

MEMORANDUM

April 21, 1967

To: A/Administrator

From: S/Associate Administrator for Space Science and Applications

Subject: Pre-launch Mission Operation Report - San Marco B

On or about April 23, 1967, the Italian Space Commission of the National Council of Research (I.S.C.) will launch the San Marco B satellite from the I.S.C. launch range located off the coast of Kenya, Africa. It is planned that the spacecraft will be placed into an equatorial orbit by the four-stage Scout vehicle, number S-153.

The San Marco program is a joint NASA-I.S.C. effort being carried out in accordance with a Memorandum of Understanding dated 31 May 1962. Under this agreement the I.S.C. has established the equatorial launch site, has designed and fabricated the satellite, and will conduct the launch operation. The NASA has provided the Scout launch vehicle, training for I.S.C. personnel, technical consultation, and tracking and data acquisition for the operational satellite.

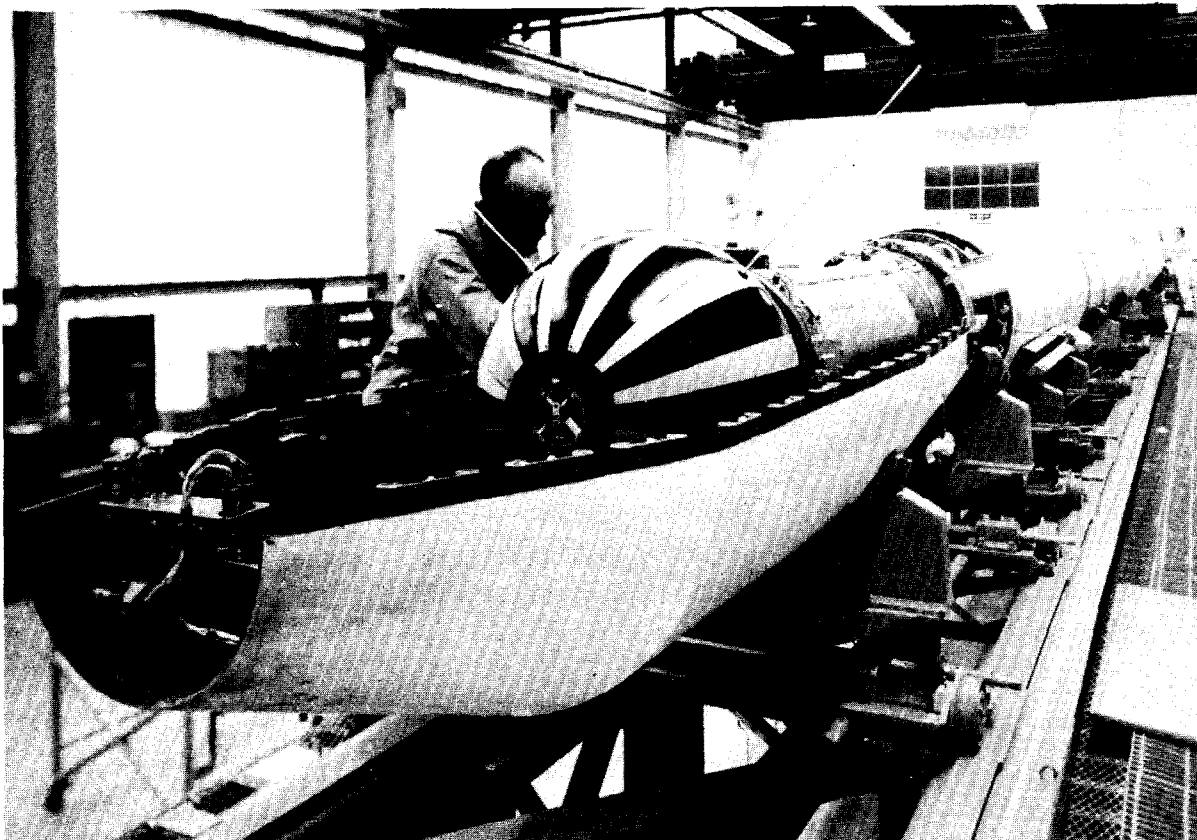

Homer E. Newell

Enclosure:
Pre-launch Mission Operation Report
No. S-894-67-02



4/18/67

MISSION OPERATION REPORT



SAN MARCO B MISSION



OFFICE OF SPACE SCIENCE AND APPLICATIONS



FOREWORD

MISSION OPERATION REPORTS are published expressly for the use of NASA General Management as required by the Administrator in NASA Instruction 6-2-10 dated August 15, 1963. The purpose of these reports is to provide NASA General Management with timely, complete and definitive information on flight mission plans and results from launchings with Scout class or larger vehicles.

Initial reports are to be prepared and issued for each flight project just prior to launch. Following launch, updating reports for each mission will be issued to keep General Management currently informed as provided in NASA Instruction 6-2-10.

Distribution of these reports has been specifically directed by General Management and they are not available for additional or general distribution. The Office of Public Affairs publishes a comprehensive series of pre-launch and post-launch reports on NASA flight missions which are available for general distribution.

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SAN MARCO PROGRAM DEFINITION

GENERAL

The San Marco program is a mutual NASA Italian Space Commission (I.S.C.) program. The first launch under this program, San Marco A, was successfully orbited from Wallops Island, Va. on 15 Dec. 1964.

The San Marco B satellite (Figure 1) will be launched on or about 23 April 1967 from the I.S.C. launch range located off the coast of Kenya, Africa by a Scout launch vehicle (Figure 2) using a FW-4 fourth stage.

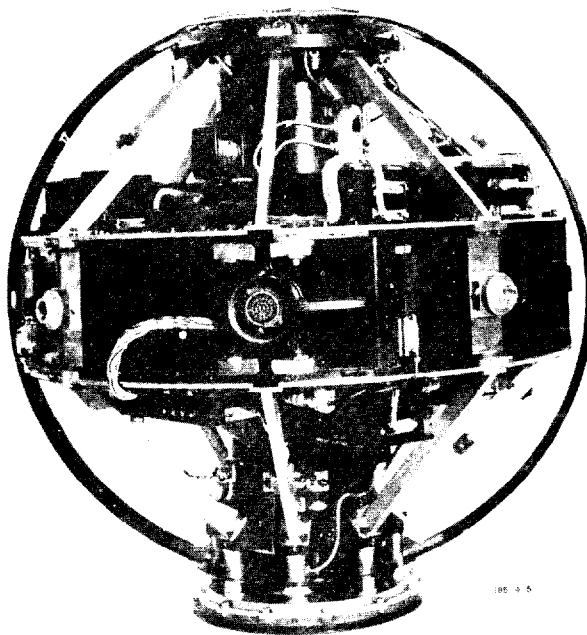


FIG. 1

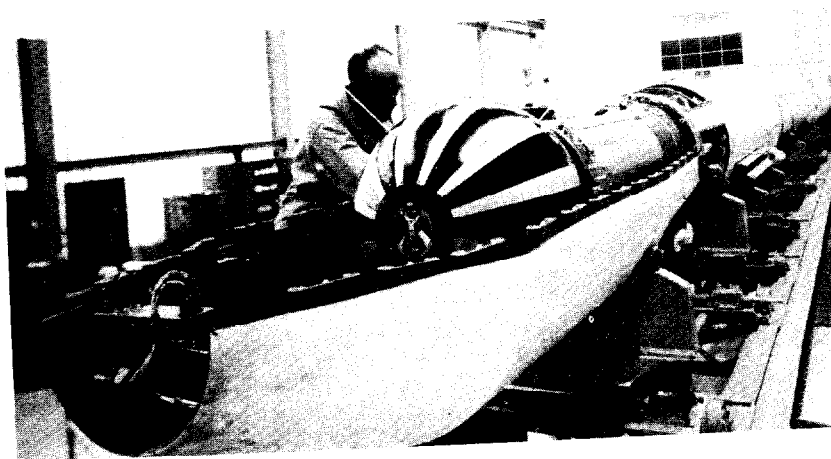
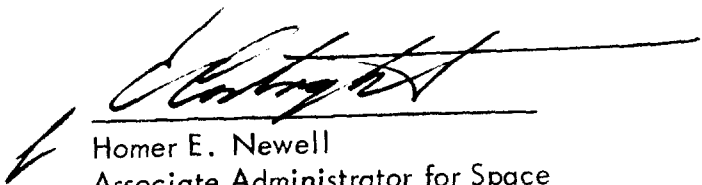


FIG. 2

NASA Mission Objectives for San Marco B Mission

To provide a Scout launch vehicle for launch of the satellite by the Italian Space Commission personnel, and to provide orbital tracking and data acquisition after launch.


Homer E. Newell
Associate Administrator for Space
Science and Applications

Date:

4/18/67


Robert C. Seamans, Jr.
Deputy Administrator

Date:

4/20/67

4/18/67

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SAN MARCO PROGRAM DESCRIPTION

LAUNCH VEHICLE AND LAUNCHING OPERATIONS

San Marco B will be launched on or about 23 April 1967 by a Scout launch vehicle, S-153. The Scout consists of four solid propellant motors; The Algol II B, The Castor II, The Antares II, and The FW4-S.

Guidance

The guidance system consists of strapped-down gyro sensors, a relay unit for power and ignition switching, an intervalometer to provide precise scheduling of events during flight, a programmer to provide torquing voltages to the pitch and yaw gyros, and an electronic signal conditioner to convert the gyro outputs to the proper control signals.

Control

A proportional control system, consisting of a combination of jet vanes and aerodynamic tip control surfaces, stabilizes the launch vehicle during first-stage burn. During the second and third-stage burns, hydrogen peroxide motors operating as an on-off system control the launch vehicle. The fourth stage, which has no active guidance or control system, receives its initial spatial orientation from the control exerted by the first three stages. After fourth-stage separation, the spacecraft is spin-stabilized.

Communications and Tracking System

The communications system monitors functional and environmental conditions in the vehicle and telemeters these data to the ground stations through a PAM/FM/FM telemetry system. The telemetry system is capable of handling 18 subcarriers and utilizes a telemetry transmitter operating between 225 and 260 MHz, with a power output of 14 watts.

Destruct System

A UHF radio command destruct system is provided as a means for destroying the vehicle should a malfunction occur. The vehicle contains two completely independent destruct systems built around a 10-channel command receiver and an integral decoder. The destruct command requires that 3 channels be modulated in the proper sequence, thus reducing the possibility of an inadvertent destruct command or of destruct by extraneous signals.

Launch Pad

San Marco B will be launched from the Mobile Launcher in the Indian Ocean off Kenya, Africa. (Figure 3)

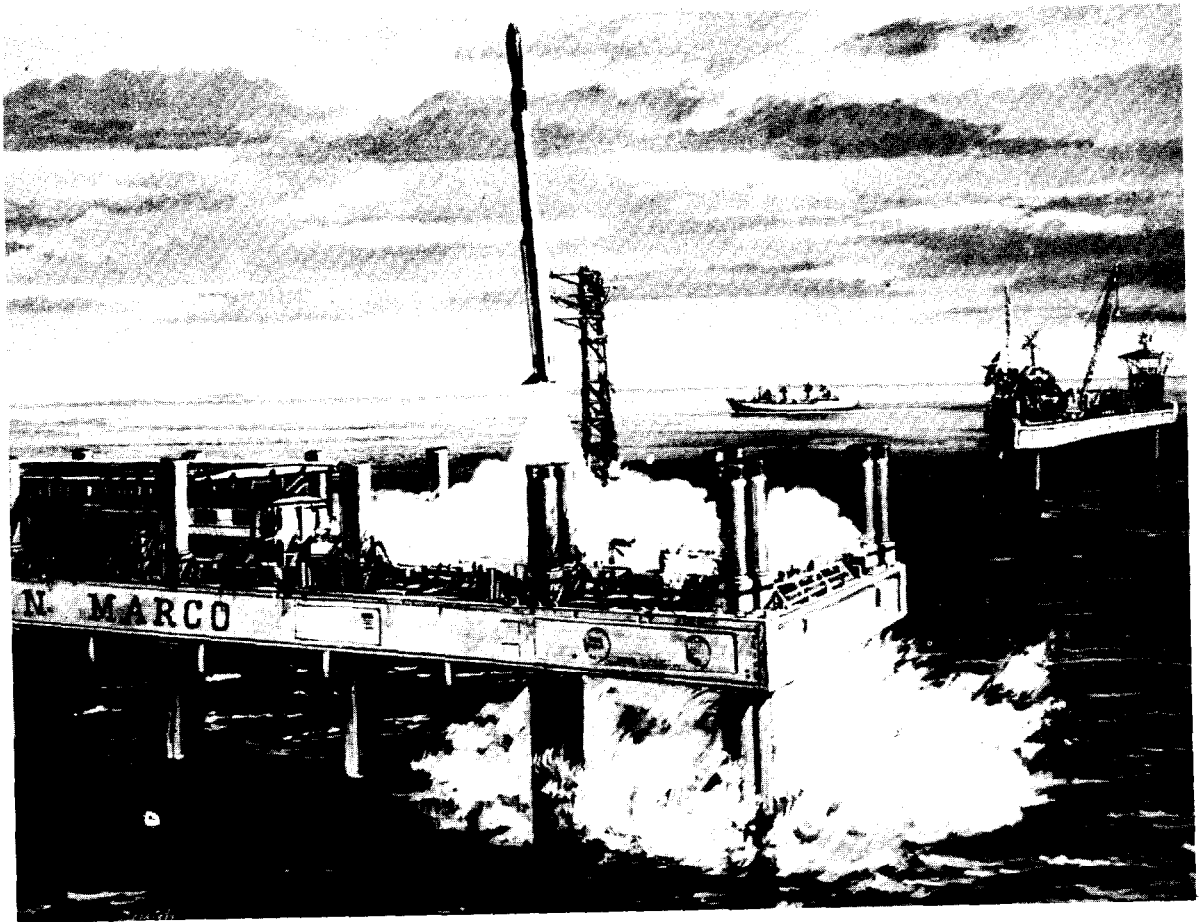


FIG. 3

SPACECRAFT

The San Marco B spacecraft is a 26 - inch - diameter sphere with four 19-inch monopole antennas for telemetry and command and two retractable 100-inch monopole antennas for the ionospheric experiment. The spacecraft weighs approximately 285 pounds. Six solar cells, mounted on the spacecraft shell, provide a rough indication of the spacecraft attitude.

The structure of the spacecraft forms an integral part of the air density experiment. The experiment configuration consists of a light external shell connected through the elastic elements of the air density measuring balance to the heavier internal structure of the spacecraft. The internal structure (see Figure 1), consists of a cylindrical center post and a central drum. The longitudinal stresses are supported primarily by the center post. A system of diagonal struts connects the periphery of the drum to the poles of the cylinder to increase the spacecraft rigidity.

The power supply, consisting of four battery packages, is stored inside the drum. The spacecraft electronic instrumentation is mounted on the upper and lower sides of the drum. The air density balance is housed in the center of the cylindrical post, in a position of symmetry with respect to the inner and outer structures. The spacecraft main body is connected to the launch vehicle during the launch phase by means of an adapter ring joined to the cylindrical post by eight short ribs. The main body of the spacecraft is constructed of aluminum alloys.

The outer shell of the spacecraft and the arms which connect the shell to the air density balance constitute the movable structure of the spacecraft. The shell is a thin-walled sphere formed from spun aluminum. The tubular arms are connected at the poles of the shell and go through the center post to the balance element. A series of windows are provided on the shell for the umbilical and continuity plugs, the antennas, and the eight columns of the adapter ring.

A pneumatic caging system protects the air density balance mechanism from excess loads during launch. The system connects the outer shell directly to the inner structure, thereby by-passing the balance mechanism. In addition, the elements of the balance are separately caged by actuators operated by the pneumatic system. At launch the pneumatic system is under pressure. The pressure is released at spacecraft separation, thereby uncaging the balance mechanism.

The spacecraft was constructed and assembled by the Centro Ricerche Aerospaziali (CRA), University of Rome. CRA has the responsibility for the design and fabrication of the spacecraft structure, power supply, RF transmitters and receivers, and the air density experiment. The Centro Microonde, University of Florence has the responsibility for the design and fabrication of the ionospheric experiment.

Environmental testing of the spacecraft was performed by CRA in Rome, Italy.

EXPERIMENTS

The Italian experimenters propose the various experiments, establish the technical requirements of their experiments, construct the experimental instrumentation, perform environmental tests on the instrumentation, conduct analyses of the telemetered data, and publish the results of their experiments.

The following experimenters are responsible for the San Marco-B experiments:

- Professor Luigi Broglio, University of Rome,
Rome, Italy - Air density experiment
- Professor Nello Carrara, University of Florence,
Florence, Italy - Ionospheric Experiment

The purpose of the experiments aboard the San Marco-B spacecraft is to investigate the earth's atmospheric characteristics. The specific areas to be investigated are:

- The atmospheric density in the altitude range between approximately 200 and 350 kilometers.
- The electron content between the spacecraft and ground, the local electron density irregularities, and the guided propagation phenomena (ducting) particularly around the geomagnetic equator.

AIR DENSITY EXPERIMENT

The purpose of this experiment is to perform a continuous and direct measurement of the atmospheric drag and, therefore, of the atmospheric density in a range of altitudes from perigee to approximately 350 kilometers. The experiment will permit measurement of short-period variations such as the daily density variation and particularly those linked to magnetic storms. The continuous measurement should assist in determining the molecular temperature of the atmosphere and, with some assumptions, the mean molecular weight. The spin rate of the spacecraft must be minimized because of the sensitivity of the air density balance. Therefore, the spacecraft is despun to less than 6 rpm shortly before spacecraft separation. The spacecraft spin axis has a random orientation.

The air density experiment performs a continuous measurement of the forces (aerodynamic pressure) acting on the external surface of the spacecraft. The main instrumentation of the experiment is the air density balance, an elastic system that connects the external shell to the inner structure of the spacecraft. Three orthogonal elastic elements connected in series are used to separate the three components of the elastic system are amplified and demodulated to obtain dc signals proportional to the force components.

The sensitivity of the balance system can be changed from 2.5 gram full-scale to 1 gram full-scale by ground command. In the 2.5-gram full-scale mode, an automatic change of gain of the amplifier (1 to 10 ratio) is provided to obtain an extension of the measured forces up to 25 grams. Zero shift of the balance (within $\pm 80\%$ of full-scale) can be corrected by ground command.

The zero shift correction circuit consists of three dc-motor-driven potentiometers, one for each axis. Correction signals obtained from the potentiometers and added to the outputs of the balance to compensate for shifts in the balance outputs. Commands are provided to produce clockwise or counterclockwise rotation of the motors. The length of the second execute tone of these commands can control the magnitude of the shift correction.

An in-flight calibration signal is included with the air density experiment. The signal consists of three levels of $1/2$ -second duration each and is superimposed every 32 seconds on each of the three force channels.

IONOSPHERIC EXPERIMENT

The purpose of this experiment is to measure the total electron content between the spacecraft and ground, study the ionospheric irregularities responsible for scintillation in the equatorial zone, and investigate the ionospheric guided propagation (ducting) phenomena. Because of the low-inclination orbit of the San Marco-B, particular propagation conditions may arise that allow an easy evaluation of the total electron number by measuring the spacecraft signal vector rotation angle. The investigation of the total electron content and its variation with time and longitude is of particular interest because of the equatorial ionospheric.

The ionospheric experiment consists of an HF transmitter operating at 20.005 MHz. The transmitter carrier is frequency-shift-keyed (FSK) for recognition of the radiated signal. The transmitter feeds two monopoles of an extensible dipole antenna through a matching network. The antenna, normally retracted, is extended when the ionospheric experiment is turned on by ground command.

TRACKING

During the launch and early-orbit phases, tracking data will be obtained by the following participating stations and tracking organizations:

- . Lima, Peru (LIMAPU)
- . Quito, Ecuador (QUITOE)
- . Mobile Italian Telemetry Station (MITS)
- . Santa Rita Station (SRS)
- . North American Air Defense Command (NORAD)
- . Smithsonian Astrophysical Observatory (SAO)

During the normal phase of operation, tracking data will be obtained by the STADAN. QUITOE will provide primary tracking support. LIMAPU will provide a limited amount of additional tracking support.

COMMAND AND DATA ACQUISITION

The Mobile Italian Telemetry Station (MITS) will have primary responsibility for commanding the San Marco-B and for acquiring telemetry data from the spacecraft. In addition, two University College of Nairobi stations (located at Dar es Saalem, Tanzania and Asmara, Ethiopia) and an Italian station in Nairobi will be responsible for acquiring ionospheric experiment data.

QUITOE will be responsible for commanding the spacecraft and acquiring ionospheric and air density experiment data. LIMAPU will be responsible for acquiring ionospheric experiment data and will act as back-up to QUITOE for commanding the spacecraft.

LAUNCH SEQUENCE

The sequence of events from lift-off to orbital injection is summarized below:

<u>Time After Lift-Off (sec)</u>	<u>Event</u>
0.0	Lift-off
80.39	1st stage burn-out
80.39	2nd stage ignition
119.00	2nd stage burn-out
179.00	3rd stage ignition
214.50	3rd stage burn-out
292.95	Spin motor ignition
294.45	3rd stage separation
298.95	4th stage ignition
330.45	4th stage burn-out

The nominal orbital parameters are as follows:

Perigee	115.6 n.mi
Apogee	431.9 n.mi
Inclination	2.93°
Period	94.56 minutes

NASA MISSION MANAGEMENT RESPONSIBILITY

<u>Title</u>	<u>Name</u>	<u>Organization</u>
Prog. Mgr.	Dr. R. K. Sherburne	NASA Hqtrs.
Asst. Prog. Mgr.	P. E. Goozh	NASA Hqtrs.
Project Mgr.	R. D. English	NASA Langley R.C.
GSFC Proj. Mgr.	A. J. Caporale	NASA GSFC
W.I. Proj. Mgr.	T. W. Perry	NASA Wallops Station

April 26, 1967

MEMORANDUM

To: A/Administrator

From: S/Associate Administrator for
Space Science and Applications

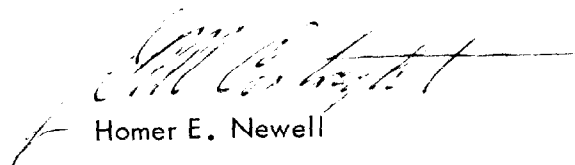
Subject: San Marco II Post Launch Report No. 1

The San Marco II satellite was successfully launched April 26 at 5:06 EST by the Italian launch crew from platforms off the coast of Kenya. This represents the first satellite launching from platforms at sea.

Orbital computations based on data of 2 orbital passes over Quito indicate the following orbital parameters:

	<u>Actual</u>	<u>Planned</u>
Perigee	218.8km	216.7 km
Apogee	748.7 km	800.7 km
Period	94.28 min.	94.60 min.
Inclination	2.892 degree	2.92 degree

The principal experiment, a drag-balance to measure variations in atmospheric density, is operating well and providing useful data; the ionosphere beacon experiment has not yet been turned on. Housekeeping data indicates that the satellite is functioning normally.


Homer E. Newell

