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TRAINING MANUAL

J-3 CR SYSTEM  
CORONA PROGRAM

Declassified and Released by the N R C

In Accordance with E. O. 12958

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31 DECEMBER 1967

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**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:

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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).

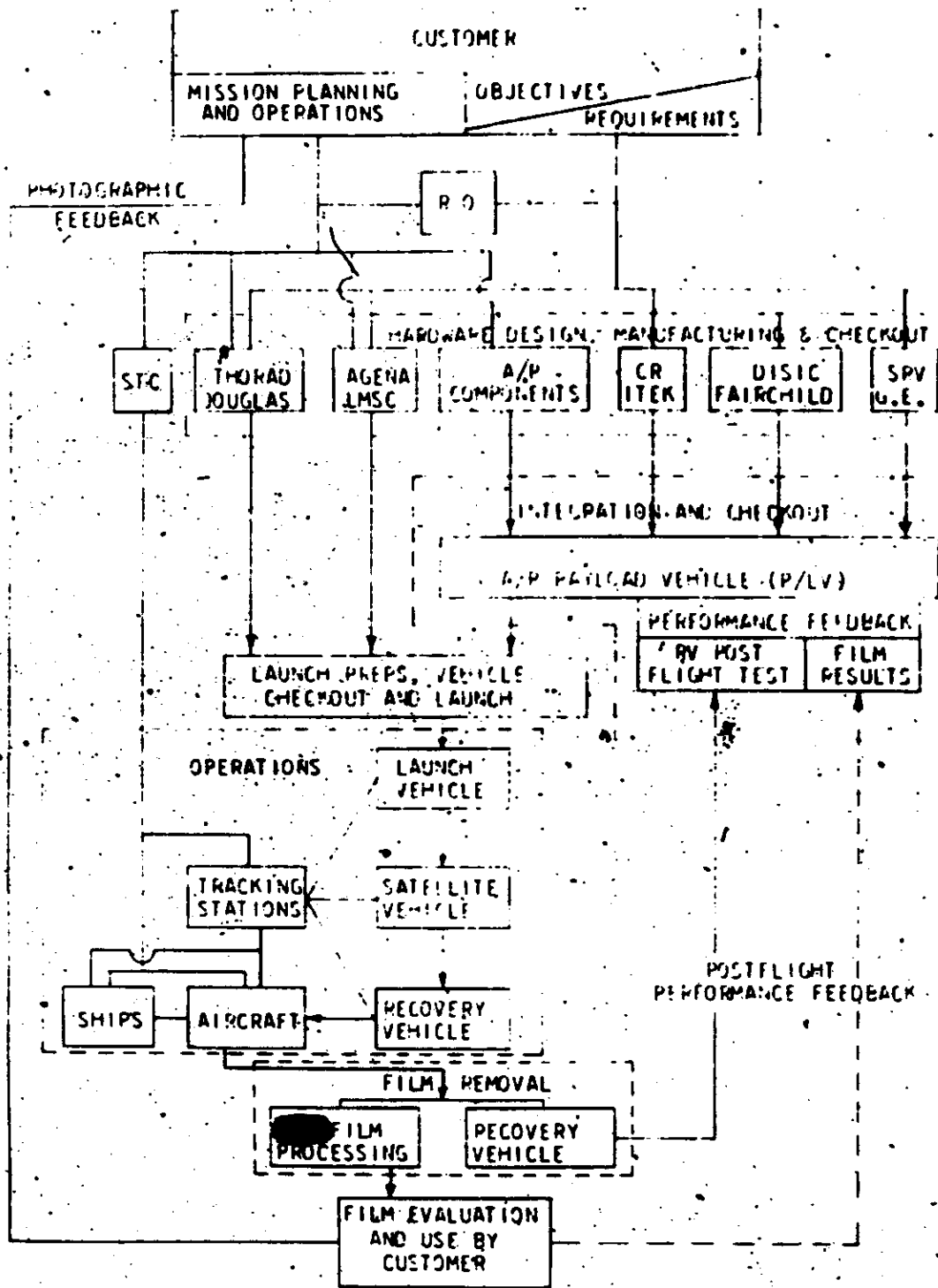


Figure A-1 Composite Organization Chart and Hardware Flow



## 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 41 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 1 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 50-inch diameter structure. Many advantages in resolution, stability, and economy accrue from the new design. A detailed description of the J-3 system may be found in Appendix BB.

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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

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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.

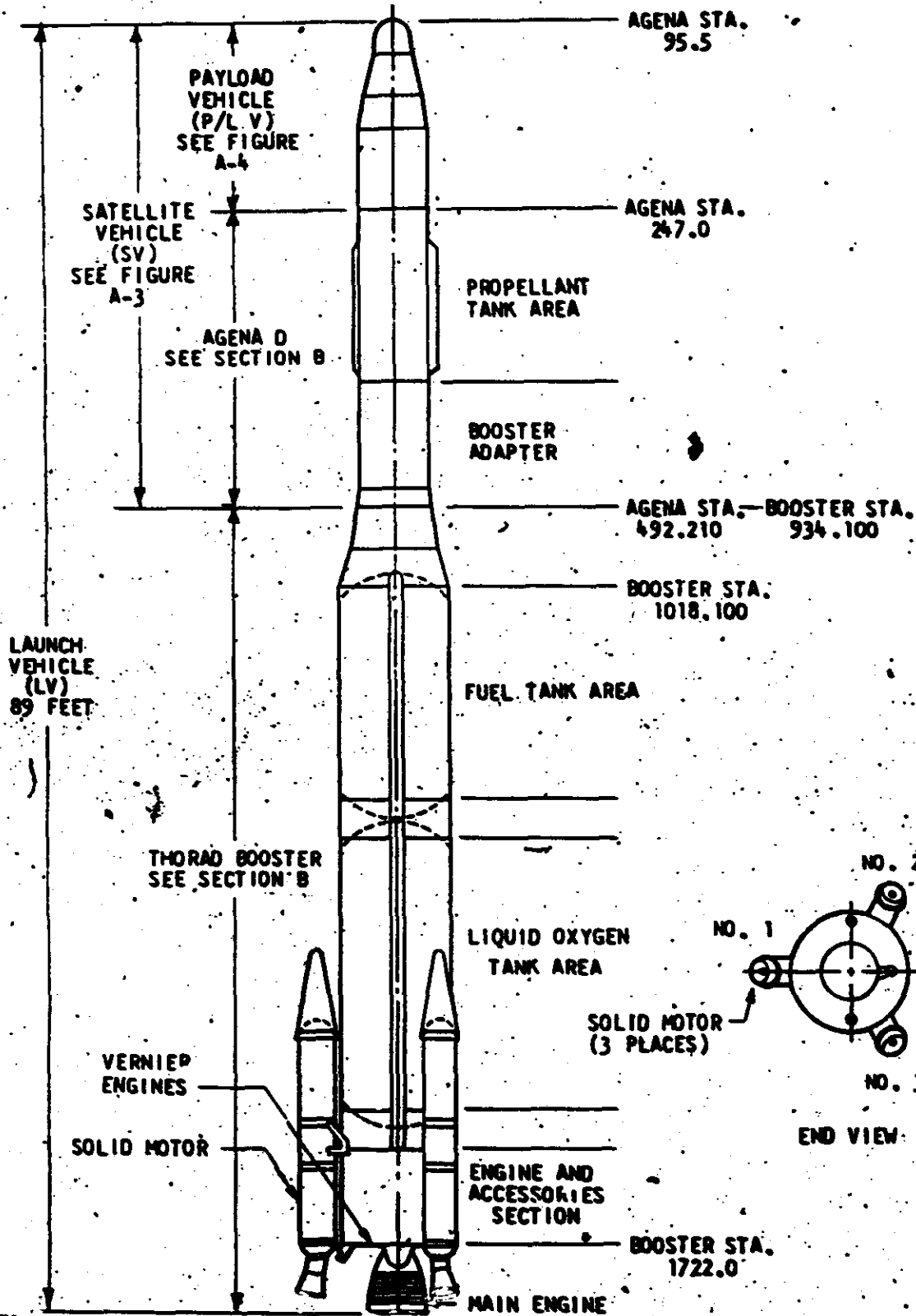
**A-4.0 OPERATIONS ANALYSIS**

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**

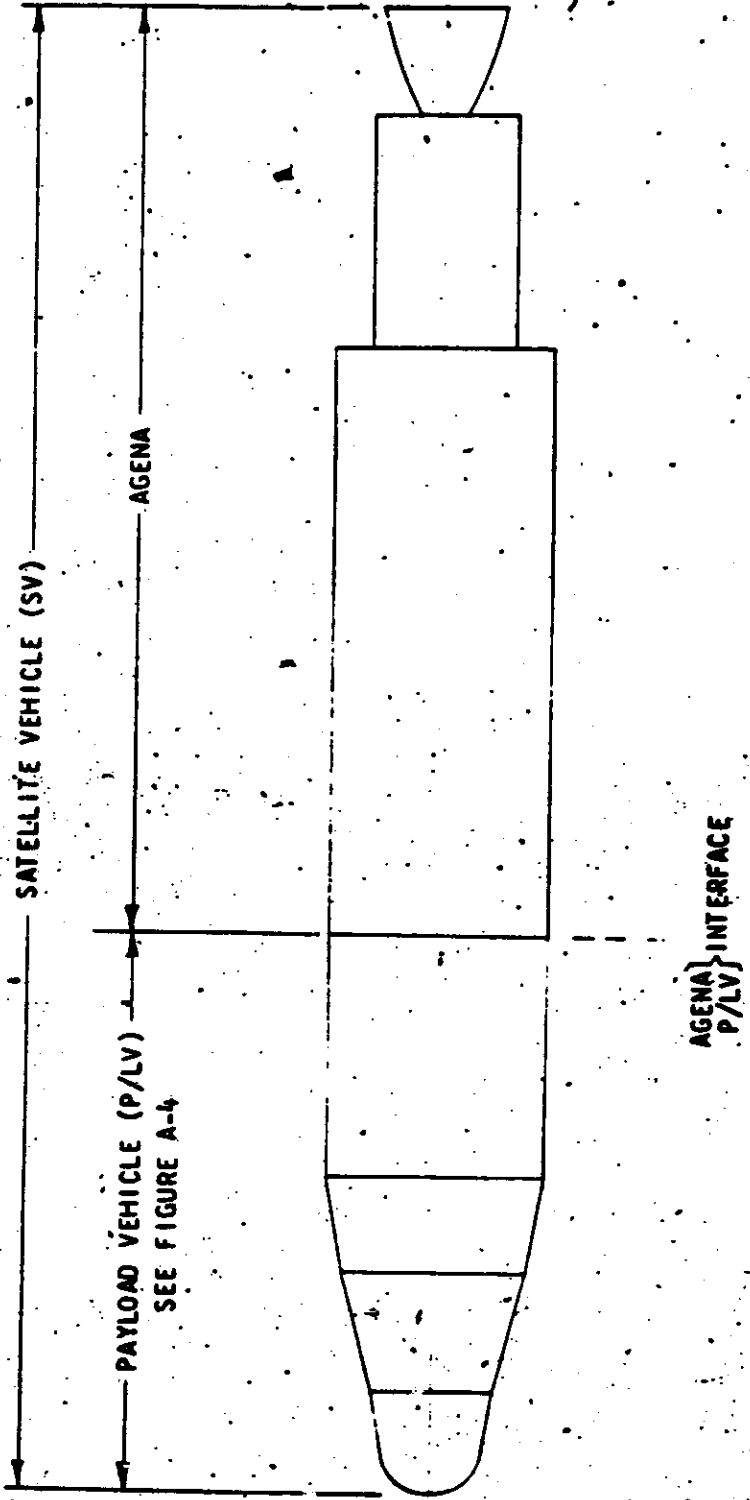


Figure A-3 Nomenclature of the Major Components Composing the Satellite Vehicle

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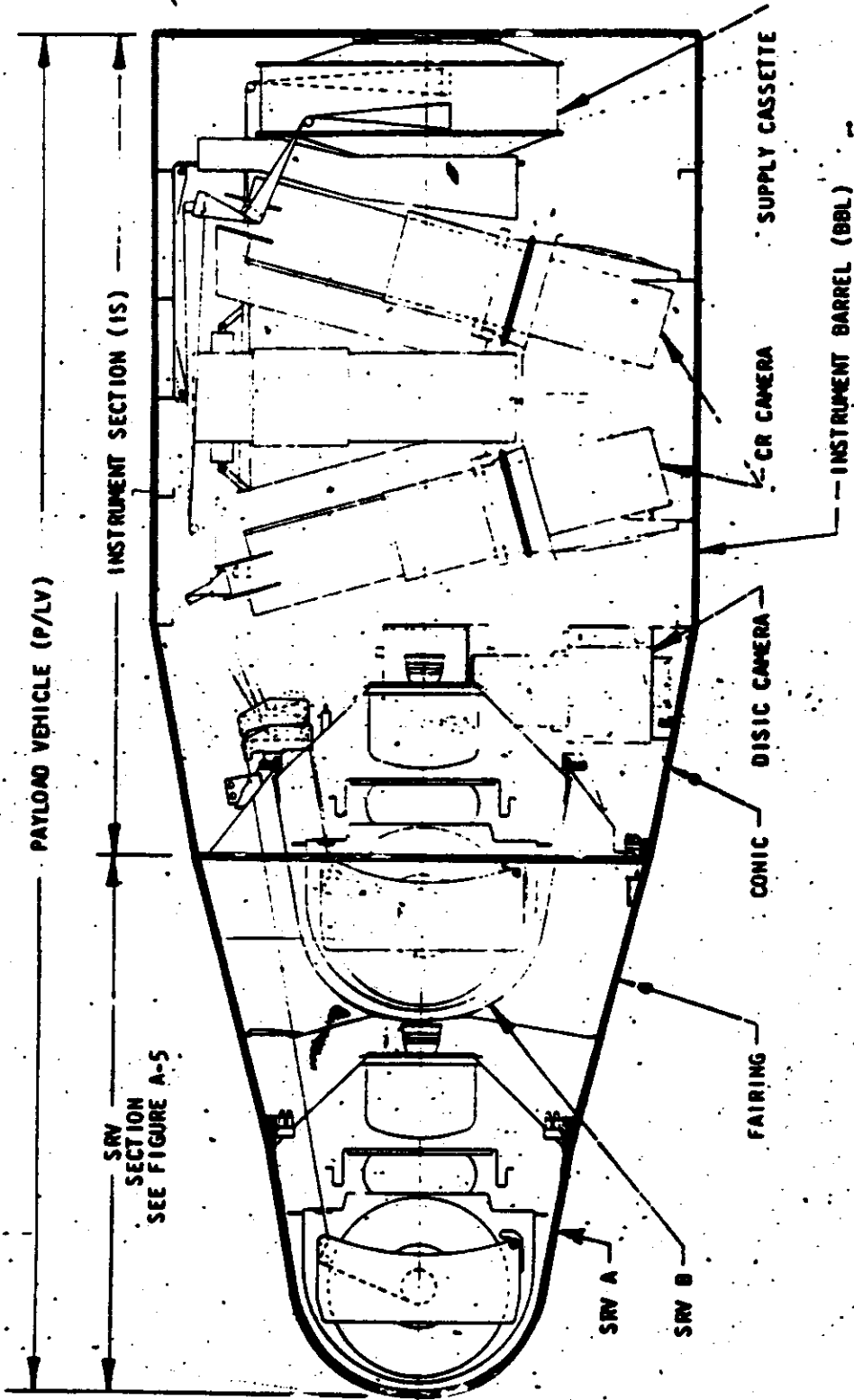


Figure A-4 Nomenclature of the Major Separable Components of the Payload Vehicle

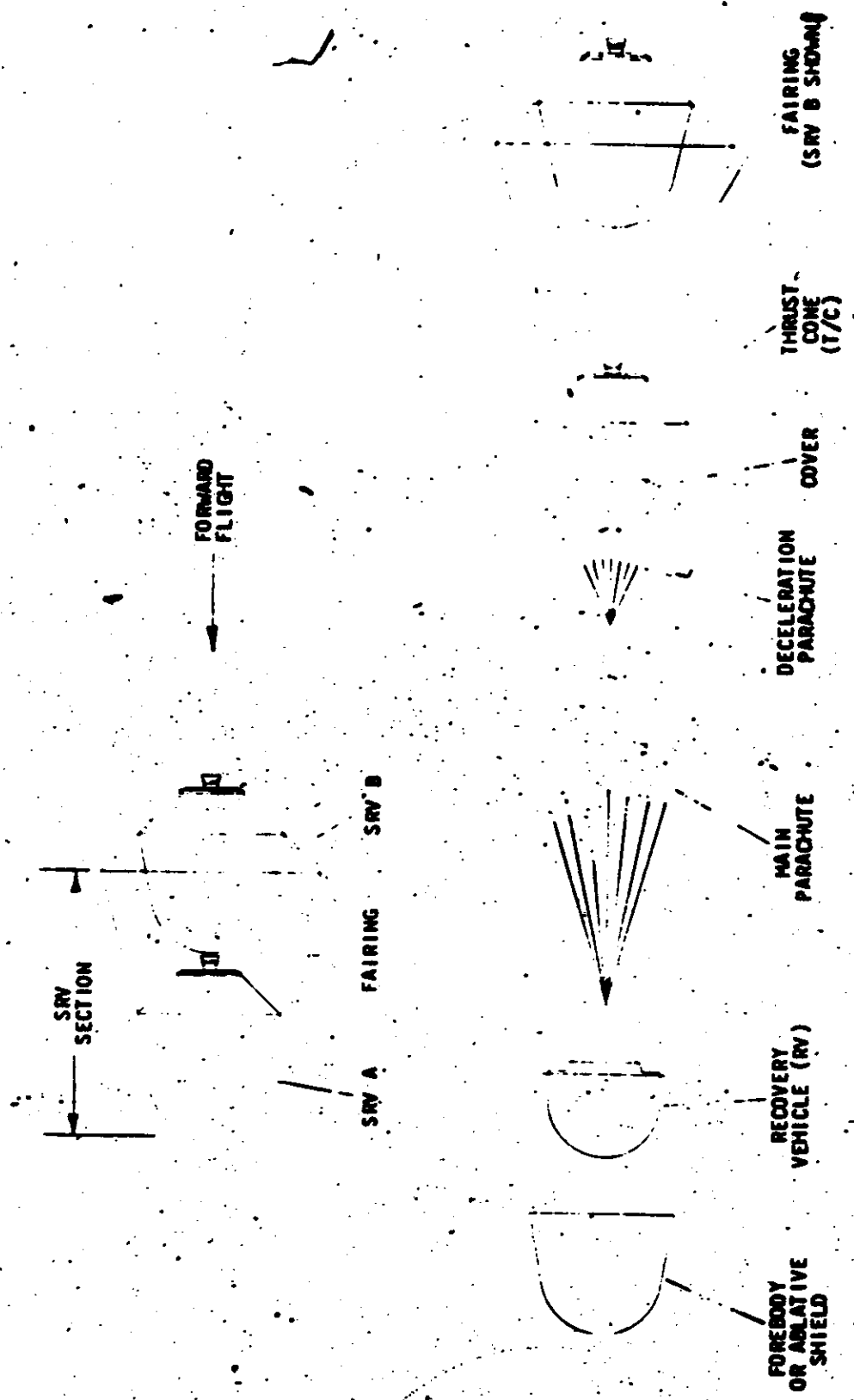


Figure A-5 Nomenclature of the Major Separable Components of the Satellite Recovery Vehicle

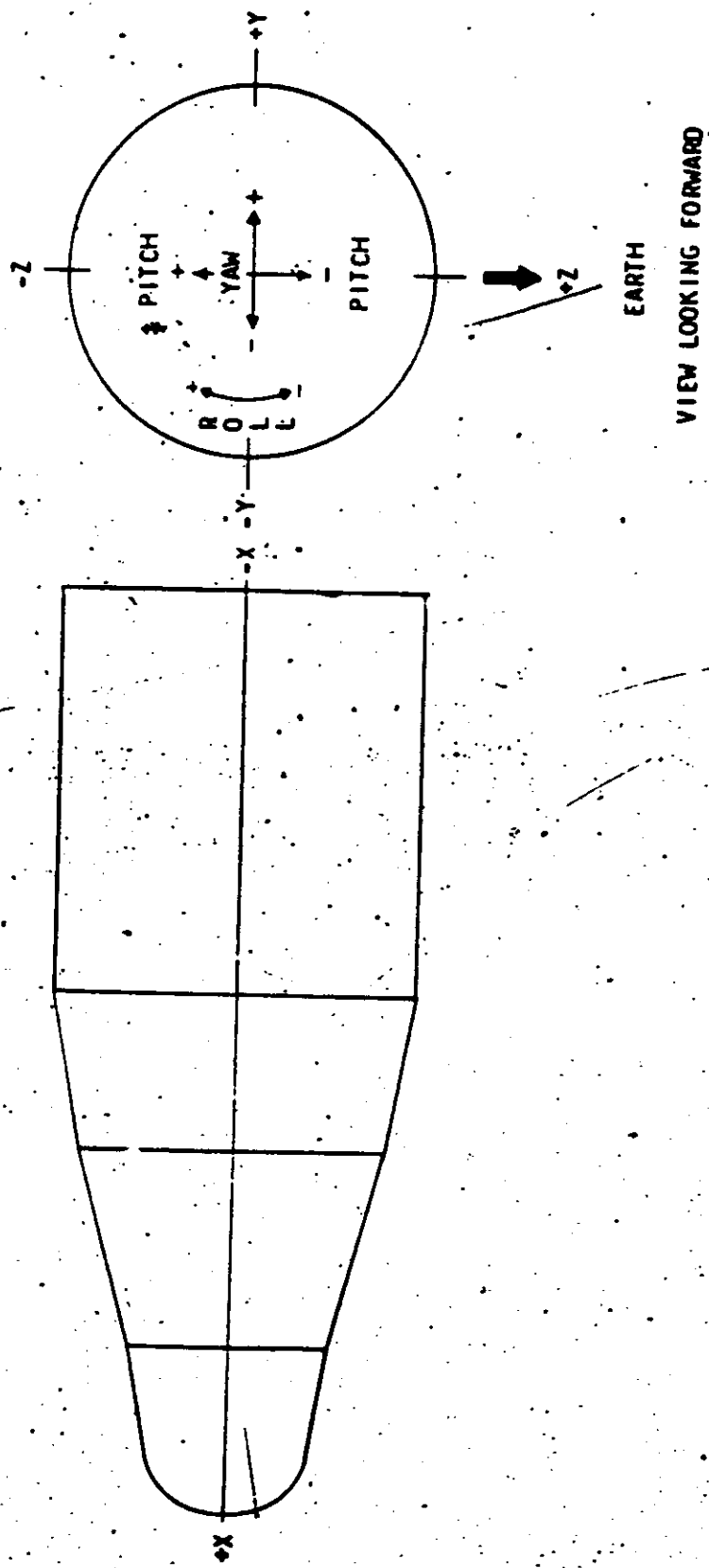


Figure A-6 Sign Conventions



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.

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.

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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

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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.

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**A-5.5 Satellite Recovery Vehicle (SRV)**

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 Recovery Operations**

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.



**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.

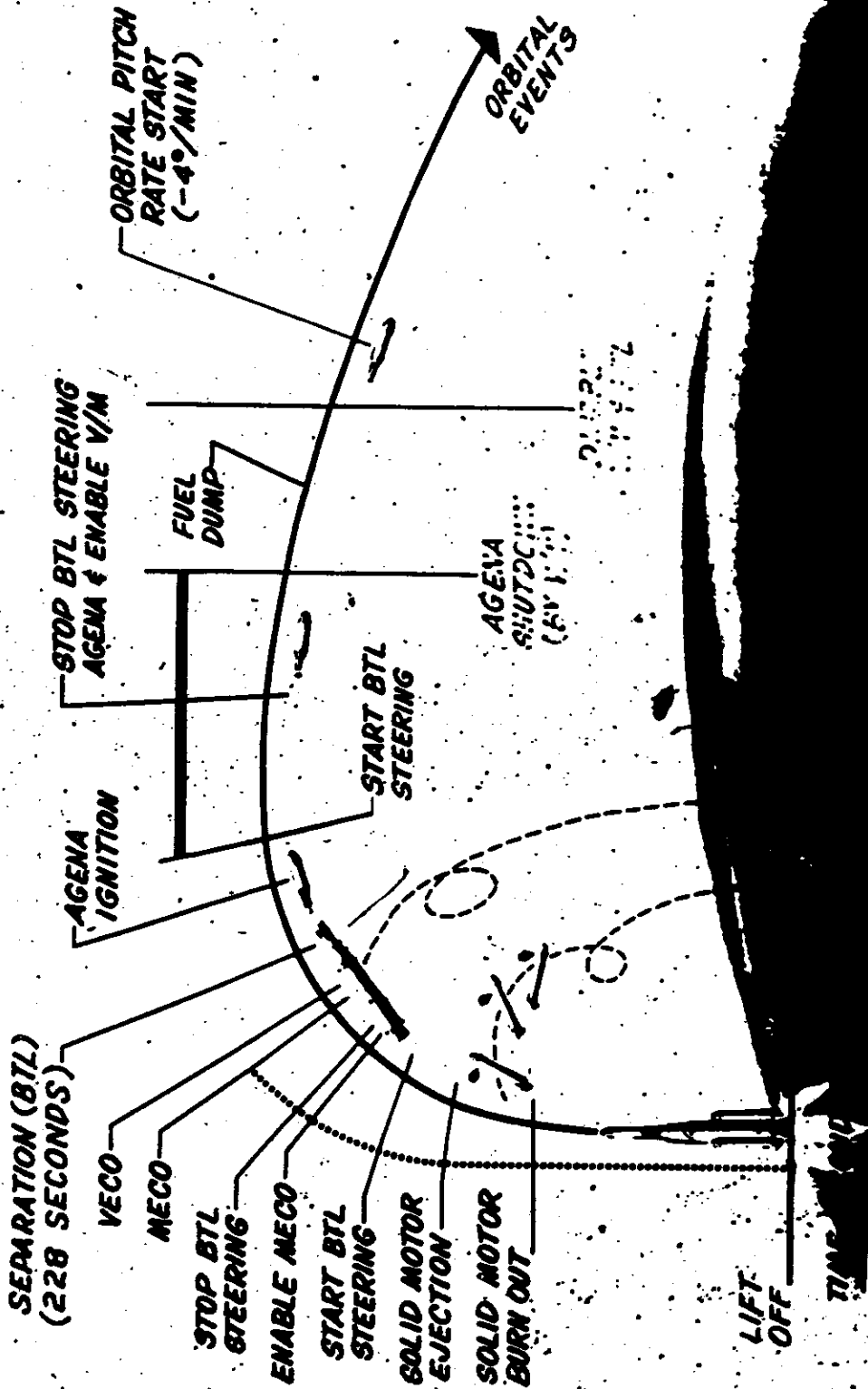


Figure B-1 Ascent Sequence of Events

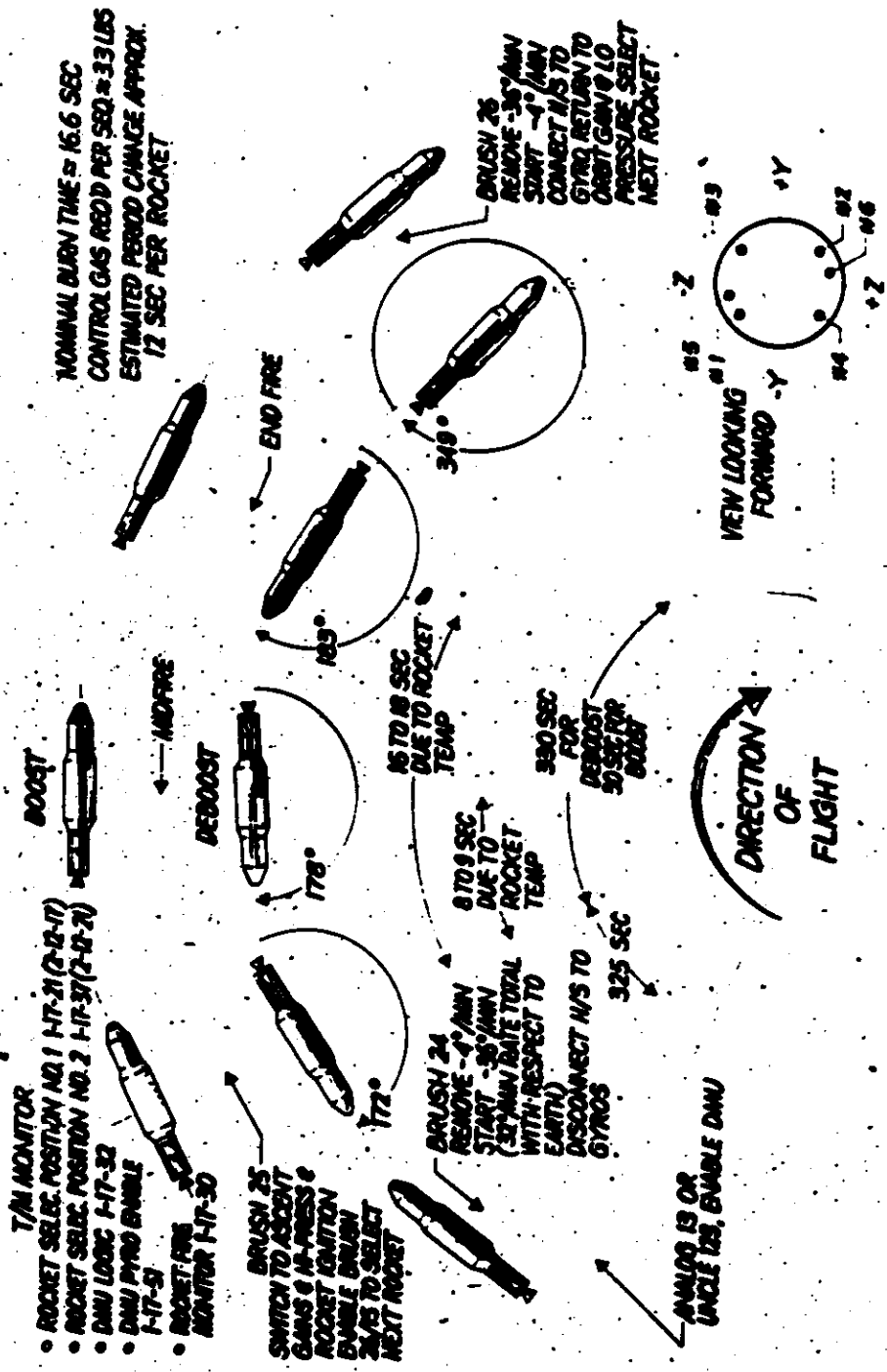


Figure B-2 Drag Make-Up Sequence (DMU)

- g. Provides electrical power for the life of the mission.
- h. Provides an Agena/Payload attitude suitable for de-orbiting 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 Launch Facilities**

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

**B-2.4 Agena Vehicle Summary**

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) space-frame (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 Agena Assembly Procedures**

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.

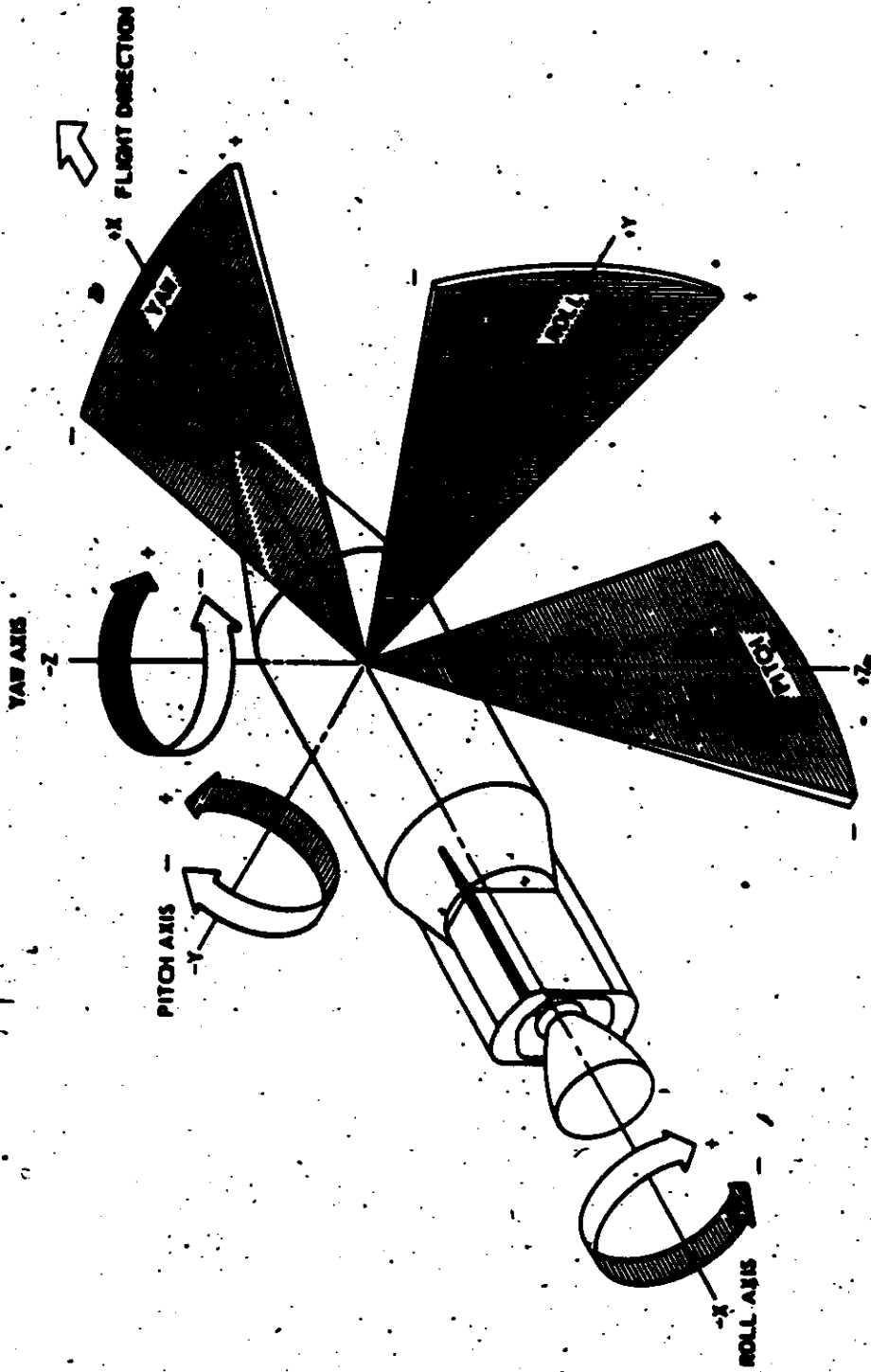


Figure B-3 Agena D Fixed-Axis and Movement Designations

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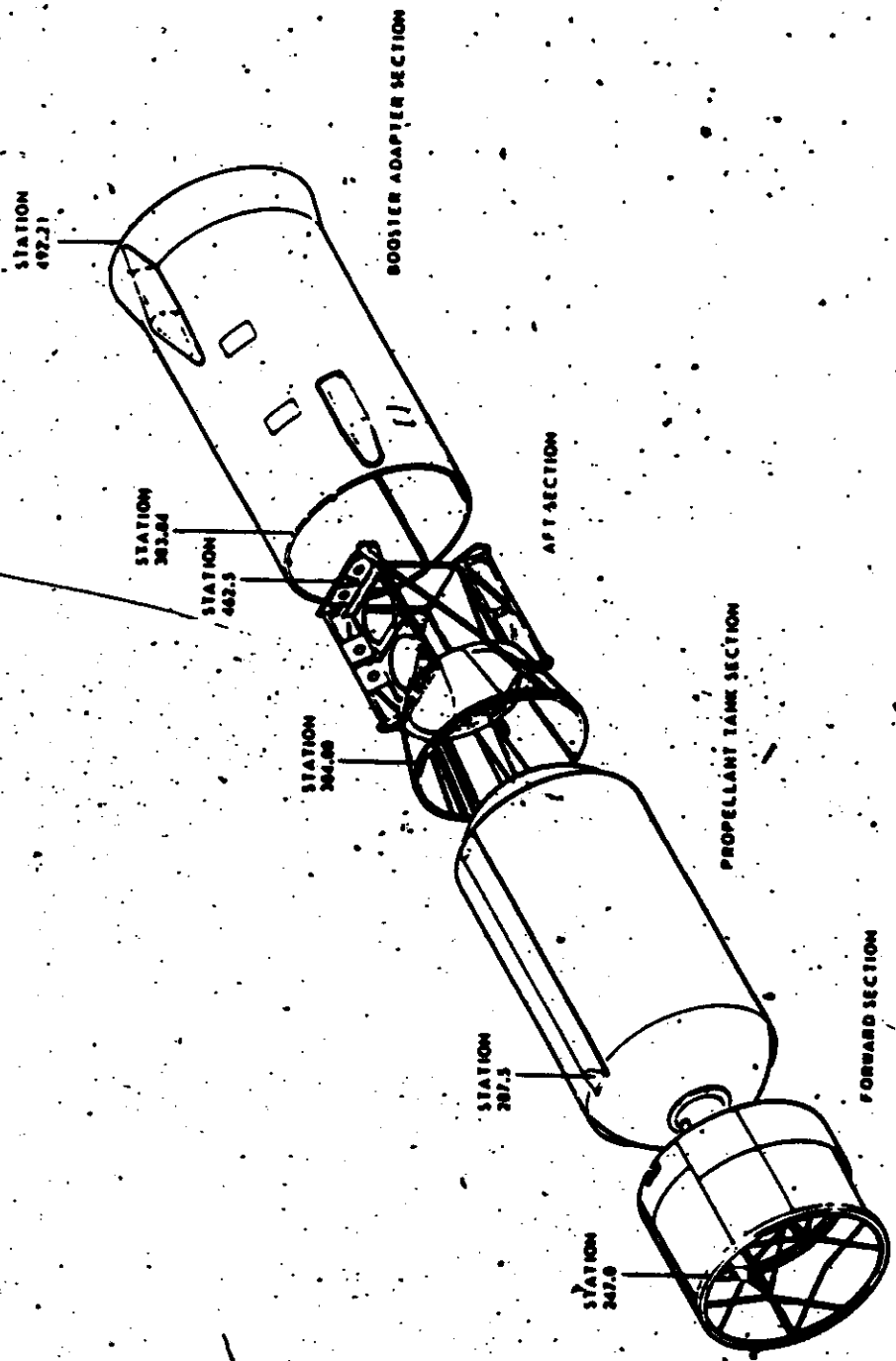


Figure B-4 Basic Agena Vehicle

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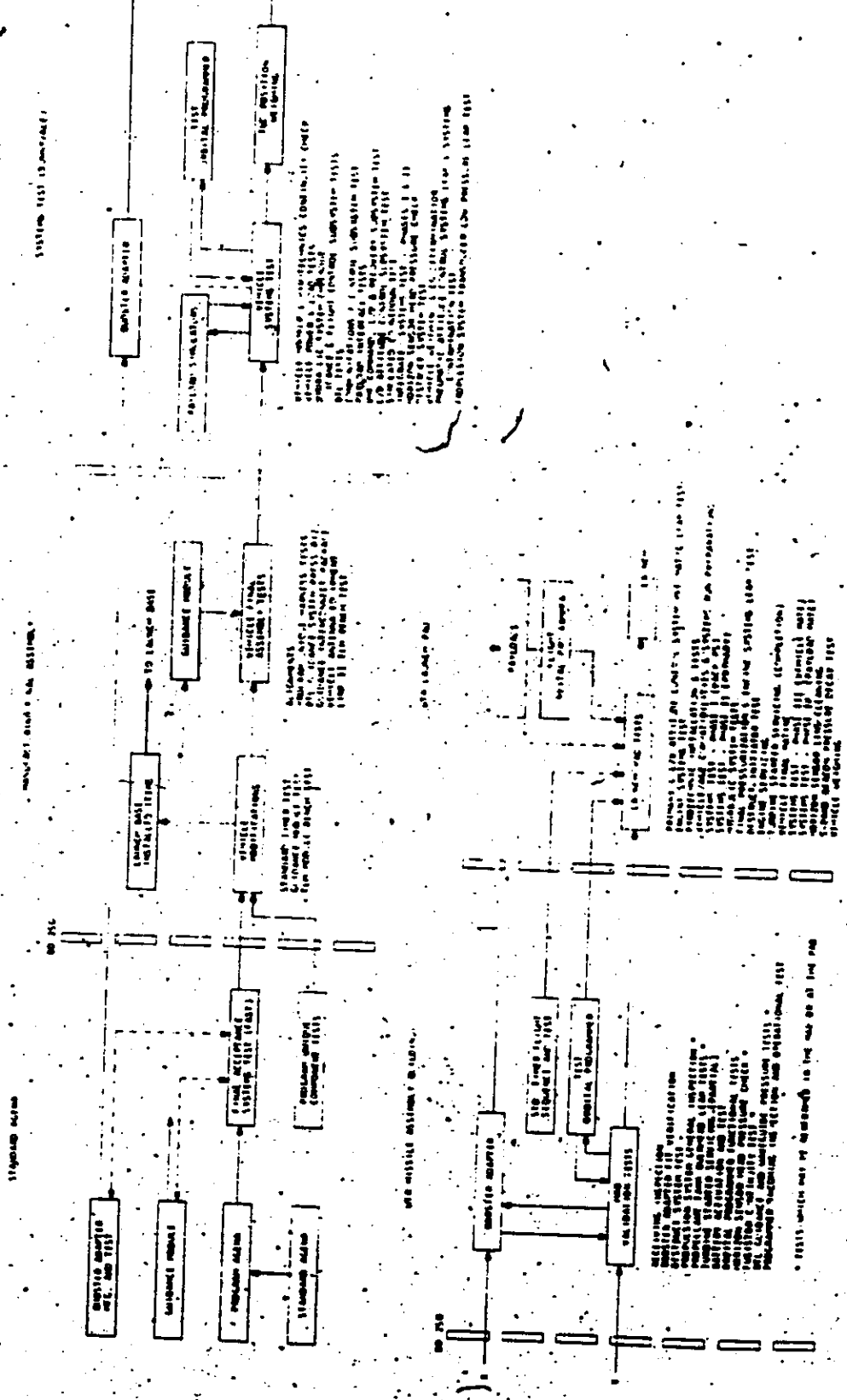


Figure B-5 Factory to Launch Test Sequence

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, long-rons, 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

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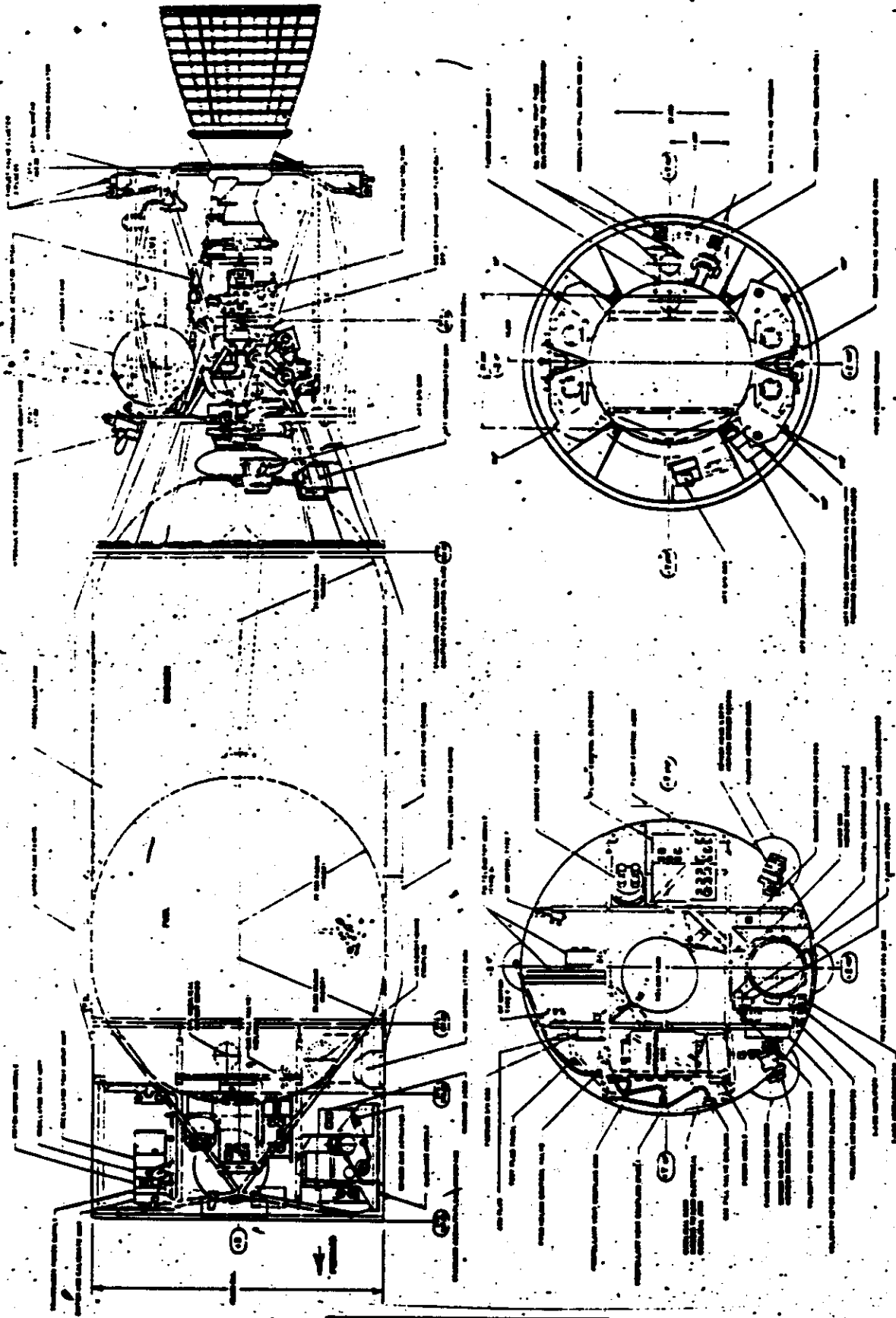


Figure B-6 Agena Inboard Profile

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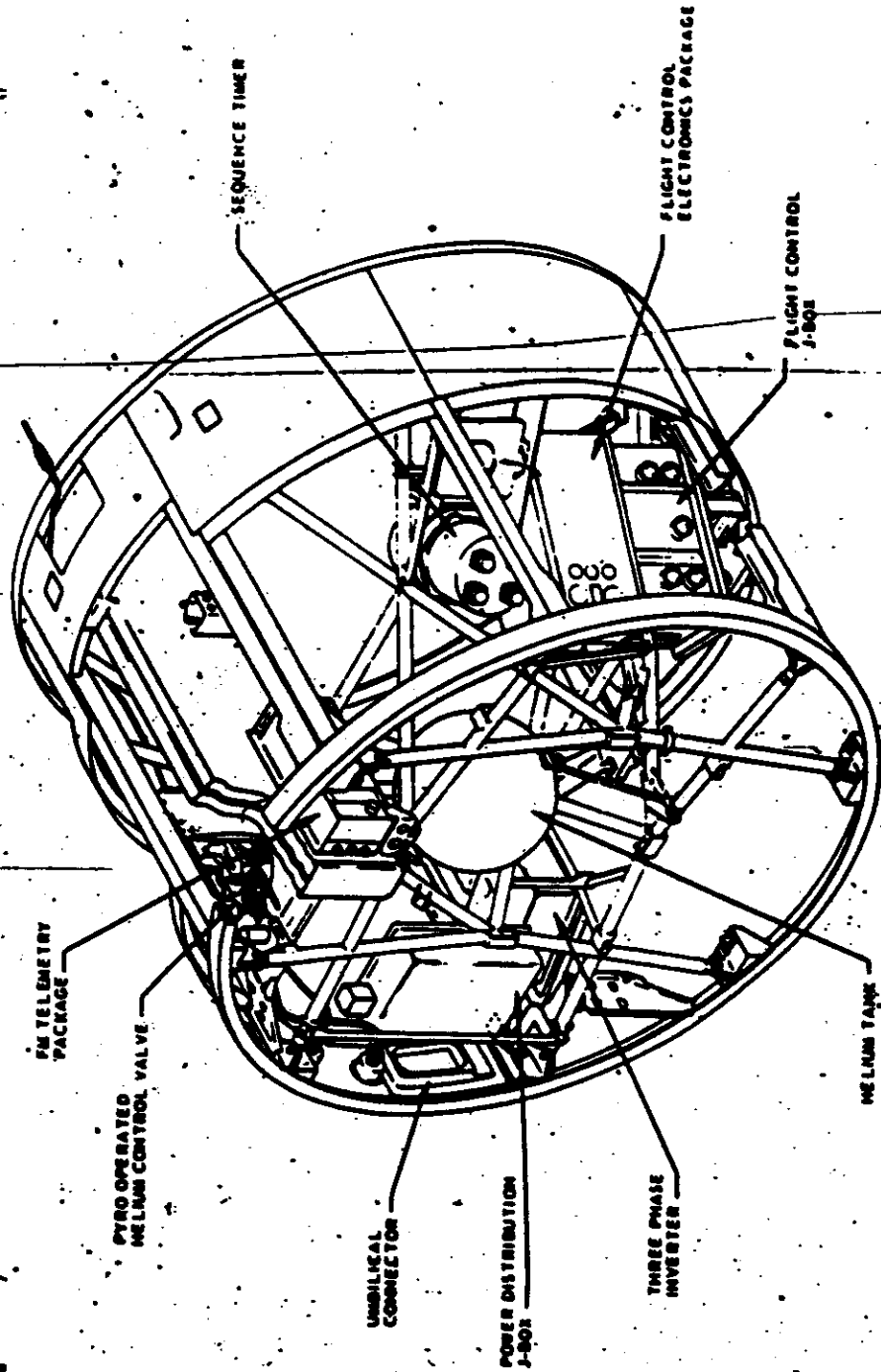


Figure B-7 Forward Section, Basic Vehicle

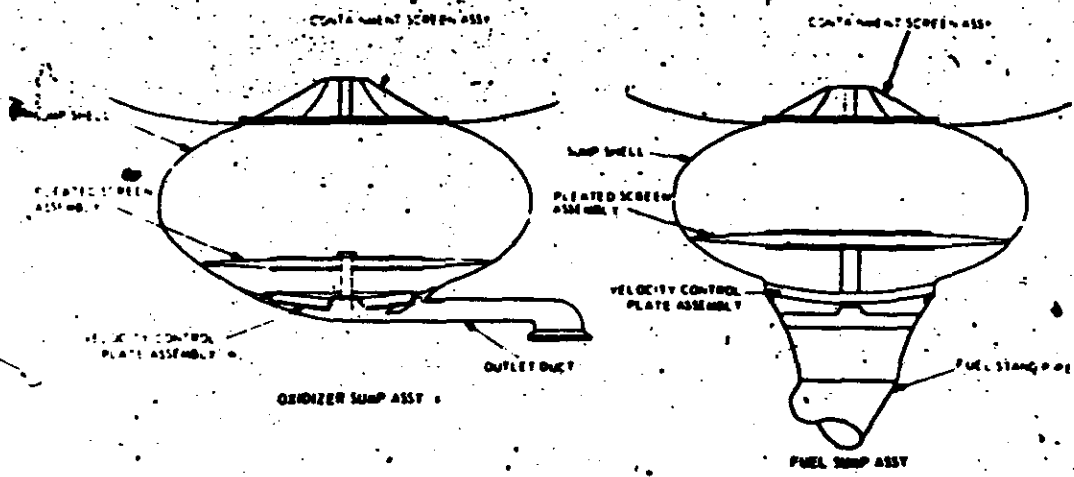
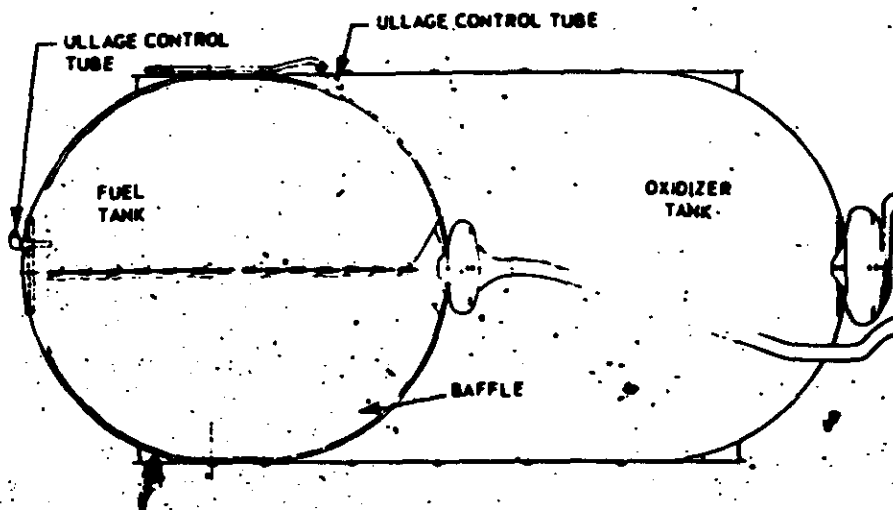


Figure B-8 Tank Section and Sump Details



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



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,

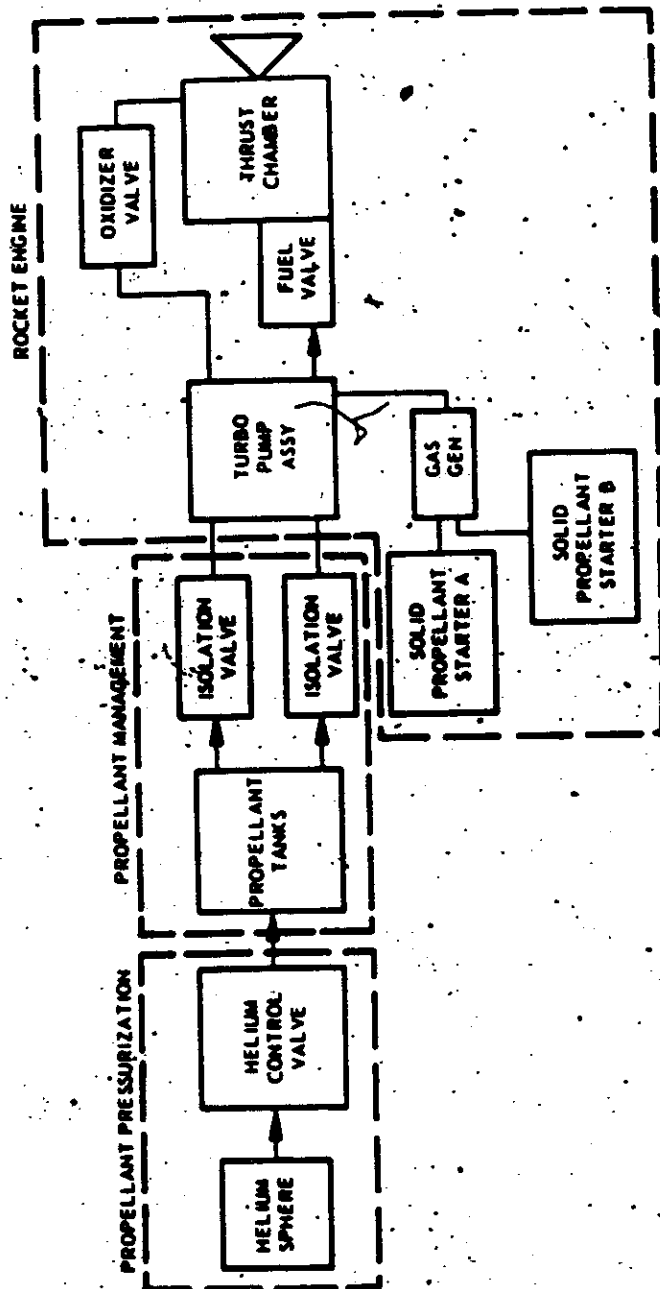
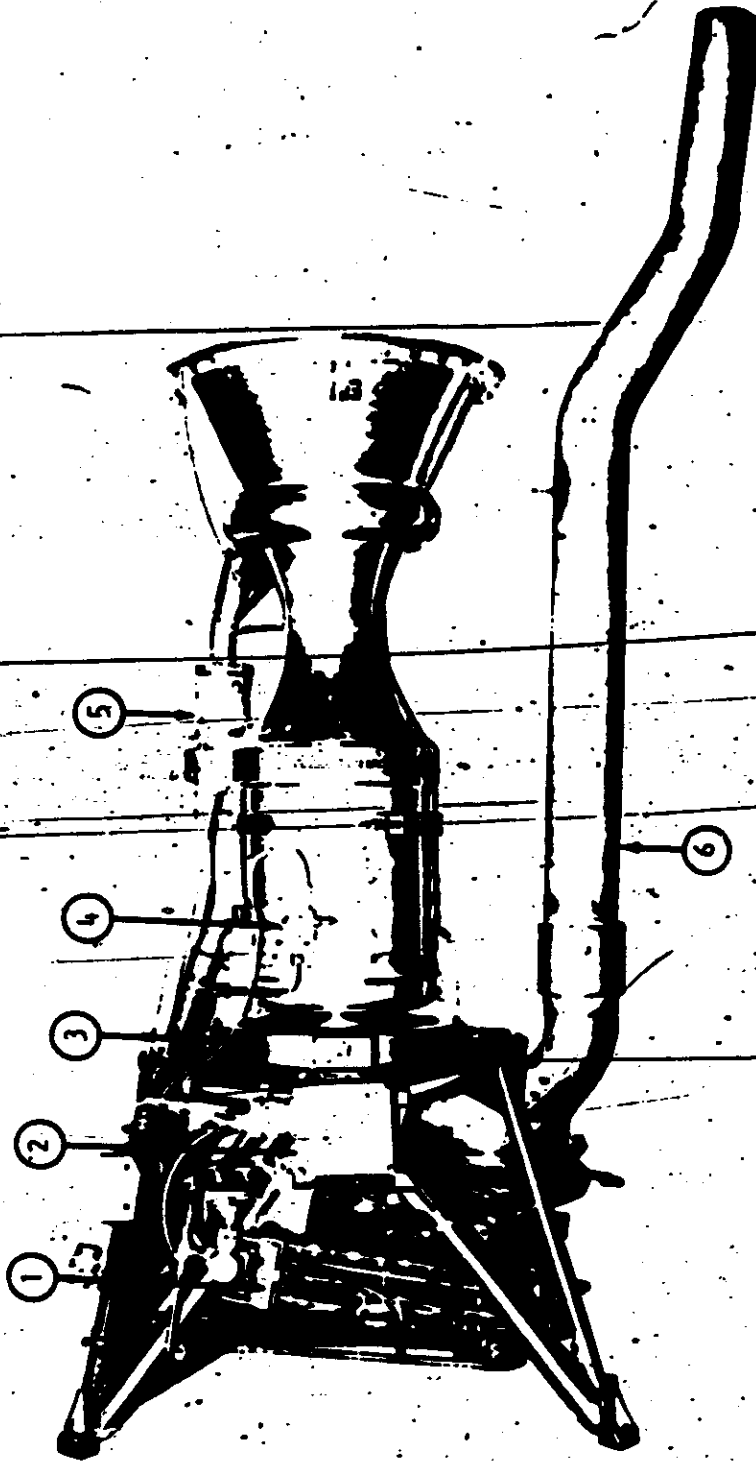


Figure B-10 Propulsion System Schematic



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

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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-4.1.1.1 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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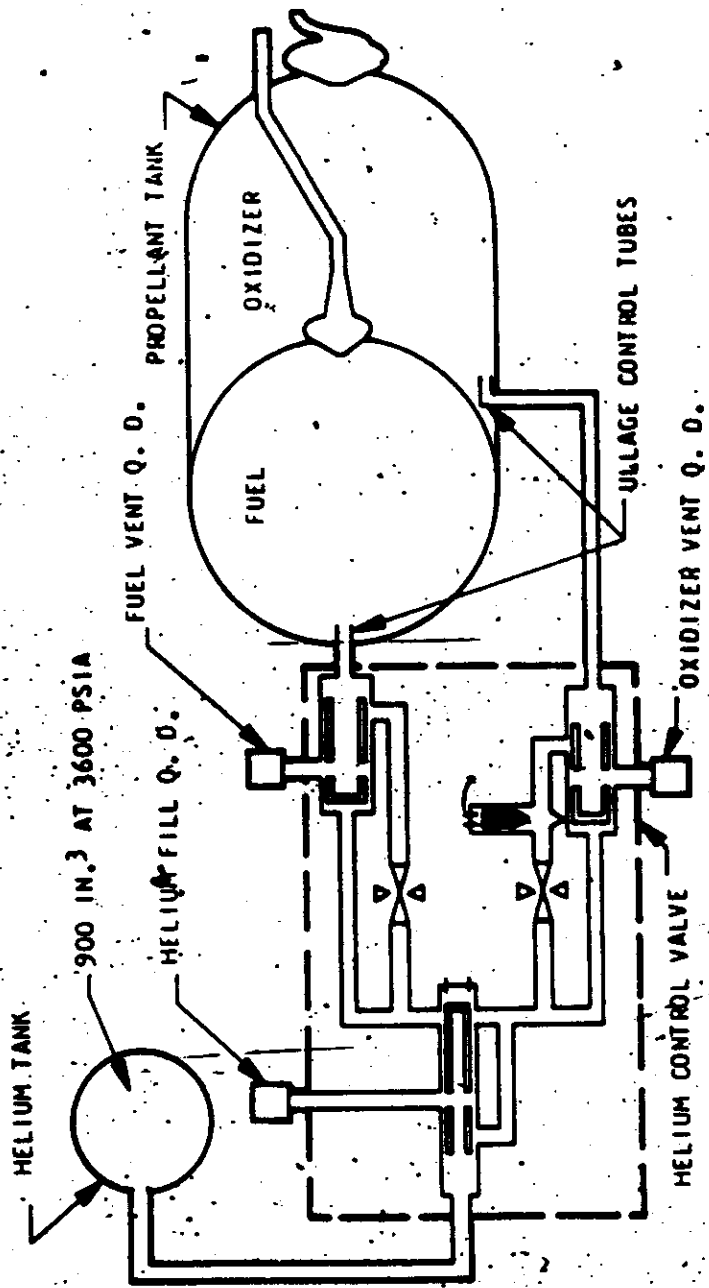


Figure B-12 Tank Pressurization System

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