at various angles between the orbital plane and the earth/sun line). It also affects the quantity and quality of the radiant visual flux reflected back to the cameras from the terrain below.
Theodolite	A precision optical instrument for precise measurement of angles and angular relationships. In the CR camera resolution-theodolite tests, theodolites are used to measure the angular relationships between the two horizon auxiliary cameras that are incorporated as part of each CR camera and the center of format of the panoramic lens of each camera. The convergent-stereo angle between the cameras of each pair of CR cameras is also measured and calibrated as part of the systems optical performance tests.
T/M link	The telemetry transmitter in the Agena, and the receiver and recording equipment in the various ground stations, for transmitting the T/M data generated at the various instrumentation points throughout the satellite vehicle. A distinction is usually made between the internal T/M subsystem (which includes the various sensors and T/M instrumentation devices, plus the signal conditioners needed to prepare the T/M signals to feed into the VCO of the T/M transmitter), and the T/M link which is the external RF communication link between the satellite vehicle and the ground stations. Together, they form the T/M system.

Term	Definition
Tracking station time	A form of systems time by which the activities and tasks of a world-wide network of satellite tracking stations can be synchronized and controlled from a single point. As local time (or real time for that location) is different at each tracking station, the usual starting point for tracking systems time is the instant of booster ignition at the launch site. Each of the tracking stations then correlates this event to local real time (ships and aircraft at sea, to Greenwich mean time for navigation purposes) for better comprehension of elapsed time intervals at each location. Elapsed tracking systems time, in preparation for the zero-point event, is controlled by the countdown procedure (on a graphic time-scale plot, the minus numbers to the left of zero). Events after ignition then become positive on the systems time scale, and can be readily correlated to the real-time situation at each of the tracking stations on the line as necessary.
Transducer (pressure, V/h, film footage, etc.)	Any of various types of devices which, when properly calibrated, change measurements from one type of unit to another. Most of the transducers used in J-3 are for the purpose of T/M monitoring of various functions or events in which the transducer output to the T/M system is a calibrated voltage level or curve in the 0 to 5 VDC range. Thus, the pressure transducer converts gas-bottle pressures from 0 to 3600 psia into a 0 to 5 VDC T/M signal proportional to the pressure applied. (It is a form of pressure potentiometer). The other T/M transducers operate on similar electromechanical principles.
Transistor/resistor logic register	An electronic device capable of retaining or storing information, and made up of transistor/resistor logic modules. It is one of many forms of memory devices.
Transponder	A specialized radar transmitter-receiver system designed to transmit signals automatically when the proper interrogation code is received.
Ullage (ullage control)	The amount that a vessel (e.g., a tank) lacks of being full. (Wantage, or that amount which is lacking.)
Umbilical (cable, hose, etc.)	The quickly detachable cables, hoses, pressure lines, etc., which connect a launch vehicle to the auxiliary ground equipment on the launch pad or in the blockhouse prior to launch. The connections are designed to break away quickly and easily, without deflecting the launch vehicle just before or during liftoff.

Term	Definition
UNCLE (commands)	Code word for commands transmitted to the Agena over the UHF command link (the ultrahigh frequency radar command and tracking system, operating in the UHF frequency range of the electromagnetic spectrum).
Unity gain	Gain is the increase in signal strength or signal power, usually expressed as the ratio of output power to input power in decibels. Unity gain is when the ratio of output to input is 1 to 1, and both are equal.
Unsymmetrical dimethylene hydrazine (UDMH)	A volatile, liquid organic hydrocarbon used as the fuel in a bipropellant rocket engine, usually with a hypergolic oxidizer (e.g., inhibited red fuming nitric acid, or IRFNA, as used in the Agena).
Vehicle time	The elapsed interval (time) since the vehicle clock (or other timekeeping or interval measuring device) was started. Also, the binary timeword read out when the vehicle clock, or DRCG, is interrogated by an electronic pulse into the clock. As with any other systems timing device, it has no other meaning than to correlate events within the system to which it is applicable (in this case, the satellite vehicle) until such time as vehicle time has been correlated to real time. Then, events in the satellite and events on earth can be correlated in real time (see systems time and real time operation).
Velcro seal	The propietary name of a sealing device which consists of two flat ribbons that mechanically lock to form a seal. One ribbon consists of many rows of small nylon hooks, and the mating counterpart has a looped monofilament pile. When the two surfaces are pressed together, the loops become enmeshed on the hooks forming a seal. The action is repeatable.
Waterseal (film cutter)	A pyro-released mechanical device mounted on the aft cover of the SRV capsule to cut the film and close off the aperture with a light-tight waterproof seal at some point prior to SRV recovery.
Water-seals	Specialized A/P terminology for film cutters, on the aft cover of the SRV's, that seal the openings after cutting the film so that the capsule is light-tight and water-tight.
Yaw	In aeronautics or astronautics, the turning or deviation from the line of flight by angular motion about the normal or vertical axis of the vehicle.

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