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SMAMA HISTORICAL STUDY NO. 35

SMAMA SUPPORT OF WS-117L

1959

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SACRAMENTO AIR MATERIEL AREA
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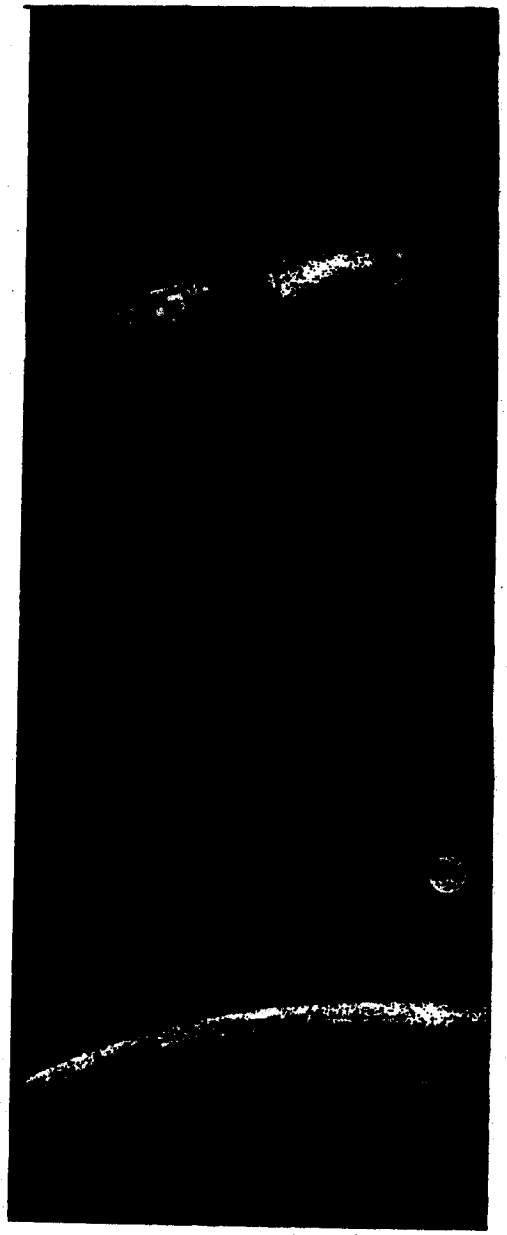

DISCOVERER SATELLITE: MIDAS: SENTRY

Designed and built by Lockheed Missiles and Space Division, the first of a series of DISCOVERER satellites was successfully placed in orbit in February. The Division has also been assigned the responsibility of systems manager for PROJECT MIDAS — an early warning system against ballistic missile attacks. The project will investigate the use of infrared sensors for detecting aggressor missiles at the moment of launch; and PROJECT SENTRY — an advanced satellite reconnaissance system. DISCOVERER, MIDAS and SENTRY are programs of the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division.

Portion of Lockheed Advertisement
Clipped from SPACE/AERONAUTICS
September 1959

~~SECRET~~

SMAMA Historical Study No. 35

SMAMA SUPPORT OF WS-117L

(Title Unclassified)

By

Fenton L. Williams

SMAMA Historian

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18 U. S. C., Sections 793 and 794. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

Approved by:

JUSTUS E. WYMAN
Information Services Officer

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No. 1. Aviation Week Clipping, October 14, 1957

2. New York Times Clipping, 20 August 1959

3. Highlights of 117L Logistics Plan

4. Brochure on GFE

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SMAMA SUPPORT OF WS-117L

CHAPTER I

PROGRAM DEVELOPMENT

The Superman and Buck Rogers-type developments of the 1950s were largely a result of the competition for supremacy between the world's great powers. On the one hand was the Communist dominated world led by the ruthless dictators in the Kremlin with world domination their announced goal. On the other, the free world led by the U. S., was determined to preserve freedom where it still existed and build hope for release of those already enslaved.

(S) Among the developments none stirred the imagination more than the program we here discuss—a program which ultimately would permit the free world to maintain an effective worldwide detection and monitoring system. The vehicles to be used were WS-117L satellites travelling over polar orbits.

While SMAMA played only a small role in the development phase, we tell the story briefly as background against the day when SMAMA's role would increase in importance.

BACKGROUND

The WS-117L program was the culmination of intensive studies dating from 1945. In 1947 scientists determined that satellite launching was feasible and the Department of Defense soon became convinced that the satellite would have military usefulness. The Department started official go-ahead action in March 1955 by issuing GOR (General Operating Requirements) No. 80 (SA-2C).

During 1955 and 1956 Air Force officials set up the systems requirements, evaluated the designs submitted, and approved the development plan. In August 1956 they issued the development directive. In October 1956 the Air Force let Letter Contract AF 04(647)-97 to Lockheed Aircraft Corporation, Missiles System Division—later changed to Missile and Space Division—making them the weapon system contractor. They definitized the contract in January 1958 and executed a new letter contract to add to and speed up the program. This letter contract—No. 181—became a supplement to Contract -97.

The WS-117L program, previously referred to as Pied Piper, Big Brother and ARS (Advanced Reconnaissance System) bore the official nickname "New Horizon."[1] It was the only reconnaissance satellite program under development by the Air Force. Its development embraced three related but distinctly separate programs: Discoverer, Sentry, and MIDAS. Each of these will be discussed later.

Objectives[2]

~~(S)~~ The overall objectives of these combined programs were to establish a system of continuous survey of otherwise unmonitorable territory; to provide intelligence information warning of impending or actual enemy action, missile launching, etc., and to determine enemy potentials—forces, stockpiles, and industrial and war making capabilities.

~~(S)~~ Objectives of those responsible for WS-117L development were (1) to find the best balance between early availability, effectiveness, and

1. Lockheed Syllabus, "Satellite Development Programs," Introduction, Jan '59. (Secret)
2. Ibid.

overall economy in manpower and funds, and (2) advance step by step with a series of reconnaissance systems capable of collecting high priority intelligence on enemy potentials and actions at the earliest date.[1]

Management Organization

To provide effective management and coordination of the Air Force Ballistic Missile program the ARDC (Air Research and Development Command) set up in 1953 a Western Development Division at Inglewood, a suburb of Los Angeles. The title later changed to Ballistic Missiles Division. Hq AMC saw the need to have an office near to handle its part in the programs and in 1955 it established a Ballistic Missiles Office (BMO) at Inglewood. This office grew in importance, under the impetus of an expanding missiles business in Southern California, and in 1957 Hq AMC made it responsible in the same degree as a Lead AMA for managing contracts and supervising maintenance. Maj Gen Ben I. Funk was the Ballistic Missiles Manager (BMM) in command. To provide logistics services Hq AMC set up a Ballistic Missiles Logistics Office (BLMO) at Mira Loma, California.

It was soon evident that the BMO had neither the manpower nor experience to accomplish the extensive Lead AMA duties required and Hq AMC arranged for SBAMA to take over the bulk of the load and designated the SBAMA commander, Maj Gen E. W. Anderson, Deputy BMO. SBAMA took over the operation, with the BMO retaining the policy-making function. The BMLO operation moved from Mira Loma to and was absorbed in SBAMA.

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1. Lockheed Syllabus, "Satellite Development Programs, Introduction, Jan 59.

SBAMA, as ISM (Logistics Support Manager) for Atlas, Titan, and Thor missiles, had hoped in addition to be given full AMC responsibility for the WS-117L,[1] but AMC decided otherwise. In May 1958 an AMC letter assigned the WS-117L to SMAMA for logistic support.[2]

Orbiting Projections Affected by Sputnik

~~(S)~~ As the WS-117L programs took shape in 1957 Air Force plans called for the first satellite to go into orbit in June 1959. Others would follow over a period of years.

~~(S)~~ But Sputnik (October 1957) apparently changed these projections.[3] It seemed to provide the incentive needed so that funds and manpower became available to the newly organized ARPA (Advanced Research Projects Agency) for a rush program. The first R&D (Research and Development) orbiting was tentatively pushed ahead to October 1958. Others were to follow with increasing frequency.

The Air Force was to have nothing to do with the manned version of the satellite since it was not a part of the defense program. NASA was directly responsible for such.

Program Acceleration - 1958

~~(S)~~ Prior to January 1948 plans called for the ICBM Atlas (SM-65) to be used in boosting all Discoverer/Sentry satellites to orbital heights. In January 1958, following the Soviet successes, the ARS program received top Defense Department (DX) priority. The Department of Defense

1. History of SBAMA, July-December 1958, pp 14-15.
2. Ltr, Lt Gen Wm. F. McKee, Vice Comdr, AMC, to Comdr SMAMA, subj: Assignment of the WS-117L, 20 May 58.
3. Aviation Week of Oct 14, 57 stated, "Soviet satellite launching will spur research and development efforts on advance US space vehicles, including Pied Piper." See Exhibit No. 1 for copy of article.

authorized the flight test date for Atlas-boosted satellites moved ahead approximately a year and assigned the name "Sentry" to the project. Nineteen IRBM Thor (SM-75) power plants were allocated to the program to develop orbital capability and test the ability to recover payloads from orbit. This portion of the program was assigned the name "Discoverer." The survey portion of the Sentry program, to determine application of satellites to missiles warning and defense, was assigned the name MIDAS (Missile Defense Alarm System).

~~(S)~~ The Sentry system divided for development into the following major subsystems:

Four under the satellite vehicle—airframe, propulsion, auxiliary power, and guidance and control.

Two under the reconnaissance element—visual and ferret.

One each for tracking, acquisition and readout, technical operations control center, and intelligence processing center.

Lockheed, as prime weapon system contractor, was responsible for all but (1) the intelligence data processing which was under Thompson-Ramo-Woolridge and supervised by Rome Air Development Center (RADC), and (2) command communications under Kellogg Switchboard and Supply Division of International Telephone and Telegraph, also supervised by RADC. Under the three-way program, Discoverer would continue as an "open end" research program general in nature, while Sentry and MIDAS on reaching some degree of productive capability would come under Air Force control.

Agency Responsibility

Overall responsibility for developing the Air Force Reconnaissance satellite program went originally to the Western Development Division—since changed to Ballistics Missile Division (BMD)—of ARDC.[1] Following the creation, in February 1958, of the Advanced Research Projects Agency (ARPA) under the OSD, direction of the satellite development and its funding went to that agency.[2]

SMAMA next entered the picture as the systems began taking shape, in providing logistic support on behalf of AMC. On 20 May 1958 AMC made the ISM assignment to SMAMA.[3]

Contractors

While Lockheed Aircraft Corporation was the principal contractor for the WS-117L project many others came prominently into the picture as subcontractors.[4]

To provide the second stage propulsion, ARPA chose the Bell Aircraft Corporation's Hustler rocket engine. The Navy's Lockheed-built Polaris had been considered[5] but apparently the solid propellant booster was too heavy for the second stage use. The lighter Hustler would do the job and be less burdensome to the 1st stage booster.

~~(S)~~ Four subcontractors had to do with developing and providing elements of the visual reconnaissance package for the satellite. They were: Eastman Kodak, Columbia Broadcasting System, General Electric, and Fairchild Camera and Instrument Corporation.

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1. Lockheed Syllabus, "Satellite Development Programs" Sec I, Jan 59.
2. Ibid.
3. Ltr, Lt Gen McKee, Vice Comdr, AMC, to Comdr, SMAMA, subj: Assignment of the WS-117L, 20 May 58.
4. Lockheed Syllabus.
5. Aviation Week, 24 Nov 58, "Sentry Satellite Shot Planned for Dec 15."

(S) Airborne Instruments Lab, Inc. contracted to provide the electronic or ferret reconnaissance package, while Aerojet General Corporation did the same with the infra-red recon package.

Finally, among the principal subcontractors, Philco Corporation contracted to provide the acquisition and readout subsystems needed to get info from and commands to the satellite in orbit.

LMSD

Lockheed Aircraft Corporation centered its missile and satellite production in its new plant at Sunnyvale, California. This was adjacent to Moffett Field near San Jose at the southern tip of San Francisco Bay, and only a short distance from Palo Alto where there was another Lockheed facility. SMAMA became responsible for administering AMC contract interests at this Lockheed plant and on 23 June 1958 AMC established a Plant Representative Office there; under SMAMA jurisdiction, to provide the needed administrative services.[1]

Involved as it was with a considerable amount of this country's highly classified defense and space exploration projects the security aspects of the plant required close watchcare. A historical report of 27 March 1959 told of an "unsatisfactory" security rating having been issued on 20 August 1958.[2] The AFPRO worked with LMSD to correct the deficiencies by establishing effective basic policy and an adequate security organization.

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1. AMC GO 50, eff 23 June 1958.
2. Historical Rpt of Ch, Security Div, AFPRO, to Dpty AFPRO, 27 Mar 59, in SMAMA Hist Archives.

Developing the Satellite Program

~~(S)~~ As the programs developed, planners called for two basic types of satellites: one would relay to the ground the data gathered; the other (introduced into the program in January 1958) would release a payload intended for recovery.[1] They scheduled the booster portion of SM-65 Atlas to power the former while Thor IRBM booster was to be 1st stage power for the latter initially. Thor was used because it was available. (Atlas wasn't) when the payload recovery program got underway.

The satellite program divided itself logically into three major parts.[2] First, was the research, design, development, and manufacture of the vehicles and their payloads, the communication networks, and the ground support equipment. Next was the selection of launching and tracking sites; the design and construction of support facilities; and the determination of manpower requirements. Finally, there was the actual launching and tracking, and the gathering, processing, interpreting, and disseminating of data.

Then there was, from the SMAMA point of view, an additional portion of some magnitude—the logistic support of the program in all its parts.

THE SATELLITE

~~(S)~~ Characteristics of the WS-117L that set it apart as a most extraordinary and effective weapon were many:[3]

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1. Lockheed Syllabus.
2. Ibid.
3. Ibid.

1. Because its orbit was North-South, almost over the Poles, it was to be capable of complete target coverage. The earth rotating under it would make possible a view of the entire earth's surface every 12 hours by just one satellite.

2. It was to have the ability to locate very accurately any given target and then provide constant surveillance of the target areas.

3. It could provide instantaneous warning of ICBM attacks so that effective counter measures might be taken.

4. Its creators claimed it to be nearly invulnerable to attack or counter-measure. (Aviation Week of October 14, 1957 gave the opinion that "relatively simple countermeasures probably could be used to bring them down." [1] Currently, however, SMAMA's LSM had no knowledge of effective countermeasures development.[2])

5. No aircrews were necessary in filling the mission designed for the WS-117L.

6. No overseas bases were needed.

7. Its data gathering rate would be tremendous and this would make it very economical per unit of data.

8. It would provide a fast response—make quickly available the information it obtained.

9. Its growth potential was without limit.

10. Data gathering life—when perfected—might be a full year.

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1. See Exhibit No. 1.
2. Interview, Tal T. Barnes and Robert E. Thompson of the WS-117L Div, 13 Aug 59.

Satellite Components[1]

(S) The Discoverer, Sentry, and MIDAS systems, while different in their payload and mission, used much of the same equipment. The satellite vehicle itself consisted of the airframe, the propulsion system, an auxiliary power system and a guidance and control system. Its overall length was almost 19 feet and its diameter was 5 feet.

(S) The nose cap was designed so that it could be dropped off as the satellite went into orbit. This would expose the data-gathering devices that were housed in the nose cone so they might perform their mission. This nose cone, also removable from the rest of the satellite, provided approximately 30 cubic feet— about 35 per cent of its volume—for housing the payload equipment. A contemplated rearrangement in the nose cone, from a radial ⊛ to an egg crate ▦ plan, would increase considerably the capacity of its payload compartment.

(S) The mid-body section contained the JP-4 fuel tanks and oxidizer tank. The oxidizer used in the first and second launching was called IRFNA (inhibited red fuming nitric acid). Later launchings used the improved oxidizer UDH (unsymmetrical dimethyl hydrazene). Beams in the aft section, which surrounded the rocket engine, provided support for batteries, antenna, pressure vessels, control gas jets, geophysical research instruments, and the propulsion system. Eighteen batteries, each 8" x 12" x 11", fitted into their compartments.

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1. Lockheed Syllabus, Sec. II.

Total payload, in nose cone and aft section, occupied about 85 cubic feet.

An arrangement to separate the satellite from its booster was a set of small retrorockets whose explosion slowed down the booster.

(S) The satellite propulsion system consisted of (1) an XLR-81 rocket (the Bell-Hustler) engine, (2) fuel and oxidizer tanks, (3) pressurization and vent system, (4) helium spheres, and (5) ullage control rockets. The rocket engine produced a thrust of 15,000 pounds for two minutes burning time. Its firing following the brief period of free coasting, gave the necessary push to proper orbiting speed. A proposed procedure called "dual burn" would permit higher orbital altitudes or heavier payloads. The satellite's engine would burn twice—once right after booster separation and again briefly to give required velocity in orbit. The propellant tanks were kept under pressure, while in operation, by helium. The small ullage rockets, using solid fuel, were fired just before the engine ignition. The acceleration provided a gravity effect to position propellants aft in the tanks and assure that the liquids were at the pump inlets.

Auxiliary power supply systems—batteries—furnished needed electrical power to the precious data-gathering and releasing equipment, etc. Currently under development to secure long duration, reliable operation, and maximum simplicity with minimum weight, were (1) higher energy batteries, (2) solar photovoltaics (generating electromotive energy from sunlight), (3) nuclear radioisotopes, and (4) nuclear reactors. Numbers 1, 2 and 3 were expected to be available in 1960; 4 in 1963.

Booster Power

On the credit side of the WS-117L development program was the almost immediate availability of necessary booster power. It was only necessary to make minor adjustments in order to utilize the power plants already developed for the IRBMs and ICBMs. Had the reconnaissance-type satellites required a special type of booster to place them in orbit their cost would have been infinitely greater and their date of effective utilization might have been delayed dangerously.

The special power units that were needed to give the satellite its final push into orbit and position it properly for performing its info-gathering mission did require a lot of attention and technical know-how. Their size and costs were small when compared with the Thor, Atlas, Jupiter, and the miltiple rocket boosters of the future, each of which in turn were power plants or potential power plants for the WS-117L.

Communications[1]

~~(S)~~ There were several important functions of the communications system: First, it provided information to prove that the satellite had actually gone into orbit, and made it possible to compute its orbital path and speed. Second, it received and executed both programmed and unprogrammed commands. Third, it performed telemetering service, measuring and recording desired distances. Fourth, it transmitted its collected information data from the satellite to the ground. Finally, the

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1. Lockheed Syllabus, Sec III. Details on communications functions may be found under Discoverer, Sentry, and MIDAS discussions.

communications system included ground communications which transmitted tracking data, payload data, and administrative traffic.

Costs

The original investment in Pied Piper or WS-117L was $4 million. This later was increased to $12 million for the first year.[1] The WS-117L program was supported at $55 million in 1958.[2] USAF asked for $215 million for FY 59 but ARPA set $152 million as a "more proper figure for the present."[3] Letter contract No. 181—supplement to Contract -97—brought the dollar value of the 117L program to $202 million for FY 59,[4] while additional reprogramming increased the amount to $213.4 million as of 8 June 1959.[5]

For the Sentry only the FY 60 Financial Plan provided $179 million for ARPA's use. SMAMA's FY-60 budget for the 117L program was $605,000.

[redacted]

tions submitted by SBAMA and ROAMA in addition to SMAMA.

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1. Aviation Week, October 14, 1957, "USAF Pushes Pied Piper Space Vehicle." See Exhibit No. 1.
2. Ibid.
3. Aviation Week, 16 June 1958, p 28.
4. Historical data from AFPR, Lockheed Missiles & Space Div, Sunnyvale, California, 25 Mar 59. Cy in SMAMA Hist Archives.
5. Aviation Week, 8 June 1959, p 28.
6. Ballistic Missile and Space Systems Budget Estimate as of July 1959. Prepared by SMAMA's Budget Div assisted by DLSM.

CHAPTER II

WS-117L PROGRAMS

As has already been indicated, the currently conceived WS-117L program was divided into three separate and distinct parts. This chapter will give some details and descriptive info on each.

DISCOVERER

The Discoverer portion of the WS-117L program was concerned mostly with the recovery of payload.[1] It embraced a series of Thor-boosted satellites, the first of which—called "Discoverer I"—was fired into orbit on 28 February 1959;[2] a second—Discoverer II—on 13 April 1959; a third—Discoverer III carrying four gray mice—on 3 June 1959; a fourth—Discoverer IV—which failed to orbit, on 25 June 1959.[3] Discoverer V and VI were fired into orbit on August 13 and 19 respectively. Others, at the rate of one or more a month were scheduled for orbiting during the remainder of 1959.

Involved in the Discoverer program were a number of government agencies in addition to SMAMA with its limited logistical support. These were: the AF School of Aviation Medicine, the AF Bioastronautical Directorate, Wright Air Development Center, Holloman Air Development Center, Los Alamos Scientific Laboratories, Hickam AF Base, and the US Navy.

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1. Lockheed Syllabus, "Satellite Development Programs," Sec IV, Jan 59.
2. Actually, the first attempt was on 21 Jan 59. Malfunctions prevented its leaving the launching pad.
3. The degree of success of these firings will be discussed later.

Tracking stations for the Discoverer, fully equipped and manned, were at Vandenberg AF Base, at Point Mugu, and at the Palo Alto Development Center in California; at Annette and Kodiak in Alaska; at Kaena Point, Hawaii; and on a specially equipped ship at sea.

Two versions of the recoverable capsule—Mark I and Mark II—were specially prepared and equipped for early firing. Mark I would accommodate mice and weighed a total of 195 pounds. Mark II would carry a six pound rhesus monkey, and the capsule's total weight was to be 279 pounds.

Roy W. Johnson, director of ARPA, described the Discoverer program as being extremely broad.[1] He said there were no limitations as to the launching locations, types of boosters, or on the services or contractors who would do the work. He described it as an "open-end" research program which might continue over a period of many years if funding was provided.

Discoverer I

The first satellite to be launched from the new Pacific Coast site at Vandenberg AF Base was Discoverer I on 28 February 1959. While not successful in orbiting a stabilized vehicle, the launching demonstrated the feasibility of using a Thor and Bell Hustler rocket engine combination to put a relatively heavy satellite into orbit. A report of the launching described the acceleration and burning time of the Thor booster as being "right on the button."[2] The separation and coast period followed

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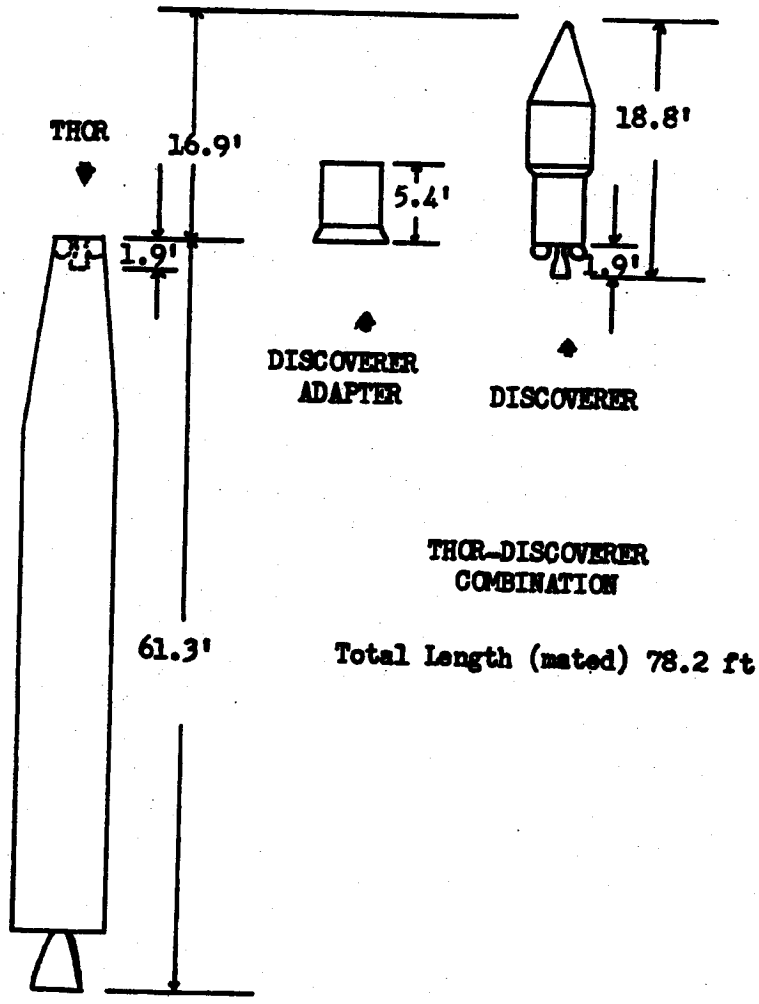
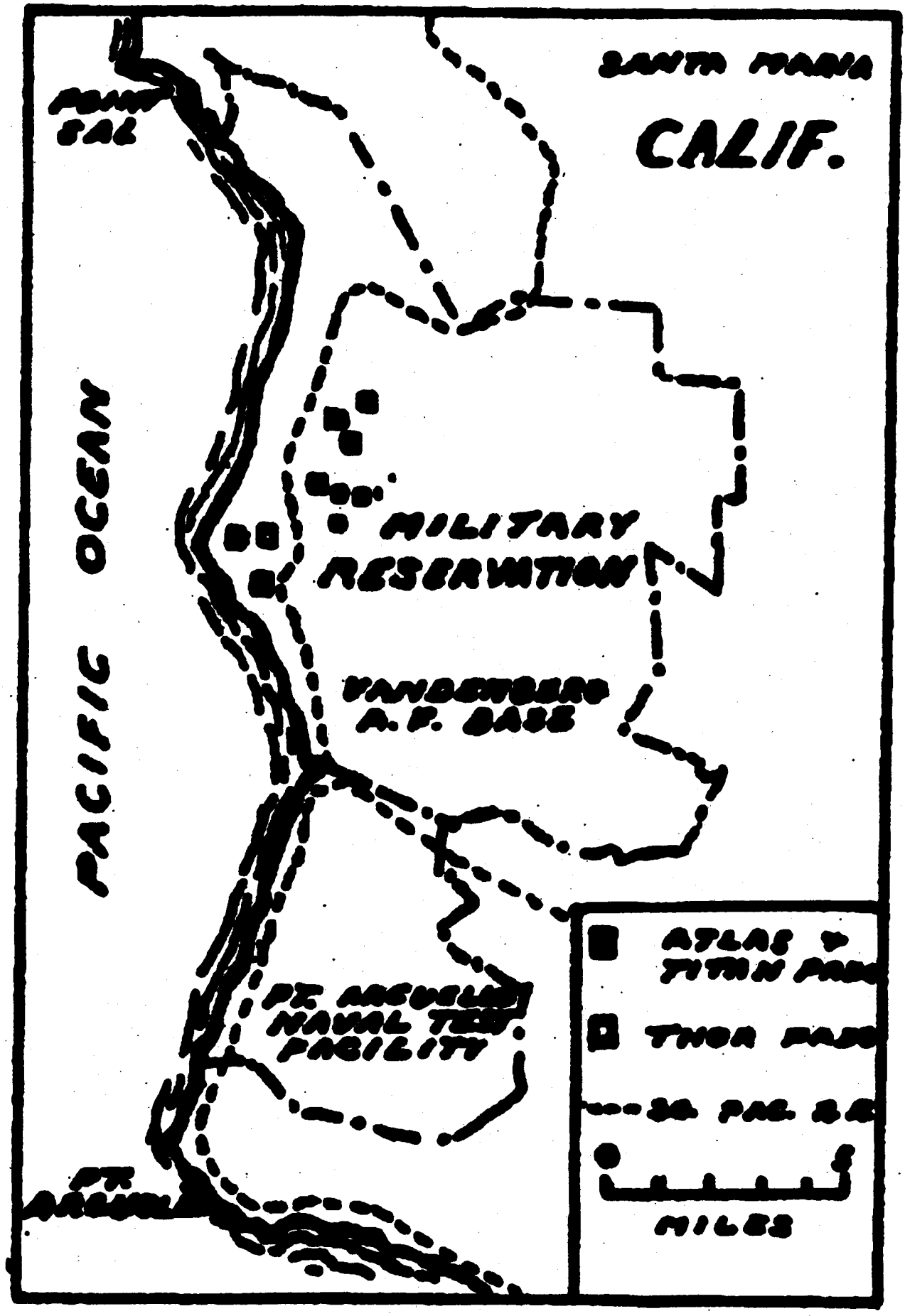
1. Aviation Week, 8 Dec 58, p 31.
2. Irving Stone in Aviation Week, 9 Mar 57, article titled: "Orbiting Discoverer Eludes Tracking."

DISCOVERER I LAUNCHING, VANDENBERG AF BASE, 28 February 1959



Over-all length of Discoverer I, including a modified Douglas Thor and Lockheed satellite vehicle, is 78.2 feet. Satellite was the first to be launched from Pacific Missile Range.

Copied from Aviation Week, March 16, 1959
Page 86


SANTA MARIA
CALIF.
PACIFIC OCEAN
MILITARY RESERVATION
VANDENBERG A.F. BASE
ATLAS D
TITAN
THOR
MILES

the prescribed pattern, the Bell Hustler rocket cut in as planned, and its burning time was just as it had been projected. The velocity measurements and ground radar tracking indicated that thrust of the Hustler and orientation of the second stage vehicle were perfect to establish the planned orbit.

Tracking stations lost telemetry contact with the satellite 8 minutes, 56 seconds after firing. It was then approximately 30 miles off its planned trajectory. About 22 hours later trackers picked up signals which approximated the predicted position and convinced them that the satellite was in orbit. The spotty nature of the signals led the authorities to believe that the radio transmitters weren't functioning properly or that the vehicle was tumbling when it should have stabilized.

Roy Johnson, Director of the Advanced Research Projects Agency (ARPA), considered that the test of the propulsion system was good but that the test of the stabilizing equipment and the tracking was inadequate.[1]

Discoverer II

On 13 April at Vandenberg AF Base, contractor personnel launched Discoverer II into a polar orbit. A primary objective of ARPA and the Air Force in this particular firing was the testing of the technique for recovery of the satellite's 195-pound re-entry vehicle containing

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1. Irving Stone in Aviation Week, Mar 9, 59, article titled: "Orbiting Discoverer Eludes Tracking."

a 160-pound instrument capsule. Another objective was the testing of the mechanism intended to stabilize and prevent the satellite from tumbling so the cameras would always be pointed toward the earth.

While not successful in its recovery objective, it was apparently successful in becoming stabilized in orbit. Mr. William H. Godel, director of planning for ARPA said the satellite would be a "very significant first" if it achieved only proper stabilization in its orbit.[1]

Hopes for achievement of the first objective which, according to Mr. Godel, had only a "very, very remote" possibility of success,[2] faded when timing was found to be faulty. The satellite went into orbit slightly lower than planned, causing it to circle the earth in 90.5 minutes instead of 94 minutes.[3] The timing device to separate the re-entry vehicle was set for the 94-minute orbital period. Repeated attempts to re-set it by radio command failed. As a result, the capsule separated from the satellite when it was in the north polar regions instead of in the vicinity of Hawaii as planned. Because both the recovery package and the rocket casing that remained in orbit emitted radio signals it was possible for tracking stations to determine that the separation had been successful.

The course of the satellite during its seventeenth pass around the world—the pre-set separation pass—plus Air Force reports of visual

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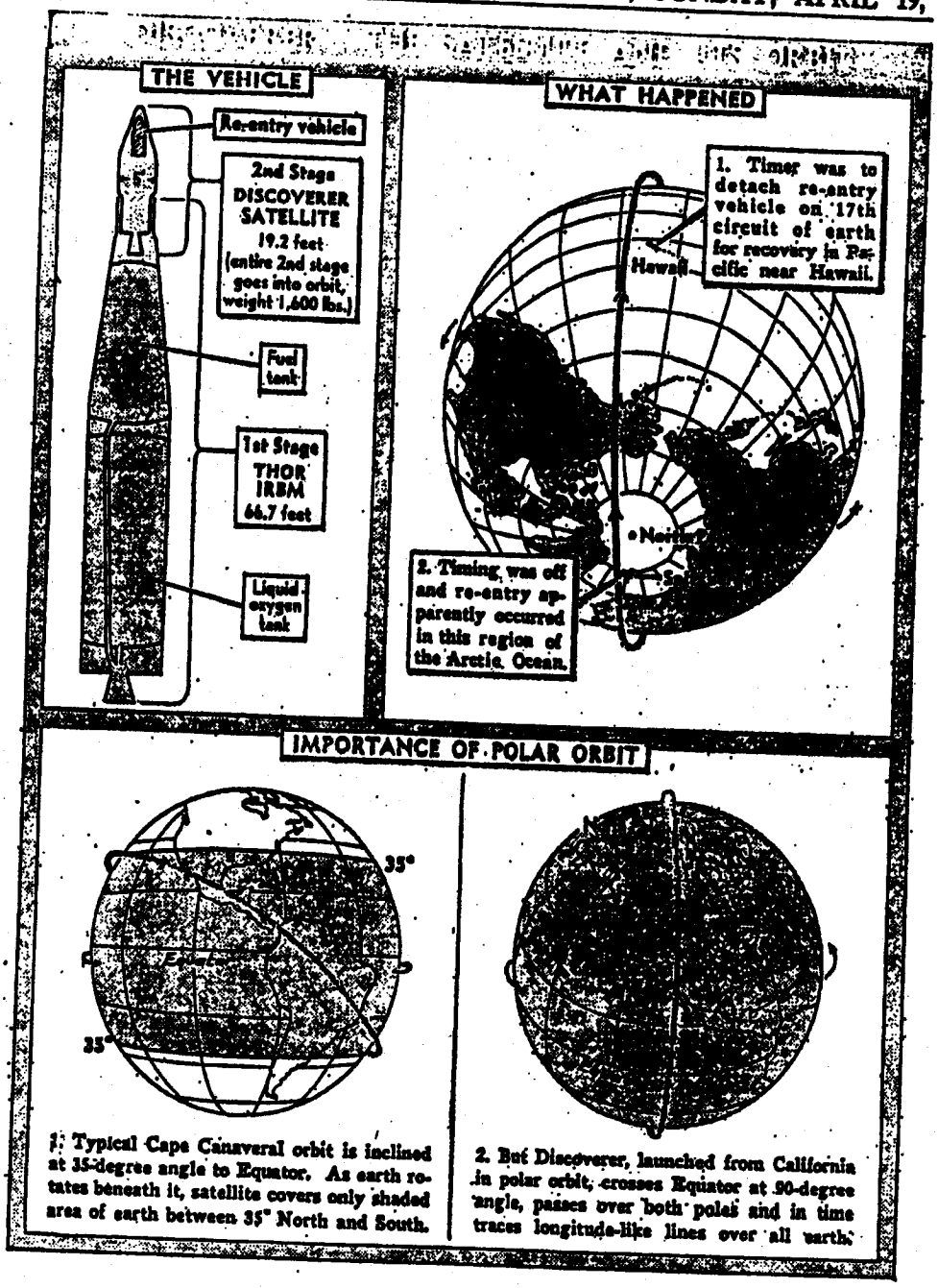
1. Quoted in New York Times Apr 14, 1959, p C21.
2. Ibid.
3. Ibid.


THE VEHICLE
Re-entry vehicle
2nd Stage
DISCOVERER
SATELLITE
19.2 feet
(entire 2nd stage goes into orbit, weight 1,600 lbs.)
Fuel tank
1st Stage
THOR
IRBM
66.7 feet
Liquid oxygen tank
WHAT HAPPENED
1. Timer was to detach re-entry vehicle on 17th circuit of earth for recovery in Pacific near Hawaii.
Hawaii
2. Timing was off and re-entry apparently occurred in this region of the Arctic Ocean.
IMPORTANCE OF POLAR ORBIT
35°
35°
1. Typical Cape Canaveral orbit is inclined at 35-degree angle to Equator. As earth rotates beneath it, satellite covers only shaded area of earth between 35° North and South.
2. But Discoverer, launched from California in polar orbit, crosses Equator at 90-degree angle, passes over both poles and in time traces longitude-like lines over all earth.

sightings, tended to support the reports that the capsule had landed near Spitzbergen in the Arctic Ocean,(see illustration).

Discoverer III[1]

Discoverer III blasted off from Vandenberg AF Base on 3 June 1959 for what was to have been this country's first attempt to collect biological data for orbital flight. This effort failed. All attempts to track the second stage vehicle were in vain. Air Force officials assumed that the satellite did not achieve sufficient velocity for outer space and that it re-entered the earth's atmosphere and burned up.

Four laboratory trained black mice in the 160-pound recovery capsule were to have provided the first US biological data from orbital flight. Primary interest was in the effect of cosmic radiation. Black mice were chosen because cosmic radiation exposure can cause a noticeable change in hair pigment.

Discoverer IV[2], V, and VI[3]

Fired at 3:49 P.M., 25 June 1959, Discoverer IV was to be a test of equipment—nothing was in the life capsule. It failed to orbit. Had orbit been achieved, the Air Force would have attempted an aerial catch of the capsule near Hawaii. Discoverer V and VI were fired on 13 and 19 August respectively. The orbiting in each case was successful

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1. New York Times, p 2B, 7 Jun 59, and Aviation Week, 8 Jun 59, p 33.
2. Sacramento Union, 26 Jun 59.
3. New York Times, 20 Aug 59. See Exhibit No. 2.