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SPACE SYSTEM DEVELOPMENT PLAN

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SAMOS R&D PROGRAM

HEADQUARTERS
AIR FORCE [illegible] DIVISION
AIR RESEARCH AND DEVELOPMENT COMMAND

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RECORD OF CHANGES

SAMOS R&D PROGRAM

15 March ~~1958~~ 1960

Change No.	Description of Change	Date Entered	Entered By
1	Funding and Facility Sections	11 July 60	Sm

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Change Number 1 - 15 March 1960 - Samos R&D

SECTION II - FUNDING PROGRAM

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SECTION III - FACILITIES PROGRAM

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1. All pages replaced or deleted should be destroyed in accordance with AFR 205-1.

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HEADQUARTERS

AIR RESEARCH DEVELOPMENT COMMAND

(UNCLASSIFIED TITLE)

SAMOS

SPACE DEVELOPMENT PLAN

15 JANUARY 1960

B. A. Schriever
Lt. General, USAF
Commander

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AIR FORCE BALLISTIC MISSILE DIVISION

AIR RESEARCH AND DEVELOPMENT COMMAND

15 January 1960

FOREWORD

This volume presents the planning, funding levels, facility requirements and schedules for the continuation of the Advanced Reconnaissance System, SAMOS, under Air Force management and in compliance with the Hq USAF (AFDAT message 98212) guidance for technical emphasis and available program funding. This volume describes the system concept, program objectives, system characteristics, the various subsystems which comprise the whole, and the testing program being employed to develop the system.

Within the funding available to the program (FY 60, $160.0 millions [redacted] and the Hq USAF guidance, cited above; the development emphasis in this plan gives priority to visual reconnaissance over ferret and to the recovery method over the readout method. Every possible effort is being taken to provide the earliest possible flight demonstration of the system. The plan will permit the development of the basic reconnaissance payloads and R&D equipment without compromise. This plan does not include any concurrent operationally directed efforts during FY 60 and FY 61 leading to an early operational configuration of the system.

The plan described herein can be summarized as a minimum essential research and development program capable of satisfying the SAMOS research and development objectives. The plan is responsive to Hq USAF guidance in that the funding allocated to SAMOS is within the current FY 60 and FY 61 fund ceilings. The disadvantage to the plan is the delay occasioned to the future operational program by fund limitations.

It is recommended that the plan be approved as written and funded in accordance with the FY 1960 Financial Plan and FY 1961 Budget Estimate included in the plan.

R. C. Curtin for

O. J. RITLAND
Major General, USAF
Commander

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[redacted]

AIR FORCE BALLISTIC MISSILE DIVISION (ARDC)

SAMOS DEVELOPMENT PLAN

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BACKGROUND

The concept for using a satellite as a platform for reconnaissance equipment was a natural outgrowth of the requirement for obtaining intelligence information of a potential enemy whose area and security precludes the effective collection of this information by ordinary aerial reconnaissance or other usual means. The need for timely and continuous intelligence information, to assess a potential enemy's capabilities and probable intent, has become more critical as the advancement of technology has produced offensive weapons with intercontinental range and greater destructive powers. The impetus which motivated the military establishment to foster work on new methods for collection of intelligence information came from the realization that current, reliable, prehostilities intelligence information is required to insure proper direction of national planning in the development of effective counterforce weapons and counterforce strategy.

The results of the numerous studies conducted since 1946, at the direction of the Department of Defense, established that a Satellite Intelligence System was feasible and would satisfy to a great extent the requirements for intelligence information to aid the national planners in making decisions.

The concept of the Advanced Reconnaissance System is a result of studies conducted at the Rand Corporation. A study completed in 1947, together with similar investigations by other contractors, concluded that a satellite vehicle was feasible as a reconnaissance vehicle but not as a weapons carrier. In 1950, the Research and Development Board vested satellite custody in the Air Force, and Rand was directed to explore its possible military utility.

Recommendations for an expanded study of reconnaissance applications were made to the Air Staff in late 1950, and a formal report (Rand-217) followed in April 1951. Feasibility studies for critical subsystems initiated at that time were television (RCA), attitude control (North American Aviation), and nuclear auxiliary power units (Bendix Aviation, Frederick Flader, Allis-Chalmers and Virto Corporation).

Recommendations for the ARS development were made by Rand in November 1953, and these were followed by a final report (Rand-262) in February 1954. Subsequently, the Air Force issued System Requirement No. 5, dated 27 November 1954, later revised on 17 October 1955, and General Operational Requirement No. 80 (SA-2C), dated 16 March 1955. In the spring of 1955, design study proposals were solicited by the Air Force from selected contractors.

The number of sources solicited was limited by the Government's desire to maintain a secure program throughout the design and development phase. The WS 117L is a reconnaissance system involving the launching of a vehicle into orbit for the ultimate purpose of collection and dissemination of intelligence information. Therefore, the problem of providing an airframe and engines did not need to be the sole guide to the type of contractors solicited. Those solicited were the Lockheed Aircraft Corp., the Radio Corporation of America, Glenn L. Martin Company, and Bell Telephone Laboratories. Bell Telephone Laboratories declined to submit a proposal.

The three contractors conducted their design studies between June 1955 and March 1956. These design studies culminated in three separate and distinct development plans. The Lockheed proposal was considered to meet the requirements most satisfactorily.

An ARDC System Development Directive No. 117L was issued on 17 August 1956. The development and test of WS 117L was awarded the Lockheed Aircraft Corp on Contract AF 04(647)-97 in October 1956. The Massachusetts Institute of Technology was awarded the contract for research and development of the WS 117L Guidance and Orbital Attitude Control Equipment on Contract AF 04 (647)-103 in November 1956. Executive management of the project is the responsibility of AFBMD.

By decision of the Secretary of Defense, 1 November 1957, the directive was issued to proceed with the WS 117L at the maximum rate consistent with good management.

The primary objective, established by the USAF's General Operational Requirement for WS 117L, was to "provide continuous (visual, electronic or other) coverage of the U.S.S.R. and satellite nations for surveillance purposes". In its capacity as Prime Weapon System Contractor, operating under the direction of AFBMD, Lockheed initiated a broad program of research and development to meet this objective; the program included both visual and electronic reconnaissance systems.

In January 1958, in order to accelerate the program, it was decided to augment the WS 117L program by making an interim use of the Thor booster for nine (9) flights. This would permit an early achievement of orbital capability. Subsequently, approval was granted for the use of five (5) additional Thor-boosted satellites to conduct biomedical experiments.

On 30 June 1958, the Advanced Research Projects Agency (ARPA) Order No. 9-58 was issued confirming previous Department of Defense directives for the assumption of responsibility by ARPA for the Advanced Reconnaissance Satellite Development Program. This directive established the Director, ARPA, as the source of policy and technical guidance for future WS 117L development.

General Operational Requirement No. 80 was revised on 26 September 1958, placing additional requirements upon the Weapon System. Two (2) significant additions included in the revised GOR 80 were the requirements for a recoverable satellite for intelligence use and a mapping and charting addendum to the GOR.

ARPA Order No. 48-59, dated 16 September 1958, confirming previous instructions directed that the Thor-boosted portion of the WS 117L development be separated from that program and continue as an independent project identified as DISCOVERER.

On 5 November 1958 the ARPA published Order No. 38-59 which separated the Infrared Reconnaissance Development (Subsystem "G") from the basic SAMOS Program and established the Infrared Development as the Missile Defense Alarm System (MIDAS).

On 1 December 1958 the ARPA proposed, in a memorandum report, a reorientation of the WS 117L program. This proposal was directed to the Under Secretary of the Air Force in a memorandum on 5 December 1958. The reorientation was generated as the result of the ARPA being provided with the consolidated SAMOS intelligence requirements by the Air Force (ACS/I).

As the result of the reorientation directives of early December, AFBMD presented a briefing to the ARPA on 15 December which included an analysis of the ARPA proposed program and an AFBMD counter proposal. The results of the briefing and subsequent negotiations culminated in an ARPA memorandum to The Under Secretary of the Air Force, dated 17 December 1958. The 30 January 1959 Development Plan reflected the instructions of the 17 December 1958 memorandum with regard to program structure and technical objectives. Further, the 30 January plan provided for the development of a SAMOS Reconnaissance System which possessed the capability to satisfy the SAMOS intelligence requirements.

By Amendment No. 11 to ARPA Order No. 9-58, dated 14 April 1959, the ARPA announced qualified approval of the 30 January 1959 SAMOS Development and Funding Plan.

On 27 April 1959 the ARPA was briefed at AFBMD on the analysis and planning for new work for the SAMOS recriented program. In the late May 1959 AFBMD was notified by Headquarters ARDC (TWX RDZGW 26-5-43-E, dated 26 May 1959) that the ARPA approval of the 30 January SAMOS Development Plan did not include approval of the SAMOS recoverable mapping payload. In compliance with this directive instructions were issued to the contractor to terminate all work relate to the development of a SAMOS mapping capability.

In late June, instructions were received from the ARPA (TWX 961412, dated 24 June 1959) to defer work on the SAMOS recovery program pending an ARPA program review. The reason for the deferral by the ARPA was fund limitations due to the demands of other programs. This deferral action

by the ARPA will possibly delay the SAMOS system capability needed to satisfy the vital intelligence requirements of the Air Force.

On 4 September 1959, ARPA directed that AFBMD proceed with contract negotiations that deferred the recovery costs but protected certain long lead time items, such as the E-5 camera, under a fund ceiling of $143.7 million.

On 9 September 1959, ARPA directed that AFBMD negotiate a program containing the High Resolution Recovery package and instructed that AFBMD was to reduce the readout programs as necessary to accomplish this goal. A new funding authorization of $148 million dollars for FY 60 and a planning level of [redacted] dollars for FY 61 accompained this directive.

In a memorandum to the Chairman, Joint Chief of Staff, subject: Coordination of Satellite and Space Vehicle Operations; dated 18 September 1959; the Secretary of Defense approved specific assignments to the Air Force of the interim satellite early warning system, MIDAS, and Phase I of the satellite reconnaissance system, SAMOS. The date of transfer of these systems from the Advanced Research Projects Agency (ARPA) to the Air Force would be subject to the approval of the Secretary of Defense. The Secretary announced that prior to assuming responsibility for a specific program, the appropriate military department would submit to the Secretary for approval detailed plans for the system including our relationship with Unified and Specified Commands and other appropriate agencies.

On 23 October 1959, General LeMay in a letter to General Schriever concerning SAMOS and MIDAS, advised General Schriever that the ARPA funding level for SAMOS would be $159.5 million dollars in FY 60 and [redacted] dollars in FY 61 instead of the previously requested [redacted]

In compliance with the instructions of the Secretary of Defense on 18 September 1959, Hq USAF (AFDAT) issued instructions and guidance on 21 October 1959 which included the preparation of the necessary plans by appropriate commands for the transfer of SAMOS to the Air Force. The required plans and responsible commands were: Research and Development Plan, ARDC; Operational Plan, SAC; and Logistic Support Plan, AMC. The time scale for submission of these plans to Hq USAF was 23 November 1959, and reaffirmed the ARPA SAMOS funding ceiling for the R&D program as follows: FY 60, $159.5 million dollars; FY 61, [redacted] dollars plus some part of [redacted] dollars of Air Force funds to be divided between SAMOS and MIDAS.

A reclama on the effect of the above funding ceilings on the SAMOS development and operational programs was made by AFBMD on 17 November 1959. In this reclama AFBMD requested permission to present the development plans then in preparation which were the result of an extensive planning effort based on all planning guidance except that contained in the Hq USAF (AFDAT 1329/59) message of 13 November 1959. It was noted by AFBMD that the plans proposed for presentation would not be within the announced funding ceilings.

On 20 November 1959, Hq USAF (AFDAT message (91935) reaffirmed the 13 November 1959 instructions and stated that the Development plans to be presented on 16 December 1959 would be consistent with funding ceilings; however, AFBMD could present as an additional agenda item a recommended program that exceeded the funding ceiling.

Two Development plans were prepared by AFBMD. The first plan, dated 1 December 1959, described the AFBMD recommended program for the continuation of SAMOS. The second plan described the continuation of SAMOS under the Hq USAF funding ceiling (AFDAT 1328/59). These plans were presented to Hq USAF during 14-16 December 1959.

As the result of the 14-16 December 1959 presentations further guidance and funding information were received from Hq USAF (AFDAT message 98212). These instructions called for the submission of a new development plan with specific guidance for the preparation of the SAMOS plan which included: emphasizing photo over ferret; earliest flight demonstration of both readout and recovery with preferential emphasis on recovery; development of basic payloads and basic R&D equipment should not be compromised; and necessary compromises should be made by reducing the sophistication and scope of the planned operational phase of the program.

Additional instructions were received from Hq USAF (AFDAT message 61415) in early January 1960 which directed that the revised development plan include FY 62 and FY 63 fund estimates. These estimates should be ARDC recommendations based on maintaining the FY 60 and FY 61 funding ceilings established in AFDAT message 98212 and the requirement to become fully operational as soon as practicable.

The plan to follow has been prepared in response to the instructions received.

DESIGN CHARACTERISTICS

I. INTRODUCTION

A. SAMOS MISSION

1. The SAMOS Program will provide a satellite reconnaissance system which will fulfill the military requirements outlined in GOR No. 80, 26 September 1958, and amendments thereto, ARDC SR No. 5, 17 October 1955, USAF DD No. 85, 3 August 1956 and ARDC SDD No. 117L, 17 August 1956. The system will be capable of obtaining reconnaissance information which will be disseminated to operational military agencies and integrated into the USAF intelligence data handling system. The SAMOS Program, employing orbiting satellites composed of AGENA vehicles and reconnaissance payloads, will provide surveillance of the entire Soviet Complex, permitting the evaluation of Sino-Soviet Bloc intentions to attack. Timeliness of receipt of the intelligence information with daily reconnaissance coverage of high resolution is the ideal. In consideration of the requirement for earliest availability of the SAMOS system, the engineering progression and Air Force acceptance will be from the lesser to the greater resolution. The research and development effort will be directed toward providing equipment which permits the following:

a. Coverage of world-wide areas of interest

b. Detecting new and hitherto unknown targets

c. Determining electronic signal characteristics

d. Locating and verifying targets and defenses

e. Collecting data on technological progress

f. Evaluating military and industrial strength

g. Monitoring electronic emissions

h. Observing enemy build-up indications

i. Evaluating attack capability

j. Assessing damage from high-yield weapons

k. Reconnoitering military movements

l. Locating naval forces throughout the world

B. SYSTEM CONCEPT

1. The SAMOS concept utilizes satellite vehicles, modified ICBM boosters, launch facilities, tracking facilities, and a complex communication and data processing network with related facilities. The booster provides the primary propulsive power to the SAMOS satellite vehicle. Separation occurs on attainment of the proper altitude and attitude. As the booster falls away, the satellite vehicle continues in a self-stabilized, predetermined coast to a programmed altitude. Orbital altitudes will be selected according to mission requirement. At the termination of the coast phase, the satellite orbital boost engine activates, supplying the orbital velocity increment required to establish a substantially circular orbit. The internal controls then orient the vehicle to the proper attitude. The most common orbits will pass within a few degrees of the poles. The vehicle will complete a revolution of the earth at approximately 94-minute intervals. Because the orbit is essentially fixed in space, while the earth rotates inside it, successive passes over the earth's surface will be displaced slightly more than $22\frac{1}{2}^{\circ}$ at the equator. This offsetting will permit a single vehicle to observe the entire earth in a total time period which depends, in part, on the width of the swath observed.

2. Two types of ground space link will be employed for SAMOS reconnaissance data retrieval: electronic readout and physical recovery. The satellite vehicle equipment used in the readout portion of the SAMOS Program will be programmed by a secure ground-space communication link to activate and deactivate visual or electronic sensing equipment over the target. Over a SAMOS ground receiving station, the vehicle shall, upon command, transmit the recorded data. These data will be received, processed, and transmitted to the using agencies. Useful operations will be terminated when air drag changes the orbit sufficiently to prevent operations, or when either the electrical power supply is exhausted or a failure of equipment takes place. Expected mean useful life for early versions of the readout satellite vehicle is about 10 to 30 days. Expected mean useful life for later versions of the readout satellite vehicle is more than a year for ferret reconnaissance equipment and 4 to 12 months for visual reconnaissance equipment.

3. The satellite vehicle equipment used in the recovery portion of the SAMOS Program will be programmed to provide high resolution photo reconnaissance of specific areas of interest. For positioning the satellite vehicle as required to obtain maximum utilization, the orbital period may be adjusted by ground command during the high resolution flights. The payload will be aimed in order to obtain coverage of the desired targets. Upon recovery, the exposed film will be transported to the processing and using agencies. Useful operations will be terminated upon command or upon the exhaustion of the film or the electrical power supply. Expected mean useful life for the high resolution payload is approximately 15 to 30 days.

4. The re-entry and recovery sequence of operations may be initiated by the vehicle timer or by ground command. The recovery capsule will be slowed to re-entry velocity by orienting the vehicle and restarting the AGENA engine. The vehicle will provide all control and stabilization functions down to 400,000 feet. Pre-recovery capsule will then be separated from the satellite vehicle and propelled in an appropriate re-entry trajectory for air recovery in the ocean area adjacent to Hawaii. While only over-water recovery is currently planned, the satellite vehicle, recovery capsule, and airborne recovery components and equipment will be designed to allow for over-land recovery within the United States Zone of Interior if required. At the proper altitude a parachute system will be deployed. Simultaneously, the recovery capsule radio beacon and light beacon begin operating. Aircraft specially equipped with direction finder systems and air recovery gear will detect, locate, and accomplish air recovery of the capsule. If over-water air recovery fails, surface vessels, similarly equipped with direction finder systems, will recover the capsule from the sea with the assistance of helicopters.

5. The data processing portion of SAMOS will develop the capability to process the data collected by the SAMOS vehicle sensors, correlate the data with time and the orbital information, and extract and report time-significant information, convert the collected data to formats which can be readily utilized by all intelligence agencies, and analyze the collected data to provide feed-back information for proper control and operation of SAMOS vehicles and associated payloads.

C. SYSTEM CONSIDERATIONS

1. The satellite network configuration is determined by the inter-relating factors of SAMOS reconnaissance coverage criteria and vehicle performance characteristics. The coverage criteria establish the minimum fraction of the U.S.S.R. which must be kept under surveillance to satisfy information requirements. The over-all system characteristics are then determined by correlation of these criteria with the obtainable vehicle performance capabilities. These include on-orbit payload versus altitude restrictions, sensor performance, power and data transmission limitations, and the ability to establish and maintain the selected work configuration.

2. The data processing portion of SAMOS will provide the Air Force with the capability to process the data collected by the SAMOS vehicle sensors, correlate the data with time and the orbital information, and extract and report time-significant information, convert the collected data to formats which can be readily utilized by all intelligence agencies, and analyze the collected data to provide feed-back information for proper control and operation of SAMOS vehicles and associated payloads.

3. It is becoming evident that this system, in its operational concept, is not a system which must necessarily follow the "stereo-typed" concepts of other systems as the system becomes operational. This is particularly true in the logistics and procurement areas. As an example, there may be no period of operational training with the vehicle. Presumably, vehicles will not be held for long periods of readiness as in the case of the Ballistic Missiles. Neither may there be extensive training flights requiring extensive logistic support as in the case of manned systems. Due consideration must be given to selecting a logistic concept which will allow this program to be handled economically and which will provide the flexibility which is desirable.

D. PROGRAM OBJECTIVES

1. Readout

a. Visual Reconnaissance (Subsystem E)

The reconnaissance equipment for the visual reconnaissance readout portion of the SAMOS Program consists of the satellite-borne equipment required to collect information in the visible spectrum, to process and store this information, and on a command signal from the ground to convert stored images to appropriate signals for transmission to the ground. In addition to the satellite-borne equipment, related ground-based equipment will be required to take the output of the satellite-borne data link and reconstitute the signal into photographic form for system control, further processing and intelligence use. The ability to view the system output provides a means of adjusting vehicle capability. The long life of the readout vehicles permits economy of operation by reducing the total number of vehicles and launch pads required to attain a particular capability. Initial visual equipment is to be capable of resolving targets 20 feet in size, and a limited study will continue toward the goal of achieving resolutions of 5 feet or less. Target location will have an error no greater than 1 mile with respect to the North American Datum. The readout system provides rapid return of reconnaissance data on a repetitive basis. The system will collect perishable intelligence information of selected targets as determined by the programming of vehicle operation. The steerable payload permit coverage up to 150 miles each side of the orbit path. Consideration will be given to the use of advanced sensors such as electrostatic tape. The incorporation of a reuseable storage medium will allow for larger active life on orbit. Within the resources available, effort will be applied to the photographic approach in order to improve the early capability prior to the time that the electrostatic tape systems could be available. The visual reconnaissance readout payloads have been defined as follows:

(1) E-1 Component Test Payload

(2) E-2 Steerable Payload providing 20 foot ground resolution

(3) E-3 Steerable Payload providing 5 foot ground resolution. (NOTE: This work will be limited to study effort. Flights are not scheduled for this payload.)

b. Ferret Reconnaissance (Subsystem F)

(1) The ferret reconnaissance portion of the SAMOS Program consists of the satellite-borne equipment required to collect information from radiation in certain selected regions of the electromagnetic spectrum, to store this information, to filter or index it as may be necessary, and at the proper time to convert the stored information into an appropriate electrical signal for transmission to the ground. Ground-based equipment will be required for inflight calibration and vehicle equipment adjustment; engineering evaluation of vehicle equipment performance, and transmission of reconnaissance, calibration, attitude, and time information to the data processing activities.

(2) This subsystem includes the equipment to conduct a program of increasing sophistication to provide a system capable of conducting effective satellite reconnaissance of the entire Soviet Bloc. This system will initially produce a general coverage vehicle (F-2) and a specific mission vehicle (F-3) capable of total coverage of the frequency spectrum from 59-18,000 mc/s. This will provide general coverage of the Soviet Bloc every five days and a capability to take close looks at all signals of interest. Indications of unusual signals and activity will be incorporated in the F-2 vehicles so that the F-3 system can then be programmed to produce data for complete analysis of these signals. [redacted]

2. Recovery (Subsystem E)

a. The recovery portion of the SAMOS Program will provide a payload (E-5) which will be designed to obtain high resolution photographic reconnaissance and is to be capable of achieving 5 foot ground resolution with a location accuracy of one nautical mile. The system will have an active orbit life of 15-30 days and will permit coverage of selected targets. The data will be returned to earth in a recovery capsule ejected from the satellite vehicle. The recovered film will be delivered to the Data Processing Subsystem for processing.