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ENVIRONMENTAL TEST PROGRAM FOR THE RADIO ASTRONOMY EXPLORER-A (RAE-A)

MARCH 1969

GSFC

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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Royal M. Tysdal
Test and Evaluation Division
Systems Reliability Directorate

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GODDARD SPACE FLIGHT CENTER
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RADIO ASTRONOMY EXPLORER-A
(RAE-A)

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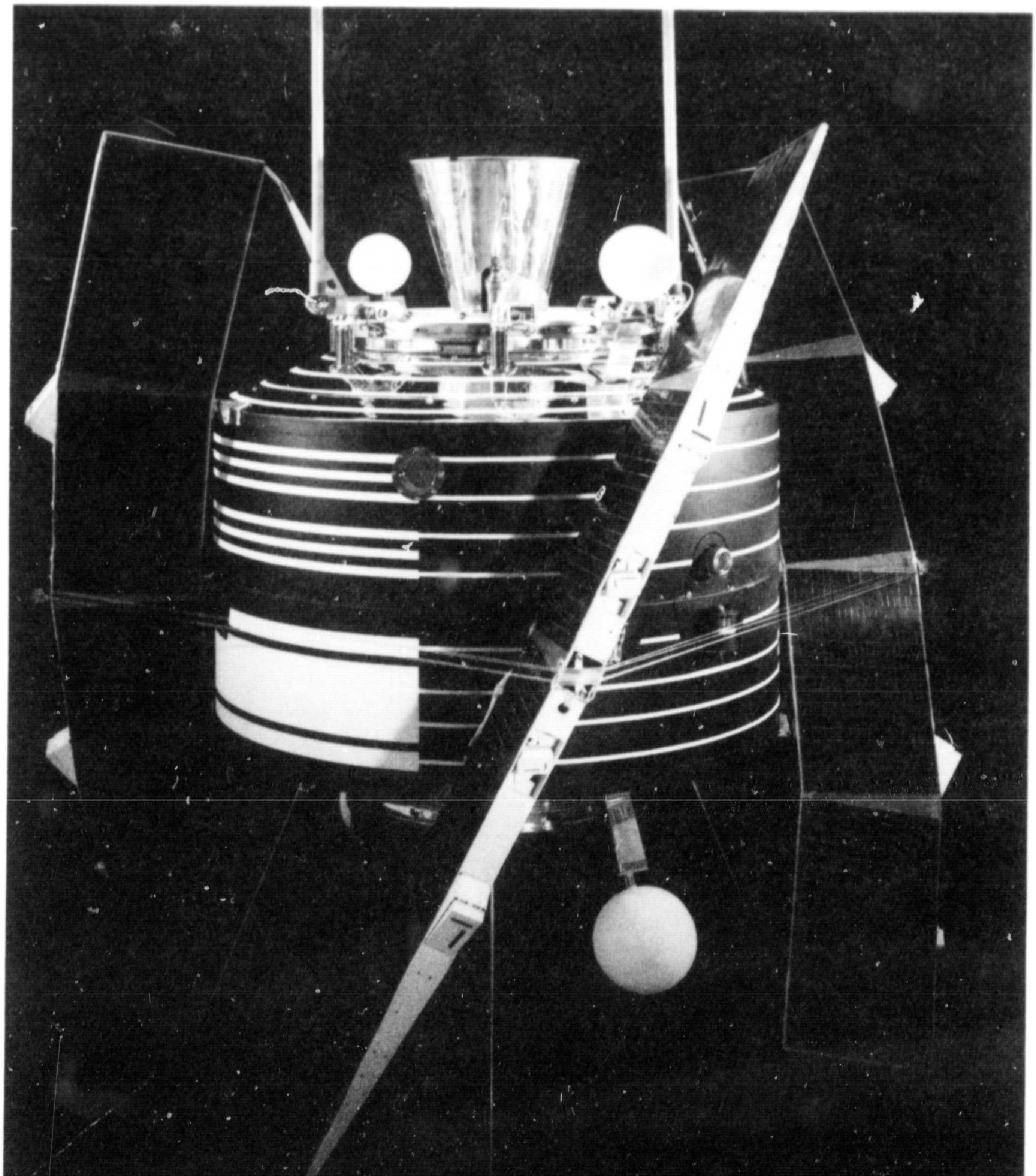

Frontispiece – RAE-A Spacecraft

TEST PROGRAM STATUS

This is the final report on the RAE-A environmental test and evaluation program. The spacecraft was successfully placed in orbit by the Delta vehicle DSV-3J-1 (Delta 57) from the Western Test Range on July 4, 1968, and is known as Explorer XXXVIII. RAE-A was officially declared a success on September 12, 1968.

The RAE-B program remains to be accomplished.

AUTHORIZATION

Test and Evaluation Charge No. 326-877-11-25-01

ENVIRONMENTAL TEST PROGRAM FOR THE RADIO ASTRONOMY EXPLORER-A (RAE-A)

Royal M. Tysdal
Test and Evaluation Division

SUMMARY

Environmental testing of the RAE-A spacecraft took place at Goddard Space Flight Center, Greenbelt, Maryland between September 1967 and May 1968. The test program, following accepted GSFC test philosophy of prime emphasis on testing spacecraft as complete systems, used a proto-flight spacecraft to qualify the design and establish flight worthiness of the spacecraft. Testing was performed in accordance with GSFC environmental test requirements for Delta-launched spacecraft and apogee kick motor, set forth in RAE Environmental Test Specifications S-320-RAE-1 and S-320-RAE-2.

RAE-A (Explorer 38) completed testing in May 1968 and was successfully launched by the Delta vehicle DSV-3J-1 (Delta 57) from the Western Test Range on July 4, 1968. RAE-A was officially declared a success on September 12, 1968. All booms have been extended to their full length as designed.

Proto-flight spacecraft tests revealed 22 malfunctions. The most significant malfunctions during the test program appeared early during the thermal-vacuum test phase and revealed several subsystems whose design control drawings were out of date which resulted in wrong capacitors being installed. After replacing the capacitors, no further trouble was encountered with these subsystems. The success of the first Radio Astronomy Explorer was achieved because of a well conceived design, the ability to encompass past experience into new concepts, and a highly motivated and cohesive team effort.

CONTENTS

CONTENTS (Continued)

TABLES

ILLUSTRATIONS

ENVIRONMENTAL TEST PROGRAM FOR THE RADIO ASTRONOMY EXPLORER-A (RAE-A)

INTRODUCTION

Mission

The Radio Astronomy Explorer Program was authorized by NASA Headquarters in February 1965.

The stated objective of the RAE program is to measure, with directivity, the intensity of radio signals from celestial sources as a function of frequency, direction, and time. RAE scientific instrumentation functions over an approximate range between 0.2 and 9.2 MHz.

To accomplish the measurements, the spacecraft carries two experiments and three experiment calibration packages.

A secondary objective is to investigate the dynamics of large (750 feet) flexible booms.

Development

The RAE Project Development Plan (Reference 1), approved by NASA Headquarters May 23, 1966, specified the development and test, by the Goddard Space Flight Center (GSFC), of one proto-flight spacecraft (RAE-A) and one flight spacecraft (RAE-B). This effort was supported by one engineering test unit (ETU) model and one thermal test unit (TTU) model for use in design testing.

The RAE study program commenced in January 1964 from which evolved the basic spacecraft design and several subsystem breadboard models. After project approval and funding in February 1965, spacecraft design progressed with an effective completion in November 1965. Integration of the proto-flight spacecraft (RAE-A) was completed in January 1968. Environmental testing of the spacecraft extended from September 1967 to May 1968, after which the spacecraft was delivered to the Western Test Range (WTR) for the start of prelaunch preparations. Figure 1 and Appendix A show the major milestones for the RAE-A program.

Although the original schedule called for a March 1967 launch, delays caused by program complexity, funding limitations, integration problems, and launch complex unavailability resulted in a July 1968 launch. Figures 2 and 3 show the

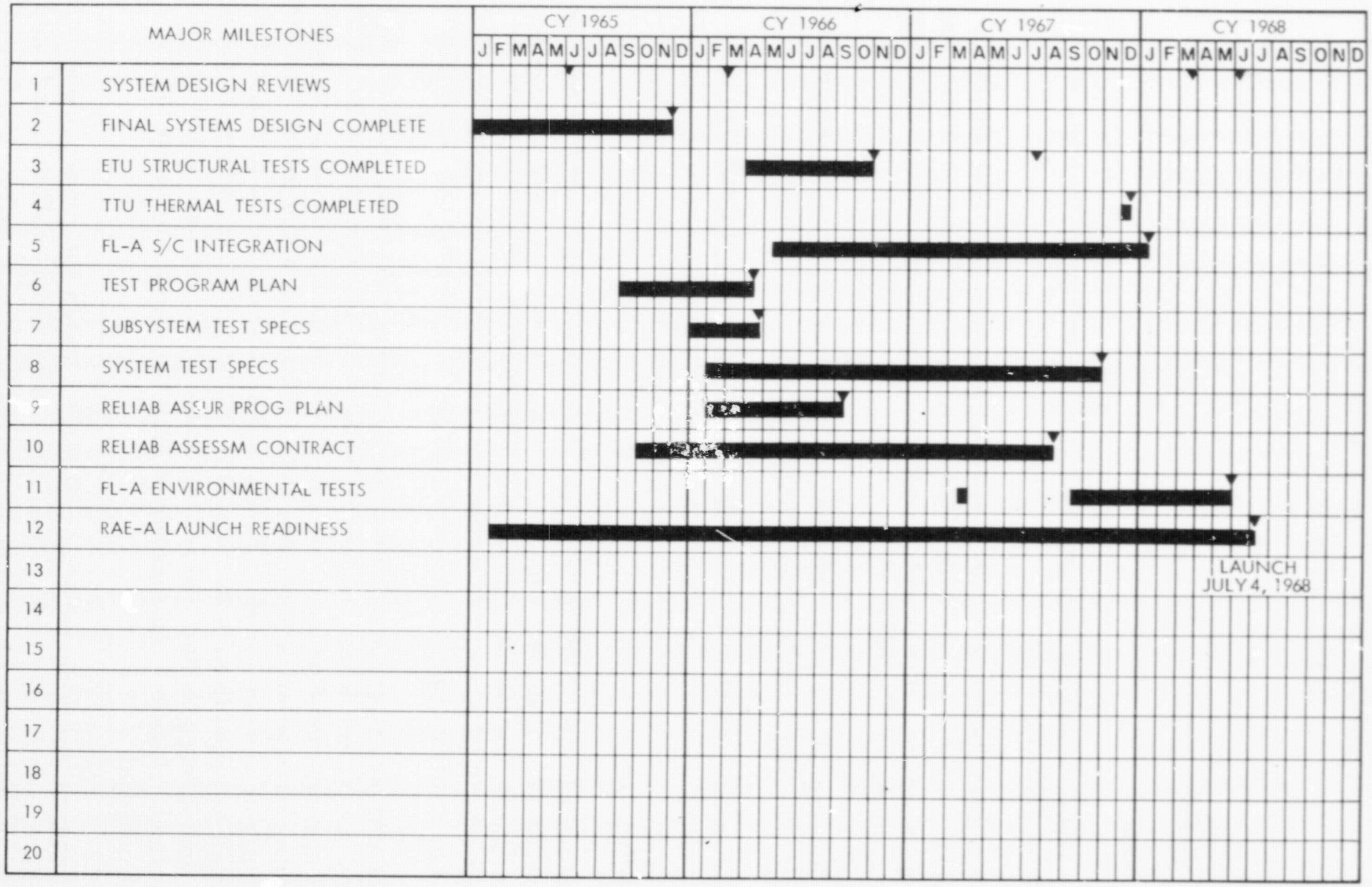

Figure 1. Major Milestones RAE-A Spacecraft

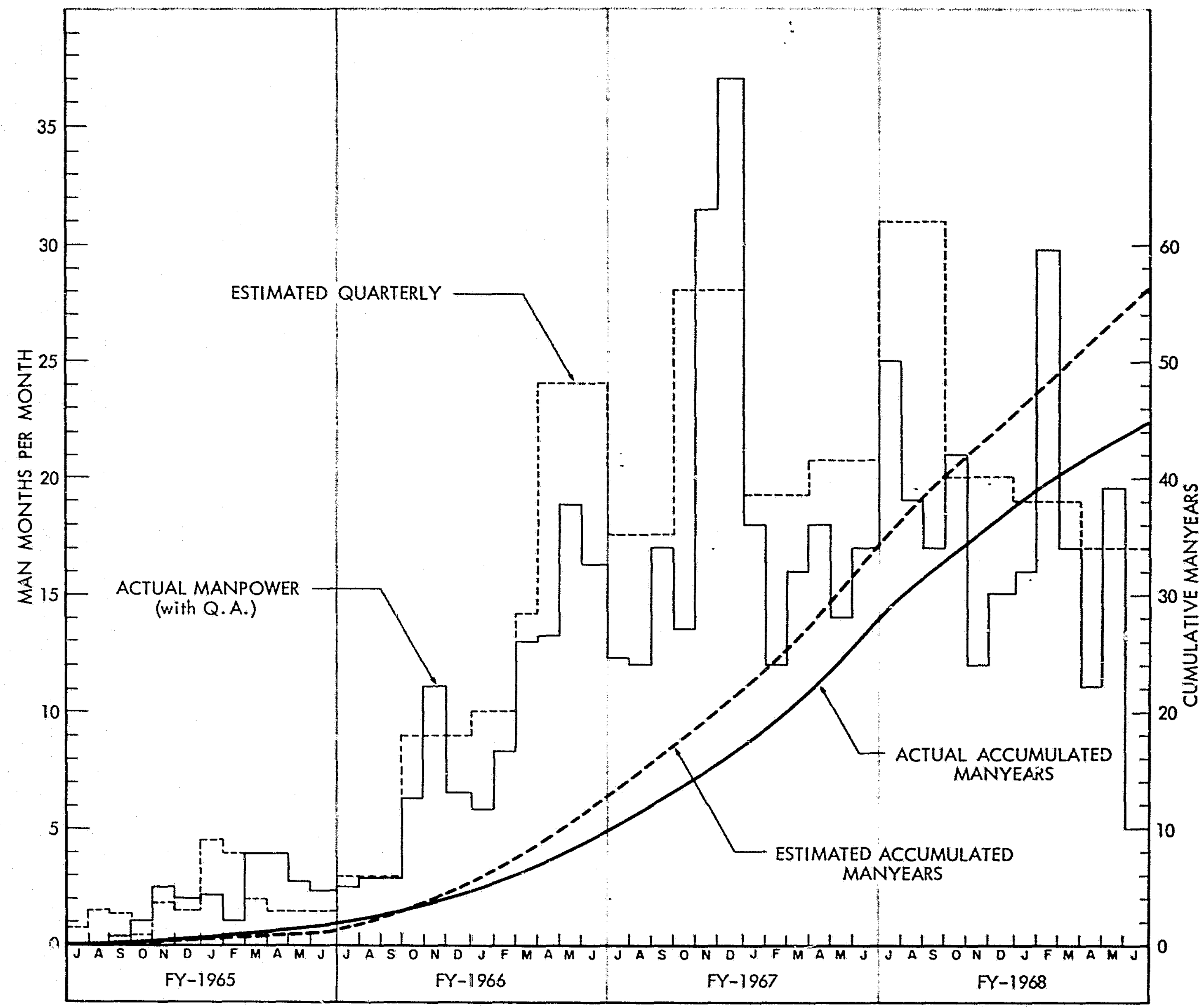

Figure 2. Test and Evaluation Division, Manpower Expenditure History

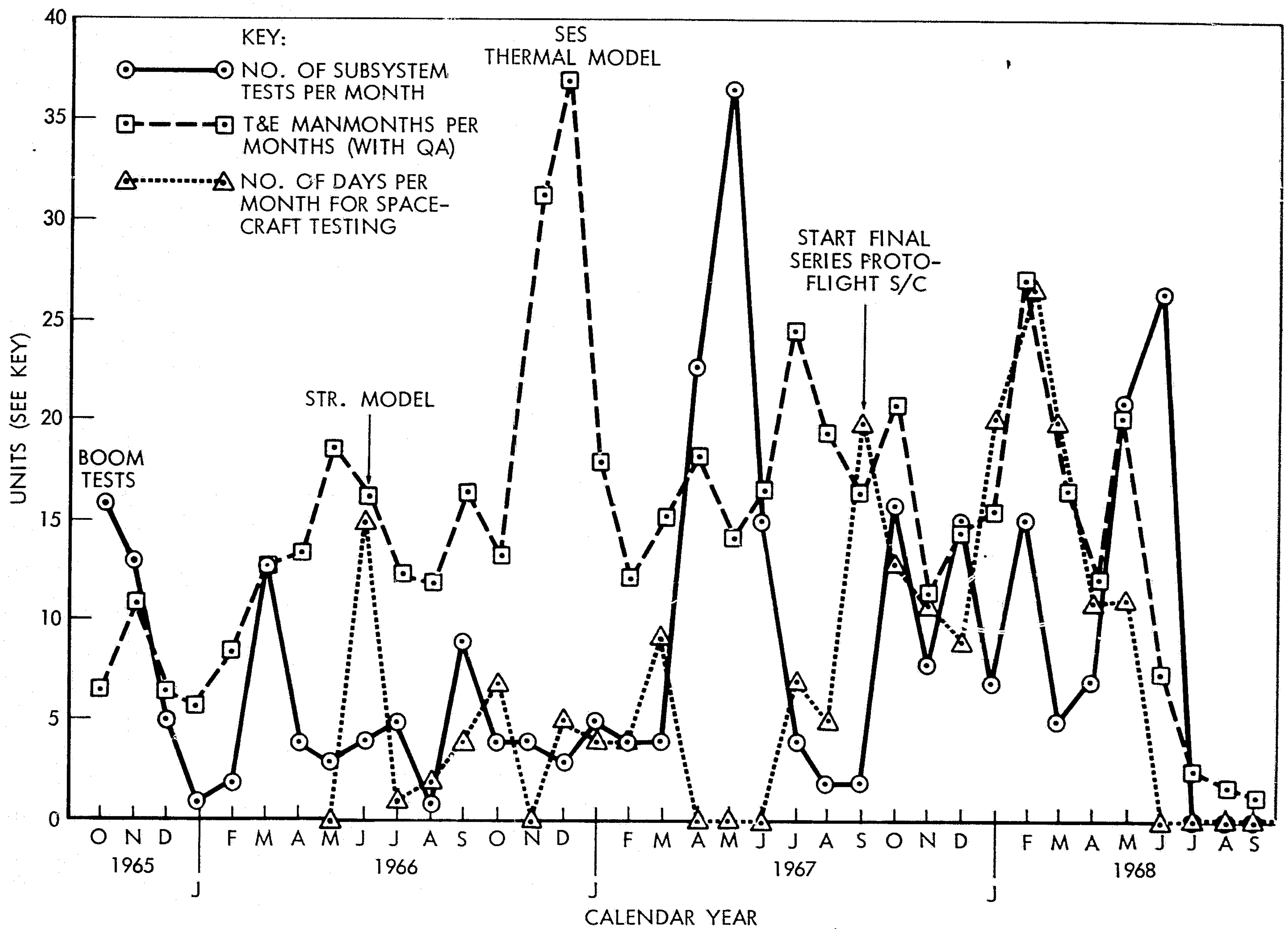

Figure 3. T&E Manpower vs Subsystem and Spacecraft Testing

T&E manpower expenditure for the development and qualification of the proto-flight spacecraft. The estimates averaged about 6% higher than actual expenditures for the program. The peak in December 1966 is due to a thermal design test in the space environment simulator (SES).

The process of returning by data line all pre-launch spacecraft data to GSFC for real time computer reduction and analysis was very successful. This same process was used during environmental testing and greatly reduces on-site equipment and manpower support required.

Launch

RAE-A (Explorer 38) was launched from the Western Test Range on July 4, 1968, on a DSV-3J thrust-augmented Delta vehicle. A nominal eliptical orbit was achieved. On July 7 the TE-364-3 fourth stage apogee kick motor was fired which circularized the orbit at an apogee of 5866 Km and perigee of 5841 Km. On July 22, the four main booms were extended to 460 feet each, the libration damper booms to 280 feet each, and the dipoles to 60 feet. On October 8, full extension was successfully accomplished to 750 feet each on the main booms and 315 feet each on the damper booms. Basically, all subsystems and experiments have operated properly. Some anomalies have occurred which do not affect the basic mission. A summary of performance in flight and anomalies of the first four months are included for correlation with the test program and for any future studies that may be requested.

ENVIRONMENTAL TEST PROGRAM

Objectives

Primary objectives of the RAE-A test program were to:

1. Ensure the adequacy of the spacecraft design by exposure to environmental tests at levels more severe than those expected during pre-launch, launch, and orbital operation.

2. Demonstrate the ability of the proto-flight spacecraft to meet all performance requirements and to have a satisfactory life expectancy in orbit.

3. Gather data relating to spacecraft operational performance in the expected environment to better evaluate spacecraft data and performance in orbit.

SCOPE OF TESTING

Spacecraft Hardware

The RAE-A test program required one proto-flight spacecraft which was tested to prototype test levels and then became the flight spacecraft. Subsystem testing was considered on an individual basis. One of the considerations was the consequence of a subsystem failure during systems test. Another was whether or not the subsystem was a new design. Finally, all vendor supplied subsystems and experiments specified environmental testing. In general, most subsystems were subjected to temperature and vibration tests, with magnetic measurements and thermal vacuum following in frequency of occurrance. In lieu of a prototype spacecraft, great reliance was placed in development and test of the engineering test unit (ETU) spacecraft and the thermal test unit (TTU) spacecraft. The complete proto-flight spacecraft was assembled as soon as possible even though all subsystems were not in their final configuration (or fully through qualification) in order to determine the problems and the fixes. The subsystems were then modified as necessary and went through final qualification. Spare subsystems were available which will be used on RAE-B.

Appendix B contains a complete list of subsystems and serial numbers for RAE-A. Figure 4 is a flow chart of hardware flow and the actual environmental test sequence for RAE-A. The formally approved test plan and specifications (References 2, 3, and 4) prepared specifically for the RAE-A program further define the specific environmental test requirements and applicable test levels.

Explosive Devices

The following explosive devices were used on RAE-A:

1. Atlas 1MT-140 piston actuator for Yo-Yo release.

2. Atlas 1MT-18 retractable piston for dipole antenna release.

3. Atlas OA-213-2 bolt cutter for libration damper clamp band.

4. Hi-Shear power cartridge PC-10 for 4th stage clamp band.

5. Holex Initiator 4480-4497 with Thiokol Pyrogen TE-386 for 4th stage motor igniter.

6. Thiokol TE-M-479 4th stage motor.

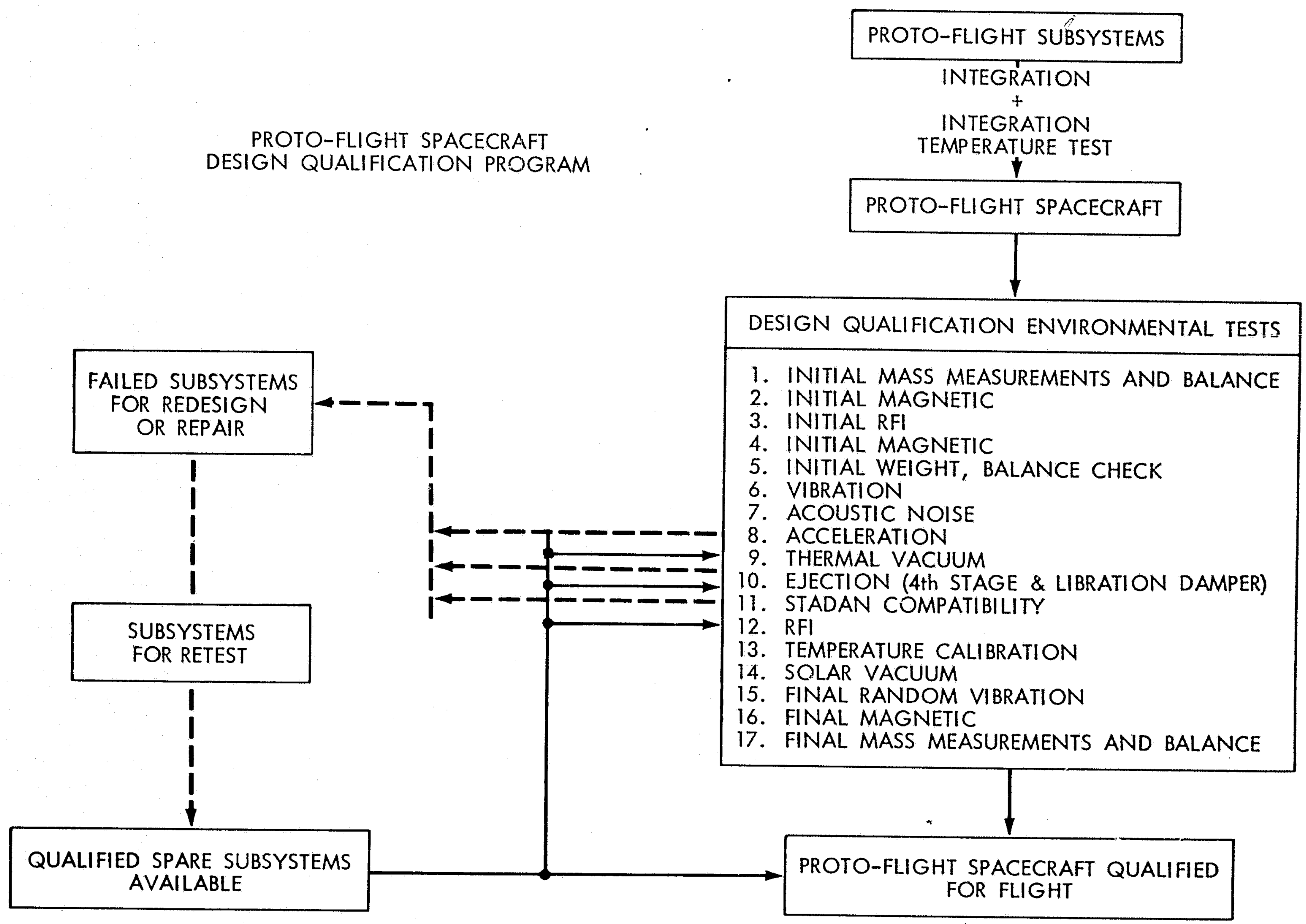

Figure 4. Flow Chart for Environmental Test Program, RAE-A

Six 4th stage motor firings, including two at the Arnold Engineering Development Center (AEDC) in conjunction with the RAE Thermal Test Unit, were accomplished by Thiokol Chemical Corporation in the motor qualification program.

Experience from past programs, such as AIMP, was used in the selection of explosive devices. This utilized extensive qualification testing of devices that were selected. In addition, 20 bolt cutters for the libration damper were tested with the system at conditions varying from ambient, ambient pressure at temperatures of +80°C to -40°C, and a pressure of 1 x 10^{-5} torr at temperatures of +40°C and -10°C. The bolt cutters fired in all cases. The 4th stage bolt cutter for the clamp band release was tested at GSFC a total of 40 times with and without the spacecraft and at conditions varying from ambient to 1.0 torr at 102 rpm, to 1.0 torr at +543°F spinning at 82 rpm. The proto-flight spacecraft was tested at 1.0 torr spinning at 82 rpm. All bolt cutters fired. The Yo-Yo release was tested at Langley Research Center in the engineering test unit (ETU) under the direction of the Mechanical Systems Branch and in the T&E Dynamic Test Chamber once with the ETU and once with the proto-flight spacecraft in conjunction with 4th stage motor ejection tests. Both tests were successful. The dipole antenna release was successfully tested several times in conjunction with ejection tests. See Table 1 for a complete actuator history.

TEST MANAGEMENT

Test and Evaluation (T&E) Organization

In accordance with general T&E organization policy, a division support manager and five test program engineers were assigned from the division branches. Program engineers were responsible for planning, conducting, and reporting the results of tests in their respective areas of cognizance. T&E personnel assigned to the RAE program were:

R. M. Tysdal	T&E support manager
D. J. Hershfeld	Program engineer - mechanical tests Structural Dynamics Branch
A. L. Seivold	Program engineer - thermal tests Thermodynamics Branch
J. G. Bunevitch	Program engineer - quality engineering Quality Assurance Branch (now Quality Assurance Division)

R. W. Rhodes (J. W. Bailey)	Program engineer - T&E telemetry ground station Electronics Test Branch
C. A. Harris	Program engineer - magnetic tests Functional Test Branch

Table 1
Explosive Actuator History

TYPE	USE	QUANTITY ORDERED	QUANTITY FIRED	LOADING DATE
PC-10	4th Stage Release	50	31	October 1965
OA-213-2	Damper Release	50	26	August 1966
1MT-18AA	Dipole Release	40	13	April 1967 (Purchased)
1MT-140	Yo-Yo Release	400	54	August 1966 (Purchased)

Environmental Test Committee

The test committee was responsible for reviewing the test program, the test results, and the requirements for additional testing as required. Personnel assigned to the committee were:

J. T. Shea - Project manager

C. L. Wagner, Jr. - Assistant project manager

Dr. R. G. Stone or Delegate - Project Scientist

M. M. Grant - Electronic Systems Branch

E. D. Angulo or Delegate - Mechanical Systems Branch

R. M. Tysdal - T&E Division

J. G. Bunevitch - Quality Assurance Division

Cognizant test and design engineers and experimenters participated as required.

Review Committee

Management reviews of the RAE-A spacecraft were conducted by the Flight Readiness Review Committee, chaired by the Systems Review Office of the Systems Reliability Directorate. Although the membership changed somewhat throughout the program, the basic disciplines remained the same. The members of the Flight Readiness Review were:

H. W. Street (Chairman)	Systems Reliability Directorate
E. A. Rothenberg	Systems Reliability Directorate
N. C. Schaller	Systems Reliability Directorate
G. A. Branchflower	Technology Directorate
P. T. Cole	Technology Directorate
C. M. Mackenzie	Technology Directorate
F. T. Martin	Technology Directorate
R. G. Martin	Technology Directorate
J. K. Steckel	Technology Directorate
E. W. Travis	Technology Directorate
R. L. Van Allen	Technology Directorate
J. Evans	Projects Directorate
A. H. Sabelhaus	Projects Directorate

Members ExOfficio

H. E. LaGow	Assistant Director, Systems Reliability Directorate
D. G. Mazur	Assistant Director, Technology Directorate
L. H. Meredith	Space Sciences Directorate

A Flight Readiness Review for the Tracking and Data Systems Directorate was held separately. Members are not listed in this report.

A special review committee was appointed to review the 4th stage apogee kick motor, Thiokol TE-M-479. Members were:

H. E. LaGow (Chairman)	Assistant Director, Systems Reliability Directorate
H. W. Street	Systems Reliability Directorate
E. A. Rothenberg	Systems Reliability Directorate
A. R. Timmins	Systems Reliability Directorate
A. E. Jones	Technology Directorate
P. Karpiscak	Technology Directorate
E. W. Travis	Technology Directorate
K. S. Kaye	Technology Directorate

Member ExOfficio

J. T. Shea	RAE Project Manager

RAE-A SPACECRAFT TESTING

Engineering Test Unit (ETU)

The ETU spacecraft, or structural model, was used to determine the adequacy of the structural design including Yo-Yo despin and 4th stage motor ejection tests. The ETU was also used as a test bed qualifying some subsystems and solar cell paddles.

The ETU spacecraft was subjected to the following measurements and environmental tests:

1. Acceleration - 20 g^s launch mode (at NOL) 9 g^s orbital mode	June 1966
2. Weight, M. I., Static Balance	June 1966
3. Vibration - 3 axes launch mode, and 4th stage mode	June 1966
4. Spin-Up and 4th Stage Separation (Unsuccessful. Programming error.)	July 1966

5.	Yo-Yo Despin @75 rpm, 60 rpm both at 10 torr (at LRC)	August 1966
6.	Vibration - 3 axes, launch mode (Engineering solar array)	September 1966
7.	Dynamic Balance on VBF in DTC @60 and 150 rpm	September 1966
8.	4th Stage Motor Separation (Six tests up to 100 rpm and 1 torr) See Figure 5.	October 1966
9.	Vibration - 3 axes, launch mode	January 1967
10.	Vibration - 3 axes, launch mode (Modification for boom aspect cameras)	February 1967
11.	Vibration - 3 axes, launch mode flight levels (Qualify flight solar paddles)	March 1967
12.	Acoustic/pressure profile	July 1967
13.	Vibration - 3 axes, launch mode 3 axes, 4th stage (proto levels) (Launch mode flight levels for flight solar paddles. Then prototype levels for modifications with dummy paddles.)	January 1968
14.	Acoustic shaping prior to Protoflight Spacecraft	January 1968

Generally, all ETU testing was accomplished by using prototype levels.

ETU Test Results

Design adequacy of the RAE structural design was demonstrated after completion of the aforementioned test series. During testing, no structural failures occurred to the ETU. Other problems were as follows:

1. It was demonstrated during test No. 7 that balancing the RAE-A configuration in a vacuum was not necessary to conform to the balance specification.

2. During vibration tests (No. 9) in January 1967, on the C-210 shaker system, difficulties were encountered in applying specification levels in the

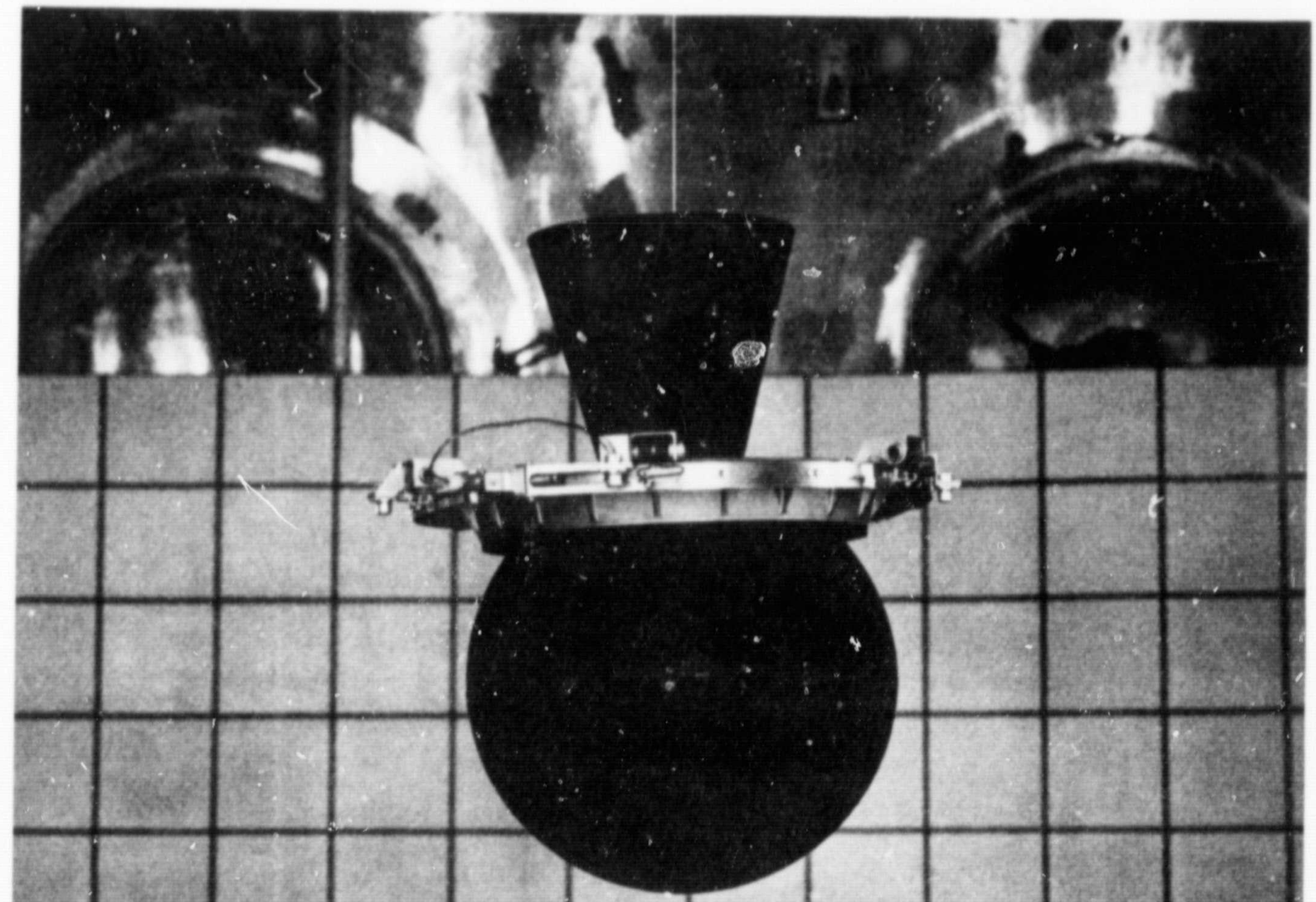

Figure 5. Ejection Test of 4th Stage Motor

lateral axes due to shaker overload dumps. The random vibration specification level (9.2 g-rms, 20-2000 Hz) could not be maintained within the maximum power capability of the shaker. The cause was a combination resonance of the slip table and the fixture above 1000 Hz. The solution was to limit all lateral vibration tests of the spacecraft to a maximum frequency of 1000 Hz in both sine and random. To test the spacecraft above 1000 Hz, an acoustic noise test was added.

3. Test No. 10. Some difficulty was encountered in the lateral axes random vibration tests in that the bolts (#10-24 UNC) holding the Delta adapter to the vibration fixture loosened after about one minute of vibration. Post-test examination of these bolts revealed yielding in tension, probably due to the high moment loads which occur at the 3 sigma peaks.

4. Test No. 11. About eighteen solar cells on the ETU paddle contained collectorstrip peeling (clean break type) following vibration. Solution was to strip back the Sylgard 182 on all paddles with more than a 10 mil coating. This peeling was more pronounced in thermal-shock tests and the vibration test was only part of the investigation. Another recommendation was to store paddles in a controlled environment (vacuum or inert gas at 25°C).

5. Test No. 13. It was necessary to increase the marmon band bolt tension from 1500 pounds to 2500 pounds in order to complete random tests in the lateral axes. Also, some screws holding the bookends and flatpacks required tightening. An engineering model of a boom tip target (this type was not flown) suffered a fracture of two ribs.

Thermal Test Unit (TTU)

The TTU spacecraft was originally designed to determine the adequacy of the thermal design. Since the spacecraft was structurally sound, it was also used to support live 4th stage motor firings at AEDC, to qualify solar cell paddles in vibration, and to support 4th stage separation tests.

The following environmental tests were accomplished:

1. I^2R (skin heaters) test (Thermophysics Branch)	Several months prior to December 1966
2. Solar-Vacuum test Phase I - 90° aspect - Battery Phase II - 90° aspect - Tape Recorder Phase III - Maximum Shade Orbit (See Figure 6)	December 1966

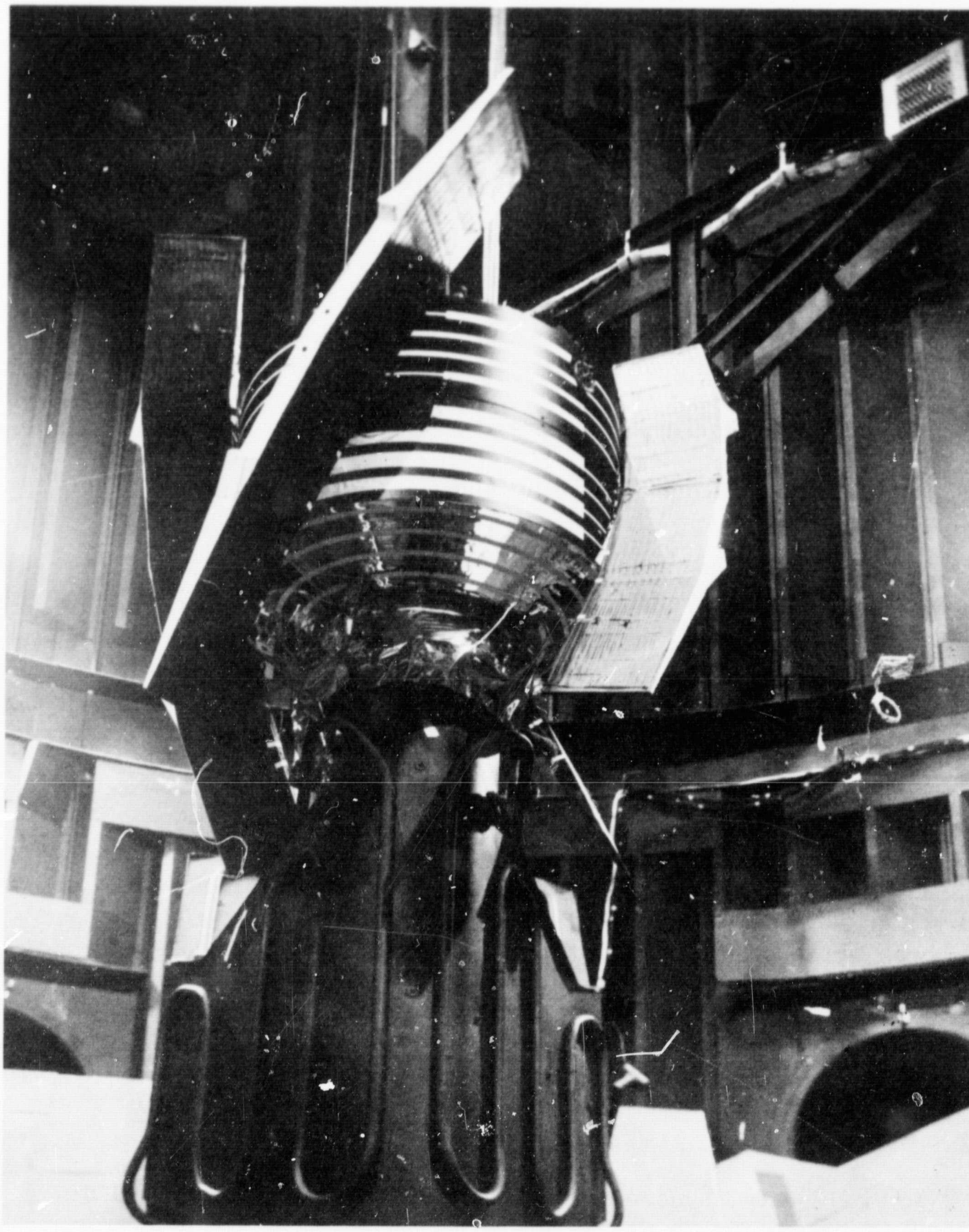

Figure 6. Thermal Test Unit in Space Environment Simulator

3. Measurement of unbalance prior to spin firing tests of fourth stage motor at AEDC	January 1967
4. Vibration 3 axes - launch mode with prototype solar array	January 1967
5. Spin fire fourth stage motors (2) at AEDC	April 1967
6. Vibration 3 axes - launch mode flight level acceptance of two solar cell paddles	May 1967
7. Separation of fourth stage motor @82,103 rpm and 1.0 torr also 0.6° tilt test	July 1967
8. Separation of fourth stage motor at 280°C	August 1967
9. Separation of fourth stage motor statically unbalanced	September 1967

TTU Test Results

The thermal design of the RAE-A was verified. Very good correlation was obtained with the temperature predictions and the I^2R test performed by the Thermophysics Branch. During test No. 4, similar vibration facility problems, as described for the ETU, were encountered with the same solution. (Refer to References 5 and 6.)

Proto-Flight Spacecraft

Environmental tests of the proto-flight spacecraft had two objectives. First, to qualify the design at stresses greater than that expected during launch and orbit, and second, to qualify the spacecraft for launch. A modification to the vibration specification allowed the spacecraft to be tested at design qualification levels but at flight acceptance time durations. Table 2 classifies the malfunctions during testing.

The proto-flight spacecraft (RAE-A) was subjected to the following measurements and tests:

1. Preliminary Magnetic Measurement (Primarily for 4th stage motor hardware, wiring harness, and magnetometer)	October 1966

2. Integration Temperature Test (-20°C to +57°C Experiment converter at +60°C)	March 1967
3. Initial Dynamic Balance	September 1967
4. Initial Weight and Center of Gravity (606 lbs with 4th stage)	September 1967
5. Initial Mass Moments of Inertia (Figure 7)	September 1967
6. Initial Magnetic Measurement (Reference 7)	October 1967
7. Radio-frequency Interference (RFI)	November 1967
8. Initial Magnetic Measurement and Magnetometer Calibration	December 1967
9. Quick-check Dynamic Balance	January 1968
10. Vibration (Figure 8) - 3 axes, launch mode 3 axes, 4th stage motor end	January 1968
11. Acoustic Noise/Rapid Pumpdown (Figure 9)	February 1968
12. Acceleration (18.5g 3rd stage, 8.6g 4th stage 3 minutes each)	February 1968
13. Thermal-vacuum (-20°C and +55°C) Figure 10	February - March 1968
14. Fourth-stage motor ejection @82 rpm, Yo-Yo despin (cables restrained) @82 rpm, Libration damper system deployment @+38°C and -10°C non-spinning, and Dipole antenna release (spools restrained)	March 1968
15. Radio-frequency Interference (RFI)	April 1968
16. Temperature Calibration (+19°C, -5°C, +35°C, -6°C, +20°C)	April 1968

17.	Radio-frequency Interference (RFI)	May 1968
18.	Solar-vacuum (90° solar aspect -Y axis and +Y axis in sun)	May 1968
19.	Final Random Vibration (Thrust axis, flight level, 2 minutes)	May 1968
20.	Final Magnetic Measurements, Magnetometer Calibration, and Torquemeter Test	May 1968
21.	Final Weight (603 pounds with 4th stage motor)	May 1968
22.	Final Dynamic Balance (Figure 11)	May 1968
23.	Final Mass Moments of Inertia	May 1968

Proto-Flight Test Results

Appendix C, RAE-A Proto-Flight Spacecraft Performance Review, presents a detailed account of the performance of the proto-flight spacecraft. Highlights of the spacecraft program follow:

1. During initial magnetic systems tests, the perm moment of the spacecraft was compensated well below the desired level of 400 pole cm. Attitude read out of the magnetic sensors was within the tolerance of 2 degrees for all modes of operation.

2. Vibration testing results were outstanding with no major problems and all systems performing satisfactorily. Primary resonance in the lateral directions was in a band between 28-31 Hz and in the thrust direction between 80-95 Hz with a peak at approximately 88 Hz.

3. No problems were encountered in the acoustic noise test combined with rapid pumpdown or in acceleration tests.

4. Results of the thermal-vacuum test are as follows: the spacecraft completed a corona check, one exposure cycle of 12 hours each at -20°C and +55°C, a 48 hour cold soak, a 96 hour hot soak, two exposure cycles of 12 hours each at -20°C and +55°C, and finally a checkout at -20°C. The total time under vacuum including transitions was 410-1/2 hours.

Table 2
Classification of Malfunctions, RAE-A

Spacecraft		Design*		Quality**		Test Error***		Unknown		Total
Name	Mod	Sub-systems	Experi-ments	Sub-systems	Experi-ments	Sub-systems	Experi-ments	Sub-systems	Experi-ments	
RAE-A	Proto-Flight	5	0	12	2	3	0	0	0	22
Subsystems and Experiments tested at T&E		2	0	19	0	2	0	0	0	23
Subsystems and Experiments not tested at T&E which were reported		7	none reported	19	none reported	2	none reported	2	0	30

*Includes failures where redesign was considered necessary.
**Includes fabrication, out-of-tolerance, material, and assembly errors.
***Includes GSE and facility test errors.

The test was stopped after the initial cycle in order to correct anomalies which had occurred. Portions of the pyrotechnic matrix did not respond to commands at low temperatures. Inspection of the related electronics revealed six capacitors of incorrect value were used. These were replaced. The tape recorder did not deliver data during playback at low temperatures. Questionable data was then received at ambient temperatures. Investigation revealed degraded tape and oxide buildup on the recording playback head, a core shift, and gap change. The number 3 transport replaced the number 1 transport and except for a short loss of sync at -20°C, the operation was satisfactory to the end of the test. For launch, the original head was replaced with an improved AMC head and qualified as a subsystem.

Three anomalies which were typical at -20°C were: (a) the undervoltage clock number 1 did not always count properly, (b) the electron trap second "0" reference calibration signal was out of tolerance, and (c) the damper aspect provided no reading below -10°C.

Anomalies at +55°C include occasional cross talk from command 56 (Hi-power transmitter able/disable) to command 66 (Lo-power transmitter ON/OFF), a one-time loss of encoder #1 analog data which probably was a bad connector between the encoder converter and the encoder, and a one-time erratic starting behavior of undervoltage clock number 2.

The overall evaluation of the thermal-vacuum test is considered to be very good. The expected maximum temperature range during the first 200 days of orbit are -5°C to +33°C, whereas the test temperatures were -20°C and +55°C. Actual expected temperatures should alleviate all temperature sensitive problems encountered. (Refer to Reference 8 for thermal-vacuum details.)

5. The radiating signals emanating from the spacecraft are within the limits specified by MIL-I-6181D. A broadband radiated test was conducted from 150 KHz to 1.0 GHz, and a radiated susceptibility test was conducted in the frequency region 10 to 424 MHz. The extraneous signals recorded at 34, 72, and 95 MHz were reduced to the noise level of the test receiver when the spacecraft was placed on internal power with the umbilical removed; the signal present at 68 MHz, however, was unaffected. During the susceptibility test, the spacecraft suffered degradation of performance to the battery charge dump circuit in the frequency region 34 to 36 MHz. The radiated power was reduced to determine the threshold of susceptibility. Normal operation occurred at a radiated power of 1.2 watts. (Reference 9)

During STADAN tests, both spacecraft command decoders acknowledged standard command addresses immediately above and below that assigned. Both decoders were desensitized to all but proper addresses.

The spacecraft was fitted with six rf filters in the experiment antenna leads which improved the residual rfi.

6. Solar-vacuum equilibrium was obtained for two positions of the spacecraft. The uniformity obtained over the portions of the spacecraft which were not shadowed by other parts of the spacecraft was ±5%. Collimation half angle was 1.5°.

   A majority of the test temperatures compared within 5° C of the predicted temperatures of corresponding nodes in the computer model. The lack of correlation on two internal nodes is probably due to incorrect coupling factors, and on the paddles is probably due to unknown radiative inputs from the chamber and/or reflections from the spacecraft. (Reference 5)

7. Final magnetic measurements indicated a significant increase in the Z-axis moment from previous measurements. Following deperm and compensation, all moments were approximately 200 pole-cm on each axis which was verified by a torquemeter test.

8. The final weight, including fourth-stage motor and hardware was 603 pounds. The spacecraft with fourth-stage ejected and Yo-Yo released was 414 pounds. (Reference 6)

9. The spin to tumble moment of inertia ratio with the fully loaded fourth-stage motor was 1.09; and with the spacecraft alone was 1.20. (Reference 6)

10. Final balance at GSFC and at the Western Test Range were well within acceptable limits, and the composite could easily tolerate slight variations from the final measurement without exceeding the specification.

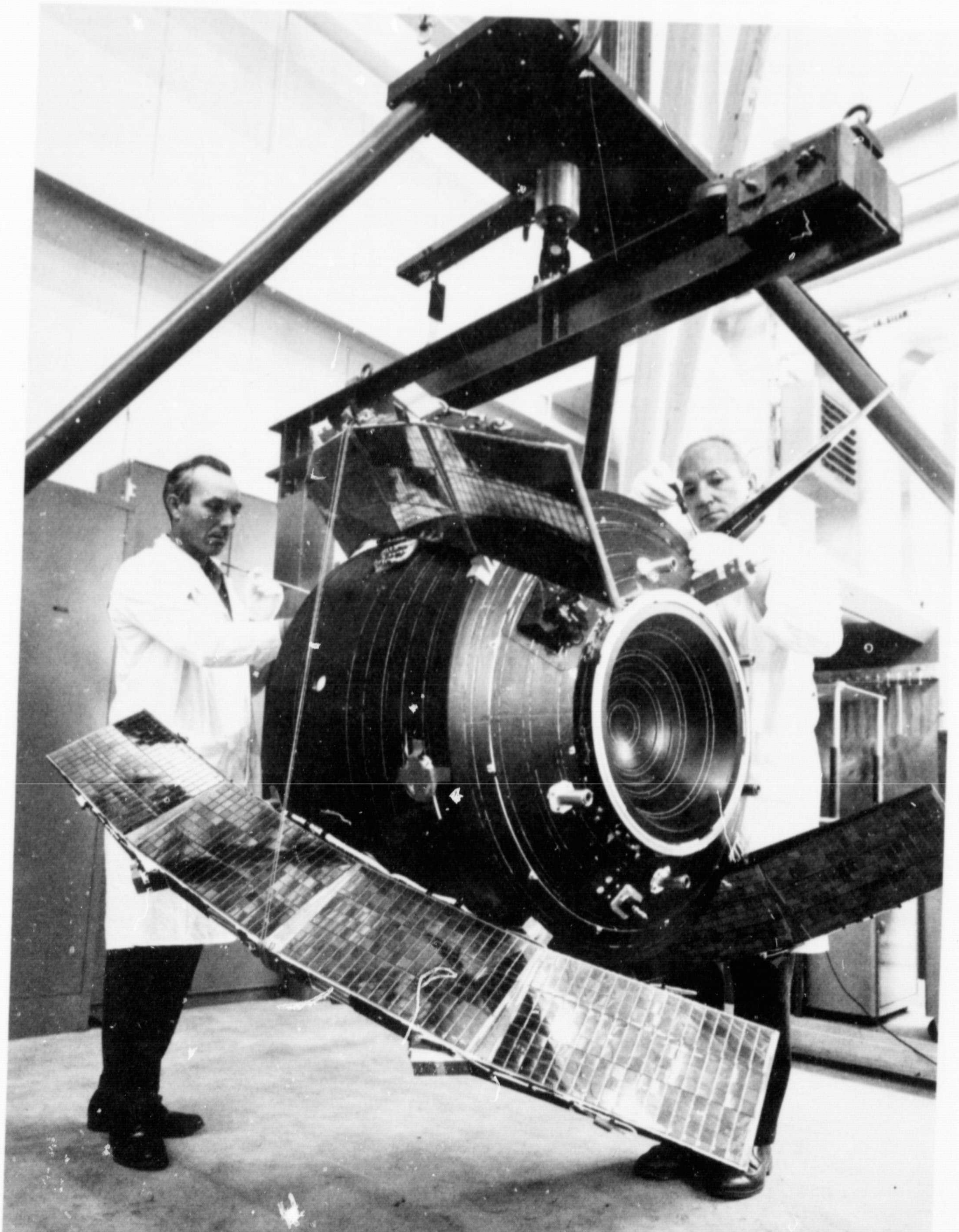

Figure 7. RAE-A on Moment of Inertia Device

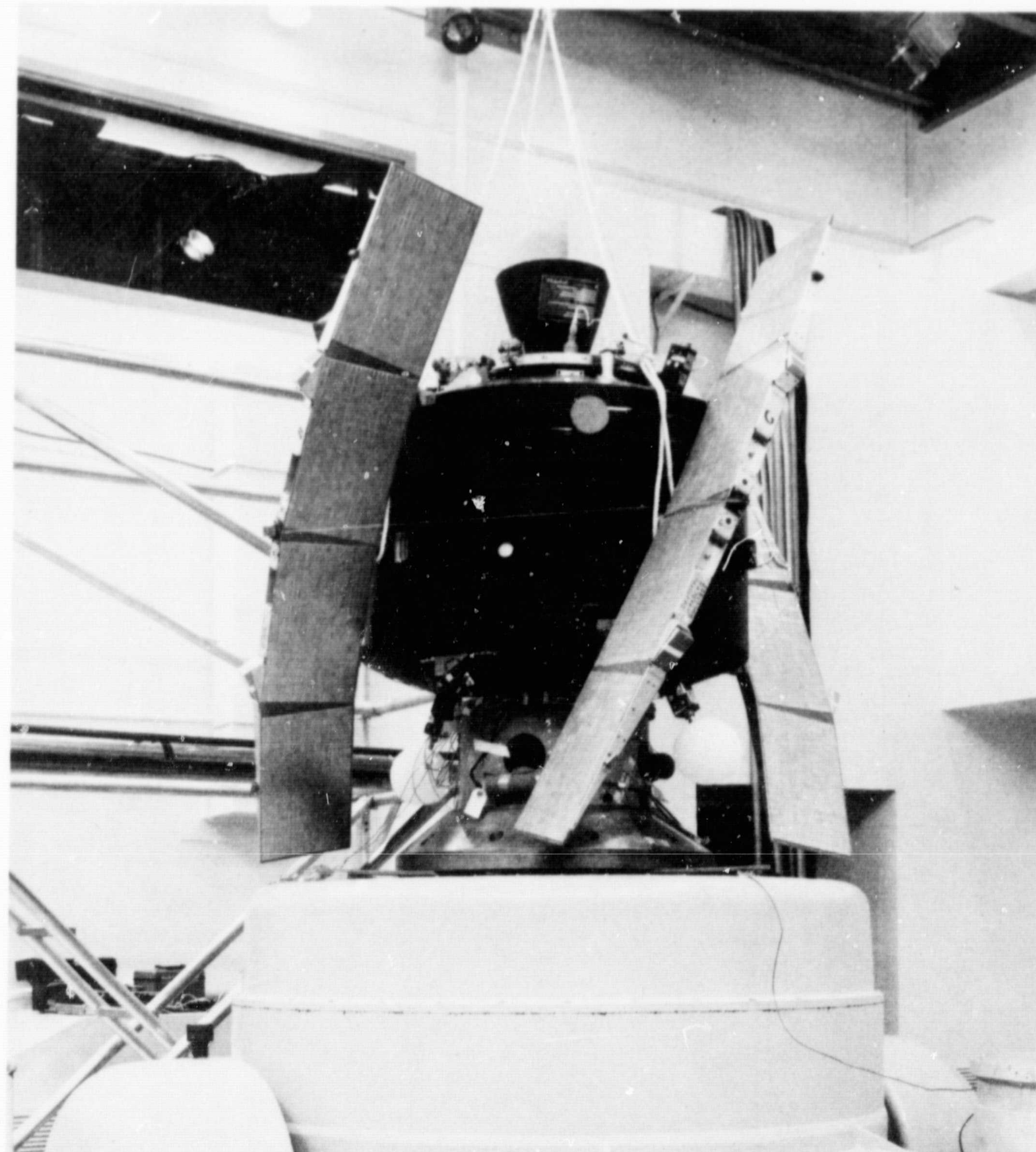

Figure 8. RAE-A on C-210 Vibrator

Figure 9. RAE-A in Preparation for Launch Phase Simulator (LPS)

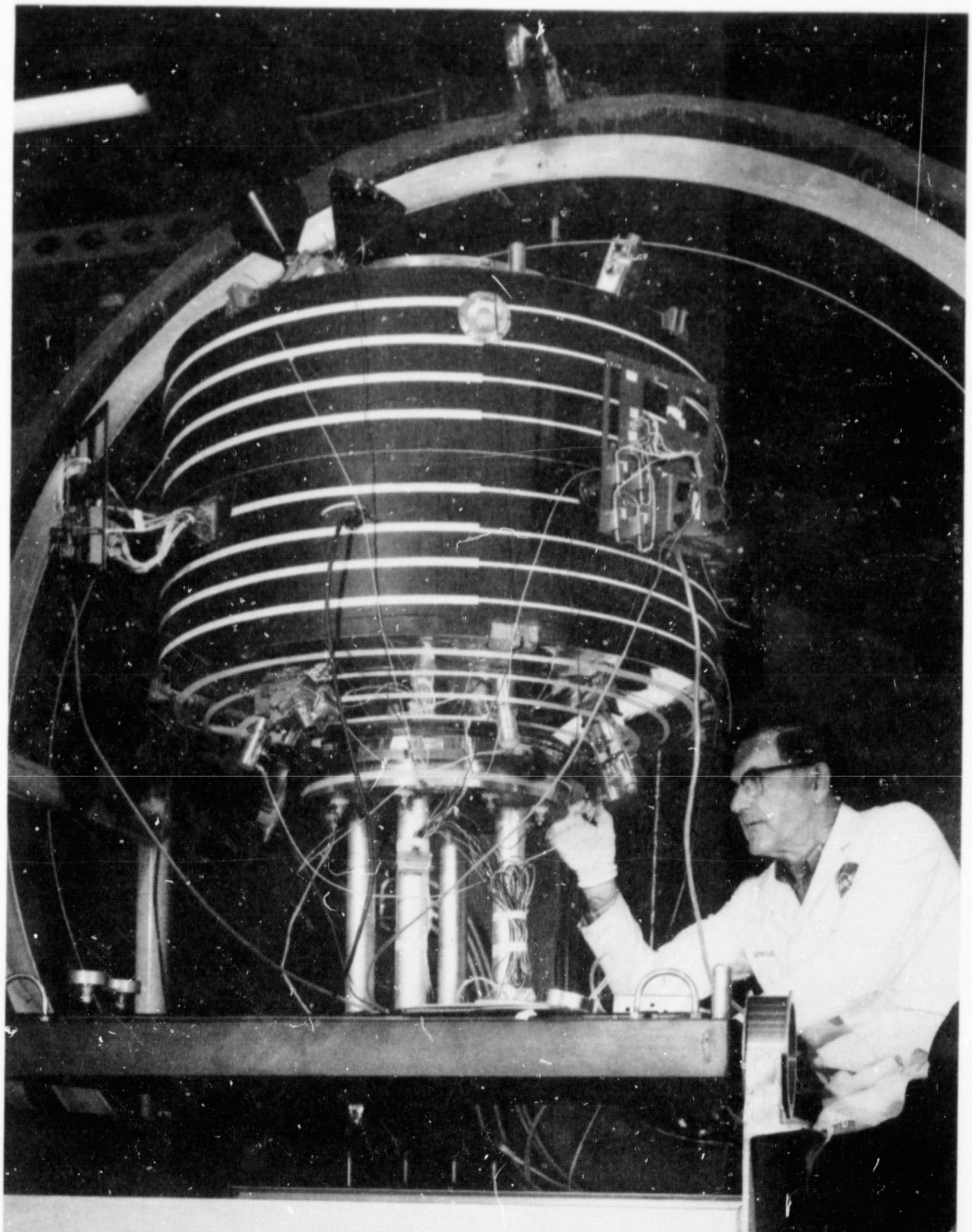
Figure 10. RAE-A Prior to Thermal-Vacuum in 8 x 8 Chamber

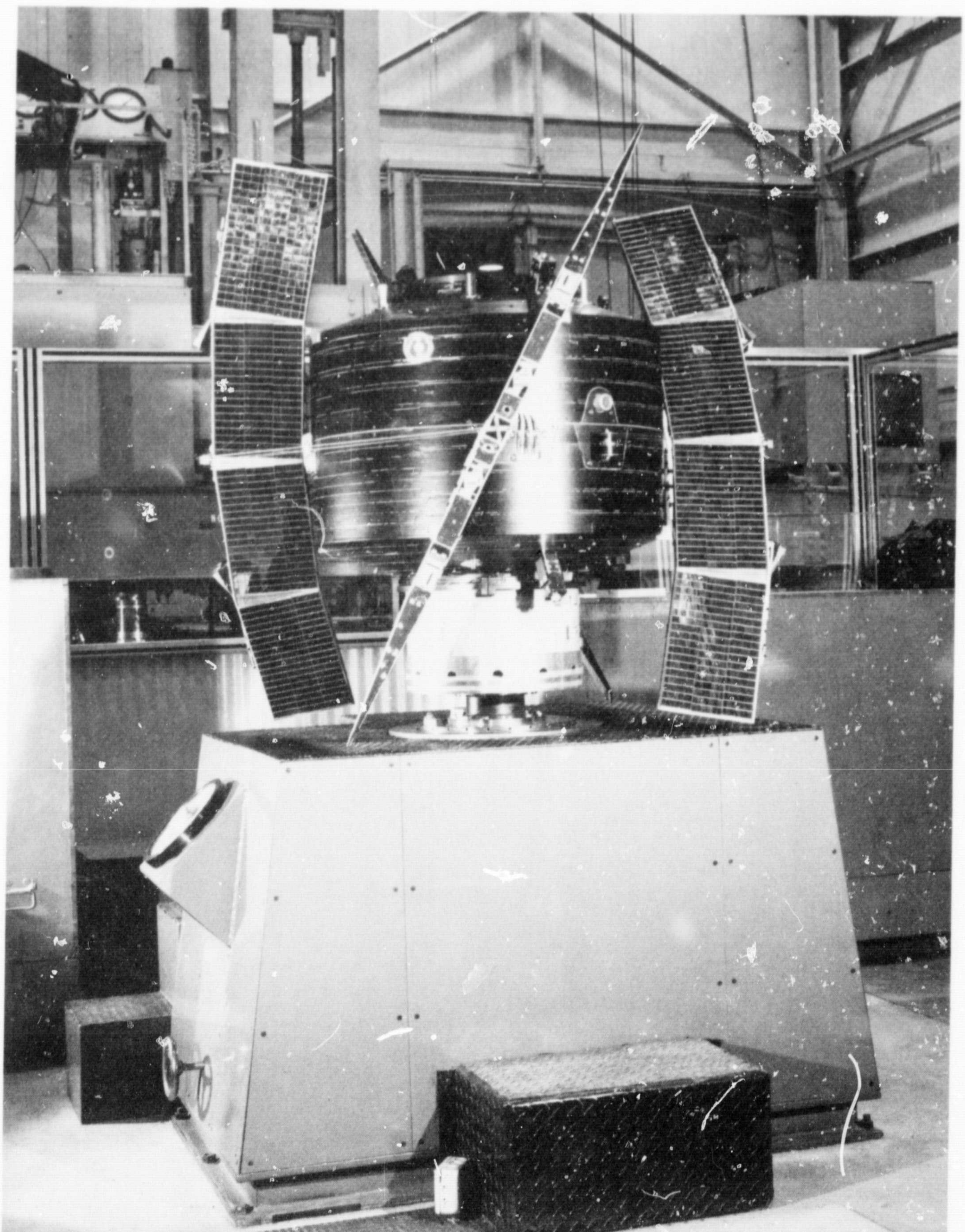

Figure 11. RAE-A on Vertical Balancing Facility (VBF)

Summary of Design Reviews

The RAE-A proto-flight spacecraft was judged acceptable for flight at the Flight Readiness Review held at GSFC on June 5-6, 1968. A summary of all major design reviews is as follows:

Design Review Minutes
June 15, 1965
Summary of Recommendations
of Meetings on June 4, 7, 10, and 11

1. Consider a sun-synchronous orbit since this would greatly simplify the dynamics.

2. Place a definite tolerance on the circularity of the orbit.

3. Prepare an RFI specification for the guidance of subsystem designers.

4. Devote more effort to the study of the boom deployment and stabilization problem.

5. The Delta Project Office should be given full responsibility for the propulsion system, including the selection of a fourth-stage motor. Defer the award of contract until orbit and weight of spacecraft are firmly established.

6. Consider an orbit up to 10,000 Km and 1000 foot booms.

7. Consider series regulators as back-up to the power converters. Require input voltage of all subsystems to be slightly lower than minimum battery voltage.

8. The effects of satellite magnetic fields should be considered, and a specification prepared giving the maximum allowable stray fields that can be tolerated.

9. The planned redundancy should be retained if possible.

10. Provide some rear hold-down for the electronic card stack.

11. The boom tip measurement system study seems to be behind schedule.

12. A frequently updated milestone chart or schedule should be established and distributed to all subsystem designers.

13. Efforts to develop the perforated boom should be given high priority.

Design Review Minutes
July 5, 1966
Summary of Recommendations
of Meetings on March 2 and 3, 1966

A. Dynamics

1. Investigate long term libration stability.
2. Look at straight forward deployment of booms.
3. Look at a higher orbit (up to 10,000 Km).
4. Further computer work should be done.

B. Test Vehicle Proposal

1. Investigate the value of a piggyback experiment aboard an improved, thrust augmented Delta. This will test out:

   (a) Flexible Dynamics
   (b) Vidicon Viewing System
   (c) Antenna Thermal Control
   (d) Libration Damper
   (e) Radio Astronomy Experiment

C. Structure

1. No major problems exist.
2. Consider computerized inertia programs.
3. Do not separate fourth-stage motor for 3 to 5 minutes minimum.
4. Thermal soak back from fourth-stage motor and thermal isolator should be considered.
5. Provide additional leads or protection (epoxy) to printed circuit return lines on paddle substrates.
6. Examine conductivity through fiberglass substrate skins.

D. Thermal Design

1. Investigate the accuracy of solar absorptance measurements of silver coatings.
2. Insure that assumptions regarding attitude of the spacecraft in the gravity oriented configuration are valid.

E. Boom Tip Viewing System

1. Do not limit the choice of sensor to the 1/2-inch vidicon.
2. Specify the intent of the sun shutter.
3. Specify the field readout time for each camera.
4. The image capability of a vidicon above +40°C is nil for all practical purposes.

F. Solar Aspect System

1. Satisfactory.

G. Magnetic Control System

1. Ensure failure of magnetometer circuit does not place more than 10 volts with respect to spacecraft ground on any telemetry input.

H. Experiments, Command and Data Systems

1. Burst Reciever - Filter C-2 on the noise generator should have two in series or R-3 should be increased unless it is a fuse.
2. Capacitance Probe - Decide whether to measure at 2 or 4 frequencies.
3. Impedance Probe - See if C-probe and Z-probe could be combined.
4. Ryle-Vonberg Radiometer - Consider percentage of electronics devoted to obtaining refined accuracy and/or resolution. Is it necessary?
5. Transmitter, Command Recievers, Command Decoder - Satisfactory.
6. Electron Trap Experiment - Investigate simplification of circuit.

I. Encoder

1. An overall redesign is not recommended.
2. Look at clocking and loading characteristics of T. I. integrated circuits.
3. Spiking problems could be helped by distributing capacitors on the supply voltage, one to each submodule.
4. Verify safety factor of emitter follower gate outputs.
5. Look at transformers required for gating. Consider FET gates in series with a single transistor gate at the input of each H/W converter.
6. Insure correct translation from logic diagram to wiring diagram.

J. Tape Recorder

1. All transistor logic types could be restricted to the complementary pair of SP100 and SN100.

2. The use of 1N645 type diodes could be replaced with 1N4153 or similar hi-rel planar types except where reverse voltage ratings would be exceeded.
3. Use less voltage for operating complementary flip-flops.
4. Determine the maximum magnetic field that can be tolerated by the recorder without interference.

K. Command System

1. Decoder cards should not be conformal coated before potting in foam.

L. Programmer

1. Resolve the delay for the under voltage cutoff.

M. Power System

1. Performance specifications, environmental specifications, RFI specifications, QA requirements, and design requirements, need to be finalized.
2. Establish requirements for under voltage, overload current sensor, charge regulator and dump circuit.
3. Look at effect of using/or not using a plume shield on power.

N. Systems Integration

1. Distribute RFI requirements.
2. Examine power "dump" circuit for failure modes which would cause dump transistors to remain on.

O. Test and Evaluation

1. Data from tests should be made available sooner.
2. Consider special tests for evaluating long antenna booms.
3. See attachment for further discussion.

P. Reliability and Quality Assurance

1. Direct Planning Research Corporation (PRC) to make a detailed reliability assessment of the Programming System, paying particular attention to the Pyrotechnic Programmer.

Apogee Kick Motor Design Review
May 6, 1968
Summary of Recommendations of March 27, 1968

1. Provide a thermal blanket over the exposed portion of the motor case.

2. Cover the open end of the nozzle cone with a sheet of metalized plastic to reduce heat loss. Sheet should be perforated to allow trapped air to escape.

3. Investigate whether the specified 1% tolerance on the total impulse can be held.

4. Apply firing current for at least 20 milliseconds.

5. There should be a minimum delay of five minutes after burnout, before the kick motor is ejected from the spacecraft.

6. As a safety precaution, a resistor should be installed across each of the firing circuits on the output side of the firing relays.

RAE-A Flight Readiness Review

Meeting - June 5, 6, and 7, 1968
Review Committee - June 11, 1968

1. The spacecraft had completed environmental tests with relatively few malfunctions, and was judged to be acceptable for flight.

2. Action of atmospheric moisture on solar cell interconnection tabs has caused them to lift. All cells having four or more of the eleven redundant tab connections degraded will be reworked before launch.

3. The thermal absorbtance of the two downward pointing 750 foot booms was higher than desired. A special dynamics study predicted satisfactory system performance.

4. An additional launch system error analysis and dynamics study was made to predict the capability of the overall launch system, including the apogee kick motor, to place the spacecraft in a circular orbit with the required tolerance.

5. A decision was made not to "bias" the orbit away from nominal from transfer orbit to circular orbit.

6. The lower 750 foot booms will not be extended beyond 450 feet until a thorough in-orbit analysis is complete.

7. The 60 foot dipoles shall not be extended until the dynamic behavior of the system is established.

8. A special RFI test on the external power supply was performed in the region 30-35 MHz to try to verify the spacecraft anomaly as being a GSE problem.

<u>Performance in Flight</u>

The RAE-A spacecraft, Explorer XXXVIII, was launched successfully from WTR at 1726 Universal Time (1026 a.m. Pacific Daylight Time), on July 4, 1968.

The following sequence of events occurred:

1. The Delta vehicle DSV-3J-1 (Delta 57) placed the spacecraft into an initial transfer orbit. The initial orbital parameters were:

Apogee	5883 Km
Perigee	639 Km
Inclination	120.1 degrees
Eccentricity	0.272
Sun Angle	126.0 degrees
Spin Rate	91.6 rpm

   All parameters were nominal except for the spin rate which was planned to be 74.5 rpm.

2. The orbit was circularized on July 7. The apogee firing was biased by firing two and one-half minutes before apogee to obtain a minimum eccentricity. The circular orbit parameters are:

Apogee	5866 Km
Perigee	5841 Km
Inclination	120.8 degrees
Eccentricity	0.001
Orbit Period	224.4 minutes
Spin Rate	93 rpm

3. The spacecraft was despun by a Yo-Yo on July 8, leaving a residual spin of 2.8 rpm. The magnetic despin was turned on to reduce the residual spin to zero.

4. The hysteresis damping mode was initiated on July 10. Also, the Z axis magnet was turned on to lock on the Earth's magnetic field. The four antenna mechanisms were uncaged in preparation for base capacitance measurements.

5. All experiments were checked out for a short time on July 11.

6. The antenna aspect cameras were turned on July 13 for checkout.

7. The libration damper system was deployed out of the spacecraft and libration damper booms uncaged on July 16.

8. The 750 foot booms were extended to 460 feet, the libration damper booms to 280 feet, and the dipole booms to 60 feet on July 22. Computer simulations predicted optimum time for second deployment for the Dead Beat to within seconds. This Dead Beat deployment was executed with such precision that little or no residual libration energy was left in the system, however, damper boom deployment introduced some. The spacecraft was stablized to within ±7° on roll and pitch and ±20° on yaw. Initial deflection of long booms is about 40 feet. Spacecraft placed in data mode.

9. One full orbit of boom tip video data was collected on July 30.

10. On August 21, the spacecraft was stable to ±2° in pitch and roll and ±10° in yaw. The boom tip motion is no greater than ±15 feet.

11. RAE-A booms were successfully extended to 600 feet on September 24. The programmed deadbeat technique was used throughout the program.

12. On October 8, the main booms were extended to 750 feet each and the libration damper booms to 315 feet each. The final status is as designed:

Antenna System:	1500 feet tip-to-tip
Libration Damper:	630 feet tip-to-tip
Dipole:	120 feet tip-to-tip

Central body oscillations remain within predictions and antenna motions are well controlled.

On September 12, 1968, about 2 months after launch, Explorer XXXVIII was officially declared a success. (References 10, 11, and 12 furnish details.)

Anomalies After Launch

Since launch, the following anomalies have occurred:

1. Since July 22, the electron trap has been on continuously. The only spacecraft effect is a continuous power drain of 0.13 watts.

2. On September 3, the fine channel on Ryle-Vonberg Radiometers #2, 3, and 4 failed. The thermistor circuit which acts as calibration for the fine channel is suspected to have failed. However, with temperatures stable as they are, the same data is obtainable as with the temperature compensated "fine" channel. Also, Radiometer #1 is redundant to Radiometer #2.

3. For five days, starting September 15, the tape recorder experienced periodic loss of PCM lock on the playback. The playback performance recovered somewhat (76% recoverable at that time), but on October 30 it was necessary to go to real-time data collection due to excessive jitter on the tape recorder data.

4. About September 18, one upper vidicon television camera failed. Analysis indicated a probable base to emitter short in either one of two transistors in the video circuit caused by a migrating or floating piece of material in the transistor. The failure was current limiting, so no interface damage occurred. On December 12, the camera recovered. Camera data is monitored once each week until the spacecraft goes into shadow orbits. The camera yoke temperature has varied between 27°C to 38°C.

5. Examination of boom tip data has shown that upper target information is obtainable, and as suspected, lower targets can not be seen against the bright Earth.

Thermal Performance

During the transfer orbit, the temperatures were basically nominal but on the low side of the tolerance zone predicted. The fourth stage motor was fired at +5.3°C which was as predicted.

After three months in orbit, the temperatures are nominal with no thermal anomalies existing. The angle between the orbital plane and the solar vector was initially 31°, with the spacecraft "+Y" axis facing the sun. The angle peaked at 65° on October 25, and will decrease towards zero producing a shadow condition at an angle of 30° on January 20, a maximum shadow condition at an angle of 0° on March 20, and again a 100% sun condition, but now with the spacecraft "-Y" axis facing the sun, on May 15, 1969.

The maximum temperature gradient across the upper two perforated interlocked 750 foot booms (Serial Numbers 2 and 5) as determined from dynamics and antenna shape is estimated at 3/4 to 1°F. This agrees quite well with the pre-flight predictions of 0.7°F for a measured silver absorptance of 9% and 1.1°F for an absorptance of 10.5% for boom No. 2 and boom No. 5, respectively. (Refer to Reference 11.)

Project "Firsts"

1. First to use the Delta DSV-3J-1 with it's new TE-364 third stage.
2. First flight of the TEM-479, fourth stage apogee motor.
3. The largest dimensional spacecraft in orbit (1500 feet tip-to-tip).
4. First spacecraft with directional antennas for measuring low frequency radio emissions.
5. First "RFI quiet" spacecraft.
6. First to fly a coulombmeter charge control.
7. First spacecraft to fly "zippered" perforated booms.
8. First to fly booms longer than 135 feet (booms are 750 feet long).
9. First to use a full deadbeat boom extension technique—which completely removed initial transients and achieved immediate gravity gradient capture.
10. First spacecraft to enter the realm of flexible body dynamics.

SUBSYSTEM TESTING

Subsystem Tests

The subsystem test philosophy was in accordance with accepted GSFC practice. Since there is no general policy which requires a formal subsystem environmental test program as a prerequisite to systems tests, the program was established based on previous experience, accepted practice, and the following considerations:

1. The consequence of a subsystem failure during a systems test.

2. Favoring the start of systems testing at the expense of reduced or eliminated subsystem tests, if necessary.

3. The state-of-the-art development of a subsystem which required more environmental testing than an off-the-shelf flight proven design.

4. Vendor supplied subsystems contracturally required an environmental test program.

5. Since RAE-A was an in-house program under the direct control of the Project Manager, more flexibility could be exercised with the subsystem program in terms of schedule, expense, and manpower required.

6. Spare subsystems were not considered fully qualified until they had successfully passed vibration, thermal-vacuum, and (if applicable) magnetics.

7. The emphasis on RAE-A subsystem testing was in vibration acceptance and magnetic measurements. Since the great majority of subsystems were temperature tested in GSFC laboratories outside of T&E, the project waived most thermal-vacuum tests on the subsystem level. Exceptions to this were solar-cell paddles where the combined thermal-shock, thermal-vacuum tests were of prime importance, and a special series of thermal-vacuum tests on the libration damper and boom assembly. (See Table 3.)

Subsystem Malfunction Reports

The RAE-A test plan and specifications established the Quality Assurance Branch of T&E (later to become the Quality Assurance Division) to be responsible for follow-up on malfunction reports at GSFC and primary responsibility for reports from contractors on subsystems and experiments. Appendix E and

Table 3
Subsystem Tests

Subsystem Category	Number of Sub-systems Tested	Total
3-axes random vibration, flight levels	62	
3-axes sine and random vibration, flight levels	34	
3-axes sine vibration, flight levels	2	
3-axes sine and random vibration, prototype levels	11	109
Magnetic measurements	52	52
Thermal-vacuum, prototype levels	3	
Thermal-vacuum, flight levels	16	19
Weight and center of gravity	8	8
Moment of inertia	3	3
Acceleration, prototype levels	2	2
Grand Total		193

Experiments Category	No. of Experiments Tested
3-axes sine and random vibration, flight levels	3
3-axes random vibration, flight levels	12
Total	15

Solar Cell Paddles (10 Paddles)

Category	No. of Tests	Total
Magnetic measurements	19	19
3-axes sine and random vibration, prototype levels	1	
3-axes sine and random vibration, flight levels	10	11
Thermal-shock, thermal-vacuum	17	17
Weight and center of gravity	1	1
(See Appendix D)		
Grand Total		48

Table 3 (Continued)
Subsystem Tests

Boom damping tests in DTC	57
Boom in solar-vacuum	1
Total	58

Special Subsystem Tests

Television camera lens - vibration, thermal-vacuum, sun gun
31 Potter and Brumfield relays - vibration
75 Filtor relays - vibration
25 relays - magnetic
20 connectors - magnetic
10 boom samples - magnetic
Tape recorder transport - 10 day thermal-vacuum test
Non-magnetic bolt cutter - temperature
Fourth-stage monitor - calibration under acceleration
60 foot dipole boom - free fall deployment
Inertia booms - deployment
10 bolt cutters - firing test
Libration damper and Fairchild boom subsystem - Vibration, deployment, temperature, thermal-vacuum

reference 13 summarize the malfunction reports available. The antenna aspect camera and the antenna mechanism were prime efforts in this program. Table 2 categorizes subsystem malfunctions.

750 Foot Boom Dispenser Mechanism

Since the development and test of the 750 foot booms was unique for this mission and vital for the RAE success, the following subsystem information is included in this report.

Boom Testing

Very early in the program, in 1965, a series of tests were performed in the T&E Dynamic Test Chamber by measuring the free vibrations of the boom by means of a bending moment transducer mounted at the root. Essentially, these tests consisted of observing the motion of a vertical cantilever boom after release from an initially displaced configuration. (See Figure 12.)

Of particular interest in these tests were the frequency of oscillation of the boom from which the bending rigidity (EI) could be calculated, and the rate of change of amplitude with respect to the number of cycles of oscillation, which was used to determine a damping coefficient in terms of the logarithmic decrement. These tests were performed in a vacuum environment of 10^{-2} torr in order to minimize the effects of air drag. (See Reference 14.)

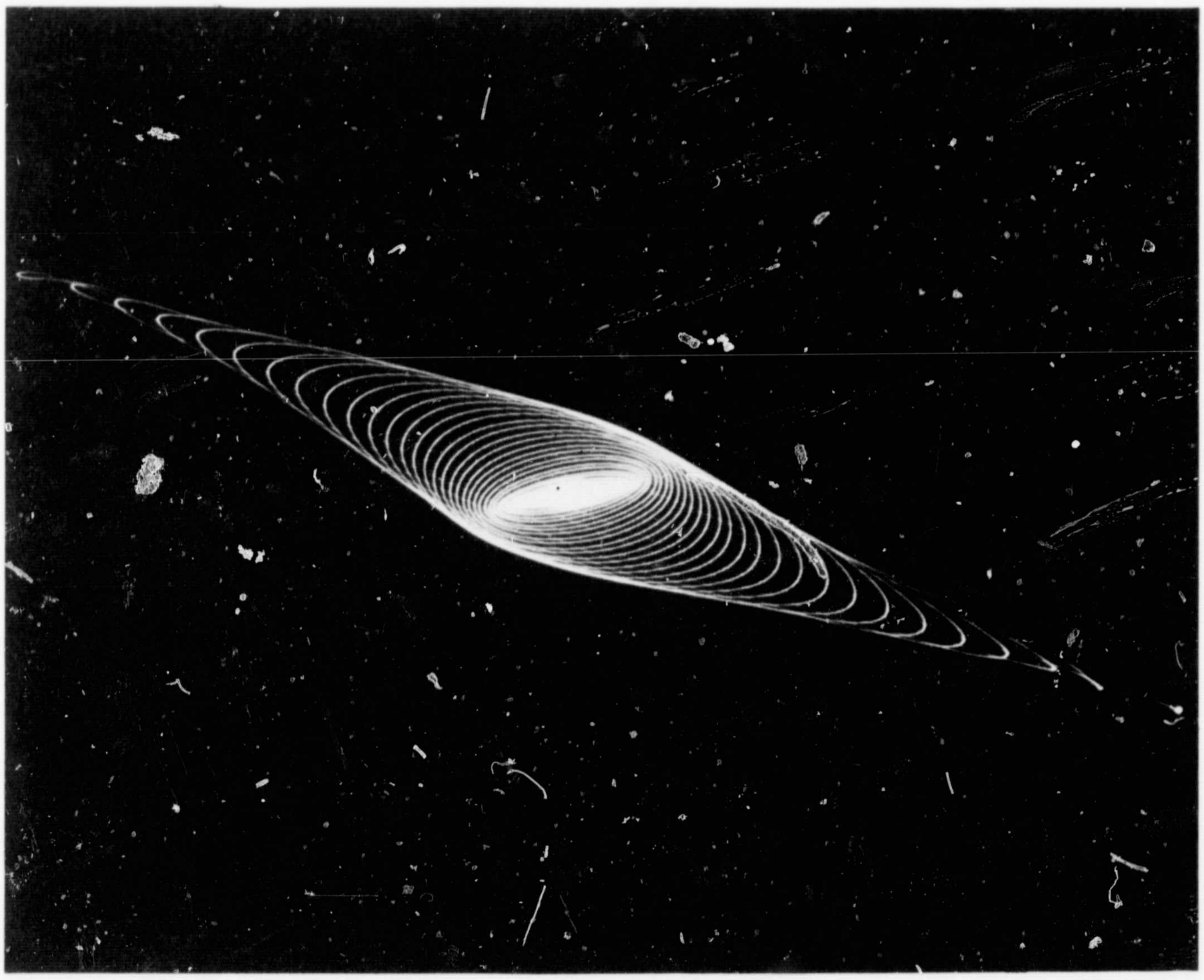

Figure 12. Photographic Time Exposure of Boom Tip Motion

Antenna Element Design

The 750 foot booms had the following final characteristics:

1. Berillium copper strip 750 feet long, 2 inches wide, 0.002 inches thick
2. Interlocked seam
3. 8% "random" hole pattern
4. Highly polished silver coating on outside
5. Dull black paint on inside
6. Diameter of boom is 0.572 inches
7. 600 ±5 ohm resistor installed 187 feet from tip.
8. Automatic motor shut-off slot at root with redundant impact absorber

Determination of Properties of Flight Elements

The following properties were determined:

1. Stiffness (EI) - Cantilever test on each element
2. Buckling - Cantilever test on each element
3. Absorbtivity - Four places on each element
4. Torque resistance - Measured on each element
5. Fatigue resistance - Design tests
6. Seam twist - 750 foot design test, and short flight samples
7. Certification that basic material meets specification.
8. Black paint - Design tests
9. Resistance to tarnish - Design tests

Boom Dispenser Flight Qualification Tests

The following subsystem tests were performed:

1. Full 750 foot extension into take-up device

2. Vibration tests at RAE component levels

3. Full 750 foot extension into take-up device

4. Full 750 foot extension under thermal-vacuum conditions into take-up device

5. Full 750 foot extension into take-up device

6. Integration into spacecraft with numerous short extensions to simulated shut-off slot

7. Full 750 foot extension with flight element into take-up device

8. Check-out on spacecraft

CONCLUSIONS AND OBSERVATIONS

The concept of starting complete systems tests as soon as possible proved to be beneficial to the RAE program. The integration temperature test, a lengthly functional test following, and system RFI tests resolved many problems that would be difficult or impractical to do on a subsystem basis.

Thermal-vacuum chamber procedures have been modified to bake-out and analyze any residuals in the chamber prior to starting a spacecraft test. Also, the cart fixture cooling system is now connected directly into the chamber wall rather than to a external Conrad unit. This eliminates any possibility of contamination from DC-200 silicone oil.

A new thermal-shock fixture for solar cell paddles is under development which will provide a closer temperature control and a better simulation of the temperature profile.

In order to avoid early problems in thermal-vacuum due to faulty design or fabrication, it is recommended that a short temperature test be performed just prior to the formal environmental tests. This will detect problems with components or potting that could not be detected during the integration temperature test where many subsystems are unpotted or where subsystems are changed later.

Original ideas were formulated and successfully performed in the Dynamic Test Chamber in the area of boom tests and various fourth stage separation tests including angular offset, unbalance, and heating and cooling. These engineering tests contributed considerably to the expected reliability of the system under anticipated in-flight conditions that could occur.

In the magnetics area, the gimbal will be modified to permit complete rotation of the spacecraft which will permit direct measurements of the near and far fields rather than performing vector calculation.

It is recommended that magnetic tests of solar cell paddles be continued at the same level of effort. However, the subsystem tests of the same design for RAE-B may be reduced if desired.

Several design changes to the spacecraft are being considered as a result of RAE-A experience. Included are adding a redundant tape recorder, changing the antenna aspect cameras from vidicon to facsimile type, designing more automatic features into the magnetic control system, and adding an audio signal to the Ryle-Vonberg radiometer.

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APPENDIX A

SELECTED COMMENTS IN CHRONOLOGICAL ORDER BASED ON WEEKLY REPORTS

APPENDIX A

SELECTED COMMENTS IN CHRONOLOGICAL ORDER BASED ON WEEKLY REPORTS

Since the first Working Group Meeting on January 22, 1964, two problem areas have been under constant study, development, and test. These are the problems of boom stability which is the overriding consideration in the feasibility of the Radio Astronomy mission, and the RFI of on-board electronics which produce noise within the areas to be studied by RAE: 1-10 MC/S.

The antennas were established in an "X" configuration of 750 feet for each leg. Approximately 34 boom tests were conducted in the T&E dynamics test chamber, during 1965, to determine damping constants for various alloys and coatings. These constants were needed for gravity gradient computations on long booms.

<u>February 1965</u>
The RAE project was approved. A firm decision was made to go with fixed solar cell paddles.

<u>April 22, 1965</u>
Objective of electronics stacking system:
1. Permit quick removal of any card without disconnecting any other card.
2. To eliminate flexing of cable harness "pigtails" and yet provide manual plug-in so that relaxed manufacturing tolerances can be used throughout.
3. Eliminate the need for long tie down bolts through circuit boards.

<u>May 1965</u>
Dynamics study contract was signed with AVCO.

<u>May 1965</u>
1/6 scale model was delivered for shadow studies and thermal and solar power analysis.

<u>June 4, 1965 and June 10, 11</u>
First Systems Design Review. This was the earliest in a project lifetime such a review had been held; before a design on systems freeze and before most of the detailed systems diagrams were available contributed greatly to firming up in-house support.

September 1965
Delta office reports the SDV-3J-1 Delta vehicle can meet mission requirements with fourth-stage motor as specified by project.

October 28, 1965
The solar power problem has been resolved. No fall-out sections will be used.

September 1965
RFI testing continues with the burst receiver, capacitance probe, impedance probe, pre-regulator, experiment converter and RFI switching programmer on hand.

October 1965
AVCO has delivered their phase-A final report.

October 1965
The power problem is considered resolved. The spacecraft is expected to operate with full power consumption throughout the first 100% sunlit period (approximately 750 days). It will then be switched to the reduced power mode as required during the shadow orbit period.

December 9, 1965
Fairchild-Hiller is assembling the first 750 foot boom deployment mechanism silver plated — internal blackened by December 27, 1965.

December 2, 1965
AVCO successfully incorporated the libration damper in the rigid body digital computer simulation and is programming the damper in the flexible body program.

February 3, 1966
A review of the pyro firing systems was held with the emphasis on safety, simplicity, and conformance to the regulations. A major change was made to reduce the complexity which had evolved.

February 10, 1966
The Project PERT has progressed to the point where it has become a productive vehicle for schedule analysis.

February 24, 1966
The design of the pyrotechnic system is completed. Redundancy is incorporated. Major problems still exist with ability to determine the solar absorptance of the silver plated boom material. GSFC shows absorptances of from 2 to 4 times higher and well outside of the specifications.

March 3, 1966
Detail design of the libration damper assembly is now fixed at 315 feet - 630 feet overall. The Preliminary Test Plan for the RAE was completed. The RAPP was submitted to the Project for review.

March 2, 1966
All subsystems were reviewed except the magnetic orientation system which was reviewed on March 3 at APL.

March 10, 1966
Two 850 foot test booms and deployment mechanisms were received from deHavilland. These "off-the-shelf" items missed the delivery date by six months.

March 23, 1966
Pre-initial thermal-vacuum test of the boom dispensing mechanism and the take-up mechanism resulted in an excessive power drain after 12 minutes operation in vacuum. The cause was traced to brush wear and bearing failure in the take-up motor drive system. High altitude type brushes and Duroid bearings will be used in the fixture motor. A flight quality sealed motor will be installed in the test fixture for later tests.

April 7, 1966
The component test specification was delivered to the Project for review.

April 14, 1966
Recommendations on the preliminary RAE pyrotechnics wiring system from the Delta Office were reviewed.

April 12, 1966
Review of magnetic control system at APL. Environmental Test Plan was approved by Project Office.

April 14, 1966
Some satisfactory silver plated boom specimens have been obtained from Fairchild-Hiller and Consolidated Controls Corporation.

May 12, 1966
Full scale 750' deployment of antenna was conducted at NOL inside their 1000 foot ballistics tunnel. Not considered successful for measuring straightness. Suspended from 150 cross bars attached at 5 foot intervals. Later tests with floats on water were satisfactory. T&E distributed Component Specification and Engineering Test Unit Specification. The apogee motor was awarded to Thiokol.

May 26, 1966
Phase II Reliability Assessment Report was received from Planning Research Corporation. This report contains a numerical reliability assessment of the overall spacecraft, experiments, and most of the subsystems.

The assembled Engineering Test Unit will be shipped to NOL for acceleration testing on May 26.

The in-house 50 foot boom straightness test facility is being redesigned to incorporate a water support system. If tests are successful, the 750 foot system will be modified accordingly.

May 26, 1966
The RAE Systems Reliability Engineer has pointed out that subsystems can be manufactured on a Task Order without quality provisions being imposed on the manufacturer. We get quality assurance only to the extent specified in the individual task assignment.

Many of the specifications for transistor procurements are 3 to 4 years old and call for a 20 X visual inspection. When inspected via a 100 or 200 magnification, they are unsatisfactory.

May 21, 1966
TTU structure was received May 21, 1966, with all 4 paddles.

June 2, 1966
A breadboard magnetometer electronic system and one sensor were operated in the RAE shield room in proximity to an operating Ryle-Vonberg receiver. RFI and audio noise levels were acceptable. No effects were seen on Ryle-Vonberg outputs.

June 9, 1966
Second accel. test of the ETU 20 g's 3 min. third stage
9 g's 3 min. fourth stage

TTU is being assembled.

The Design Review Committee's suggestion of an engineering boom deployment test (piggyback) does not appear feasible at this time. No scheduled Delta vehicle has the weight capability in the second stage.

June 16, 1966
ETU vibrated at design Qual levels with no structural problems. 30 acceleration channels and 23 strain gage channels. All loads were within calculated limits.

Completed on June 24. Sinusoidal vibration in the thrust axis of the apogee configuration was limited to an upper frequency of 1300 cps due to fixture resonance.

Negotiations were completed for contract award of the flight boom assemblies and the boom take-up devices.

August 25, 1966
De-spin tests in LaRC's 60 foot vacuum facility have been completed. The ETU was successfully de-spun to zero each time.

The structural mock-up has been modified to accept flight solar paddles and was delivered to the Magnetics Test Section for use in RAE magnetic testing.

August 25, 1966
The RCA antenna aspect contract was executed on August 23.

September 22, 1966
The FU #1 structure was delivered to SIB on September 15. The TTU electronics cards have all been integrated with their shelf and are ready for the application of thermal coatings.

The ETU model was subjected to an engineering test balance on the vertical balancing facility in the dynamic test chamber during the period September 13-16.

October 6, 1966
Motor ejection tests have been initiated at MSB.

October 13, 1966
Motor ejection tests successful. The ETU is now being set up in DTC for ejection tests.

A second assembly dolly has been ordered.

October 27, 1966
A preliminary system magnetic fields survey is being conducted. Completed November 3, 1966, ETU testing indicates the test magnetometer location is quite critical.

November 3, 1966
A refined procedure straightness test was held this week at the NOL 1000 foot range. The prototype mechanism deployed 750 feet of boom material suspended over water by floats. Excellent sensitivity to seam twist and in plane bending were obtained.

November 15, 1966
Phase I of the Black Ball Calibration in SES completed on November 22.

December 7, 1966
The inert loaded apogee kick motor was received from Thiokol. The magnetic attitude control system has been received from APL. TTU is in SES.

January 5, 1967
A down looking camera for viewing the lower boom tips has been designed into the spacecraft.

Design and fabrication of the antenna aspect system is well under way at RCA.

TTU in SES from December 14 to December 18. The correlation of internal temperatures with predictions was very good.

Four flight 750 foot antenna dispensing mechanisms and one libration damper boom dispenser were delivered January 5, 1967.

January 12, 1967
The first tape (boom) samples have been processed through the precision progressive punching dies. A prototype model of the 750 foot dispenser has been successfully modified to accept the interlocking tape.

February 1, 1967
Evaluation of initial samples of interlocking booms indicates that a higher maximum torsional restraint can be obtained by changing the engagement angle of the tabs.

February 9, 1967
Four items on the critical list:
1. Flight encoders
2. Boom aspect system
3. Angular position indicator for the damper boom
4. Interlocked boom development.

February 24, 1967
The contractor has converted the boom forming furnace to process the prepunched elements.

Three apogee kick motors have been test fired. The nominal spin rate for the Delta third stage was changed from 60 rpm to 74 rpm.

March 2, 1967
The modifications made to the prototype dispenser to accept interlocking elements appear to be satisfactory.

March 9, 1967
The second spacecraft structure, which has been designated as the RAE-A Flight Structure, has been received from the contractor.

Three flight solar cell paddles were successfully qualified at flight vibration levels on the ETU.

March 24, 1967
The "A" spacecraft arrived at T&E on March 21, for the systems integration thermal test in the 12x12x20 temperature chamber. See boxscore.

April 6, 1967
Two successful firings of the apogee kick motor were conducted at AEDC. All parameters were nominal. This was the sixth and last test firing in the motor qualification program.

April 13, 1967
All revisions to the precision progressive dies for punching the 11° interlock elements have been received.

April 27, 1967
The prototype antenna aspect system was delivered by RCA to GSFC.

May 11, 1967
Minute cracks found in radius of new 11° interlocking tape. Will modify feed tooling.

May 18, 1967
Thermal-vacuum testing of the prototype solar array developed a substantial number of solar cell collector peelings. Subsequent testing indicated the thickness of the Sylgard 182 coating on the cell collectors was critical. Will strip and recoat to 10 mils.

June 1, 1967
The automatic feed system used for forming the boom has been modified to eliminate stress cracks.

June 14, 1967
The Project recommends using the Thermophysics Branch Solar Vacuum Facility in lieu of going out-of-house.

June 21, 1967
An unfavorable spin to tumble ratio condition was corrected by adding filament wound fiberglass inertia booms hinged on the motor mount where they will be jettisoned with the motor.

The preliminary system test specification has been completed.

June 28, 1967
The first flight encoder was delivered. This is the last essential subsystem required for electrical integration.

Continue to have problems with the prototype camera. Failed welds in the prototype vidicon attributed to poor welding technique. Also, mounting in vibration indicates Q^s of up to 10.

July 13, 1967
The TTU is in the DTC for motor separation test.

July 27, 1967
The ETU successfully passed rapid decompression and acoustic noise tests in the LPS.

The second flight encoder was received.

A major problem was discovered with Potter Brumfield relays TL17D. Contact arms are permanently deflected. The RAE spacecraft has 62 units in fifteen flight modules.

August 9, 1967
RCA is replacing temperature sensitive vidicons.

750 foot mechanisms, damper booms and deployment mechanisms will be required to be returned to contractor for clutch and tape replacement.

August 9, 1967
The third, and last required, flight encoder has been delivered.

August 31, 1967
RCA still having problems with camera shutters.

Installation of modified scuff plates and improved clutches has been completed on the 750 foot antenna dispenser #5.

September 13, 1967
The spacecraft was delivered to T&E September 8, for initial balance, c.g., and M.I.

October 5, 1967
The spacecraft is now in a complete operational configuration, except for replacing relays.

October 12, 1967
The first lot of Potter and Brumfield relays were received.

November 8, 1967
Fabrication of all "A" subsystems with the new qualified P&B relays was completed. Potter and Brumfield have agreed to replace all the original relays (202 units).

December 6, 1967
The fourth boom deployment assembly was installed and checked out in the spacecraft.

January 24, 1968
All spacecraft subsystem and structural preparations for vibration are complete. Spacecraft was delivered to T&E on January 23. See boxscore report for environmental tests.

March 28, 1968
A Design Review on the apogee kick motor was held on March 27.

All boom dispenser mechanisms have been returned to the vendor for installation of flight elements. A final full scale extension will be run on each dispenser after the flight elements are installed. This will be the fifth and last scheduled full extension of each flight dispenser mechanism prior to launch.

April 24, 1968
The spacecraft has been fitted with six rf filters in the experiment antenna leads which have rendered a significant improvement in the residual rfi found several weeks ago.

The ETU was fit tested at the Cape with the Delta spin table, third stage, and fairing (heat shield).

A straightness test at NOL has been completed on a full extended 750 foot, perforated, interlocked boom element. All tabs locked during the extension. A maximum deflection of 32 inches occurred at the tip. While floating on the water, a sine wave shape was assumed with two complete cycles having a maximum amplitude of eight inches.

April 24, 1968
The RAE solar paddles are experiencing the problems with solderless solar cells that have been noted on other projects. The basic problem is the degradation of the contacts. The contact problem increases with age and is apparently accelerated by humidity exposure. New shipping containers are being fabricated for the A&B paddles which will be gas tight and back-filled with dry nitrogen.

May 1, 1968
Installation of the refurbished tape recorder will complete flight configuration of the spacecraft. New recording heads are being installed. All four 750 foot flight boom mechanisms are installed in the spacecraft.

May 15, 1968
RAE successfully completed the solar vacuum test in the Thermophysics Branch facility.

May 29, 1968
Environmental testing of the RAE-A spacecraft was completed on schedule.

June 12, 1968
The RAE-A spacecraft was shipped to the Western Test Range on June 12. The Flight Readiness Review was held on June 5-6.

July 12, 1968
The RAE-A spacecraft was launched on July 4, 1968.

APPENDIX B

COMPONENT SERIAL NUMBERS, RAE-A PROTO-FLIGHT SPACECRAFT

APPENDIX B

COMPONENT SERIAL NUMBERS, RAE-A PROTO-FLIGHT SPACECRAFT

Experiment or Subsystem	ID Code	Flight Serial Number
Battery and Coulombmeter	01A	05
Charge Regulator	01B	01
Dump Circuit	01C	FLT
Bus Box	01D	03
Command Converter	01E	01
Umbilical Connector	01F	FLT
Pre Regulator	01G	01
Encoder Converter	01H	03
Experiment Converter #1	01J	03
Experiment Converter #2	01K	04
Command Receiver #1	02A	01
Command Decoder #1	02B	01
Command Receiver #2	02C	01
Command Decoder #2	02D	01
Fourth-Stage Assembly	03A	FLT PV16-659-5 Motor
Checkout Connectors (2)	03B	FLT
Third-Stage Separation Monitor	03C	FLT
Nutation Damper	03D	FLT
Yo-Yo Release Paddle B	03F	FLT
Yo-Yo Release Paddle D	03G	FLT
Encoder #1	04A	04
Encoder #2	04B	03
Low Power Transmitter	04D	01

Experiment or Subsystem	ID Code	Flight Serial Number
High Power Transmitter	04E	01
MLTPLX-DIPLX	04F	01
TM, Antenna Cup #1	04G	A
TM, Antenna Cup #2	04L	A'
TM, Antenna Cup #3	04M	B
TM, Antenna Cup #4	04N	B'
Boom #1 Assembly	05A	02
Boom #2 Assembly	05B	05
Boom #3 Assembly	05C	01
Boom #4 Assembly	05D	03
Dipole #1	05E	01
Dipole #2	05F	07
Damper Assembly	05G	01
Damper Deployment Switch	05H	FLT
Damper Boom Assembly	05J	01
Damper Electronics	05K	ETU
Solar Cell Paddle A	06A	05
Solar Cell Paddle B	06B	03
Solar Cell Paddle C	06C	02
Solar Cell Paddle D	06D	04
Undervoltage Programmer	07A	03
Data Programmer	07B	03
Lo-Antenna Switch	07C	03
Hi-Antenna Switch	07D	01
Exp. SS #1	07E	01
Exp. SS #2	07F	03
Pyrotechnic Programmer	07G	02
Sequence Programmer	07H	04

Experiment or Subsystem	ID Code	Flight Serial Number
Dipole Switch #1	07J	02
Dipole Switch #2	07K	02
Fourth-Stage Monitor	07L	02
Damper Commutator Control	07M	01
Tape Recorder Converter	08A	01
Tape Recorder Transport	08B	01
Tape Recorder Electronics	08C	03
Spin Aspect Electronics	09A	E104
Solar Sensor - Paddle A	09B	119
Solar Sensor - Paddle A	09C	121
Spin Sensor - Paddle A	09D	105
Spin Sensor - Paddle A	09E	106
Solar Sensor - Paddle B	09F	125
Solar Sensor - Paddle B	09G	124
Solar Sensor - Paddle C	09H	118
Solar Sensor - Paddle C	09J	120
Solar Sensor - Paddle D	09K	112
Solar Sensor - Paddle D	09L	113
Antenna Aspect Camera (HI)	10A	02
Antenna Aspect Electronics	10B	02
Antenna Aspect Target #1	10C	FLT
Antenna Aspect Target #2	10D	FLT
Antenna Aspect Camera (LO)	10E	03
Antenna Aspect Target #3	10F	FLT
Antenna Aspect Target #4	10G	FLT
Magnetic Aspect Electronics	11A	02
Magnetometer Assembly	11B	02
Electromagnet X	11C	01

Experiment or Subsystem	ID Code	Flight Serial Number
Electromagnet Y	11D	01
Electromagnet Z-1 HI	11E	02
Electromagnet Z-2 LO	11F	02
Burst Radiometer #1	12A	02
Burst Radiometer #2	12B	03
Ryle-Vonberg Radiometer 1, Card #1	13A	01
Ryle-Vonberg Radiometer 1, Card #2	13B	01
Ryle-Vonberg Radiometer 2, Card #1	13C	02
Ryle-Vonberg Radiometer 2, Card #2	13D	02
Ryle-Vonberg Radiometer 3, Card #1	13E	03
Ryle-Vonberg Radiometer 3, Card #2	13F	03
Ryle-Vonberg Radiometer 4, Card #1	13G	04
Ryle-Vonberg Radiometer 4, Card #2	13H	04
Impedance Probe	14A	01
Electron Trap Electronics	15A	01
Electron Trap Sensor #1	15B	01
Electron Trap Sensor #2	15C	02
Capacitance Probe	16A	02
Thermistor Power Bus-Hi	17B	01
Thermistor Power Bus-Lo	17C	01
Shelf Disconnects	18A	01
Center Tube Disconnects	18B	01
Antenna Cable Filter, Boom #1	17D	FLT
Antenna Cable Filter, Boom #2	17E	FLT
Antenna Cable Filter, Boom #3	17F	FLT
Antenna Cable Filter, Boom #4	17G	FLT
Antenna Cable Filter, Dipole #1	17H	FLT
Antenna Cable Filter, Dipole #2	17J	FLT

RAE-A Component Serial Numbers
Proto-Flight Spacecraft

Date 1967 1968	Test	Unit: Componet / ID Code	Power: Batt. & Coul. / 01 A	Power: Chg. Reg. / 01 B	Power: Dump Ckt. / 01 C	Bus Box / 01 D	Converters, Pre-Regulator: Cmd. Conv. / 01 E	Umbilical Conn. / 01 F	Pre Reg. / 01 G	Encoder Conv. / 01 H	Exp. Conv. #1 / 01 J	Exp. Conv. #2 / 01 K	Command Receivers and Decoders: Cmd. Rx #1 / 02 A	Cmd. Dec. #1 / 02 B	Cmd. Rx #2 / 02 C	Cmd. Dec. #2 / 02 D	4th Stage Assy / 03 A	Checkout Connectors (2) / 03 B	3rd Stage Sep. Monitor / 03 C	Nutation Damper / 03 D	Yo-Yo: Yo-Yo Rel. P. B. / 03 F	Yo-Yo Rel. P. D. / 03 G	Telemetry: Encoder #1 / 04 A	Encoder #2 / 04 B	Tx-Lo / 04 D	Tx-Hi / 04 E	Mltplx-Diplx / 04 F	TM, Ant. Cup #1 / 04 G	TM, Ant. Cup #2 / 04 L
3/22	Integration Temperature		01	01	01	03	02	01	01	02	02	03	01	01	01	01	—	01	—	—	—	—	—	ETU	01	01	01	—	—
9/19	Initial Balance, M.I.		02	01	F-B	03	02	01	01	01	02	03	01	01	01	01	Inert	01	01	FLT	—	—	F2	F3	01	01	01	A	A'
10/11	Initial Magnetic 10-11-67 10-20-67		02	01	B	03	02	01	01	01	02	03	01	01	01	01	Inert	FLT	FLT	FLT	—	—	02	03	01	01	01	A	A'
11/16	RFI Bldg. 10 11-16-67 11-17-67		02	01	B	03	02	01	01	01	03	02	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
11/22	RFI Bldg. 7 11-22-67 11-29-67		02	01	B	03	02	01	01	01	03	02	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
12/20	Initial Magnetic 12-20-67 12-28-67		02	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
1/23	Weight Balance Check 1-23-68 1-24-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
1/24	Vibration X-X axis Launch 1-24-68 1-29-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
1/30	Vibration Y-Y axis Launch 1-30-68 1-30-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
1/30	Vibration Z-Z axis Launch 1-30-68 1-30-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
1/31	Vibration Z, X, Y axes Apogee Kick 1-31-68 2-2-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
2/5	LPS Acoustic Noise Rapid Pumpdown 2-5-68 2-7-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
2/8	LPS 3rd Stage Acceleration 2-7-68 2-8-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	Inert	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
2/9	LPS 4th Stage Acceleration 2-8-68 2-9-68		02	01	See Note	03	01	01	01	03	03	04	01	01	01	01	—	Test	FLT	FLT	ETU	ETU	04	03	01	01	01	A	A'
2/16	T-V 8 x 8 2-16-68 2-20-68		02	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
2/24	T-V 8 x 8 2-24-68 3-8-68		02	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
3/11	DTC 4th Stage Ejection 3-11-68 3-14-68		02	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	Inert	FLT	FLT	FLT	ETU	ETU	—	03	01	01	01	A	A'
3/15	DTC Libration Damper Eject. 3-15-68 3-21-68		02	01	—	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	—	03	01	01	01	A	A'
3/24	STADAN 3-24-68 4-1-68		02	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	Safe	FLT	FLT	—	—	—	03	01	01	01	A	A'
4/2	Final Flight Systems Integration - Temp 4-2-68 4-29-68		05	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
5/9	SES 5-9-68 5-13-68		05	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	—	FLT	FLT	FLT	—	—	04	03	01	01	01	A	A'
5/16	Random Vibration 5-16-68		05	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	Inert	FLT	FLT	FLT	FLT	FLT	04	03	01	01	01	A	A'
5/20	Magnetics 5-20-68 5-24-68		05	01	Dummy	03	01	01	01	03	03	04	01	01	01	01	Inert	FLT	FLT	FLT	FLT	FLT	04	03	01	01	01	A	A'
7/4	Launch 7-4-68		05	01	FLT	03	01	FLT	01	03	03	04	01	01	01	01	FLT	FLT	FLT	FLT	FLT	FLT	04	03	01	01	01	A	A'

Yo-Yo	Telemetry									750 Foot Antennas				Dipole Antennas		Libration Damper				Solar Cell Paddles				Programmers and Switches											
Yo-Yo Rel. P.D.	Encoder #1	Encoder #2	Tx-Lo	Tx-Hi	Mlplx-Diplx	TM, Ant. Cup #1	TM, Ant. Cup #2	TM, Ant. Cup #3	TM, Ant. Cup #4	Boom #1 Assy	Boom #2 Assy	Boom #3 Assy	Boom #4 Assy	Dipole #1	Dipole #2	Damp. Assy	Damp. Deply. Sw.	Damp. Boom Assy	Damp. Electronics	Paddle A	Paddle B	Paddle C	Paddle D	U.V. Prog.	Data Prog.	Lo-Ant. Sw.	Hi-Ant. Sw.	Exp. S.S. #1	Exp. S.S. #2	Pyro. Prog.	Seq. Prog.	Dipole Sw. #1	Dipole Sw. #2	4th Stage Monitor	Damp. Comm. Control
03 G	04 A	04 B	04 D	04 E	04 F	04 G	04 L	04 M	04 N	05 A	05 B	05 C	05 D	05 E	05 F	05 G	05 H	05 J	05 K	06 A	06 B	06 C	06 D	07 A	07 B	07 C	07 D	07 E	07 F	07 G	07 H	07 J	07 K	07 L	07 M
—	—	ETU	01	01	01	—	—	—	—	4	3	5	6	—	—	—	—	—	—	—	—	—	—	01	02	02	02	01	01	01	01	02	02	02	01
—	F2	F3	01	01	01	A	A'	B	B'	06	4	1	3	01	4	—	—	—	ETU	01	06	07	08	02	02	02	02	02	02	02	02	02	02	03	01
—	02	03	01	01	01	A	A'	B	B'	06	4	02	3	01	02	FLT	—	01	ETU	09	06	07	08	02	02	02	02	02	02	02	02	02	02	03	01
—	04	03	01	01	01	A	A'	B	B'	06	03	02	05	—	—	FLT	—	01	ETU	09	06	07	08	02	02	02	02	02	02	02	02	02	02	03	01
—	04	03	01	01	01	A	A'	B	B'	06	03	02	05	—	—	FLT	—	01	ETU	09	06	07	08	02	02	02	02	02	02	02	02	02	02	03	01
—	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	Dummy	Dummy	Dummy	Dummy	03	02	03	01	03	03	02	02	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
ETU	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	ETU	ETU	ETU	Proto	03	03	03	01	03	03	02	01	02	02	02	01
—	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	—	—	—	—	03	03	03	01	03	03	02	01	02	02	02	01
—	04	03	01	01	01	A	A'	B	B'	01	03	02	05	01	07	FLT	—	01	ETU	—	—	—	—	03	03	03	01	03	03	02'	01'	02	02	02	01
ETU	—	03	01	01	01	A	A'	B	B'	—	—	02	05	01	07	FLT	—	01	ETU	Proto	ETU	ETU	ETU	02	03	03	01	03	03	02'	01'	02	02	02	01
—	—	03	01	01	01	A	A'	B	B'	—	—	02	05	01	07	FLT	—	01	ETU	—	—	—	—	02	03	03	01	03	03	02'	01'	02	02	02	01
—	—	03	01	01	01	A	A'	B	B'	—	—	—	—	—	—	—	—	—	ETU	ETU	ETU	ETU	ETU	02	03	03	01	03	03	02'	01'	02	02	03	01
—	04	03	01	01	01	A	A'	B	B'	02	05	01	03	01	07	FLT	FLT	01	ETU	05	03	02	04	02	03	03	01	03	03	02'	01'	02	02	03	01
—	04	03	01	01	01	A	A'	B	B'	02	05	01	03	01	07	FLT	FLT	01	ETU	05	03	02	04	02	03	03	01	03	03	02'	01'	02	02	03	01
FLT	04	03	01	01	01	A	A'	B	B'	02	05	01	03	01	07	FLT	FLT	01	ETU	05	03	02	04	02	03	03	01	03	03	02'	01'	02	02	03	01
FLT	04	03	01	01	01	A	A'	B	B'	02	05	01	03	01	07	FLT	FLT	01	ETU	05	03	02	04	03	03	03	01	01	03	02	04	02	02	02	01
FLT	04	03	01	01	01	A	A'	B	B'	02	05	01	03	01	07	01	FLT	01	ETU	05	03	02	04	03	03	03	01	01	03	02	04	02	02	02	01

RAE-A Component Serial Numbers
Proto-Flight Spacecraft

PRECEDING PAGE BLANK NOT FILMED.

RAE-A Component Serial Numbers
Proto-Flight Spacecraft

			Unit	Tape Recorder			Attitude and Control														
			Component	T. R. Conv.	T. R. Transp.	T. R. Elect.	S. A. Elect.	Sol. Sens. P.A.	Sol. Sens. P.A.	Spin Sens. P.A.	Spin Sens. P.A.	Sol. Sens. P.B.	Sol. Sens. P.B.	Sol. Sens. P.C.	Sol. Sens.. P.C.	Sol. Sens. P.D.	Sol. Sens. P.D.	Upper Ant. Aspect Camera	Ant. Asp. Elect.	Ant. Asp. Target #1	Ant. Asp. Target #2	Lower Ant. Aspect Camera
Date 1967 1968	Test		ID Code	08 A	08 B	08 C	09 A	09 B	09 C	09 D	09 E	09 F	09 G	09 H	09 J	09 K	09 L	10 A	10 B	10 C	10 D	10 E
3/22	Integration Temperature			01	F1	01	E 101	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/19	Initial Balance, M.I.			01	OSO #3	01	F 104	118	119	5	6	120	121	124	125	122	123	Dummy	ETU	—	—	Dummy
10/11	Initial Magnetic			01	OSO #3	01	E 104	118	119	105	106	112	113	120	121	124	125	02	02	—	—	01
11/16	RFI Bldg. 10	11-16-67 11-17-67		01	OSO #3	01	E 104	118	119	105	106	112	113	120	121	124	125	02	02	—	—	01
11/22	RFI Bldg. 7	11-22-67 11-29-67		01	OSO #3	01	E 104	118	119	105	106	112	113	120	121	124	125	02	02	—	—	01
12/20	Initial Magnetic	12-20-67 12-28-67		01	F1	03	E 104	126	109	107	108	127	128	129	130	131	132	02	02	—	—	01
1/23	Weight Balance Check	1-23-68 1-24-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
1/24	Vibration X-X axis Launch	1-24-68 1-29-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
1/30	Vibration Y-Y axis Launch	1-30-68 1-30-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
1/30	Vibration Z-Z axis Launch	1-30-68 1-30-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
1/31	Vibration Z, X, Y axes Apogee Kick	1-31-68 2-2-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
2/5	LPS Acoustic Noise Rapid Pumpdown	2-5-68 2-7-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
2/8	LPS 3rd Stage Acceleration	2-7-68 2-8-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
2/9	LPS 4th Stage Acceleration	2-8-68 2-9-68		01	F1	03	E 104	—	—	—	—	—	—	—	—	—	—	02	02	FLT	FLT	01
2/16	T-V 8 x 8	2-16-68 2-20-68		01	F1	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	01
2/24	T-V 8 x 8	2-24-68 3-8-68		01	F3	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	01
3/11	DTC 4th Stage Ejection	3-11-68 3-14-68		01	—	—	E 104	—	—	—	—	—	—	—	—	—	—	02	02	—	—	01
3/15	DTC Libration Damper	3-15-68 3-21-68		01	—	—	E 104	—	—	—	—	—	—	—	—	—	—	02	02	—	—	01
3/24	STADAN	3-24-68 4-1-68		01	F3	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	—	—	01
4/2	Final Flight Systems Integration, Temp	4-2-68 4-29-68		01	02	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	03
5/9	SES	5-9-68 5-13-68		01	02	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	03
5/16	Random Vibration	5-16-68		01	02	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	03
5/20	Magnetics	5-20-68 5-24-68		01	02	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	03
7/4	Launch	7-4-68		01	01	03	E 104	119	121	105	106	125	124	118	120	112	113	02	02	FLT	FLT	03

	Control											Experiments															Misc.				Antenna Cable Filters					
	Ant. Asp. Target #1	Ant. Asp. Target #2	Lower Ant. Aspect Camera	Ant. Asp. Target #3	Ant. Asp. Target #4	Mag. Asp. Elec.	Magnetometer Assy	Electromag. X	Electromag. Y	Electromag. Z-1 Hi	Electromag. Z-2 Lo	Burst Rad. 1	Burst Rad. 2	R.V. Rad 1, Card 1	R.V. Rad 1, Card 2	R.V. Rad 2, Card 1	R.V. Rad 2, Card 2	R.V. Rad 3, Card 1	R.V. Rad 3, Card 2	R.V. Rad 4, Card 1	R.V. Rad 4, Card 2	Impedance Probe	Electron Trap Electronics	Electron Trap Sensor #1	Electron Trap Sensor #2	Capacitance Probe	Therm. Pwr. Bus-Hi	Therm. Pwr. Bus-Lo	Shelf Disconnects	Center Tube Disconnect	Boom #1	Boom #2	Boom #3	Boom #4	Dipole #1	Dipole #2
	10 C	10 D	10 E	10 F	10 G	11 A	11 B	11 C	11 D	11 E	11 F	12 A	12 B	13 A	13 B	13 C	13 D	13 E	13 F	13 G	13 H	14 A	15 A	15 B	15 C	16 A	17 B	17 C	18 A	18 B	17 D	17 E	17 F	17 G	17 H	17 J
	–	–	–	–	–	201	201	201	201	201	201	02	02	02	02	04	04	01	01	03	03	01	01	01	01	01	01	01	01	01	–	–	–	–	–	–
U	–	–	Dummy	–	–	201	201	201	201	201	201	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	–	–	01	–	–	201	201	201	01	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	–	–	01	–	–	201	201	201	01	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	–	–	01	–	–	201	201	201	01	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	–	–	01	–	–	02	02	02	01	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	FLT	FLT	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	–	–	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	–	–	01	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	–	–	–	–	–	–
2	–	–	01	–	–	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	01	02	03	04	05	06
2	FLT	FLT	03	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	01	02	03	04	05	06
2	FLT	FLT	03	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	01	02	03	04	05	06
2	FLT	FLT	03	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	01	02	03	04	05	06
2	FLT	FLT	03	FLT	FLT	02	02	02	02	01	01	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	01	02	03	04	05	06
2	FLT	FLT	03	FLT	FLT	02	02	01	01	02	02	02	03	01	01	02	02	03	03	04	04	01	01	01	02	02	01	01	01	01	FLT	FLT	FLT	FLT	FLT	FLT

RAE-A Component Serial Numbers
Proto-Flight Spacecraft

APPENDIX C

PERFORMANCE REVIEW, RAE-A PROTO-FLIGHT SPACECRAFT

RAE-A PROTO-FLIGHT

SPACECRAFT

PERFORMANCE REVIEW

Page 1 of 4

												Vibration								Thermal-Vacuum				
TEST CONDITION			Weight	Initial Balance	Recheck Balance After Instal-ling Weights	Moment-of-Inertia X,Y,Z	Initial Magnetic ACTF	RFI Building 10 (Small Room)	RFI Building 7 (Large Room)	Initial Magnetic ACTF	Weight Balance Check	X-X Axis Proto Levels Sine and Random	Y-Y Axis Proto Levels Sine and Random	Z-Z Axis Proto Levels Sine and Random	Z,X,Y Proto Levels Sine	Acoustic Noise Rapid Pumpdown On LPS	3rd Stage Accel-eration 18.5 g for 3 Min on LPS	4th Stage Accel-eration 8.6 g for 3 Min on LPS	Corona Check Ambient Temperature	Calibration of Thermistors at $-10°C$	12 Hour Soak at $-20°C$ $<1x10^{-6}$ Torr	Calibration of Thermistors at $+40C <1x10^{-6}$ Torr	12 Hour Soak at $+54°C$ $<1x10^{-6}$ Torr
OPERATING MODE			Off	Off	Off	Off	Functional	Functional	Functional	Functional	Off	Launch Mode Launch Config.	Launch Mode Launch Config.	Launch Mode Launch Config.	Apogee Mode Apogee Config.	Launch	Launch	Launch	Launch	Data/Cal. Launch	Orbital	Data/Cal. Launch	Orbital
DATE			9/8/67	9/8/67 9/13/67	9/19/67	9/20/67 9/22/67	10/11/67 10/23/67	11/16/67 11/17/67	11/22/67 11/29/67	12/20/67 12/28/67	1/23/68 1/24/68	1/24/68 1/29/68	1/30/68 1/30/68	1/30/68 1/30/68	1/31/68 2/2/68	2/5/68 2/7/68	2/7/68 2/8/68	2/8/68 2/9/68	2/16/68 1948 2/17/68 0108	2/17/68 1325	2/17/68 1630 2/18/68 1000	2/18/68 2005	2/18/68 2300 2/19/68 1100
NAME	I.D.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STRUCTURE		A																					
POWER	01A-01D	B																					
CONVERTERS, REGULATOR	01E-01K	C																					
CMD. REC. & DECODERS	02A-02D	D																					
NUTATION DAMPER	03D	E																					
YO-YO	03F-03G	F			N	N	N	N	N		N								N	N	N	N	N
TELEMETRY	04A-04N	G																					
750' ANTENNA ASSEMBLIES	05A-05D	H													◪								
60' DIPOLE ANTENNA	05E-05F	I																					
DAMPER BOOM & ELEC.	05G-05K	J																					⬓
SOLAR CELL PADDLES	06A-06D	K						N	N		N	S	S	S	S	S	S	S	N	N	N	N	N
PROGRAMMERS & SWITCHES	07A-07M	L										◫								⬓ ◫	⬓ ◫		◫ ⬓
TAPE RECORDER & ELEC.	08A-08C	M																		⬓	⬓		
SOLAR SENSORS & ELEC.	09A-09L	N									N	N	N	N	N	N	N	N					
ANT. ASPECT CAMERAS, ELEC.&TARGETS	10A-10G	O																					
MAGNETIC CONTROL	11A-11F	P																					
MISCELLANEOUS		Q																					
ANTENNA CABLE FILTERS	07D-07J	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
		S																					
		T																					

CODE

E - Facility Induced Problem
■ - Failure
◪ - Questionable Operation
⬓ - Marginal Operation

⊠ - Procedural Failure
◫ - Special Problem
R - Subsystem Repaired
C - Subsystem Changed

M - Subsystem Modified
D - Subsystem Redesigned
N - Subsystem Not Under Test
S - Special Operating Condition for Test

326-075
320-87(3/65)

RAE-A PROTO-FLIGHT
SPACECRAFT
PERFORMANCE REVIEW

NAME	I.D.		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
			Thermal-Vacuum																				
TEST CONDITION			Soak at -20°C Vacuum < 1x10-6 Torr	All Systems at Ambient Temperature and Pressure	48 Hr. Soak at -20°C Vacuum < 1x10-6 Torr	96 Hr. Soak at +54°C Vacuum < 1x10-6 Torr	12 Hr. Soak at -20°C Vacuum < 1x10-6 Torr	12 Hr. Soak at +54°C Vacuum < 1x10-6 Torr	22 Hr. Soak at -20 C Vacuum < 1x10-6 Torr	12 Hr. Soak at +54°C Vacuum < 1x10-6 Torr	Check at -20°C Vacuum < 1x10-6 Torr	Checkout at Ambient Conditions	DTC - 4th Stage Ejection @ 82 RPM Vacuum 0.5 Torr	DTC - Libration Damper 750' Boom ex. (2) @ +40°C Vacuum 0.2 Torr	DTC - Libration Damper 750' Boom ex. (2) @ -10°C Vacuum 2 Torr	STADAN Compatibility	Final Flight System Integration	RFI Building 7 (Small Room)	Temperature Calibration +20°C, -5°C, +35°C	Solar-Vacuum Building 4	Final Random Vibration Thrust Axis Flight Levels	Final Magnetic Calibration, Meas., Torquemeter	Final Wt, CG, Bal., MI, and RFI
OPERATING MODE			Orbital	Terminate Test Off For Repair	Orbital	Orbital	Orbital and Undervoltage Lockout	Orbital and Undervoltage Lockout	Orbital	Orbital	Orbital	Functional	Functional	Functional	Functional	Functional	Functional	Functional	Functional	Orbital	Launch	Functional	Off or Functional
DATE			2/20/68 0200 2/20/68 0830	2/21/68 0100 2/24/68 1645	2/25/68 0625 2/27/68 0800	2/27/68 1740 3/2/68 1740	3/3/68 0700 3/3/68 1935	3/4/68 0800 3/4/68 2015	3/5/68 0800 3/6/68 0610	3/6/68 1535 3/7/68 0345	3/7/68 1600 3/7/68 1800	3/8 0900 3/8/68 1200	3/11/68 0800 3/14/68 1715	3/15/68 0800 3/20/68 1000	3/20/68 1000 3/21/68 1100	3/24/68 4/1/68	4/2/68 4/17/68	4/18/68 4/22/68	4/22/68 4/29/68	5/9/68 5/13/68	5/16/68	5/20/68 5/24/68	5/27/68 5/29/68
STRUCTURE		A		N																	◫		
POWER	01A-01D	B		N													C	◫					
CONVERTERS, REGULATOR	01E-01K	C		N																			
CMD. REC. & DECODERS	02A-02D	D		N												⊟	M						
NUTATION DAMPER	03D	E		N																			
YO-YO	03F-03G	F	N	N	N	N	N	N	N	N	N	N	S	N	N	N	N	N	N				
TELEMETRY	04A-04N	G		N				⊟						S	S	S	C						
750' ANTENNA ASSEMBLIES	05A-05D	H		N										S	S	S							
60' DIPOLE ANTENNA	05E-05F	I		N																			
DAMPER BOOM & ELEC.	05G-05K	J		N												N							
SOLAR CELL PADDLES	06A-06D	K	N	N	N	N	N	N	N	N	N	N	S	N	N	N	N	N	N				
PROGRAMMERS & SWITCHES	07A-07M	L	■ ⊟ ◫	M	⊟ ◫	◫ ⊟	⊟ ◫	⊟ ◫	⊟ ◫	◫ ⊟	⊟ ◫	◫ ⊟		C			MC	⊟ R					
TAPE RECORDER & ELEC.	08A-08C	M	■	C			⊟							N	N			S	S	S	S	S	
SOLAR SENSORS & ELEC.	09A-09E	N		N					◫	◫	◫			N	N								
ANT. ASPECT CAMERAS, ELEC. & TARGETS	10A-10G	O		N				◩	◩	◩	◩	◫					C						
MAGNETIC CONTROL	11A-11F	P		N																			
MISCELLANEOUS		Q		N													M						
ANTENNA CABLE FILTERS	07D-07J	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N							
		S																					
		T																					

CODE

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S - Special Operating Condition for Test

326-075
320-87(3/65)

RAE-A PROTO-FLIGHT

EXPERIMENTS

PERFORMANCE REVIEW

Page 3 of 4

													Vibration								Thermal-Vacuum				
		TEST CONDITION	Weight	Initial Balance	Recheck Balance After Installing Weights	Moment-of-Inertia X,Y,Z	Initial Magnetic ACTF	RFI Building 10 (Small Room)	RFI Building 7 (Large Room)	Initial Magnetic ACTF	Weight Balance Check	X-X Axis Proto Levels Sine and Random	Y-Y Axis Proto Levels Sine and Random	Z-Z Axis Proto Levels Sine and Random	Z,X,Y Proto Levels Sine	Acoustic Noise Rapid Pumpdown on LPS	3rd Stage Acceleration 18.5 g for 3 Min on LPS	4th Stage Acceleration 8.6 g for 3 Min on LPS	Corona Check Ambient Temperature	Calibration of Thermistors at -10C <1x10^{-6} Torr	12 Hour Soak at -20°C <1x10^{-6} Torr	Calibration of Thermistors at +40C <1x10^{-6} Torr	12 Hour Soak at +54°C <1x10^{-6} Torr
		OPERATING MODE	Off	Off	Off	Off	Functional	Functional	Functional	Functional	Off	Launch Mode Launch Config.	Launch Mode Launch Config.	Launch Mode Launch Config.	Apogee Mode Apogee Config	Launch	Launch	Launch	Launch	Data/Cal. Launch	Orbital	Data/Cal. Launch	Orbital
		DATE	9/8/67	9/8/67 9/13/67	9/19/67	9/20/67 9/22/67	10/11/67 10/23/67	11/16/67 11/17/67	11/22/67 11/29/67	12/20/67 12/28/67	1/23/68 1/24/68	1/24/68 1/29/68	1/30/68 1/30/68	1/30/68 1/30/68	1/31/68 2/2/68	2/5/68 2/7/68	2/7/68 2/8/68	2/8/68 2/9/68	2/16/68 1948 2/17/68 0108	2/17/68 1325	2/17/68 1630 2/18/68 1000	2/18/68 2005	2/18/68 2300 2/19/68 1100
NAME	I.D.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
BURST RAD 1	12A	AA																					
BURST RAD 2	12B	BB																					
R.V. RAD 1, CARD 1	13A	CC																					
R.V. RAD 1, CARD 2	13B	DD																					
R.V. RAD 2, CARD 1	13C	EE																					
R.V. RAD 2, CARD 2	13D	FF																					
R.V. RAD 3, CARD 1	13E	GG																					
R.V. RAD 3, CARD 2	13F	HH																					
R.V. RAD 4, CARD 1	13G	II																					
R.V. RAD 4, CARD 2	13H	JJ																					
IMPEDANCE PROBE	14A	KK																					
ELECTRON TRAP ELECTRONICS	15A	LL																		◩	◩		
ELECTRON TRAP SENSOR #1	15B	MM																					
ELECTRON TRAP SENSOR #2	15C	NN																					
CAPACITANCE PROBE	16A	OO																					
		P																					
		Q																					
		R																					
		S																					
		T																					

CODE

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■ - Failure
◩ - Questionable Operation
⬓ - Marginal Operation
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◫ - Special Problem
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C - Subsystem Changed
M - Subsystem Modified
D - Subsystem Redesigned
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S - Special Operating Condition for Test

326-075
320-37(3/65)

RAE-A PROTO-FLIGHT

EXPERIMENTS

PERFORMANCE REVIEW

			Thermal-Vacuum																			
TEST CONDITION			Soak at -20 C Vacuum <1x10-6 Torr	All Systems at Ambient Temperature	48 Hr. Soak at -20 C Vacuum <1x10-6 Torr	96 Hr. Soak at +54 C Vacuum <1x10-6 Torr	12 Hr. Soak at -20 C Vacuum <1x10-6 Torr	12 Hr. Soak at +54 C Vacuum <1x10-6 Torr	22 Hr. Soak at -20 C Vacuum <1x10-6 Torr	12 Hr. Soak at +54 C Vacuum <1x10-6 Torr	Check at -20 C Vacuum <1x10-6 Torr	Checkout at Ambient Conditions	DTC - 4th Stage Ejection + 82 RPM Ambient Temperature Vacuum 0.5 Torr	DTC - Libration Damper ex. (1) 750' Booms at +40 C 0.2 Torr	DTC - Libration Damper ex. (2) 750' Booms at -10 C 2 Torr	STADAN Compatibility	Final Flight System Integration	RFI Building 7 (Small Room)	Temperature Calibration +20 C, -5 C, +35 C	Solar-Vacuum Building 4	Final Random Vibration Thrust Axis Flight Levels	Final Magnetic Calibration, Meas. Torquemeter	Final Wt.CG,Bal., MI, Sunshine Test, and RFI
OPERATING MODE			Orbital	Terminate Test Off	Orbital	Orbital	Orbital and Undervoltage Lockout	Orbital and Undervoltage Lockout	Orbital	Orbital	Orbital	Functional	Functional	Functional	Functional	Functional	Functional	Functional	Functional	Orbital	Launch	Functional	Off or Functional
DATE			2/20/68 0200 2/20/68 0830	2/21/68 0100	2/25/68 0625 2/27/68 0800	2/27/68 1740 3/2/68 1740	3/1/68 0700 3/3/68 1935	3/4/68 0800 3/4/68 2015	3/5/68 0800 3/6/68 0610	3/6/68 1535 3/7/68 0345	3/7/68 1600 3/7/68 1800	3/8/68 0300 3/8/68 1200	3/11/68 0800 3/14/68 1715	3/15/68 0800 3/20/68 1000	3/20/68 1600 3/21/68 1100	3/24/68 4/1/68	4/2/68 4/17/68	4/18/68 4/22/68	4/22/68 4/29/68	[illegible]	[illegible]	[illegible]	[illegible]
NAME	I.D.		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
BURST RAD 1	12A	AA		N																			
BURST RAD 2	12B	BB		N																			
R.V. RAD 1, CARD 1	13A	CC		N																			
R.V. RAD 1, CARD 2	13B	DD		N																			
R.V. RAD 2, CARD 1	13C	EE		N																			
R.V. RAD 2, CARD 2	13D	FF		N																			
R.V. RAD 3, CARD 1	13E	GG		N																			
R.V. RAD 3, CARD 2	13F	HH		N																			
R.V. RAD 4, CARD 1	13G	II		N																			
R.V. RAD 4, CARD 2	13H	JJ		N																			
IMPEDANCE PROBE	14A	KK		N			◪																
ELECTRON TRAP ELECTRONICS	15A	LL	◪	N	◪		◪		◪		◪												
ELECTRON TRAP SENSOR #1	15B	MM		N																			
ELECTRON TRAP SENSOR #2	15C	NN		N																			
CAPACITANCE PROBE	16A	OO		N																			
		P																					
		Q																					
		R																					
		S																					
		T																					

CODE

E - Facility Induced Problem
■ - Failure
◪ - Questionable Operation
⬓ - Marginal Operation

⊠ - Procedural Failure
◫ - Special Problem
R - Subsystem Repaired
C - Subsystem Changed

M - Subsystem Modified
D - Subsystem Redesigned
N - Subsystem Not Under Test
S - Special Operating Condition for Test

326-075
320-97(3/65)

RAE-A PROTO-FLIGHT SPACECRAFT PERFORMANCE REVIEW

Line Item	Name	Comments
STRUCTURE		
A-40 (◫)	Wedges	Two wedges holding electronic packages tight were not fully tightened before test. Wedges were tightened.
POWER		
B-36 (C)	Battery and Coulometer (01A Serial 02)	Battery Serial 02 was replaced with Serial 05. This was a planned change to be made prior to the solar-vacuum test.
B-37 (◫)	Dump Circuit (01C)	During RFI susceptibility test, the dump circuits resonated at 34.5-35.5 Mc causing battery charge control to be lost.
COMMAND RECEIVERS AND DECODERS		
D-35 (⬓)	Command Decoder (02-B, D Serial 01, 01)	The decoders acknowledges illegal commands with address tones 77 Hz below and 88 Hz above RAE address tone. There was no failure of a component. Threshold bias level was set too low for the receiver drive level on the address tone circuit. (MR No. A-05292)* (MR No. A-05293)*
D-36 (M)	Command Decoder (02-B, D Serial 01, 01)	On 02-B, a 560K resistor was placed across the output of the address detector circuit. The receiver-decoder system sensitivity was then measured

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
D-36 (Cont.)		to be -114 dbm. Temperature tests from -40°C to +60°C indicated a variation of no more than 1 db. On 02-D, a 470K resistor was placed across the output of the address detector circuit. The receiver-decoder system sensitivity was then measured to be -118 dbm. Temperature tests from -40°C to +60°C indicated a sensitivity variation of no more than 1 db.
YO-YO		
F-3 thru F-7, F-9 F-17-31 F-33-38	Yo-Yo	The yo-yo despin system was not installed for tests listed.
F-32 (S)	Yo-Yo	Due to danger of yo-yo bouncing off DTC wall, the despin weights were released but caged.
TELEMETRY		
G-27 (■)	Encoder #1 (04A Serial 04)	Encoder #1 malfunctioned for the duration of one 12-hour hot soak (+52°C). Digital data was correct, but all analog data was identical with no changes from mode-to-mode or period-to-period. Encoder #1 (Serial 04) replaced with Serial 02 on 4/9/68. Cannot duplicate failure on Serial 04. (MR No. A-05290)*
G-33, 34, 35 (S)	Encoder #1 (04A Serial 04)	During DTC and STADAN tests, Encoder #1 was removed from the spacecraft. Tests were accomplished with Encoder #2, Serial 03.

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
G-36 (C)	Encoder #1 (04A Serial 04)	Due to the problem with this encoder in the thermal-vacuum test (see line item G-27), the encoder was replaced with Serial No. 02. (MR No. A-05290)*
750' ANTENNA ASSEMBLIES		
H-13 (■)	Boom #2 (05B Serial 03)	Following vibration through all axes, the spacecraft shells were removed and a boom-partial-deployment test was conducted. All antenna booms apparently stopped travel in both extend and retract directions through actuation of appropriate limit switches. All limit switches indicated normally, except for the <u>extend limit</u> switch for boom #2 which continued to indicate "1", or "boom in midtravel," until retracted to its retract-limit position, at which time "retract limit" was indicated. This was not a flight stop in that in-flight stop is set at 750 feet.
H-33, 34, 35 (S)	2 Upper booms	During libration damper tests in DTC and STADAN, only the 2 lower booms (750') would be extended 3 feet. The 2 upper booms had been removed from the spacecraft for installation of flight boom material.
DAMPER BOOM AND ELEC.		
J-21 (■)	Boom Electrical Disconnect	During the first hot 12-hour cycle, actuation of the Damper Commutator (BED) did not provide correct temperature readings for the damper motor. Readout indicated insufficient pressure

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
J-21 (Cont.)		of contact fingers on slip rings. Position of damper assembly in retract position in 1-G field or contaminated contact and/or slip ring could cause trouble. Commutator provided correct readings for balance of test, including continuous operation at greater than +52°C for almost two hours. The cognizant engineer will examine finger pressure; the mechanical team will ensure that contacts and slip rings are maintained free from contamination and/or oxidation. Test in DTC was satisfactory.
J-35 (N)	Libration damper	The libration damper system was removed for installation of flight boom material and final preparation for flight. The system was not required for the STADAN test.
SOLAR CELL PADDLES		
K-6, 7, 9 K-17-31 K-33-38 (N)	Four Solar Cell Paddles	No paddles were on the spacecraft for these tests. The flight paddles were qualified by separate test in vibration, thermal-vacuum, and thermal-shock.
K-10-16, 32 (S)	Four Solar Cell Paddles	Engineering Test Unit and dummy paddles were installed for these tests.
PROGRAMMERS AND SWITCHES		
L-10 (M)	Experiment Selector Switch #2 (07-F Serial 03)	During the initial, ambient, standard test, it was noted that the program relay for the Electron Trap was in the "on" position during Data Mode. It continued "on" through its normal turn-off time, which is concurrent with capacitance probe "on" in Cal Mode, and thence throughout the remaining

Line Item	Name	Comments
L-10 (Cont.)		data/cal cycles of the test. No change was effected by selection of redundant encoders. It was thought that the relay in question, K07F4, may have become unseated during transportation and other handling. Electron Trap data verified the relay flag's indication of continuous operation when abled. Following the first axis of vibration, checkout indicated that the relay in question was operating properly. It continued to do so throughout the remainder of testing. (MR No. A-05283)*
L-19, 22, 24, 26, 28, 30 (⬓)	Fourth-Stage Monitor (07-L Serial 02)	SCR power gate for 1 second delay was not coming on below -14°C. The SCR was replaced with one of higher holding current characteristics. (MR No. A-05287)* (MR No. A-05291)*
L-33 (C)	Fourth-Stage Monitor (07-L Serial 02)	This card was removed from the spacecraft at the time shown and replaced with Serial No. 03.
L-36 (M, C)	Fourth-Stage Monitor (07-L Serial 02)	The SCR power gate was replaced with one of higher holding current characteristics as previously noted. Serial 03 replaced with modified Serial 02 in spacecraft. (MR No. A-05291)* (MR No. A-05287)*
L-18, 19, 21, 22, 24, 25, 26, 28, 29, 30, 31 (◫)	Undervoltage Programmer (07A Serial 03)	Undervoltage clock #1 in undervoltage Programmer Card had intermittent operation at all temperatures. Clock #2 sometimes erratic at 52°C. At least one clock timed-out in every test

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
L-18, 19, 21, 22, 24, 25, 26, 28, 29, 30, 31 (Cont.)		performed. Cause of malfunction was GSE equipment in that resistors which speed-up timers (from 6 hours nominal to 5 minutes nominal for test) were too low in value causing uni-junction oscillators to conduct at all times. (MR No. A-05285)*
L-21, 25, 27, 29, 31, 33, 36 (■ CM)	Undervoltage Programmer (07A Serial 03)	Command #1 acts like Command #54 at +52°C, i.e., if the spacecraft is in undervoltage configuration, with Data Systems Relay OFF, Command #1 will turn Data Systems Relay ON. This circuit is in the Undervoltage Programmer Card. Cause of malfunction was insufficient filtering to reduce crosstalk in command decoders on channel 54. Corrective action taken: A 200 ohm resistor and a 0.1 uf capacitor were added in line with command 54 from command decoder. (MR No. A-05289)*
L-25, 27 (◫)	Data Programmer (07B Serial 03)	Command #56 (Hi-Power Transmitter Able) turned lower power transmitter OFF at +52°C sometimes. As this ABLE command function also provides power to the tape recorder playback programmer, there is the possibility of a "C34 + 720" signal (end of playback) reaching the low power transmitter OFF relay circuit. These functions are all internal to the Data Programmer Card. In flight, Hi-Power Transmitter should always be ABLED although not POWERED, and playback programmer should be powered, thus precluding a need for Command #56 except in case of system overload or

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
L-25, 27 (Cont.)		inadvertent DISABLE command. Operators will be cautioned on the possibility of a Hi-Power ABLE command turning OFF low-power transmitter.
L-18, 19, 22, 23 (◪ ■ M)	Pyro Programmer (07G Serial 02)	Below +10°C, Command #63 provided no pyrotechnic firing pulse out of the Pyro Programmer. Command #62 would not reset Pyro Register Relay 24 below -10°C. The thermal-vacuum test was stopped on February 21 for investigation. It was found that design control drawings were out of date and the wrong capacitors had been installed. The capacitors were replaced with the correct value (2.2 micro-farad), returned to the spacecraft and operated correctly. No further trouble. (MR No. A-05261)*
L-18, 19, 22, 23 (◪ ■ M)	Sequence Programmer (07H Serial 01)	Below -10°C, Command #15 would not reset Boom Select Relays Numbers 1, 2, and 4. Command #15 would not reset boom power relay. The cause and disposition was the same as for the Pyro Programmer. No further trouble. (MR No. A-05284)*
L-25, 29 (◫)	Data Programmer (07B Serial 03)	Command #59 turns Playback Program OFF when transmitted during a Playback Program. This command alternates selection of Encoder Converter #1 and #2. As these converters provide +12V to the Playback Programmer, the switching transient probably causes termination of the Playback Program. Operators will be cautioned not to

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
L-25, 29 (Cont.)		transmit Command #59 during a Playback Program. Not affected by any temperature condition.
L-37 (■ R)	Dipole Switch #1 (07J Serial 02)	Due to lowered sensitivity of the Burst Receiver and Ryle-Vonberg radiometer on the dipole and upper-V antenna, the card was removed from the spacecraft and opened up. One transistor in the preamplifier was bad and was sent to failure analysis. Also, it was discovered that potting material had not been filled in under the R.F. shield (cap) on the preamplifier. All components on this section were replaced, the card was repotted, and the card was requalified in vibration and temperature before reintegrating into the spacecraft. (MR No. A-04208)*
L-37 (■ R)	Dipole Switch #2 (07K Serial 02)	Due to lowered sensitivity described for dipole switch #1, dipole switch #2 was also removed from the spacecraft. The potting problem was the same, i.e., no potting material under the RF shield. All components under the shield were replaced, repotted, and requalified in vibration and temperature before reintegrating into the spacecraft.
TAPE RECORDER AND ELEC.		
M-18, 19, 22, 23 (■ ■C)	Tape Recorder Transport (08B Serial F1)	Tape recorder output provided no useful data until recording above +5°C. Transport, Serial F1 replaced with Serial F3 using F1 can. (MR No. A-05297)*

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
M-26 (■)	Tape Recorder Transport (08B Serial F3)	Tape recorder output marginal at temperatures below -10°C in at least one of two modes. Output partially retrievable for recordings at -20°C after 96-hour hot-soak period. Operation of unit is good at flight temperature levels. (MR No. A-04217)*
M-33, 34 (N)	Tape Recorder Transport and Electronics (08B, C Serial F3, 03)	Items noted were not required for DTC tests and were removed for investigation and preparation for flight.
M-37, 38, 39, 40, 41 (S)	Tape Deck	The flight tape deck was not installed for these tests. Instead a spare unit was used.
SOLAR SENSORS AND ELEC.		
N-9 thru 16 (N)	Solar Sensors (09B-L)	Solar Sensors attached to solar cell paddles were not under test at this time.
N-28 thru 30 (◫)	Solar Sensors (09B-L)	Solar aspect spin mode provided no information during last three days of thermal-vacuum test program. Stimulation with a sun gun at ambient conditions following the test program indicated the SAS spin mode and related sensors were operating correctly. It was discovered that spin sensor exciter bulbs had changed position during the test. These small lamps were taped to the sensors and both tape and lamps had moved. Sensors were not attached to paddles.

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
N-33, 34 (N)	Solar Sensors (09B-L)	Sensors were not required for DTC tests.
ANTENNA CAMERAS, ELECTRONICS, AND TARGETS		
O-27 thru 30 (◩)	Antenna Aspect Camera (10E Serial 01)	One shutter on lower camera could not be closed when its sun sensor was stimulated with a sun gun. Shutter itself operated (opened when system was turned on) and all sun sensors were checked for correct output after test. The sensor was located in the chamber window and connected to the camera electronics by a long cable. This sensor/shutter circuit was difficult to actuate at ambient conditions with short connector cable. All antenna aspect sun sensors (4) will be soldered and not crimped. GSFC will inspect connections. (MR No. A-04218)*
O-31 (◫)	Lens for Camera #1 (10E Serial 01)	Following the thermal-vacuum test, it was discovered that the cement between the first two elements of the lens was crystallizing. The anomaly has been getting progressively worse at ambient conditions. It is not known what the exact condition of this lens was in before the thermal-vacuum test. A spare lens of the same type is undergoing subsystem tests. (MR No. A-04216)*
O-36 (C)	Camera (10E)	Camera, Serial 01, was replaced with Serial 03 because of lens problem.

*NOTE: Malfunction reports marked (*) indicate they are closed out.

Line Item	Name	Comments
MISCELLANEOUS		
Q-36 (M)	Wiring Harness	The harness was modified to accept the antenna cable filters.
IMPEDANCE PROBE		
KK-26 (■)	Impedance Probe (14A Serial 01)	Channel 5 calibration point was occasionally out-of-tolerance at low temperatures. The experiment will be flown, with caution to data programmers that this point may occasionally be out-of-tolerance.
ELECTRON TRAP ELECTRONICS		
LL-18, 19, 22, 24, 26, 28, 30 (■)	Electron Trap Electronics (15A Serial 01)	The second "zero" calibration reference is out-of-tolerance below +15°C measured at the electron trap electronics. This is a redundant calibration point. The first "zero" calibration reference is satisfactory. The experiment will be flown, with caution to data programmers that this point may occasionally be out-of-tolerance. (MR No. A-05288)*
ANTENNA CABLE FILTERS		
R-1 thru 35	Cable Filters (17D-J Serial 01-06)	Not under test.

*NOTE: Malfunction reports marked (*) indicate they are closed out.

APPENDIX D

SOLAR CELL PADDLES

APPENDIX D

SOLAR CELL PADDLES

The flight solar paddle "A" set exhibited the following discrepancies after environmental tests:

Flight Paddle No.	Cells Exhibiting Contact Peeling	Cells With Open Tabs Requiring Rework	Total Number of Open Tabs	Cracked Cells
02	91	153	1537	6
03	21	74	710	4
04	37	66	936	3
05	30	116	1121	2

The cells with open tabs requiring rework resulted from an individual case decision by the solar array engineer. The criteria employed was the overall reliability effect on the array. Electrical performance curves were taken prior to optical inspection, and discrepancies in the relatively lower performance quadrants were dealt with more severely. A general rule of thumb followed. It required at least 7 of 11 tabs soldered to specification with each 2 x 2 cm cell, and at least 3 of the 5 tabs connecting each 1 x 2 cm cell.

The contact peeling criteria involved electrical continuity of the grid lines to the ohmic strip contact and the extent of the Ti-Ag contact bonding to the cell. Up to 15% ohmic strip peeling was tolerated if it was not concentrated in a critical region. Another point in this cell by cell decision was the appearance of the remainder of the contact.

This contact peeling problem with silicon solar cells is not unique to the RAE program. The problem encountered on RAE is characterized by separation of the Ti-Ag contact from the silicon substrate under the shear stress levels developed at the interconnector tab solder joints under extreme thermal conditions. This peeling generally occurred around the interconnector tabs on cells in a random pattern. Characteristically, the predominant peeling occurred as tearing around the tabs in a non-preferred direction. Occasionally a triangular buckling between tabs indicative of predominant transverse shear stress was noted. In rare cases, large sections of the "N" contact would peel with a characteristic surface ripple appearance. It should be noted that GSFC solar array inspection is probably the most extensive and strictest in the field. (Weekly Progress Report dated June 27, 1968).

APPENDIX E

INDEX OF SUBSYSTEM MALFUNCTION REPORTS SUBMITTED

APPENDIX E

INDEX OF SUBSYSTEM MALFUNCTION REPORTS SUBMITTED

M.R. Number	Subsystem	I.D. Code	Date of M.R.
2608	Experiment Converter	01J/K	4-17-67
3795	Tape Recorder Transport	08B	4-3-67
3789	Bus Box	01D	10-18-67
3791	Pyro Programmer	07G	10-21-66
10869	Tape Recorder Transport	08B	12-5-67
10868	Encoder No. 1	04A	11-27-67
5260	Paddle D	06D	2-14-68
5337	Data Programmer	07B	8-2-67
4219	Antenna Boom #3 Assy	05C	5-3-68
4220	Sequence Programmer	07H	5-3-68
3792	Encoder No. 2	04B	4-18-67
10859	Encoder No. 1	04A	10-3-67
5295	Fourth Stage Monitor	07L	3-26-68
10861	Under Voltage Programmer	07A	11-6-67
10870	Sequence Programmer	07H	12-5-67
10899	Exp. Selector Switch No. 1	07E	6-9-67
3805	Antenna Aspect Camera	10A	6-20-67
4784	Antenna Aspect Camera	10A	7-25-67
3811	Antenna Aspect Camera	10A	7-25-67
3819	Antenna Aspect Camera	10A	9-14-67
5299	Antenna Aspect Camera	10A	2-16-68
3806	Antenna Aspect Camera	10A	6-26-67
3818	Antenna Aspect Camera	10A	7-28-67
3812	Antenna Aspect Camera	10A	8-23-67
5300	Antenna Aspect Camera	10A	2-19-68
3807	Antenna Aspect Camera	10A	7-19-67
3817	Antenna Aspect Camera	10A	7-16-67
3821	Antenna Aspect Camera	10A	9-1-67
3802	Antenna Aspect Camera	10A	5-27-67
10866	Damper Aspect Electronics	05K	11-10-67
4216	Antenna Aspect Camera	10A	4-15-68
T.R. 2066	Antenna Mechanism	05C	4-12-68
T.R. 2067	Antenna Mechanism	05C	4-12-68
T.R. 2068	Antenna Mechanism	05C	4-12-68
T.R. 2065	Antenna Mechanism	05C	4-13-68