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PROJECT VANGUARD REPORT NO. 30

PROGRESS THROUGH DECEMBER 31, 1957 (u)-⑥

[UNCLASSIFIED TITLE]

Project Vanguard Staff

March 27, 1958

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PREVIOUS PROJECT VANGUARD REPORTS

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Project Vanguard Report No. 2, "Report of Progress" by the Project Vanguard Staff, NRL Report 4717 (Confidential), March 7, 1956

Project Vanguard Report No. 3, "Progress through March 15, 1956" by the Project Vanguard Staff, NRL Report 4728 (Confidential), March 29, 1956

Project Vanguard Report No. 4, "Progress through April 15, 1956" by the Project Vanguard Staff, NRL Report 4748 (Confidential), May 3, 1956

Project Vanguard Report No. 5, "Progress through May 15, 1956" by the Project Vanguard Staff, NRL Report 4767 (Confidential), June 2, 1956

Project Vanguard Report No. 6, "Progress through June 15, 1956" by the Project Vanguard Staff, NRL Report 4800 (Confidential), June 28, 1956

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Project Vanguard Report No. 11, "Progress through November 15, 1956" by the Project Vanguard Staff, NRL Report 4880 (Confidential), December 3, 1956

Project Vanguard Report No. 12, "Progress through December 15, 1956" by the Project Vanguard Staff, NRL Report 4890 (Confidential), January 16, 1957

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Project Vanguard Report No. 16, "Progress through April 15, 1957" by the Project Vanguard Staff, NRL Report 4950 (Confidential), May 1, 1957

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Project Vanguard Report No. 25, "Firing Times of Satellite Launching Vehicles from Cape Canaveral, Florida, as Related to Solar Illumination and Satellite Visibility," By J. W. Stry, R. H. Wilson, Jr., et al., NRL Report 5066 (Unclassified), in publication

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Project Vanguard Report No. 28, "Progress through October 31, 1957," by the Project Vanguard Staff, NRL Report 5111 (Confidential), in publication

Project Vanguard Report No. 29, "Progress through November 30, 1957," by the Project Vanguard Staff, NRL Report 5112 (Confidential), in publication

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PREFACE

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem A02-90

Manuscript submitted March 20, 1958

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RANGE OPERATIONS

The first flight failure in the Vanguard program occurred on 6 December when TV-3 lost thrust immediately after lift-off, collapsed onto the launch stand, and was destroyed in the ensuing conflagration. ~~(Fig. 1)~~ As the first complete three-stage Vanguard vehicle, TV-3 was intended primarily to flight-test the second stage and the separation systems. It carried a 6.44-inch test satellite, however, and had theoretical orbital capability.

The first-stage engine started smoothly after a relatively untroubled countdown. The vehicle rose a few feet, then a small internal fire or explosion caused damage to the high-pressure fuel feed system, interrupting the flow of fuel to the thrust chamber. This initial small explosion probably was due to atomized fuel or hydraulic fluid from a small leak; however, definite confirmation of this must await complete analysis of the available data. Telemetry data indicate nominal control system performance during lift-off; motion pictures show little sidewise motion of the vehicle and no engine collision with the launch stand. The wind velocity was about 14 mph, or well below the allowable 20 mph.

The Grand Central Rocket Co. third-stage rocket and the satellite were thrown clear and fell some 60 feet. The impact flattened the case of the rocket, split the circumferential weld on the aft end, and crumpled the nozzle. Although the case was darkened by the flames, the propellant did not ignite; after the inspection the rocket was destroyed. The satellite, although split open by the impact, was still radiating when picked up.

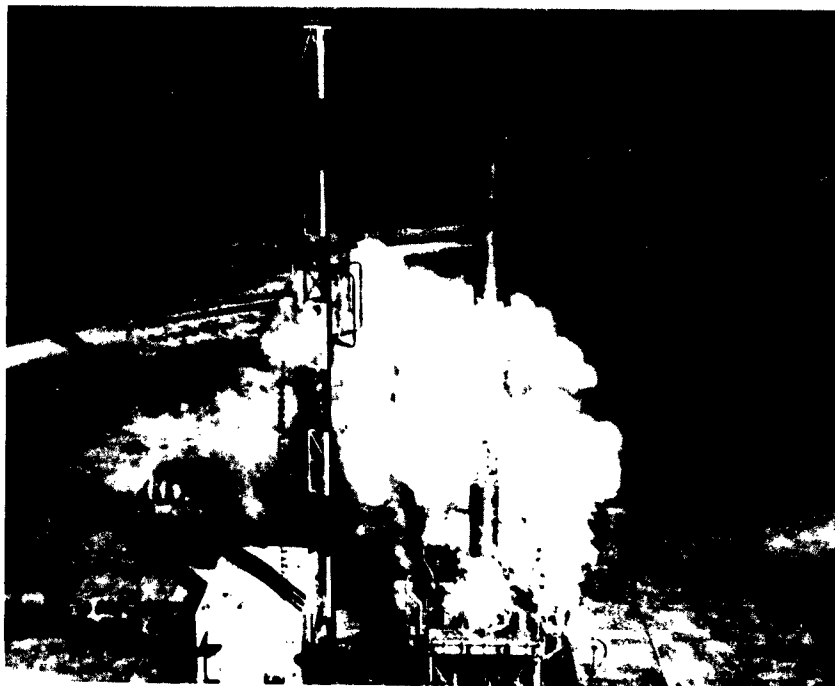
As a result of the TV-3 studies which are being conducted, a number of corrective and preventive measures have been initiated. Those considered sufficiently important will be adopted before the TV-3 backup launching; the remainder will be implemented as early as is compatible with the schedule of operations.

An earlier launch attempt had been cancelled on 4 December when increased winds and propellant servicing difficulties were added to severe crew fatigue following an already protracted countdown. Only liquid oxygen and hydrogen peroxide were removed from the vehicle. Thus a significant part of the armament and servicing operations did not have to be repeated in the second countdown, which was thereby shortened from the original 660 minutes to 360 minutes (not considering delays). The 6.44-inch satellite also remained installed and was radiating continuously during the interim. On 6 December the second and final countdown proceeded very smoothly except for an intermittent short circuit in the coasting-time computer, the repair and checkout of which caused a "hold" of 4-hours 40-minutes duration.

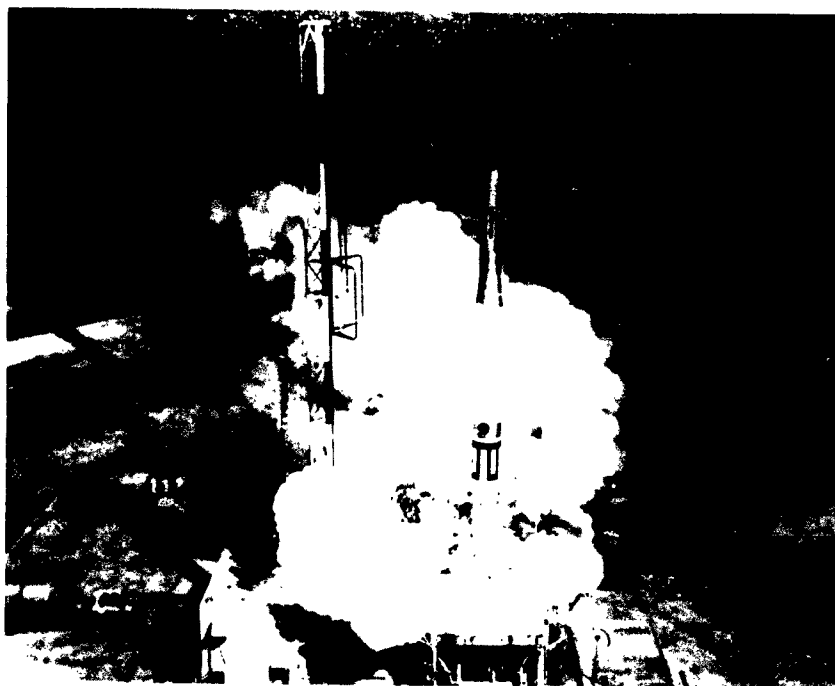
The TV-3 mishap caused damage to the launch stand and associated equipment which was extensive but major only at the flame deflector and the vehicle mounts. Repairs were begun almost immediately on a 24-hour 7-day basis; by 17 December the stand was completely restored except for the Baldwin-Lima load cells. Operations with the TV-3 backup vehicle TV-3S, which had been completely checked out in the hangar, were begun immediately. A successful 15-second static firing of the second stage was conducted on 23 December. After this firing, inspection disclosed apparent small leaks from the cooling jacket into the thrust chamber. The engine was removed and special checks confirmed the existence of the leaks. However, they were of a minor nature and it was decided that the chamber was usable; it has been reinstalled.

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(a)



(b)

Fig. 1 - Lift-off, collapse, and burning of TV-3



(c)



(d)

Fig. 1 - Lift-off, collapse, and burning of TV-3 (continued)

The first stage of TV-3S has been erected on the launch stand and the second stage will be erected upon the first on 1 January. First-stage pre-static tests have begun and the static firing is scheduled for 6 January. The launching is planned for about 18 January. From a performance standpoint TV-3S has the capability of placing the 6.44-inch test sphere in orbit. However, its principal mission will be that of TV-3, to flight-test a complete three-stage Vanguard vehicle.

The final hangar overall systems check on TV-4 will be completed on 1 January. This vehicle will then be ready for immediate erection following the TV-3S launching.

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THE LAUNCHING VEHICLES

VEHICLE PRODUCTION

The final acceptance tests on TV-5 have been completed and the vehicle should be delivered to the field in January. It is presently lacking the flight coasting time computer, the helium regulator, and the Aerojet second-stage chamber.

The final acceptance test (Vertical Interference) of SLV-1 was completed on 26 December; no major problems were encountered and the telemetry records were accepted upon review. The manufacture of SLV's 2 and 3 has been completed and the horizontal tests of both vehicles are underway. All structural subassemblies for the remaining satellite launching vehicles are complete, and manufacturing is proceeding approximately two weeks ahead of schedule.

PROPULSION

First Stage

Two more X-405 powerplants, S/N-9 and S/N-15, have been delivered to The Martin Co. Originally in TV-2, S/N-9 had been returned to GE for repair of its thrust chamber which was believed cracked when subjected to an accidental liquid oxygen spray in the field. After 30 seconds of firing at Malta, a crack was observed visually; the chamber was therefore replaced and now has been successfully test-fired. This engine is designated for the TV-4 backup vehicle, which now follows SLV-6. The second engine, S/N-15, was acceptance tested in accordance with the new specification changes;* it will be used for SLV-3. The next engine - S/N-16, for SLV-4 - is now being assembled. The X-405 engines, both delivered and scheduled, are allocated as follows:

<u>Powerplant</u>	<u>Status</u>	<u>Designated Vehicle</u>
S/N-5C	Delivered	Spare
S/N-7		SLV-1
S/N-8		TV-5
S/N-9		TV-4S
S/N-10		TV-3
S/N-11		TV-4
S/N-12		TV-2
S/N-13		TV-3S
S/N-14		SLV-2
S/N-15		SLV-3
S/N-6	In repair	Spare
S/N-16	In production	SLV-4
S/N-17		SLV-5
S/N-18		SLV-6

*P.V.R. No. 29

Tests of the helium roll-jet augmentation system are almost completed, with only one "hot" test remaining. Helium flow ("cold") tests to determine the system pressure drops were followed by transitions from nominal turbine exhaust flow to helium gas flow ("hot" tests) to determine actual operating transition characteristics. A total of three "hot" tests have yielded data indicating that the resultant jet pressures are compatible with the roll control requirements during the critical first-stage cutoff and separation period.

Second Stage

The tungsten carbide coating of all second-stage thrust chambers by the Linde Products Co. has now been completed; a total of 17 chambers were coated. After modification of a fixture used in flame spraying, the chambers were coated satisfactorily without damaging the tubes.

Propulsion unit PU-9, which has an A. O. Smith tank assembly and a coated thrust chamber, was acceptance tested during this report period; three minor specification deviations were noted.

Although the qualification program for the thrust chamber assembly has been completed,* the coated thrust chamber has been subjected to additional firings and now has a total of 738 seconds firing time. Leaking was noted after 285 seconds. Welds between the tube bundle and injector as well as the tubes themselves are suspect, and the exact position and nature of the leaks could not be determined. However, the leaking area was patched with an aluminum-oxide-glass-cloth patch. This patch was replaced after each firing, held satisfactorily for pressurization prior to firing, and burned off during the next firing. Aerojet considers the patch satisfactory in field applications for minor thrust chamber leaks. A total of 738 seconds was accumulated on the qualification thrust chamber assembly before the leaking of oxidizer and chamber gas was too severe to allow pressurization prior to firing.

The A. O. Smith Co. has delivered four tanks to Aerojet, completing the required number for the program; one of these is a spare.

Two coated thrust chamber assemblies intended for PU-5 and PU-6 have been completed. The assembly intended for PU-5 was rejected and is being reworked to correct a low natural frequency.

The Aerojet structural test program is nearing completion. Expected delivery dates for the second-stage propulsion units are as follows:

PU-5	7 January
PU-9	8 January
PU-6	9 January
PU-7	15 January
PU-10	16 January
PU-8	27 January

* P.V.R. No. 29

Third Stage

Grand Central Rocket Co.

The Grand Central Rocket Co. has resumed the qualification testing of its third-stage rocket. Two environmental motors (exposed to rain, salt, and humidity) have been fired. During both firings, the nozzle burned through near the point of exhaust-jet separation. The cause was found to be moisture under the Rockide coating, which caused separation of the bond to the metal. To preclude this problem in delivered flight units, covers (in the form of plates) will be positioned at the exits and the nozzle cones will be filled with Silica-gel. An additional problem has been weakening of the nozzle closures, resulting in their bursting at a lower pressure than was intended. Greater control over closure manufacture, and addition of a plastic coating to the Styrafoam should assure a more consistent burst pressure. It is now anticipated that the four remaining firings of the qualification test program will be completed by mid-January.

One of the third-stage rockets delivered to the field after inspection was rejected because of discoloration of the Rockide-coated nozzle surface. This rocket will be returned to GCR for replacement of the nozzle, rebalancing, and realignment, and should then be usable as a flight motor.

Allegany Ballistics Laboratory

The Allegany Ballistics Laboratory completed the six-round prequalification test program on its third-stage motor. Round No. 1 failed within 2 seconds of burnout: an improperly fabricated nozzle assembly had caused the graphite to be expelled from the fiberglass cylindrical section of the body. Successive tests at conditioning temperatures of 40°, 60°, and 100°F were made for full duration with no malfunction. The ballistic data produced in each case are given in Table 1.

TABLE 1
Ballistic Data from ABL Prequalification Firings

Round No.	Conditioning Temp. (°F)	Velocity Increment* (ft/sec)	Gross Weight (lb)	Specific Impulse* (sec)	Burning Time (sec)	Chamber Pressure	
						Avg. (psi)	Max. (psi)
PQ 1	100	-	433	-	29.3†	-	-
PQ 2	100	14,492	433.1	258.9	33.6	221	267
PQ 5	100	14,527	432.6	259.5	34.4	205	254
PQ 4	60	14,710	433.1	262.8	38.1	191	230
PQ 3	40	14,699	433.0	261.7	39.9	183	219
PQ 6	40	14,615	433	260.2	39.5	188	227

*Computed for altitude (vacuum) conditions.

†Terminated within 2 seconds of burnout because of nozzle failure.

After the casting of the first two rounds, minor cracks developed in the inner-forward domed surface of the propellant. The next two castings showed improvement but had "wrinkles" instead of cracks. Investigation revealed that the temperature of the casting powder might be a contributing factor, and improved control over this temperature alleviated the problem on the subsequent castings. The six prequalification grains were fired without malfunction. An evaluation is presently being conducted toward a proposed qualification test program.

FLIGHT CONTROL

There have been repeated transistor failures in the heater-control amplifiers of the Minneapolis-Honeywell gyro reference systems. Good temperature control is necessary in this system to maintain constant density and viscous properties in the gyro flotation liquid. Therefore the heater circuits are being modified to employ transistors with higher power ratings. All units will receive this modification, which has already been made on the delivered units in the field by a Minneapolis-Honeywell representative.

With the exception of the life test, all qualification tests have been completed on the newly developed oscillator to be used as the frequency source in the vehicle program timer; completion of the life test is expected by mid-January. The new oscillator will be used in the TV-3 backup vehicle.

During the vertical interference test of TV-5 at the Martin plant completed on 10 December, excessive first-stage engine oscillations were observed. These were attributed to transients in the control amplifier B+ supply, which result from changing loads on the first-stage battery that supplies input voltage for the control-system dynamotor. This condition had been noted in previous vehicles but was never as severe as in TV-5. To remedy this situation the dynamotor input supply was shifted to the second-stage battery, which has less load variations during first-stage flight when the oscillations could result in vehicle instability. The modification will be made in all subsequent vehicles.

The vertical controls test on SLV-1 was completed on 14 December and the vertical interference test on 27 December. This vehicle went through the control system testing without any major problem and in less time than any previous vehicle.

The slave relays used to energize the second-stage roll, pitch, and yaw jets have been welding shut because of excessive surge current from the solenoid which occurs when the relays chatter. Relay chatter results from system noise when the relay input signal nears the control point. To minimize arcing across the relay contacts during operation, and thus increase the relay life, a 1- μ f capacitor will be installed across each relay contact; observation indicates that relay arcing is nearly eliminated by this means. The modification will be made in all vehicles.

Modification of the launch stand has been completed; thus launching will now be possible with a maximum wind velocity of 26.5 mph. The modification consists of revision of the mountings for the various tail disconnects so that upon lift-off they are free to move away from their initial positions of possible interference with the first-stage engine structure.

Because of repeated shorts and grounds due to moisture condensation, the vehicle electrical ground disconnect receptacles will be replaced on the TV-3 backup and all subsequent vehicles. The new receptacles have a solid one-piece Teflon insert and are of the type presently being used between the first and second stages.

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ELECTRONIC INSTRUMENTATION

All electronic instrumentation equipment in TV-3 performed well. When those equipments not completely destroyed were examined, the range safety and tracking equipments (Fig. 2) were still in operating condition. There was some hydrazine damage to the command signal decoders, and the power supply transformer had been broken off one command receiver. The first-stage PPM/AM telemetry transmitter and calibrator were completely destroyed, and parts of this transmitter were found in the launch stand flame deflector and strewn down the concrete flume area. The second-stage PWM/FM and FM/FM telemetry transmitters were inoperable but intact and about 90 percent salvageable.

All telemetry systems and equipment for the Vanguard program are now complete with the exception of the final five PWM/FM transmitters, which will be completed at NRL by the end of January.



Fig. 2 - Range safety and tracking equipment from TV-3

Ten transistorized command signal decoders are also under construction at NRL and should be completed by mid-January.

Three C-band models of the AN/DPN-48(XE-1) beacon remain to be delivered by Melpar, Inc. Vibration tests on late models of this beacon have revealed discrepancies which can be corrected by simple expedients and modifications in the Melpar quality-control inspection procedures. Some modifications have been made to improve the performance of the beacon.

Space for an electronic equipment test and maintenance laboratory at the Baltimore plant has been provided by The Martin Co. A list of the required equipment has been submitted to the Bureau of Aeronautics Representative at the plant; those items not provided by the BAR will have to be purchased.

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THE SATELLITES

6.44-INCH TEST SPHERES

A culture-chamber and piston arrangement designed by the University of Maryland will be used as the sensor in the biological experiment planned for TV-3S or TV-4. In this design (Fig. 3), the yeast culture solution and its gasses are in direct contact with the piston head, which is sealed with an O-ring. Air in the pressure chamber behind the piston resists expansion of the carbon dioxide evolved by the culture and damps the effects of shock and vibration on the piston. The position of the piston is indicated by the value of a variable resistance and is telemetered by amplitude-modulation of one of the Minitrack signals at frequencies below 500 cps. The frequency of the carrier is a function of the internal compartment temperature; thus the pressure, temperature, and volume of the evolved carbon dioxide may be known and will provide a measure of the growth of the culture. The complete sphere will weigh about 4.25 pounds as compared to the regular 3.95-pound weight of the 6.44-inch test spheres.

SCIENTIFIC SATELLITES

Group 1

Two complete flight units of the NRL Lyman-alpha and environmental satellite have now received the final pre-flight tests; except for dynamic balancing and batteries, these satellites are ready for shipment to the field whenever needed. A third complete unit has been assembled and wired, and all but the acceleration test have been completed.

Special covers have been designed to protect the Lyman-alpha ion chambers from exhaust products of the spin and retro rockets as well as of the third-stage rocket. These thin metallic covers are held in place by two lugs extending outward from the plastic insulators in which the ion chambers are mounted. As the satellite is released from the separation mechanism, the covers of both ion chambers are pulled free by a wire attached to the separation mechanism. Removal of the covers is accomplished by the time the satellite completes half its guided travel on the separation mechanism. Vibration tests have been satisfactorily performed on this system, which will therefore be used on the flight satellites.

The dynamic balancing of the flight satellites will be carried out in the following manner: First, the separation mechanism is dynamically balanced by the addition of weights at appropriate locations. Then the satellite is mounted on the mechanism and the combination is dynamically balanced by the addition of weights to the satellite. This method should result in a balanced system during third-stage spinning and burning as well as a balanced satellite after final separation. The procedure has been tested with the first Group 1 flight satellite, and a total weight of 0.26 pound was required to balance the combination.

Group 2

NRL has agreed to supply both design and components of the antennas and phasing networks for the cloud cover satellite. It is necessary to connect two Minitrack transmitters and the receiver to the antennas while providing isolation between the transmitters and the receiver. Since this design is similar to that employed in the Group 3 satellite, some Group 3 parts will be utilized to meet a deadline of 6 January for one set of Group 2 equipment.

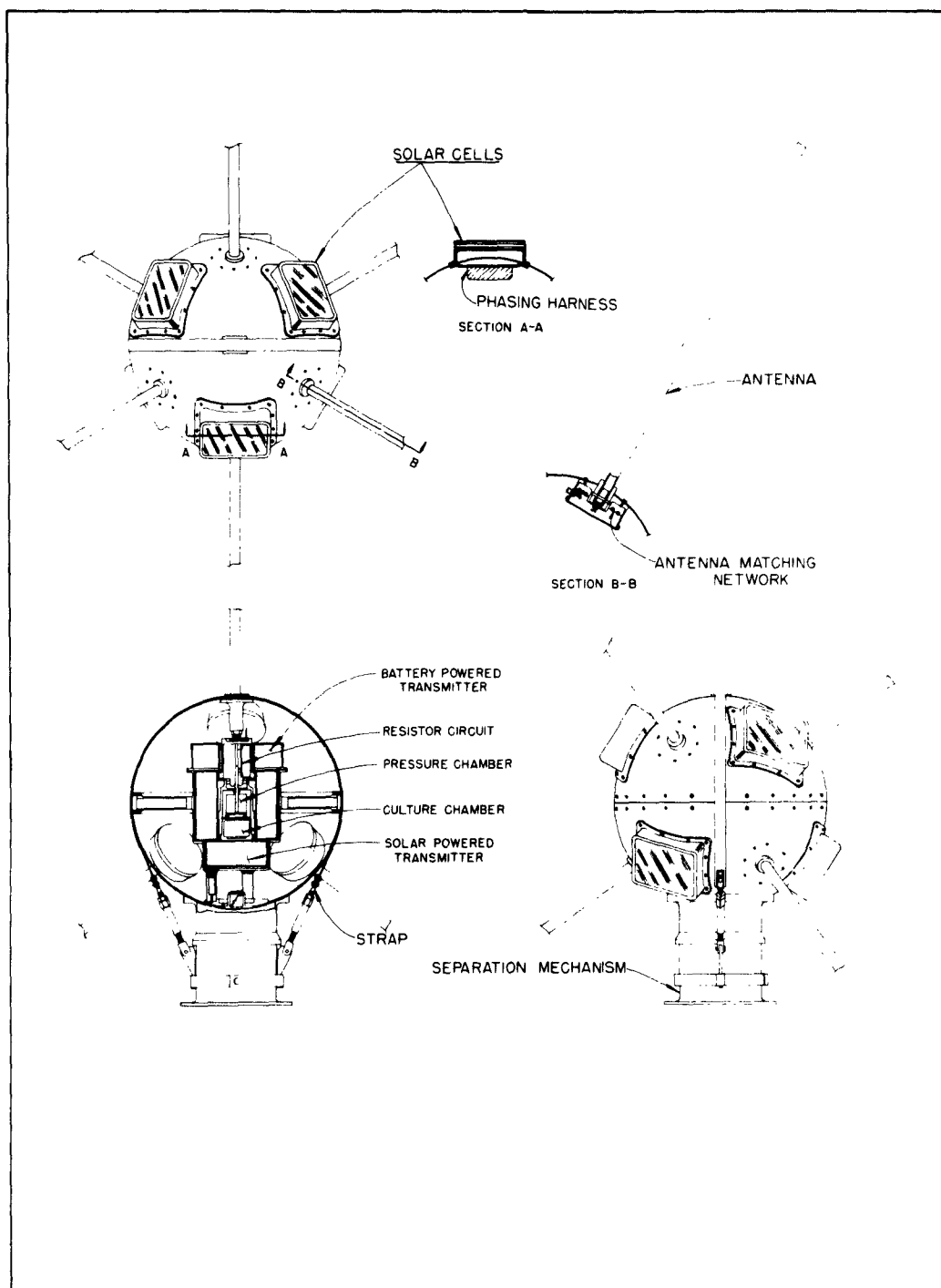


Fig. 3 - Design of life-science 6.44-inch test sphere

To provide against the possibility that the cloud cover experiment may not be ready in time for the flight of SLV-2, NRL is preparing a backup satellite. This is substantially the same as the Group 1 satellite, but the solar Lyman-alpha measurement has been replaced by a solar x-ray measurement. The ion-chamber x-ray detector is similar to the Lyman-alpha detector, and the amplifier, peak memory, and orbital switch circuits require only minor modifications. Operation of the x-ray module with the peak memory and telemetry encoder modules has been satisfactory except for microphonics in the input cable which are partially eliminated by immobilizing the cable.

Group 3

The third and fourth 13-inch Spiralloy spheres for the NRL magnetometer satellites have been received from the Young Development Laboratories. Three additional spheres are expected in January and three in February, completing the order for ten.

One sphere and an aluminum internal instrument container have been assembled as an instrumentation test unit in addition to the existing structural test unit. Assembly of two additional test spheres has begun and these units, with magnesium internal containers, will be completed by about mid-January.

The structural test unit (Fig. 4) has undergone a preliminary design vibration and acceleration test. Included were batteries, antennas, and simulated electronics modules and magnetometer sensor. No failures occurred in the satellite, but during the vibration cracks developed in the plastic sub-satellite container near the hold-down screws; this area will be reinforced with aluminum to prevent such cracking.

The design of the magnetometer satellite is shown in Fig. 5.



Fig. 4 - NRL magnetometer satellite, structural test unit shown with vibration test equipment

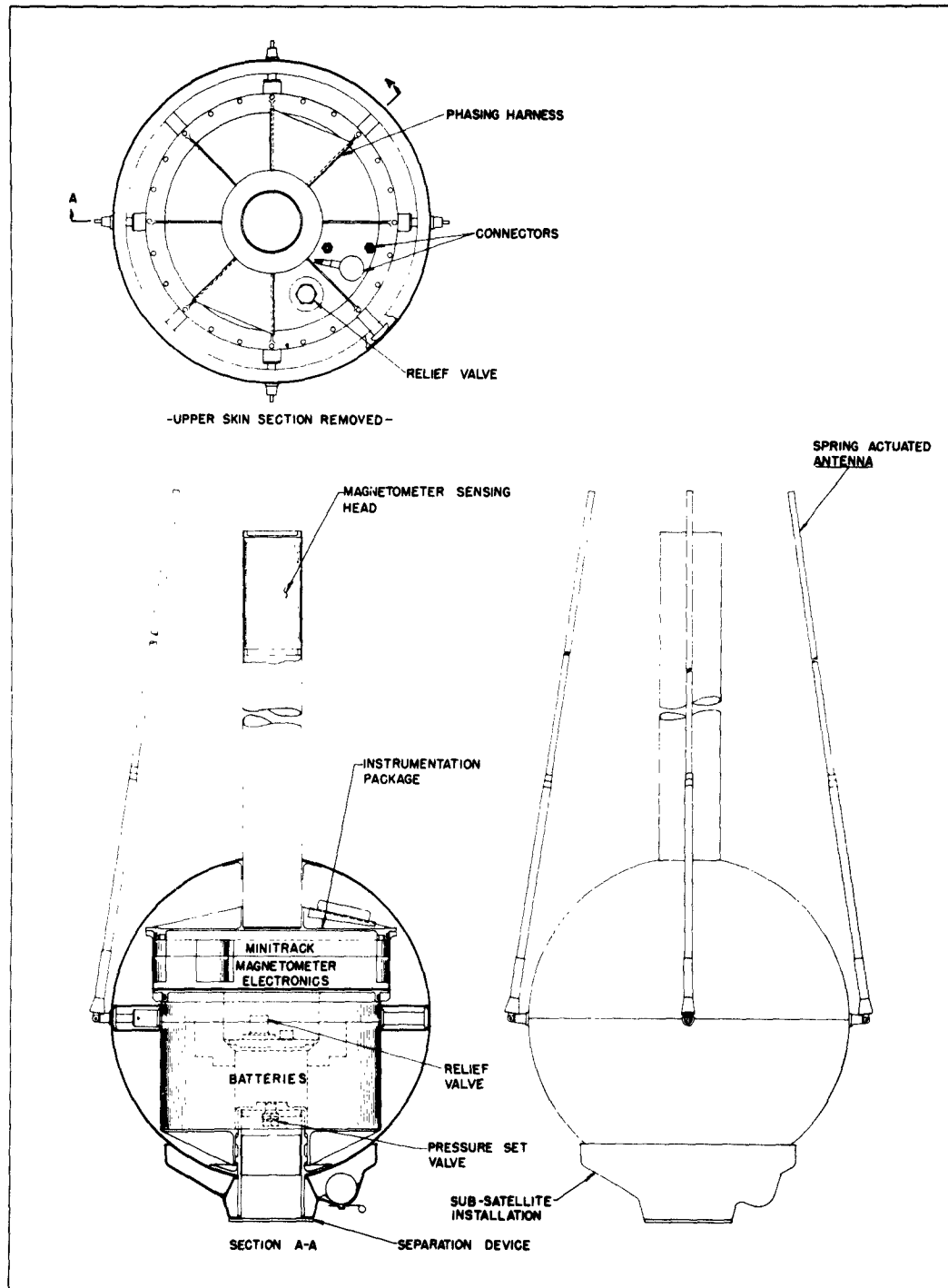


Fig. 5 - Design of NRL magnetometer satellite

The Minitrack transmitter for the first prototype has been completed and foam-potted. The antenna design is complete and the phasing network for the first prototype is complete. This network utilizes lumped constants for line elements, providing a circuit with lower losses and lighter weight than would coaxial line circuits.

A uniform absorptivity-to-emissivity ratio (a/e) over the surface of the magnetometer sphere is desirable. The "Spiralloy" spheres have a nonuniform, medium-brown coloring, hence a nonuniform a/e . To determine whether the curing time affected the color and whether a more uniform color was possible, nine samples were heated to approximately 385° F, and one was removed every half-hour. Changes in color and in uniformity of color were noted. However, after 1-1/2 hours of baking little further change occurred; the material was almost uniformly dark brown. Therefore, if it is desired to obtain a uniform dark color, it is best to bake the material 1-1/2 hours.

The magnetometer satellite design as shown in Fig. 5 now has a total weight of 22.00 pounds, 0.56 pound more than that last reported in October 1957. A weight reduction must be made, since the 21.5-pound limit must not be exceeded.

The work on the Group 3 satellites is on schedule.

Group 4

The second and third magnesium spheres for the Group 4 (radiation balance of the earth) satellites have been received from Brooks and Perkins. Plating of the four magnesium internal containers made by NRL has also been completed by Brooks and Perkins.

Eddy currents set up in the metal sphere by virtue of its motion in the earth's magnetic field would interfere with the radiation balance experiment. Therefore the spheres and internal structures are to be split in two planes parallel to the satellite equator (perpendicular to the spin axis) and insulated with a fiberglass material; this will limit the flow of such eddy currents. The first sphere and internal structure have been so modified.

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THE MINITRACK SYSTEM

The following Minitrack stations are in a standby satellite-tracking condition: Blossom Point, Fort Stewart, Havana, Quito, Lima, Antofagasta, Santiago, San Diego, Antigua, Grand Turk, and Woomera. The planned station at Olifantsfontein, South Africa, will soon be established; equipment is due to arrive early in January.

Of the above stations, all but Quito and Woomera have been calibrated. An effort is being made to transfer the Lima calibration to Quito by means of simultaneous sun-tracking operations; aircraft calibration at Quito's altitude is not possible with the available plane. The Woomera station will be calibrated in the near future.

"Dry run" operations are being conducted at all operable stations for practice and proficiency.

All stations are now capable of monitoring 20-Mc and 40-Mc satellite transmissions, and the following are capable of actual tracking at 40 Mc: Blossom Point, Lima, Santiago, San Diego, and Woomera.

Preliminary construction of ground station facilities for the NRL magnetometer satellite experiments has begun at Fort Stewart, Lima, Antofagasta, and San Diego.

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DATA PROCESSING

TELEMETERED DATA

Within 13 hours of machine operating time after the firing of TV-3, all the PPM/AM and PWM/FM telemetry data required were reduced by the data reduction system of the Automatic Recording and Reduction Facility (ARRF). These data were delivered within 24 hours after the firing.

Immediately after completion of the TV-3 data reduction, the data reduction system at Radiation, Inc. (Orlando) was dismantled and moved on 10 December 1957 to the nose-cone room of Hangar S at Cape Canaveral. Since the air-conditioning system in this room was not completed until the last week in December, the ARRF data reduction system could not be put into normal operation in time for use during this month. The telemetered data from the static firing on 23 December of the second stage of the TV-3 backup vehicle was reduced on the Oscar Model J equipment.

The FM/FM input equipment for the ARRF is now installed in the new FM/FM trailer at the NRL telemetry pad at Cape Canaveral. Differences between the presently used discriminators and those for which the system was designed have required reduction in the number of FM/FM channels that can be recorded digitally at one time from 12 to 6. Because of the poor quality of the signal obtained from the new trailer, reduction of the FM/FM data on the ARRF is of doubtful value, but efforts to improve the situation are being continued.

During December additional maintenance and operating personnel were acquired from Radiation, Inc. to furnish continuing support with the telemetered data reduction operation at AFMTC.

ORBITAL DATA

In preparation for the TV-3 launching, a series of simulated runs was conducted at the Vanguard Computing Center to check operations with the IBM 704 computer there and with the secondary computer at Poughkeepsie linked to the Center by an IBM transceiver system. Despite the failure of the flight, valuable operational experience was gained by the Computing Center personnel during the countdown.

To furnish position fixes as an aid in resolving the ambiguities of the Grand Turk Minitrack data, the position of the launching vehicle will be calculated at 10-second intervals of the second-stage coasting flight period. The coasting flight path will be calculated at the Vanguard Computing Center from a set of position and velocity vectors established by the ground-controlled third-stage firing system at AFMTC. In addition, this second-stage coasting flight information and the time at which the third stage is fired can be used to determine whether or not a suitable satellite orbit could be achieved on the assumption of a satisfactory firing of the third stage.

Orbit predictions for 1957 Beta, the second Soviet satellite, were continued on a very limited basis only during the first part of the month. Although the radio transmitter in this satellite had ceased to operate, some radar observations became available from Stanford University and from the long-range tracking radar of Lincoln Laboratory at Westford, Massachusetts. The task of orbit predictions for 1957 Beta was assumed by the Smithsonian Astrophysical Observatory since most of the observations were optical.

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THIRD-STAGE FIRING PREDICTION

At the time of the TV-3 launching, the complete radar-computer digital system was ready to provide both impact and third-stage firing predictions. The final readiness of the system was achieved only by an all-out effort on the part of all personnel concerned. Although the opportunity to use the system was not provided by the TV-3 vehicle, subsequent firings of several missiles at AFMTC demonstrated satisfactory performance of the digital impact prediction operation. After a firing of Jupiter A, for example, a magnetic tape recording of the skin-tracking data from the AN/FPS-16(XN-1) and (XN-2) radars gave impact prediction results which compared favorably with those derived from the Azusa-704 computer system.

The tracking capability of the XN-1 and XN-2 radars was dramatically demonstrated when both sets skin-tracked a Thor vehicle automatically to 250 nautical miles, the limit of the AFMTC radar. Further, on 21 December 1957 the XN-1 radar automatically tracked the 1957 Beta satellite for about 1 second at a range of about 250 nautical miles; as far as is now known, this was the first tracking of a satellite by a high-precision tracking radar.

* * *

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