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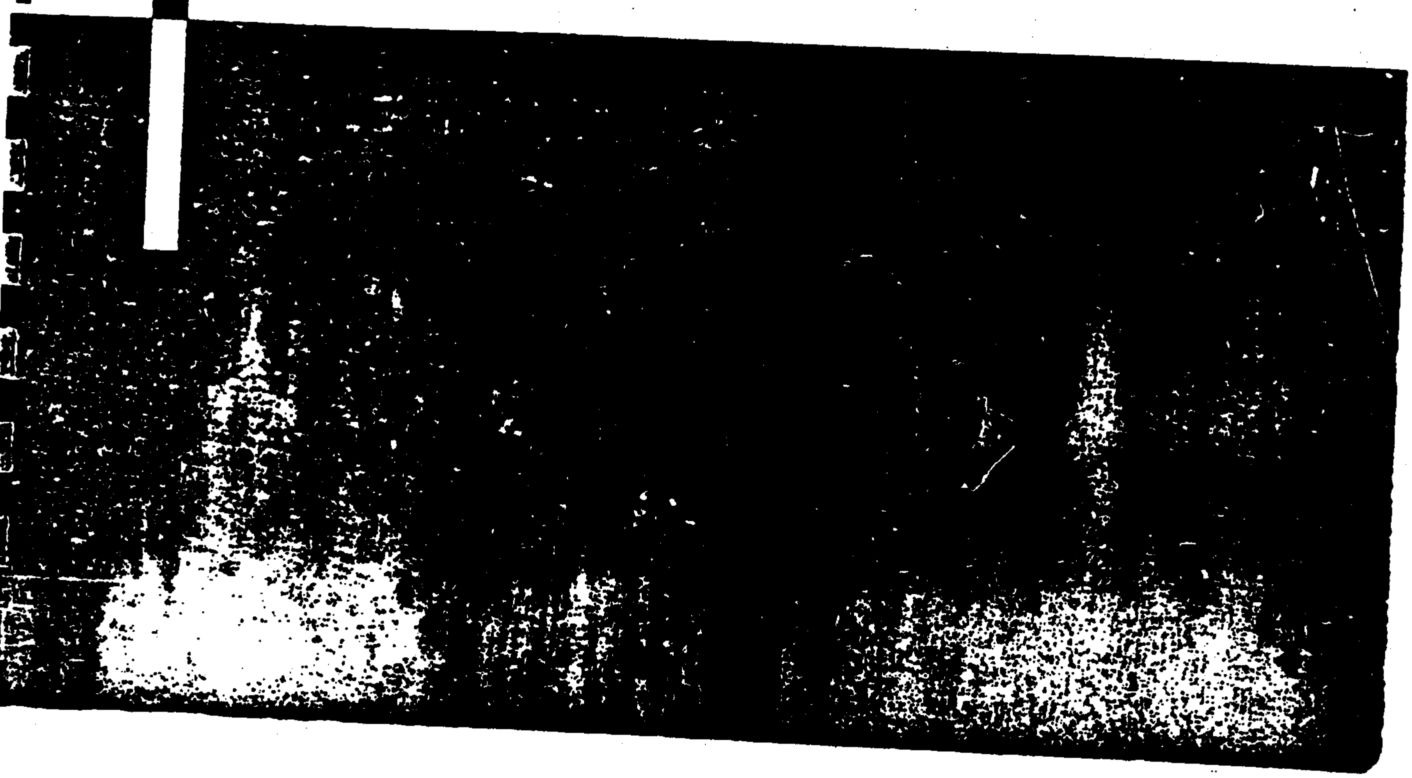
LMSD SATELLITE SYSTEMS BRIEFING

PART II

THE SAMOS PROGRAM

LMSD-445737X 14 SEPTEMBER 1959



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SATELLITE SYSTEMS BRIEFING.

PART II.

THE SAMOS PROGRAM

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PREFACE

The Samos program is defined in the Air Force Space System Development Plan, WDPP-59-11, 30 January 1959. Lockheed Missiles and Space Division is the weapon system contractor responsible for implementation of this plan.

The material presented ~~herein~~ highlights some of the more significant aspects of the Samos development program, with particular emphasis on visual reconnaissance (Subsystem E), ferret reconnaissance (Subsystem F), and communications (Subsystem H).

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INTRODUCTION

SAMOS PROGRAM DEVELOPMENT OBJECTIVES

PROVIDE SATELLITE RECONNAISSANCE SYSTEM THAT WILL PERMIT:

- TERRAIN & MAPPING COVERAGE
- TARGET DETECTION, VERIFICATION & LOCATION
- MONITORING OF ELECTRONIC EMISSIONS
- DETERMINATION OF ELECTRONIC SIGNAL CHARACTERISTICS
- MILITARY SURVEILLANCE
  - EVALUATION OF MILITARY & INDUSTRIAL STRENGTH
  - BUILD-UP INDICATORS
  - SIGNIFICANT MILITARY MOVEMENTS INCL. NAVAL FORCES, WORLDWIDE
  - ATTACK WARNING
- BOMB DAMAGE ASSESSMENT
- COLLECTION OF DATA ON TECHNOLOGICAL IMPROVEMENTS

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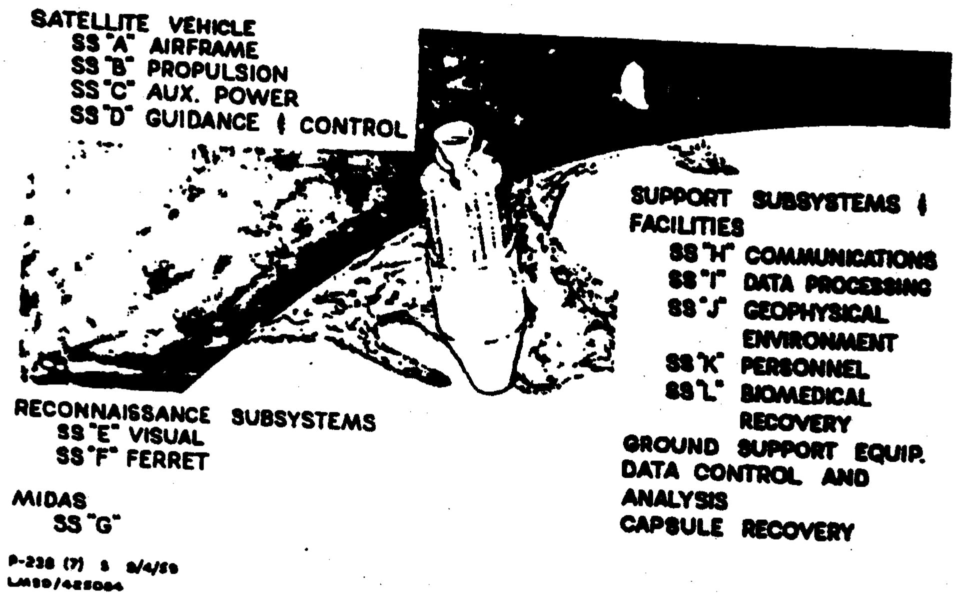
The great diversity of performance objectives for the Samos program requires the development of a system offering a high degree of flexibility in operational use and functional performance.

For example, terrain and mapping coverage implies a requirement for a visual reconnaissance system having moderate resolution with rather extensive area coverage capability to enable obtaining photographic coverage of large land masses in a reasonable period of time, and also to simplify the problem of converting the photographic coverage into maps.

On the other hand, detection and analysis of small enemy installations (such as radar equipment, aircraft, missiles, and their launch bases), while not requiring extensive area coverage, do require extremely high ground resolution capability. In addition, some of the objectives can be satisfied on a one-time basis while other objectives require daily observations.

In a similar manner, the requirements for electronic reconnaissance vary greatly, depending upon whether the objective is to merely monitor the level of activity at various locations within enemy areas, or to obtain sufficient detail on the electronic emissions to permit an accurate evaluation of the technical and functional capabilities and characteristics of the source of these emissions.

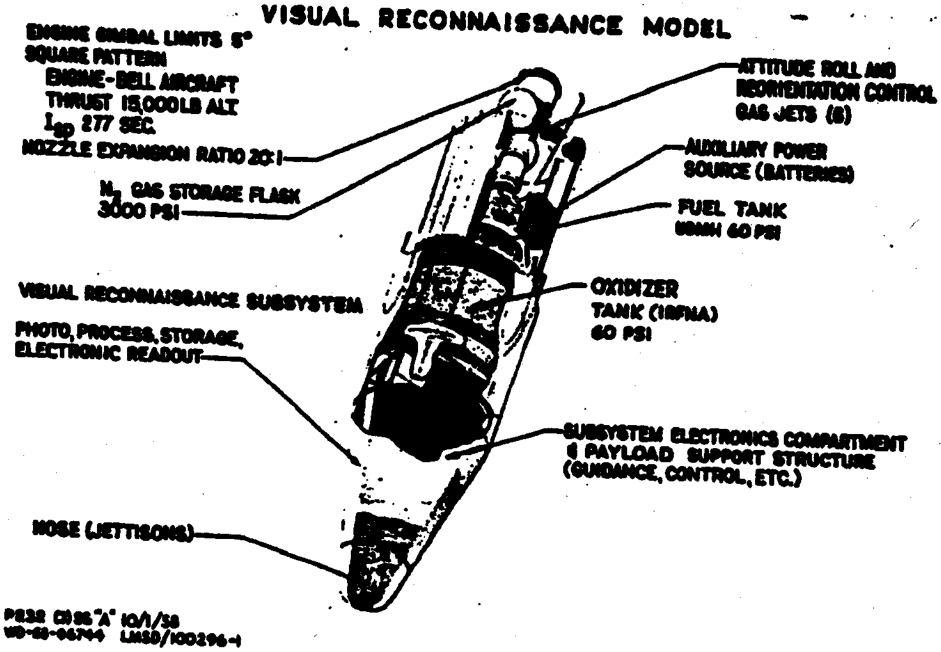
SUBSYSTEM STRUCTURE



The scope and complexity of the Samos program necessitates a subdivision into tasks of reasonable size for organizational and technical control purposes. As a result the program has evolved as a series of subsystems which represent a logical grouping of the various areas of effort on the program. In addition to the LMSD management and development responsibilities in the various subsystem areas, there is also the function of integrating all of the subsystems into one effective operational system. Although the MIDAS (Subsystem G) and the Subsystem L areas are now beyond the scope of the reoriented Samos program (and Subsystem I is not the responsibility of LMSD), cognizance of these areas of effort is required to insure the implementation of a technical program of maximum efficiency and economy.

SAMOS ORBITAL VEHICLE

VISUAL RECONNAISSANCE MODEL



The Samos reconnaissance program utilizes the basic Agena orbital vehicle. Minor variations in the detailed vehicle arrangement are required for the various payload configurations employed in implementing the variety of visual and electronic reconnaissance missions. The basic vehicle, however, remains essentially unchanged and affords a highly reliable means for orbit injection and controlled space platform operation of the intelligence sensing equipment.

The configuration shown provides a reconnaissance subsystem weight capacity on the order of 1,000 pounds. Through the use of dual burning during orbital boost, larger fuel and oxidizer tanks, and higher energy fuels, reconnaissance payloads of up to 5,000 pounds can be readily accommodated.

VISUAL RECONNAISSANCE MISSIONS

	PAYLOAD	PURPOSE	ALT. (S.M.)	PAYLOAD LIFE	COVERAGE	RESOL.
READOUT	E-1	R&D	300	1 MO.	100 MI. WIDE STRIP	100 FT.
	E-2	SURVEILL.	300	4 MO.	PROGRAMMED 17 MI. WIDE STRIP	20 FT.
	E-3	SURVEILL.	300	12 MO.	PROGRAMMED 5X5 MILES	5 FT.
RECOVERY	E-4	MAPPING	300	1 MO.	FRAME 460 X 460 MILES	200 FT.
	E-5	RECONN.	160-200	1 MO.	PROGRAMMED 60 MI. WIDE STRIP	5 FT.

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The visual reconnaissance program includes five basic payload configurations which provide:

a. Preliminary evaluation of the orbital operation of a readcut type payload (E-1)

b. Reconnaissance and surveillance capabilities at limited resolution (E-2)

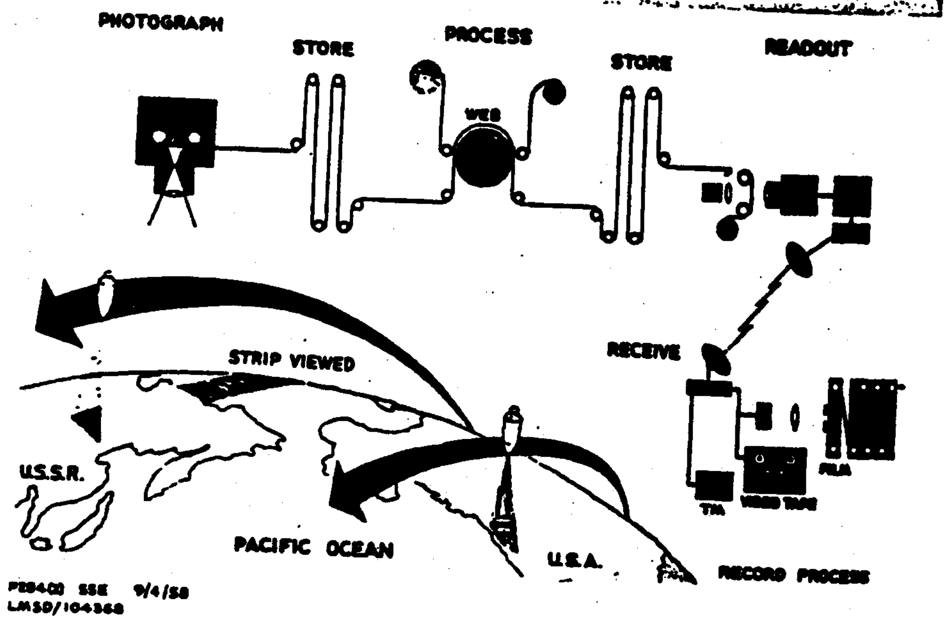
c. High resolution readout capabilities (E-3)

d. A highly accurate mapping capability (E-4)

e. A high resolution recoverable payload (E-5).

VISUAL RECONNAISSANCE
SUBSYSTEM E

E-2 PAYLOAD-FUNCTIONAL SCHEMATIC



The visual reconnaissance payload employs a slit-type camera to photograph, on command from the programmer, a strip of the earth's surface. The payload uses 70mm-wide film which, after exposure, is held in a variable capacity looper until processing by means of a pre-soaked "web" type material which is brought into contact with the film over a processing roller.

Upon contact with a ground readout station within the continental United States, the information on the film is read out by a high-resolution TV-type scanner and transmitted to the ground. At the station the video signal from the satellite is reconstructed into a film record for intelligence use.

SAMOS READOUT E-2 PAYLOAD DATA

GROUND RESOLUTION	20 FEET
GROUND WIDTH COVERAGE	17 MILES
MAXIMUM OBLIQUITY	26 DEGREES
STEREO CONVERGENCE ANGLE	34 DEGREES
GROUND COVERAGE AREA	55,000 SQ.MI./DAY
FILM CONSUMPTION	10 LB./MONTH
OPERATING LIFE	4 MONTHS
READOUT BANDWIDTH	6 MEGACYCLES
WEIGHT	919 LBS.
LENGTH	67 INCHES
BASE DIAMETER	55 INCHES
AVERAGE POWER CONSUMPTION	28 WATTS

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The basic parameters of the E-2 payload are listed in this chart. Obliquity steering involves 105 positions (plus or minus 26 degrees in half-degree steps). Stereo convergence angles of 0, 10, 20, and 34 degrees are available. The operating life listed assumes a readout-limited system with three readout stations and information being read out during every contact with a readout station.

SAMOS READOUT E-2 CAMERA DATA

FOCAL LENGTH	36 INCHES
FILM WIDTH	70 MM
PICTURE WIDTH	2 INCHES
LIMITING RESOLUTION	250 LINES/MM
APERTURE RATIO	F/4
APERTURE DIAMETER	9 INCHES
EXPOSURE TIME NOMINAL	1/100 SEC.
SPECTRAL RANGE	.500-.720 MICRONS
SLIT WIDTH	.0027 TO .085 INCH
WEIGHT	83 LB.

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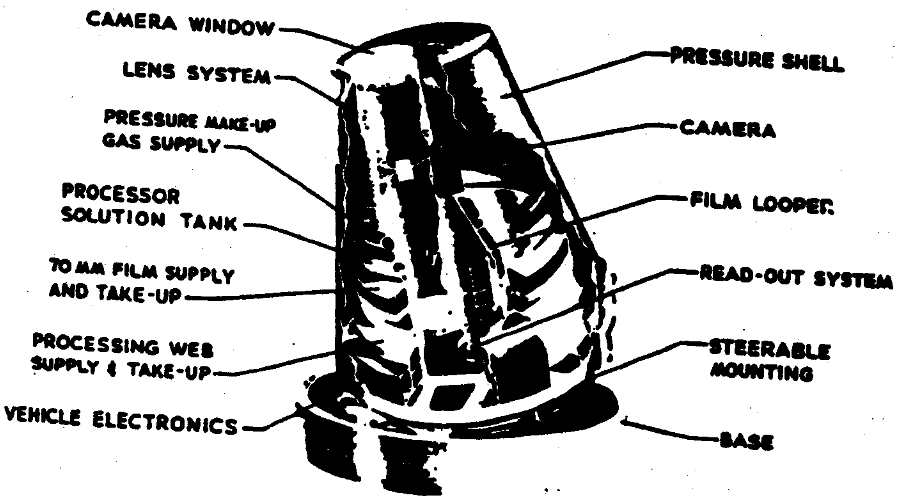
Data listed on the chart are those resulting when a slit camera is installed. A frame camera is being developed which can be used inter-changeably to give a 2 x 2-inch square format. A comparable weight is expected for this model.

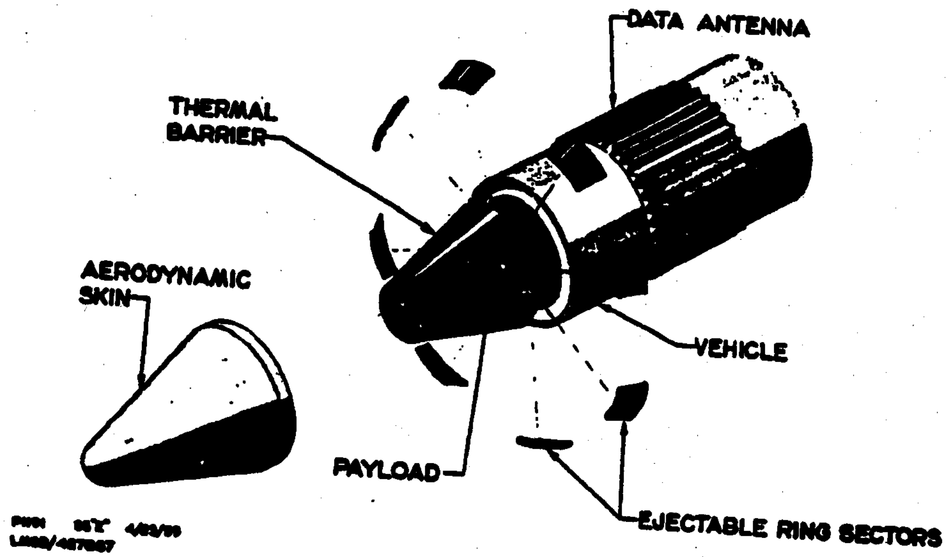
VISUAL RECONNAISSANCE PAYLOAD (E-2)



The largest single component of the E-2 payload is its 36-inch focal length lens, which occupies the central core of the payload package. All other components (including the film handling equipment, processor, readout packages, and environmental control equipment) are fitted around the lens but within the conical configuration imposed by the vehicle nose section.

SAMOS READOUT - EJECTION OF SUPPORTS

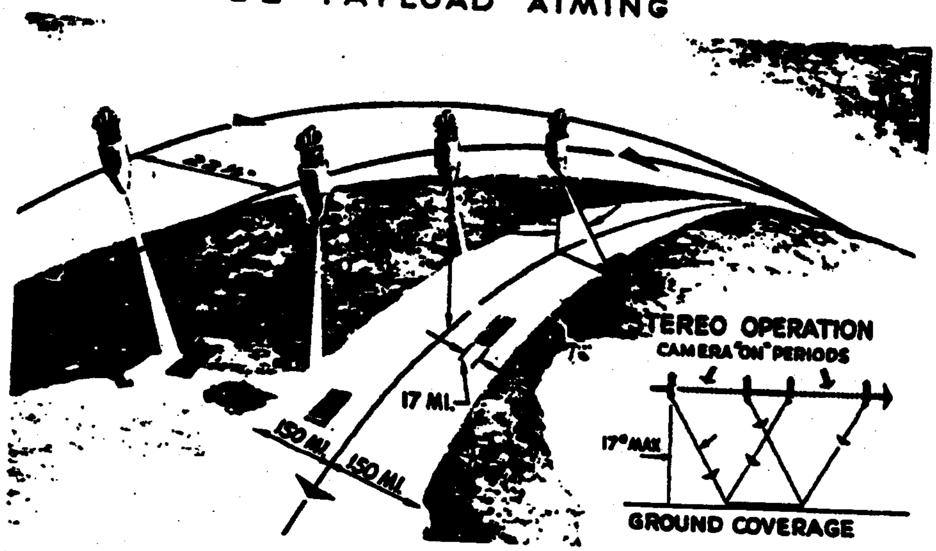
E-2 LAUNCH STABILIZING SUPPORTS



Upon attaining the proper nose-down orientation, the entire nose section of the aerodynamic skin is jettisoned, exposing the E-2 payload which is still locked rigidly in position. To prepare the payload for full operation, the trunnion support rings, which are necessary during the launch phase, are ejected and the payload is free to move as necessary to cover specific targets.

SAMOS READOUT-CAMERA PROGRAMMING

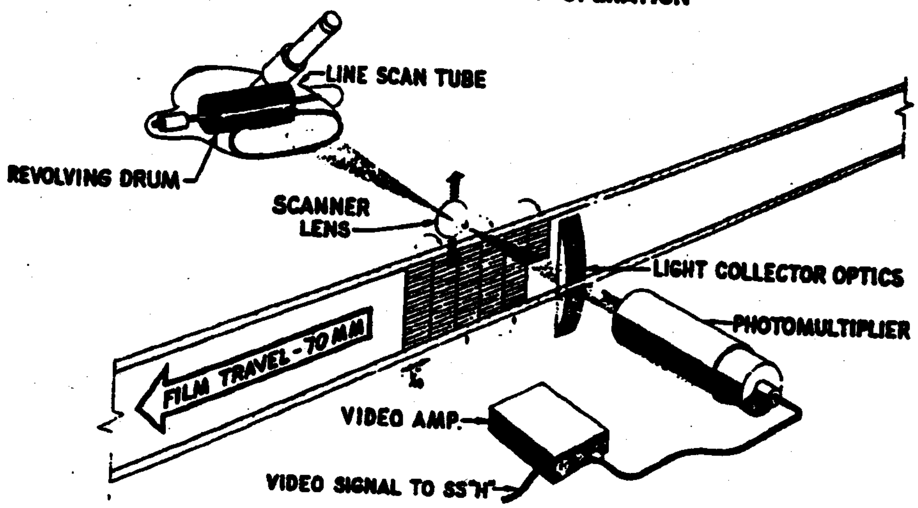
E-2 PAYLOAD AIMING



With the long focal length employed in the E-2 payload, a relatively narrow ground swath (17 miles) is covered. Provision for covering targets up to 150 miles on either side of the ground track is included in the E-2 system. The entire payload can be programmed to point up to 26 degrees to either side. In addition, a stereo capability is provided by fore and aft aiming of the payload. A typical camera command, which must be stored in the vehicle programmer for execution over the territory of interest, includes exposure time and camera image-motion compensation data along with the obliquity, stereo, and crab orientations of the payload trunnion mount.

SAMOS READOUT SYSTEM

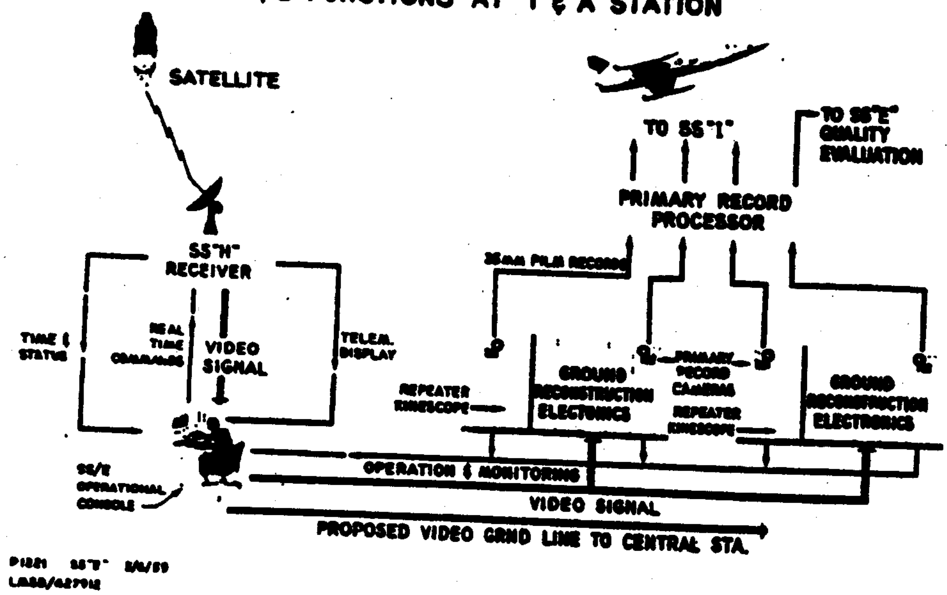
E-2 PAYLOAD READOUT OPERATION



The information is taken from the payload film ("read out") by scanning the film with a TV-like scanner. A mechanical drive is used to scan lateral strips of the 70mm film, with electronic sweep being used to cover the 0.10-inch strip. It is necessary to demagnify the scanning spot produced by the scanning tube to obtain a scanner resolution of 100 optical line pairs per millimeter. Light passing through the film is gathered by a collector optics system and photomultiplier tube in which the output is a video signal suitable for transmission to the ground.

SAMOS READOUT-GROUND RECONSTRUCTION

SS/E FUNCTIONS AT T & A STATION

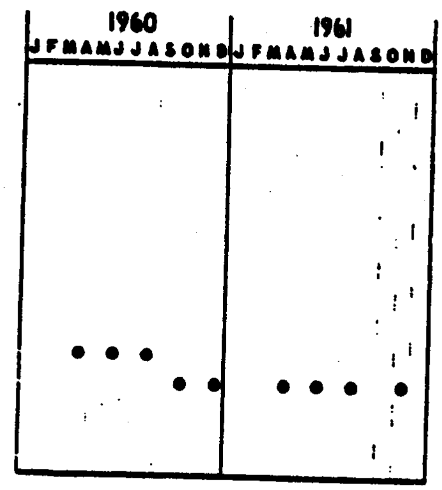


Upon reception at the ground station by the ground-space communications subsystem, the video signal is relayed to sets of ground reconstruction electronics whose function is the production of 35-millimeter primary ground records. Four duplicate records are produced at a typical tracking and acquisition station. The operator of the Subsystem E console can make adjustments in the payload scanner to optimize the video signal, and in addition acts as a nerve center for the subsystem area during a readout. Real-time transmission of the video signal to a central station is contemplated at a later date in the program, at which time a reduction in the number of records produced at a tracking and acquisition station will be possible.

SAMOS VISUAL READOUT FLIGHT DATES

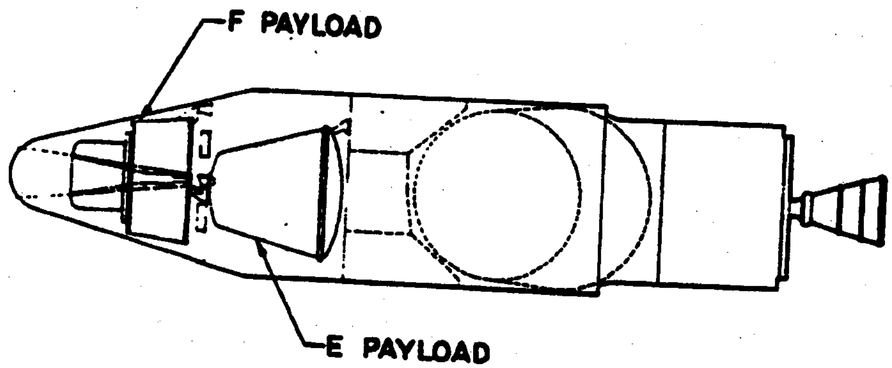
ARPA REORIENTED SCHED.

DUAL PAYLOAD (E-1,F)
(E-2 COMPONENT TEST)
E-2 VISUAL PAYLOAD



The primary effects of ARPA program reorientation included an advance of nine months in E-2 visual payload flight dates and de-emphasis of the former 6-inch focal length payload. Hardware from the 6-inch focal length program is being utilized in the E-1 component test flight configuration.

COMBINED E & F PAYLOAD



The E-1 components test payload will share the satellite vehicle with early ferret payloads. The E-1 payload is mounted behind the ferret equipment and, during the first few days of operation, will have a very limited view through a hole in the ferret antenna. After E-1 operation is proved, the ferret payload can be jettisoned, thus allowing the visual equipment an unrestricted view.

SAMOS READOUT ORBITAL OPERATIONS

DUAL PAYLOAD

CONCURRENT OPERATION

- SS/F FULLY OPERABLE
- SS/E FULLY OPERABLE BUT CAMERA FIELD RESTRICTED

CONSECUTIVE OPERATION

- SS/F JETTISONED AFTER EVALUATION & DETERMINATION OF SS/E OPERABILITY
- SS/E FULLY OPERABLE WITH UNRESTRICTED FIELD

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Operation of the dual payload configuration involves two distinct modes: concurrent operation of Subsystems E and F payloads to evaluate E-1 operation and to fully exercise the ferret system; and operation of the E-1 payload alone after jettisoning Subsystem F. Total payload lifetime is determined by battery exhaustion and is estimated at ten days.

SAMOS READOUT–E-2 GROWTH POTENTIAL

- RESOLUTION APPROACHING 5 FT. ON GROUND
- UTILIZE E-2 STRUCTURE & MAJOR COMPONENTS
- DEVELOP LONG FOCAL LENGTH LENS (120 IN. f/4)
- IMPROVE LENS-FILM RESOLUTION (250 LINES/MM)
- ADOPT LARGER FORMAT (5-IN. WIDE FILM)
- IMPROVE SCANNER RESOLUTION (100 LINES/MM)
- INCREASE DATA LINK BANDWIDTH (12 MC)
- IMPROVE ATTITUDE CONTROL (± 1/4°)
- CONSIDER FRAME TYPE CAMERA
- ADOPT AUTOMATIC IMAGE-MOTION COMPENSATION

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This chart represents the presently-estimated growth potential of the E-2 payload assuming: (1) maximum use of payload hardware being developed for E-2; (2) maximum compatibility with ground control and reconstruction equipment used in the E-2 program; and (3) logical extension of E-2 payload design, with no significant increase in scanner resolution.

E-3 VISUAL RECONNAISSANCE SYSTEM

CHARACTERISTICS & CAPABILITIES

- ACTIVE LIFE - 1 YEAR (300 S.MI. ORBIT ALTITUDE)
  POWER SUPPLY - SOLAR
- GROUND RESOLUTION - 5 FT. (2.5 FT. WITH 2X POWER CHANGER)
- OPTICS - 144" E.F.L. F/4.5
  SENSOR - ELECTROSTATIC STORAGE TAPE (60 FEET, REUSABLE)
- EXPOSURE - 1 MILLISECOND (REDUCED ATTITUDE CONTROL & IMC REQMTS)
  READOUT - ELECTRON BEAM DIRECT FROM TAPE
  DATA LINK - 12 MCS VIDEO BANDWIDTH
- GROUND RECONSTRUCTION - ELECTRON BEAM FILM RECORDER
  OPERATING MODES - VERTICAL, OBLIQUE, STEREO

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A nominal circular orbit altitude of 300 statute miles, together with the reusable electrostatic storage tape and a solar power supply, will permit the desired one-year active life on orbit.

An exposure period of only one millisecond, resulting from the high sensitivity of the photoconductive sensor, considerably simplifies the vehicle attitude control and the camera image-motion compensation problems.

System "optical" resolution capability is maximized through system simplifications achieved by the all-electronic visual reconnaissance equipment and the direct image reconstruction from the electron beam to film at ground bases.

Use of the 12-mc video bandwidth data link permits doubling the readout capacity of high resolution video data without requiring additional ground stations.

OPN'L ADVANTAGES OF ALL-ELECTRONIC E-3 RECON. SYS.

- RELIABILITY MORE READILY ATTAINED DUE TO DESIGN SIMPLICITY AND REDUNDANT EQUIPMENT POSSIBILITIES
- LOWER SENSITIVITY TO RADIATION
- IMAGE MOTION COMPENSATION REQUIREMENTS REDUCED (i.e., MORE SENSITIVE SENSOR ALLOWS A SHORTER EXPOSURE)
- REUSABLE IMAGING-STORAGE MEDIUM SIMPLIFIES ACHIEVING ONE-YEAR OPERATIONAL LIFE
- INCREASED SENSITIVITY PROVIDES CLOSER APPROACH TO 24-HOUR SURVEILLANCE CAPABILITY
- POSSIBILITY OF IMMEDIATE DATA TRANSMISSION (i.e., NO DELAY FOR FILM PROCESSING)
- FEASIBILITY OF PROVIDING REAL-TIME ADJUSTMENT OF PICTURE QUALITY DURING READOUT CONTACT

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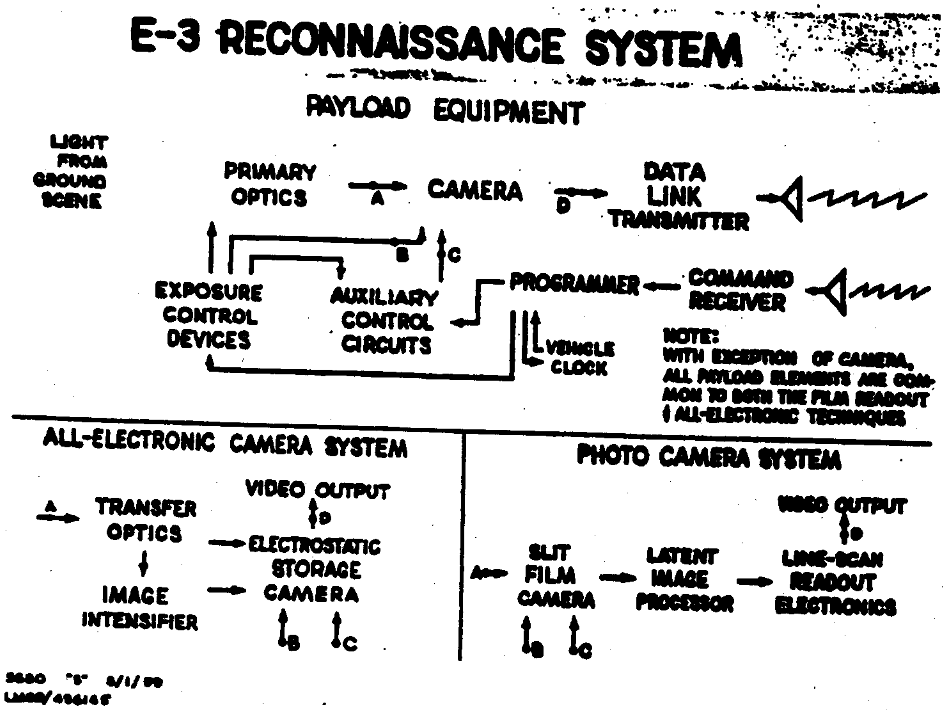
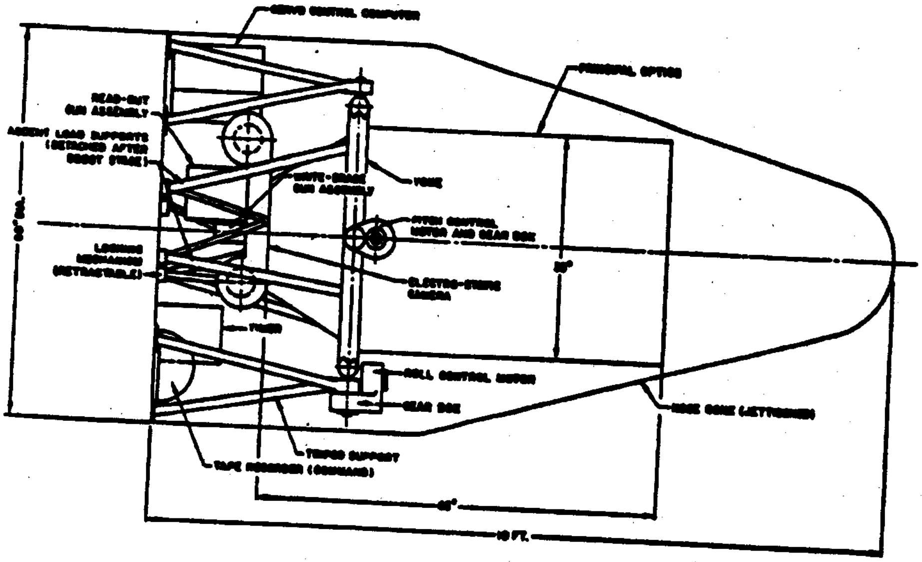
The unique capabilities of the electrostatic storage camera, supplemented by optional use of the image intensifier section and relay lenses of additional magnification, offers a very high degree of flexibility in operational use and performance capability. This approach enables accomplishing functions within the broad area of visual reconnaissance requirements that would otherwise be technically unfeasible or economically prohibitive.



The relative simplicity of this technical approach is of particular interest. Even with the added functional capability provided by the transfer optics, image intensifier, and relay lenses for additional magnification, system simplicity is retained. This is largely due to the unique capability of the electrostatic storage camera to perform the imaging, image-motion compensation, temporary data storage, and data readout within the one self-contained unit, plus the additional factor that chemical processing attendant to operation with photographic film is no longer required.



The relative simplicity of the E-3 high resolution reconnaissance subsystem is illustrated above. Savings in space and weight resulting from use of the reusable electrostatic storage tape for video imaging and temporary data storage are apparent. While this initial preliminary layout is rather tentative with regard to specific detail, it does indicate the general payload hardware design concepts and requirements.

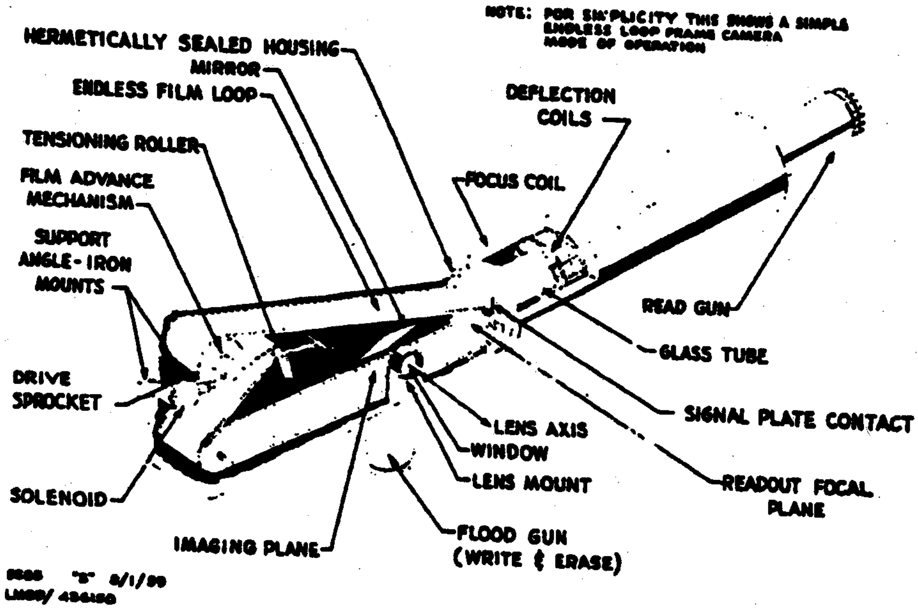
E-3 VISUAL RECONN. SUBSYSTEM

OPTICS	
EFFECTIVE FOCAL LENGTH	44"
APERATURE & FOCAL RATIO	32"(F/4.5)
ANGULAR COVERAGE	APPROX 1°
FILTER	WRATTEN NO.12
CAMERA	
IMAGING MEDIUM	ELECTROSTATIC STORAGE TAPE
IMAGE SURFACE	61MM (PRIM. IMAGE)+7.5MM (AUX. DATA)
SPECTRAL RANGE	0.5 TO 0.72 MICRONS
SENSITIVITY	EQUIVALENT ASA 145
EXPOSURE TIME	1-5 MILLISECONDS
STORAGE & READOUT	
STORAGE CAPACITY	60 LIN. FT. OF 3.25" WIDE TAPE
SYSTEM RESOLUTION	100 OPTICAL LINE PAIRS/MM AT 10% SINE WAVE RESPONSE
READOUT BANDWIDTH	12 MC
GROUND RECORDING	
ELECTRON BEAM FILM RECORDER	

P-1201 88"2" 9/8/59
LMSD/ 439187

The characteristics of particular interest required for the performance of the high resolution readout surveillance missions include the relatively high sensitivity of the imaging medium which permits the employment of rather short exposure time, thus significantly reducing the attitude control and image-motion compensation problems. The system provides a very high resolution capability and, through the use of the reusable image storage medium, permits a payload design of minimum size and weight.

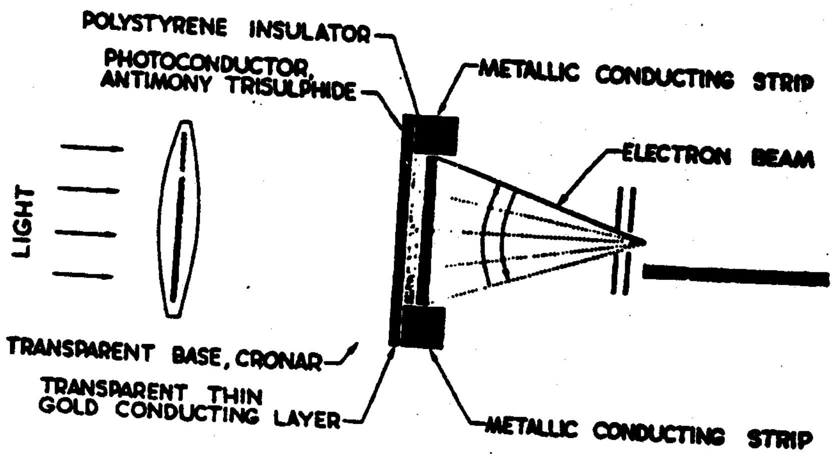
ELECTROSTATIC STORAGE CAMERA



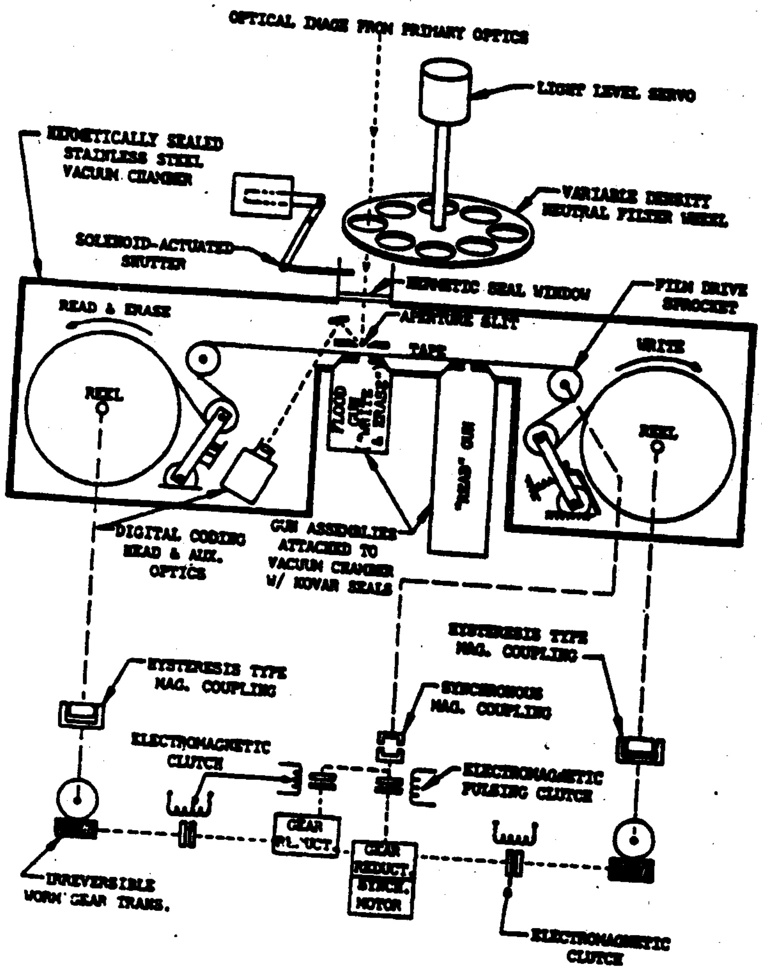
The above schematic representation of the electrostatic storage camera indicates the mechanization of such a camera for frame photography operation. Actually for applications where the ultimate in high resolution is desired and the metrical properties of the photography are not important, such as the E-3 reconnaissance mission, strip photography is preferable to frame camera operation.

The camera to be used in the E-3 system employs a slit before the image plane and a tape drive mechanism for image-motion compensation. The tape will be wound on rather conventional reels within a stainless steel evacuated chamber. Breadboard designs of this camera have already been built and tested by Radio Corporation of America, Astro-electronic Products Division. Technical feasibility of this approach is adequately demonstrated by currently available test data.

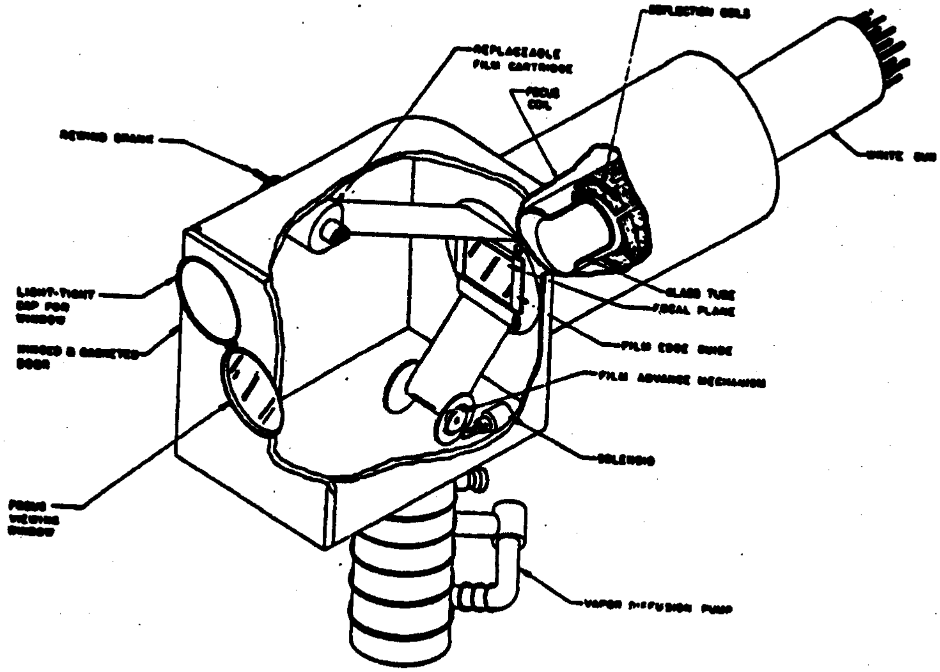
ELECTROSTATIC STORAGE TAPE



The electrostatic storage tape illustrated here is the heart of the E-3 reconnaissance system. Materials used in the construction of this tape were selected to meet the particular requirements for very high resolution, long storage time without image degradation, high resistance to radiation effects, and highly reliable reusability over a long active operating life.

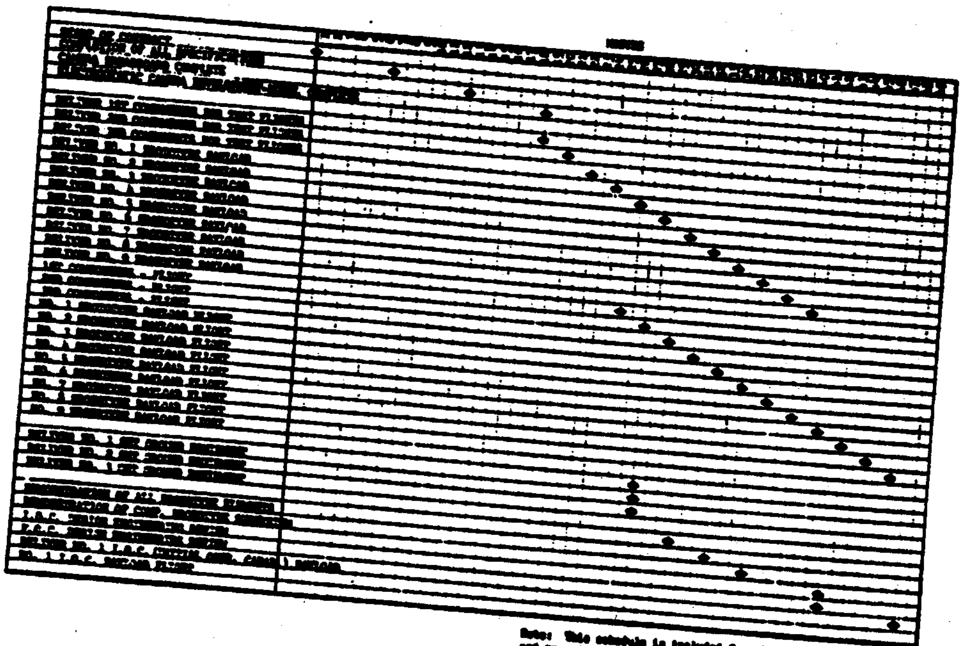


This chart illustrates schematically the salient features of the electrostatic camera. Items of particular design interest include the magnetic drive couplings and clutches that are employed to minimize the number of working parts that must be included within the evacuated chamber, and also the combination steel and glass design of the chamber wall. Partial breadboard models of this equipment have been built and tested at Radio Corporation of America, Astro-electronic Products Division.



The balanced design of a high resolution system for visual reconnaissance implies the need for high resolution capability in the reconstruction of the video image after reception at the ground readout station.

This electron-beam film recorder permits imaging the video data directly on photographic film without incurring the degradation in quality that normally would result from the use of an intermediate conversion medium, such as the phosphor of a cathode ray tube. By avoiding the degrading characteristics of the fluorescent phosphor and taking advantage of the finer electron beam diameters that are possible with a lower beam intensity, the electron-beam film recorder is capable of very high resolution.



Note: This schedule is included for planning purposes only and provides an indication of the timing that appears feasible for an adequately funded hardware development program.

As indicated in the included footnote, the above schedule is provided as a general indication of the timing that appears appropriate for the suggested E-3 development program.

SAMOS RECOVERY PROGRAM E-5 PAYLOAD

E-5 PAYLOAD OBJECTIVES

- 100% PHOTO POTENTIAL ABOVE 33° N LATITUDE
- 30 x 30 N. MI. PHOTOGRAPHS OF SPECIFIC TARGETS WITH 5 FOOT RESOLUTION
- 60 x 60 N. MI. PHOTOGRAPHS OF SPECIFIC TARGETS WITH 10 FOOT RESOLUTION
- STEREO CAPABILITY
- COMPATIBILITY WITH SENTRY READOUT
- LOCATION ACCURACY OF ONE N. MILE

This chart outlines the objectives of the high resolution photographic reconnaissance program. The system should be capable of photographing any specified target area in the Eurasian land mass above 33 degrees north latitude.

The target area is defined as a 30 x 30-nautical mile area. In this area the photography should achieve 5-foot ground resolution. This 30 x 30-nautical mile area may be enclosed in a 60 x 60-nautical mile area which has 10-foot resolution at the edges.

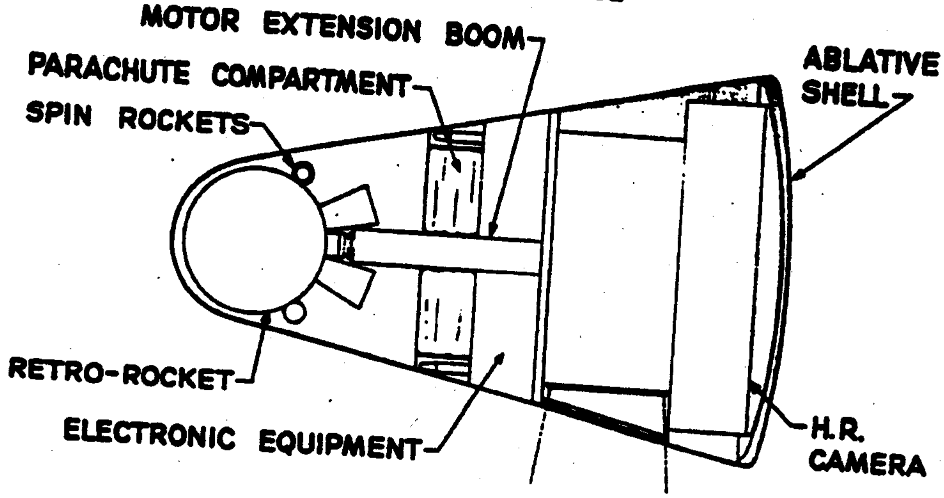
It is required that the camera be capable of obtaining overlapping stereoscopic photography. This would permit maximum extraction of intelligence information from the photography.

A desirable, but not necessarily essential, objective is compatibility with the Samos readout system. This objective might permit use of the high resolution camera interchangeably with the cameras being specifically developed for the readout systems.

A necessary condition for the photography to be useful is that it be readily located. This objective would be fulfilled by recording the time of photography and correlating this information with the orbit ephemeris. It is required that the locational accuracy be one nautical mile or better.

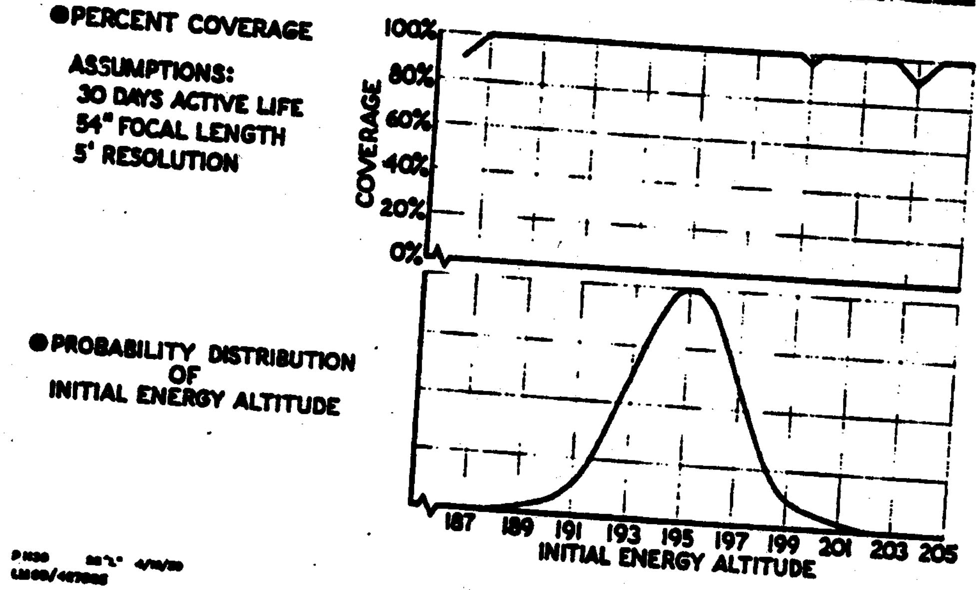
SAMOS RECOVERY-CAPSULE (H.R-I)

INBOARD PROFILE



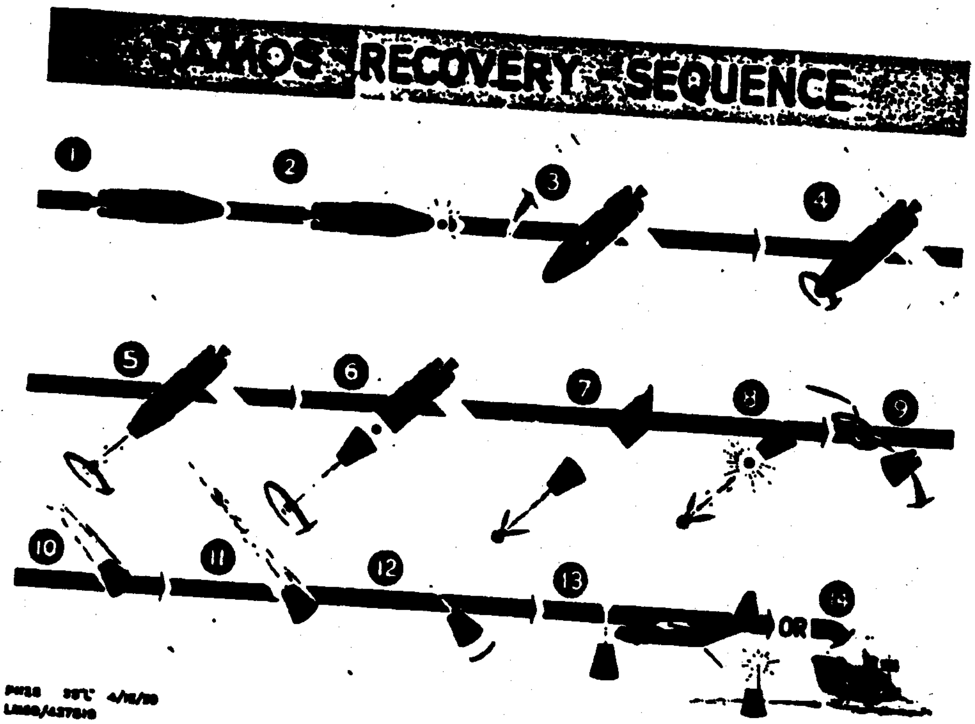
This chart is a schematic inboard profile showing the expected placement of the recovery payload in the capsule. The tractor rocket motor and extension boom are located in the nose section. Immediately behind this are the parachutes and recovery antennae and lights. The camera, including its film supply and take-up spools, is located in the aft section of the capsule immediately ahead of the ablative shield, resulting in a favorable location of the center of gravity for correct orientation of the capsule during recovery operations. The maximum diameter of the capsule is six feet.

SAMOS RECOVERY-H.R. COVERAGE



This diagram illustrates the relationship between photographic coverage and the expected orbit altitudes that would be achieved. The top curve shows that 100 percent coverage would be achieved for all orbits lying between 187 and 199 miles altitude. The dips at 199 and 203 miles altitude are due to nearly synchronous orbits.

The bottom curve shows the probability distribution of orbits expected to be achieved. For the majority of expected orbits, 100 percent coverage should be achieved.



This chart indicates the sequence of events in the recovery operation. The design objective is to impact the capsule into an area of 30 x 30 miles. Beginning at Step 1, the satellite is seen in the horizontal position used during photographic operations. The cut-down command has already been given and the sequence of events is under control of the recovery sequence programmer.

Actual recovery operations would begin with the separation of the nose cone covering the retro-rocket motor by firing an explosive device (Step 2). The entire vehicle is then rotated by action of the gas jets (Step 3) into the proper attitude for re-entry. Note that this attitude would result in the capsule being pulled downward and in a direction opposed to the satellite's flight.

At Step 4, the spin rockets of the retro-rocket are ignited. The action of the spin rockets (Step 5) extends the collapsible motor boom so that the retro-rocket would be well away from the capsule, thereby protecting it from the rocket blast. When the boom is fully extended, the capsule is separated from the satellite vehicle by the action of explosive devices, and the main rockets of the retro-rocket motor are fired (Steps 7 and 8).

The retro-rocket pulls the capsule downward and backward toward the earth. When sufficient velocity has been attained, a velocity integrator causes an explosive device to separate the retro-rocket from the recovery capsule (Step 8). The recovery capsule then continues downward until it reaches sensible atmosphere. Here, due to the location of its center of gravity and aerodynamic properties, it would re-orient itself so that the blunt end protected by the ablative shield would be pointed toward the earth (Step 9).

At Step 10, the capsule is shown in the ablative phase. Here it is being slowed down by atmospheric drag and the heat generated is being absorbed by the ablative shield. At Steps 11 and 12, the capsule is shown at the end of the ablative phase where it has slowed down and reached a sufficiently low altitude (approximately 50,000 feet) to deploy the parachute.

When the parachute is fully open, the ablative shell is separated from the capsule in order to avoid the effects of its heat on the photographic film and to lighten the load on the parachute. Opening of the parachute also initiates the radar recovery beacon. Previously deployed recovery aircraft home on this beacon and attempt to recover the capsule in the air. Should the recovery aircraft fail to retrieve the capsule, recovery attempts would be made in the water by ships previously deployed in the area.

FERRET RECONNAISSANCE SUBSYSTEM F

SAMOS ELECTRONIC RECONNAISSANCE

OBJECTIVE

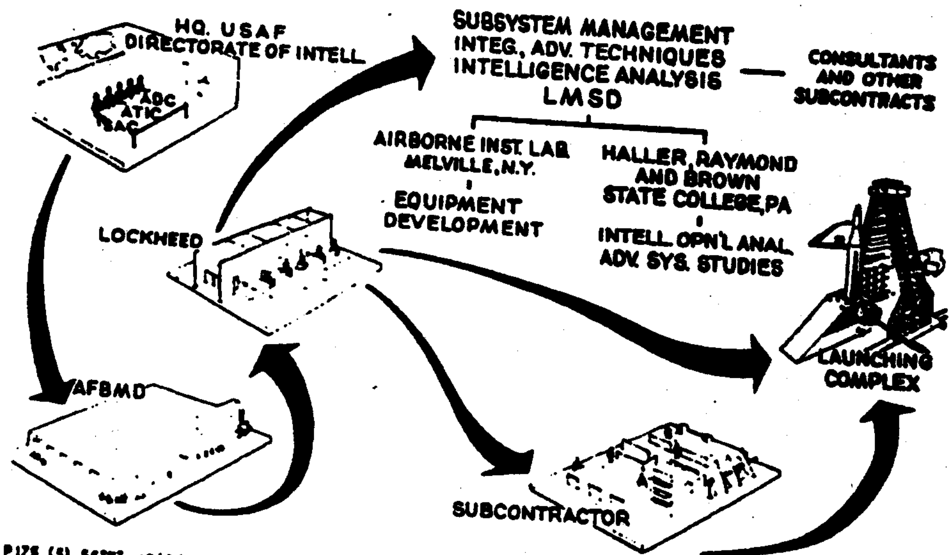
THE OBJECTIVE OF ELECTRONIC RECONNAISSANCE IS TO DETECT AND OBTAIN INFORMATION ON ELECTRONIC EMITTERS IN AREAS WHERE SUCH INFORMATION DOES NOT NOW EXIST.

ADVANTAGES OF SATELLITE FERRET SYSTEM OVER CONVENTIONAL FERRET TECHNIQUES:

1. COMPLETE WORLD COVERAGE
2. CONTINUOUS UNATTENDED SURVEILLANCE
3. ALL WEATHER OPERATION
4. RELATIVE FREEDOM FROM CAMOUFLAGE
5. ABILITY TO IDENTIFY HIGH PRIORITY INSTALLATIONS BY ELECTRONIC SIGNATURES
6. RAPID RECOVERY AND DISSEMINATION OF ELINT INFORMATION

P170 (2)SS "T"   9/5/59
WD-59-00082   LMSD/425127

SAMOS FERRET SS PROJECT STRUCTURE



P175 (S) SS"F" 10/3/58
WD-58-06744 LMSD/104362

LMSD manages the Samos Subsystem F program and engages in systems engineering and integration efforts, as well as studies involving advanced techniques and intelligence analysis. In addition to the companies indicated, Lockheed is negotiating with a number of organizations to assist in advanced techniques and analytical efforts.

SAMOS READOUT - FERRET SYSTEMS

EARLY DEVELOPMENT OBJECTIVES

- COLLECT INFORMATION ON KNOWN EMITTERS TO EVALUATE FERRET SYSTEMS:
  - ANTENNA PATTERNS
  - REAL TIME ADJUSTMENTS
  - READ-OUT
  - DIGITAL AND ANALOG RECORDING

VERIFY RADAR SIGNAL RECEPTION

PROVIDE TYPICAL RECONNAISSANCE INFORMATION FOR COMPLETE SYSTEMS TESTS

[illegible] 60 [illegible] 4/[illegible]/59
LMSD/[illegible]

Early Subsystem F activities are directed primarily towards the development and testing of techniques for accomplishing the objectives indicated above. In later phases of the program, emphasis will be placed on the collection of useful intelligence information.

SAMOS READOUT FERRET REORIENTATION

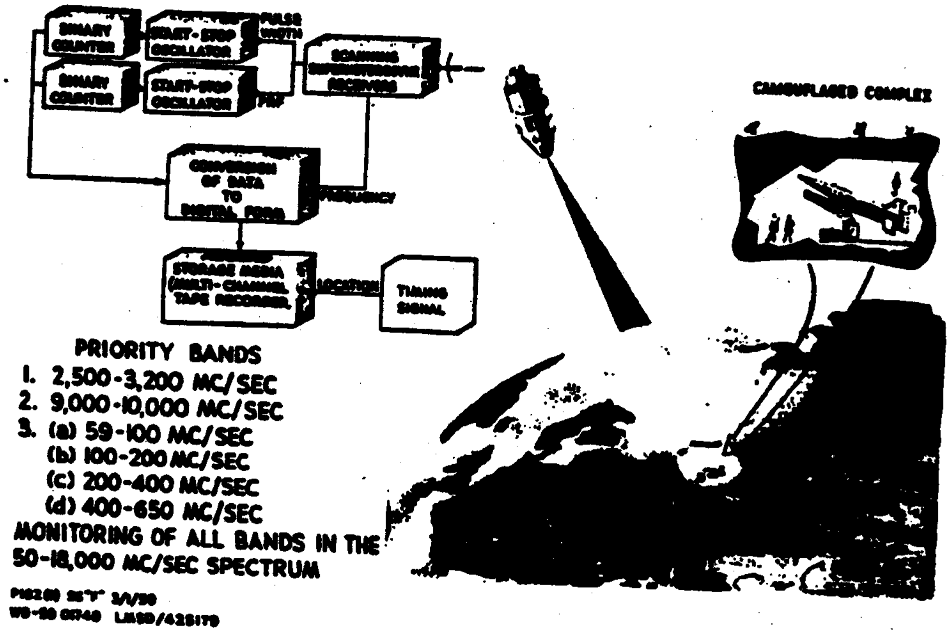
ELECTRONIC RECONNAISSANCE SYSTEM (MARCH 1959)

- INITIATION OF DUAL PAYLOAD E/F COMBINATION
- ACCELERATION OF F-2 DELIVERY SCHEDULE
- ACCELERATION OF F-3 FROM STUDY TO FLYABLE HARDWARE
- INCREASED FREQUENCY COVERAGE
- INITIATION OF LATER FERRET RECONNAISSANCE STUDIES(F-4)

6346(I) ... 5/6/59
LMSD/427871

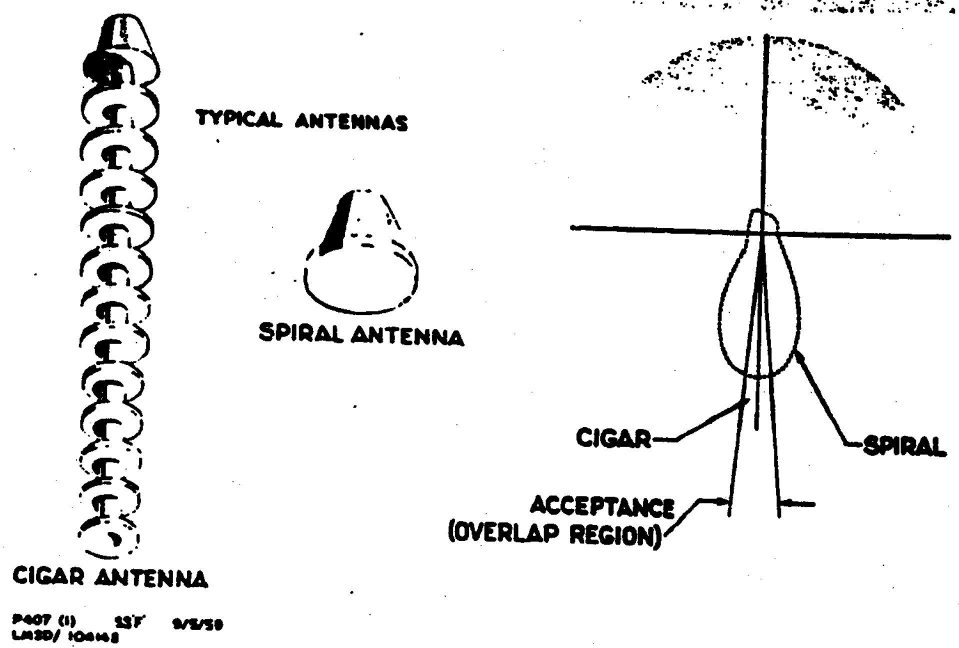
The major program reorientation as directed by AFBMD in March 1959 is indicated above. The dual payload (Subsystems E and F) combination on the first three Samos vehicles utilizes the vehicles to maximum capability and provides an early indication of the eventual utility of combining various sensors in a reconnaissance system.

SAMOS FERRET AIRBORNE RECEPTION



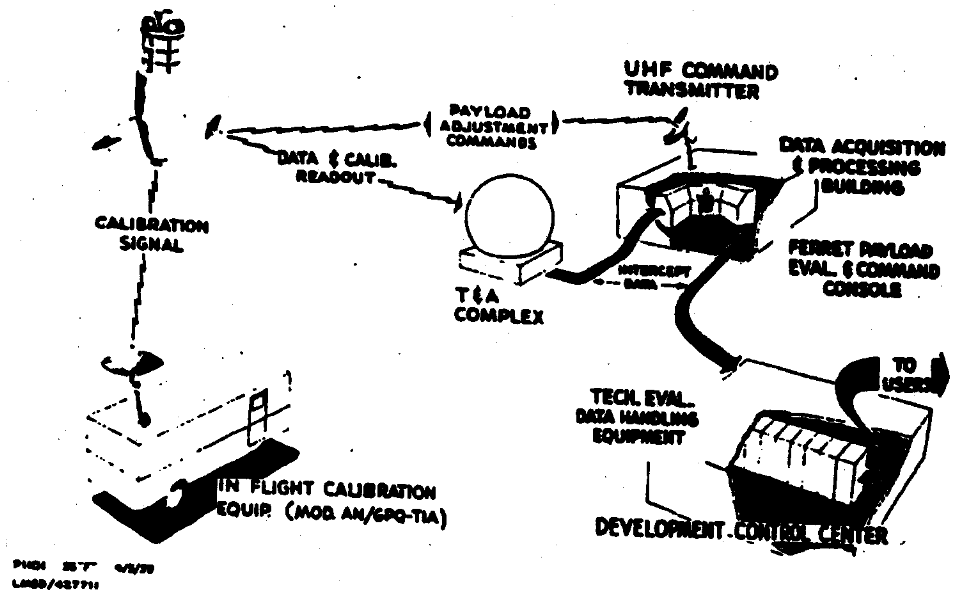
This diagram indicates the general technique employed in the initial Samos ferret systems. Scanning superheterodyne receivers utilizing fixed downward-pointing antennas are employed. The initial F-1 equipment converts data to digital form, stores it on a magnetic tape recorder and measures location, frequency, pulse width, and pulse repetition interval in the priority bands indicated.

SAMOS FERRET SWATH DEFINITION



The antennas shown are typical of the types under development for this program. This system employs fixed nadir-looking antennas, one of which is the signal antenna and one the inhibit antenna for side lobe cancellation. Steerable antennas and horizon-looking antennas for other special applications are currently under development for advanced versions of the system.

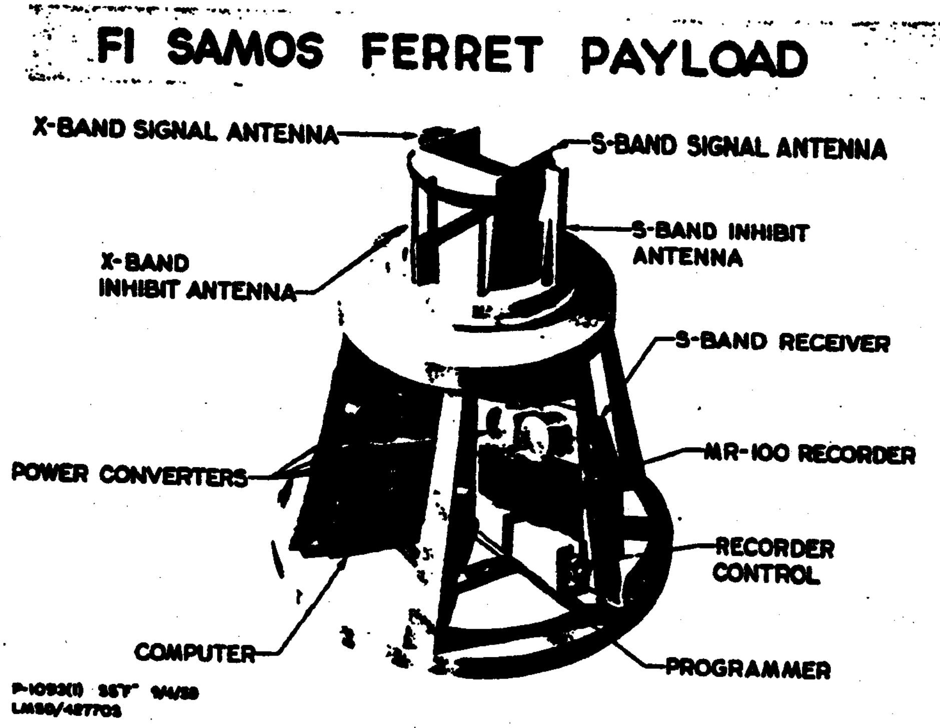
ELECTRONIC RECONNAISSANCE SYSTEM



This chart illustrates the various portions of the complete ferret system in somewhat simplified form.

Calibrations are made as indicated when the vehicle is over friendly territory, and data readout over a telemetry-type data link is achieved through the tracking and acquisition (T&A) complex. Commands for payload adjustments are also transmitted from the T&A stations.

The intercept data is processed by ground data handling equipment for technical evaluation purposes.



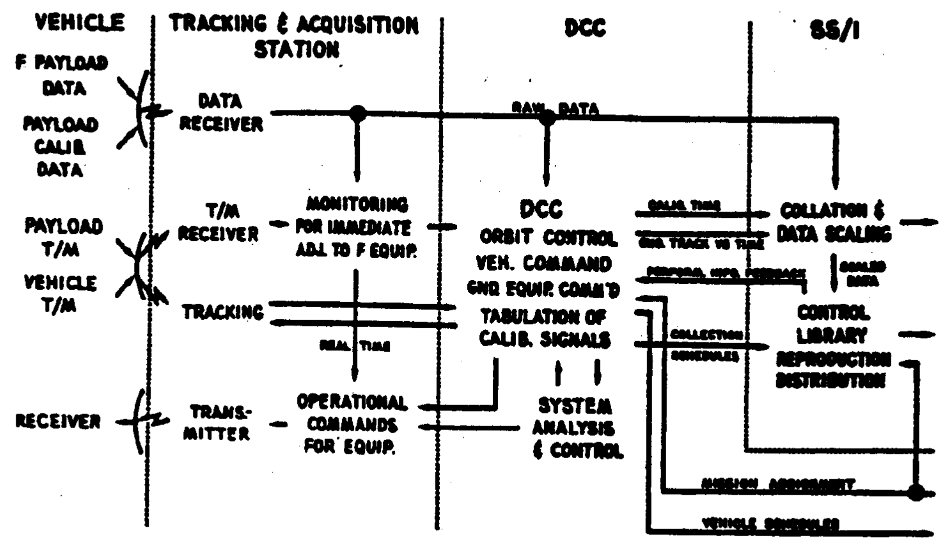
The mockup of the initial F-1 Samos ferret payload is shown with certain key components identified. The visual (Subsystem E) payload will be mounted directly behind the ferret package and both will be capable of operating simultaneously. A small aperture has been provided at the base of the large S-band signal antenna for the Subsystem E lens system.

[redacted]

The F-1 equipment, developed on a minimum-time basis, is considerably heavier and will consume more power than later systems.

This equipment was thoroughly flight tested in a test aircraft over the New York metropolitan area in the first quarter of 1959. Many thousands of intercepts were made, stored, read out, and interpreted in this test program.

SS/F GROUND DATA FLOW



P1081 DCA 4/1/59

This block diagram illustrates the functions and ground data flow throughout the electronic reconnaissance system.

[redacted]

[illegible]

The F-2A equipment will be flown on the third flight in the Samos readout series in 1960. This equipment is considerably lighter and more specifically adapted to the satellite mission.

Significant differences between this equipment and F-1 include the use of a newly developed fast start-stop tape recorder; a higher degree of miniaturization, making use of transistors; greater attention to reliability; greater flexibility in command programming of equipment operation and switching in and out of redundant circuits; and reduction in power consumption and weight.

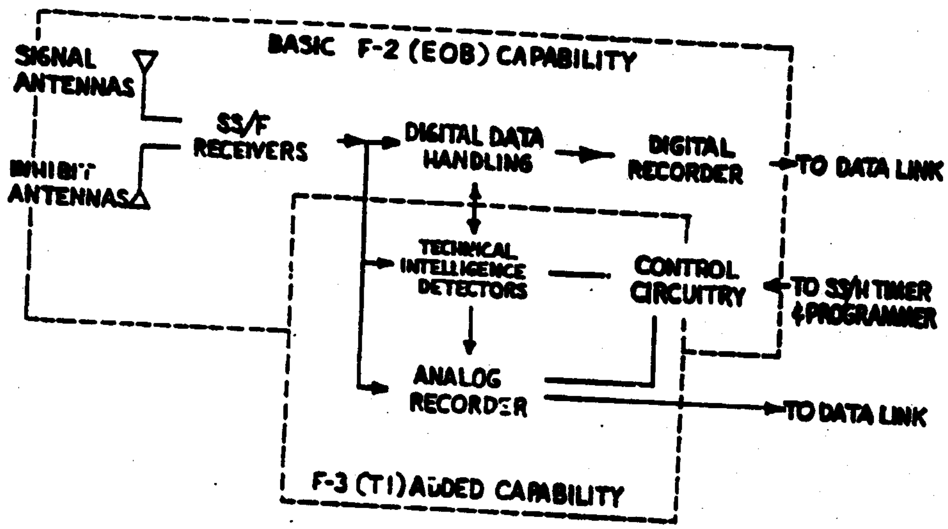
[redacted]

The F-2B equipment outlined above represents the first equipment which would be suitable for operational use.

[redacted]

The F-3 equipment, which is planned for a series of four flights in 1961, has capabilities which are not possible within time and budget limitations in F-1 or F-2. Some of these important additions are indicated above.

SAMOS READOUT - F-3 SYSTEM DIAGRAM



LMSD/427872

The F-3 version of the ferret subsystem retains the basic F-2 capability for providing Electronic Order of Battle (EOB) information in digital form with the added capability, as shown in the lower dotted block, for analog recording of items related to technical intelligence.

SAMOS READOUT F-3A CAPABILITY

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[illegible]

The main capabilities of the F-3A system, which will be flown on two Samos vehicles, are indicated above.

SAMOS READOUT-F-3B CAPABILITY

[redacted]

The capabilities listed above will be available on two of the Samos program flights.

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[redacted]

The development of a wide band analog recorder has recently been initiated. This capability will be available in time for the F-3B flights in 1961.

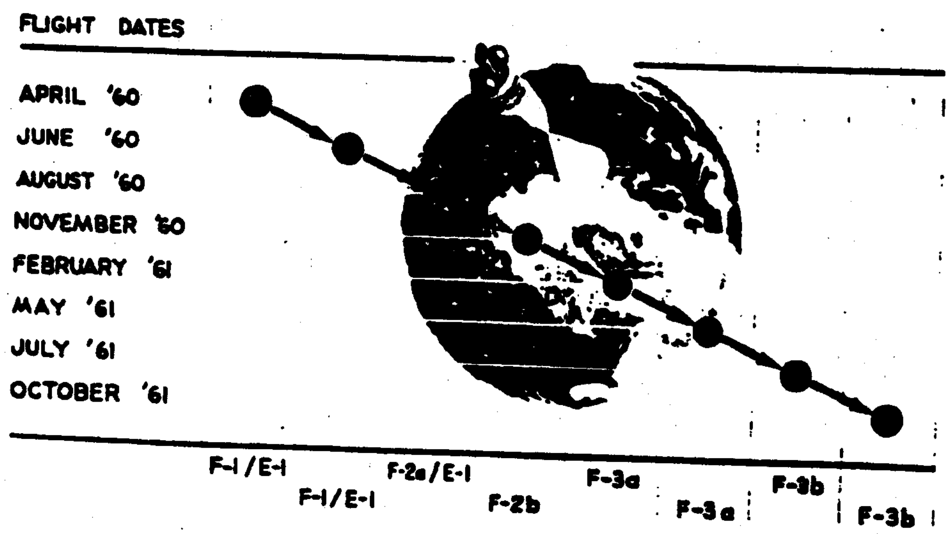
SAMOS READOUT F-4 CAPABILITY

- PROVIDE WARNING INFORMATION ON BALLISTIC MISSILE LAUNCHINGS
- AID IN ESTIMATING SOVIET ICBM AND IRBM CAPABILITY
- DETECTION OF AICBM RADARS AND ANALYSIS OF THEIR CAPABILITIES
- OBTAIN TECHNICAL INTELLIGENCE DATA
- PROVIDE AN INDICATION OF ACTIVITY IN THE ELECTRO-MAGNETIC SPECTRUM
- POSSESS A QUICK REACTION CAPABILITY TO MEET OTHER COLLECTION REQUIREMENTS

P-1286 "S" 9/8/59
LMSD/439436

This program is currently in the early study and investigation phases. Implementation of the above indicated capabilities requires a major advance in the ferret art.

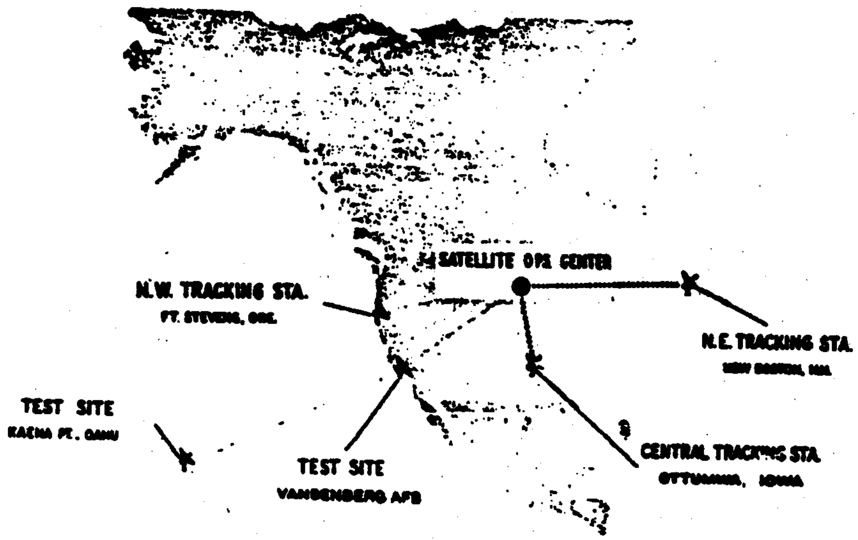
ELECTRONIC RECONNAISSANCE FLIGHTS



This schedule lists all flights currently on contract with AFBMD. The first three flights indicated are dual flights with the ferret and visual payloads operating on a time sharing basis.

COMMUNICATIONS
SUBSYSTEM H

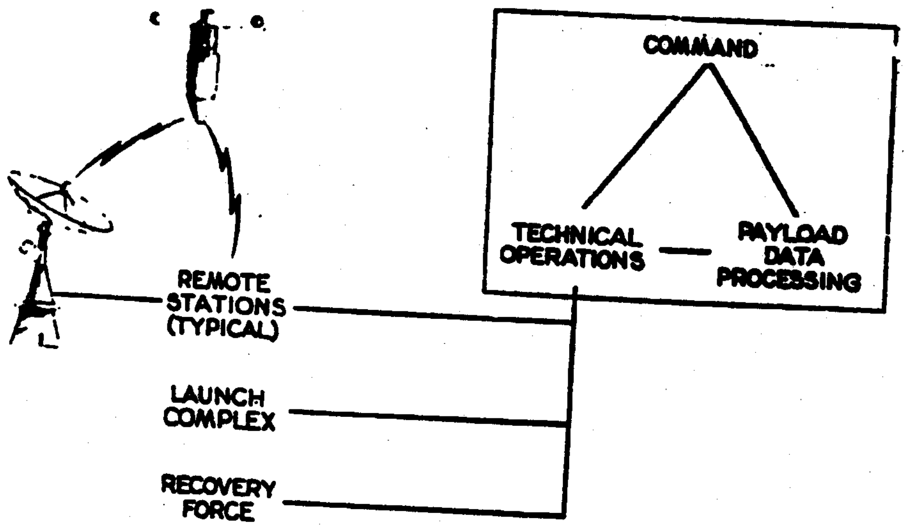
SAMOS PROGRAM STATION LOCATIONS



Plans for Samos station locations include three operational tracking stations located at New Boston, New Hampshire; Ottumwa, Iowa; and Ft. Stevens, Oregon, plus a technical operations center whose location is not yet specified.

A development control center located at Sunnyvale, California, together with tracking stations at Vandenberg AFB and Hawaii, will assist in the operational program and will continue to support the R&D program.

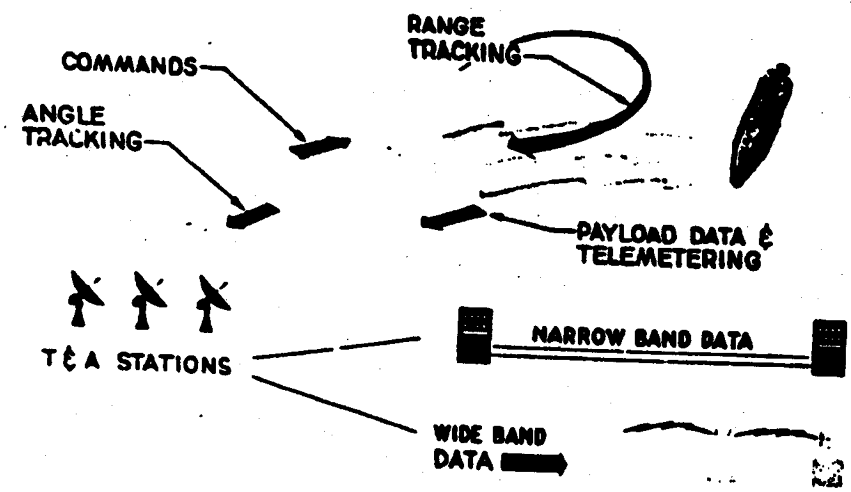
SAMOS OPERATIONAL SYSTEM



5048 SS "S" 9/2/59
LMSD/429134

The major elements making up the operational system are command, technical operations, payload data processing (all located in the satellite operations center), tracking stations, the launch complex, and a recovery force.

COMMUNICATION LINKS



Communications with the satellite are carried out over three radio links: a command link from ground-to-satellite; a narrowband data and telemetry link from satellite-to-ground; and a wideband data link from satellite-to-ground. Angle tracking is obtained by passively tracking the satellite telemetry signal; range information is obtained by transmitting range tones up the command link, returning them through the telemetry link, and measuring the total phase data.

Narrowband telephone and teletype lines are used to transfer tracking data, commands, and administrative traffic between the tracking stations and the operations center. Wideband (6-mc) communication lines are planned to transmit payload data from the tracking stations to the operations center.

SAMOS WIDE BAND SPACE-GROUND DATA LINK

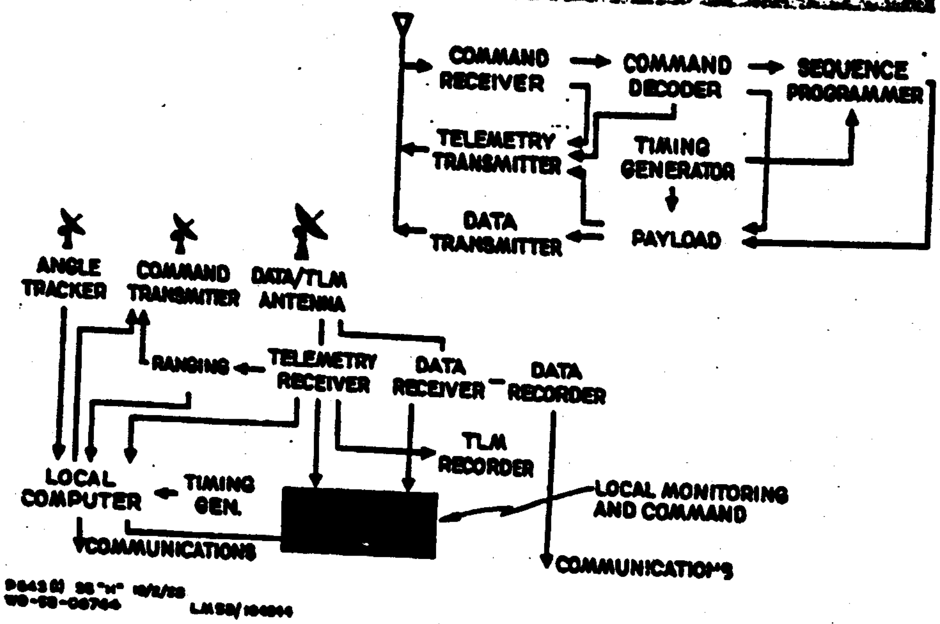
FACTORS INVOLVED IN INCREASING BANDWIDTH TO 12 MCS

- INCREASED BANDWIDTH ALLOCATION IN RF SPECTRUM
- INCREASED MODULATOR BANDWIDTH (6 TO 12 MC)
- INCREASED DEVIATION CAPABILITY IN TRANSMITTER
- BROADBAND ANTENNA DEVELOPMENT (GAIN IN DIRECTIVITY)
- LOW NOISE RECEIVER INPUT AMPLIFIERS (9db TO 3db)
- IF BANDWIDTH INCREASED BY 65% (30 TO 50 mc)

[illegible]

This chart lists areas where advanced capability is required to extend the current 6-mc wideband data link capability to a video bandwidth of 12 mcs. Only nominal development effort is required and technical implementation appears to be well within current state-of-the-art capability.

SAMOS COMMUNICATIONS SYS. DIAGRAM



This chart shows the major elements of the communications system. Commands generated either at the operations center or at the tracking station are sent by the command transmitter to the satellite command receiver in digital form, where they are decoded and either acted upon immediately or stored for future implementation.

The satellite clock programs the accomplishment of stored commands and provides time indexing of the payload and telemetry data for later conversion to geographical coordinates.

Narrowband ferret, MIDAS, and telemetry data are transmitted to the ground over a narrowband link. A wideband transmitter is used with the visual and advanced ferret payload.

A high degree of countermeasure immunity is obtained through the operation of the sequence programmer, since all electronic communications equipment is completely turned off except when the satellite is over a tracking station.

A computer is used at the tracking station to perform a number of control functions as well as real-time telemetry analysis for payload adjustments. The basic orbit computations, however, are performed by computers at the operations center.

GROUND STATION FUNCTIONS

1. TRACK VEHICLES
2. COMPUTE ORBITS
3. GENERATE COMMANDS
4. TRANSMIT COMMANDS
5. RECEIVE DATA
6. PROCESS DATA
7. COMMUNICATE TO CENTRAL USA

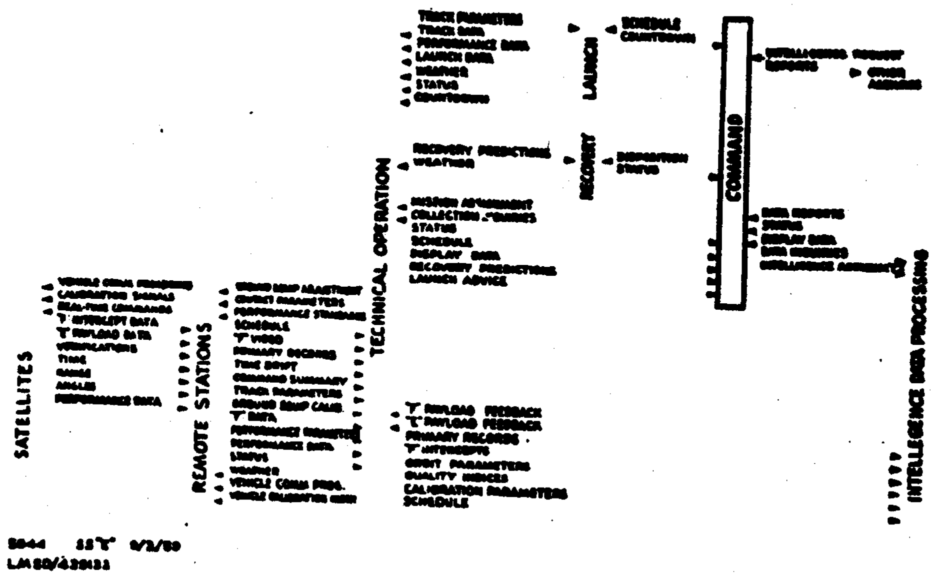
P 775 (U) [illegible]
WD-58-05183 LMSD 100885

The tracking and acquisition stations are the only link with orbiting satellites after launch and orbit inspection. All functions of satellite command programming, tracking, reception of intelligence data from orbiting vehicles, and transmission of data to using agencies must be performed by, or go through, these ground stations.

Due to the limited number of ground stations (three at present) and the brief time when satellites are within radio line-of-sight with these ground stations, information transfer rate must be very high.

SAMOS SYSTEM

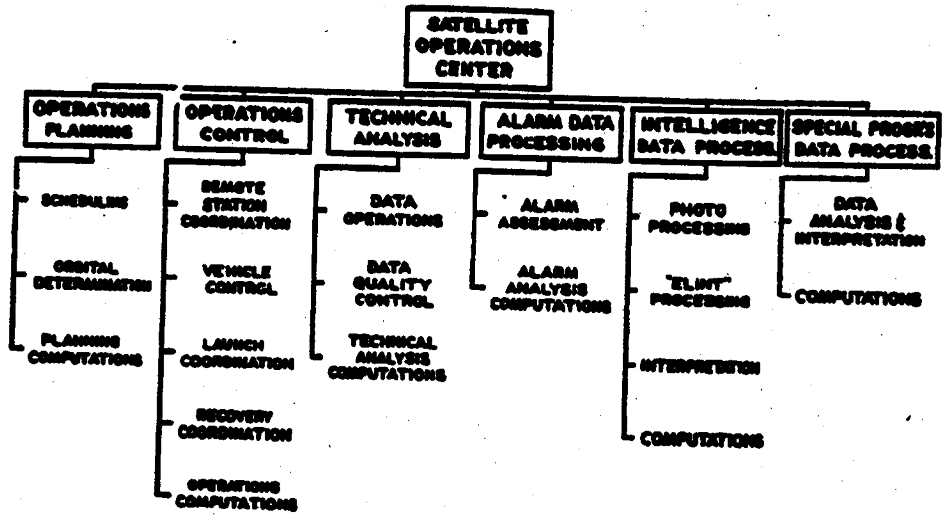
FUNCTIONAL RELATIONSHIPS



This chart identifies the significant information which must flow between the elements of the operational system.

SATELLITE OPERATIONS CENTER

FUNCTIONAL ORGANIZATION



The satellite control concept proposed by LMSD for the operational system is presented on this chart.

Requests for intelligence information are received from the using agency by the command element in the satellite operational center and transmitted to the operations planning area. Operations planning is responsible for the detailed assignment of satellite missions. Ephemerides for all active satellites are computed and stored in this area.

The operations control area is responsible for the execution of mission assignments and maintaining detailed status of all active vehicles. Decisions concerning vehicles which fall outside the scope of computer programs are made in this area.

Technical analysis is concerned primarily with data quality. Quality assessments and recommendations for adjustments to the satellite equipment are made in this area.

Similarity of operations makes it logical to control the MIDAS satellites in the technical analysis center. The alarm data processing done here, however, will be carried out in a special way and will probably be transmitted to a different user.

The intelligence data processing area is responsible for photo and ELINT data processing and first order intelligence evaluations. Outputs are sent to the command group for transmission to the eventual user. Certain quality information is also exchanged between intelligence data processing and technical analysis.

The system is expandable to control other satellites, such as communications and weather satellites. Many of the control elements of the operational system are the same as those for Samos and MIDAS, with special provisions being required only for the payload information.

SAMOS GROWTH POTENTIAL

- CONTINUOUS SURVEILLANCE & MONITORING WITH COMPLETE SIMULTANEOUS AREA COVERAGE.
- COORDINATED FERRET SATELLITE NETWORK.
- INCREASED CAPABILITY FOR OBTAINING TECHNICAL INTELLIGENCE INFORMATION (INCLUDES INDUSTRIAL RADIO FREQ. NOISE).
- IMPROVED CAPABILITY IN OBTAINING EOB TYPE INFORMATION.
- LONG DWELL-TIME ON SELECTED SIGNALS.
- RECOGNITION OF SELECTED PARAMETERS OR COMBINATIONS OF PARAMETERS (SUCH AS NATIONAL INDICATORS).
- REDUCTION OF REDUNDANCY.
- CHANGING OF ORBITAL PARAMETERS WHILE ON ORBIT.

P-1292 SS"F" 9/8/59
LMSD/439186

Some of the more significant gains to be achieved in the Samos program may be realized through coordinated operation of all intelligence-gathering satellites and real-time readout of data via appropriate satellite communications relay links.

The ability to make post-injection corrections to satellite orbits will facilitate coordinated operation of the satellite network.

On-board processing of intelligence data with automatic rejection of undesired or redundant information will greatly diminish problems attendant to space-ground data link bandwidth and ground processing of the vast quantities of collected intelligence data.