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SYSTEM
PERFORMANCE EVALUATION TEAM
MISSION 1201

27 SEPTEMBER 1971

This report consists of 85 pages.



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PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

SECTION I

SUMMARY

1.1 INTRODUCTION

The first HEXAGON Program Satellite Vehicle was placed into a planned 100 x 165 NM sun-synchronous orbit by the Titan III D Booster Vehicle at 1841Z, 15 June 1971. Photographic operations were performed on days two through 31. The Reentry Vehicles were deorbited on Revs 82, 179, 405 and 502. RV-1 was recovered from the water and RVs 2 and 4 were aerially recovered. RV-3 was not recovered. The best ground resolution (average in-track and cross-track) subjectively obtained from the CORN tribar targets was 2.3 feet.

1.2 CONSTRAINTS

The constraints outlined below are those applicable to HEXAGON Mission 1201.

1.2.1 Preflight

The following constraints were imposed before launch:

- A. Solar heating (Beta) angle from -20 to +10 degrees.
- B. Altitude range of 93 to 135 NM over illuminated area of interest.
- C. No orbit adjusts prior to first recovery.
- D. First recovery on day five.
- E. Fixed minimal rewind.
- F. No negative scan centers during mono operations.
- G. No operational photography prior to sensor subsystem validation through engineering photography within COOK tracking station cone.
- H. RV mass imbalance not to exceed 60% for first unbalanced RV.

1.2.2 On-Orbit

Constraints imposed on-orbit were:

- A. After Emergency Shut Down (ESD) on Rev 314, the 30° scan width was prohibited from Revs 326 to 440.
- B. After ESD on Rev 445 all negative scan centers and 30° scan widths were prohibited in the mono mode from Revs 471 to 476.
- C. Recovery for RVs 3 and 4 was restricted to areas within range of land based helicopter support.
- D. Max allowable load for RV-4 was 50%.
- E. Sensor subsystem operating time was restricted to 17 minutes per fixed block of four revs from Revs 20-35 and 30 minutes from Revs 36-100. From Rev 101 to end of mission, operating time was restricted to 30 minutes per sliding four-rev span.

PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

1.3 SENSOR SUBSYSTEM PERFORMANCE

During Mission 1201 the sensor subsystem had four ESDs. Three of these shut downs were caused by problems in the film path. The fourth was caused by incompatible V_x/h and film velocity (V_g) inputs from the Extended Command System (ECS). On-orbit efforts to clear these ESDs were successful in every case. Nominal performance was experienced in the remainder of the sensor subsystem.

1.4 SATELLITE VEHICLE SYSTEM PERFORMANCE

The Titan III D Booster Vehicle (BV) performed satisfactorily, injecting the Satellite Vehicle (SV) into orbit with the following differences from the planned parameters.

Perigee Altitude	-0.216 NM
Perigee Argument	+6.168 Deg
Period	+0.004 Min
Inclination	-0.005 Deg

The BV Command Guidance System performed satisfactorily. The overall performance of the SV was excellent and all HEXAGON mission objectives except the recovery of RV-3 were met. Following a 21 day SOLO (operations beyond the primary mission) operation (which is not described in this report), the SV was successfully deboosted. The overall SV performance for the ascent phase and each of the four mission segments is summarized as follows:

A. Ascent. Ascent events were nominal and stabilization of the SV allowed deployment of the Solar Arrays on Rev 1. Apparent contamination of Aft Section thermal control surfaces during ascent caused an over-temperature condition in the battery module which remained constant throughout the mission.

B. Segment One. By Rev 16, all subsystem health checks had been completed and operational photography began on Rev 24. On Rev 82, RV-1 was successfully separated with a total film load of 40,000 feet. Damage to the aerial retrieval target cone was observed which led to the decision to allow the RV to water impact. The RV was recovered from the water with no damage to the payload.

C. Segment Two. Operational photography continued on Rev 88 using RV-2. On Rev 179, RV-2 was successfully separated with a total film load of 52,000 feet. Main parachute damage occurred but aerial recovery of the RV was successful.

D. Segment Three. Operational photography continued on Rev 185 using RV-3. On Rev 405, RV-3 was successfully separated but was not sighted nor recovered. Major damage to the main parachute apparently occurred during deployment. As a result of this malfunction, the film load of 54,000 feet was lost.

E. Segment Four. Following some difficulties with ESDs, operational photography was resumed on Rev 470. The premature degradation of the pyro batteries led to the decision to separate RV-4 on

BYE 15285-71

PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

Rev 502. Separation and aerial retrieval of RV-4 was entirely normal and 26,000 feet of film was recovered.

1.5 SATELLITE BASIC ASSEMBLY PERFORMANCE

The performance of the Satellite Basic Assembly (SBA) subsystems was acceptable with few anomalies, with the exception of the electrical distribution and power subsystem. All primary equipment functioned throughout the four segments and no backup equipment was required. Subsystem performance is summarized below with detailed discussions provided in later sections of this report.

- A. Attitude Control System (ACS). The ACS met performance requirements in all operating modes.
- B. Reaction Control System (RCS). Apparent early degradation of thruster pulse shape was observed but with no impact on control of the SV. The cause has not yet been determined, but no changes are indicated at this time. Propellant capacity is adequate for the design mission.
- C. Electrical Distribution and Power (EDAP). The Main Power System meets requirements. The Reserve Power System (RPS), carried on this vehicle only, was not required. No adjustments are necessary for the design mission. Relocation of Bay 12 batteries to Bay 3 is necessary until the ascent contamination problem is eliminated. The pyro power system is marginal.
- D. Orbit Adjust System (OAS). The system meets performance requirements. No adjustments are necessary for the design mission. Propellant capacity is adequate for the design mission.
- E. Tracking, Telemetry, and Command (TT&C). The system meets performance requirements and no adjustments are necessary for the design mission. Antenna performance lead to the recommendation to restrict secure word block commanding to favorable station elevation angles. Extended Command System (ECS) logic errors prohibit use of certain [REDACTED] Impact of these constraints is minor. Instrumentation was adequate for SV control and diagnosis.
- F. Lifeboat II. Health checks showed performance met the requirements for this mission. However, neither a demonstration of operation at the extreme of the orbit regime nor a simulated Lifeboat capture was attempted during primary mission.
- G. Structures and Mechanisms. Performance requirements were met and no adjustments are necessary for the design mission. Solution of the contamination problem may require new ejectable shields over the Aft Section thermal control surfaces.
- H. Thermal Control System (TCS). Active and passive thermal control designs met operational requirements except for the Bay 12 over-temperature condition associated with ascent contamination. A solar heating (beta) angle constraint is necessary until the contamination problem is eliminated but no changes to the basic thermal design are indicated.

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PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

1.6 ANOMALY SUMMARY

Significant anomalies and malfunctions are listed chronologically in Table 1-1. The list includes a description of the anomaly, the mission consequences and in some cases, the changes indicated for subsequent vehicles. Detailed discussions of these anomalies can be found in appropriate sections of this report.

1.7 CONCLUSIONS

- A. There was thermal surface contamination over the entire SBA on Mission 1201.
- B. The catastrophic parachute failure experienced on RV-3 requires a fix prior to Mission 1202.
- C. The validity of the current center of gravity (CG) offset criteria is questionable in view of the RV performance on Mission 1201.
- D. The demonstrated RV performance was less than predicted.
- E. The overheating of the Type 29 and Lifeboat batteries requires a fix prior to Mission 1202.
- F. The available pyro battery energy for flight must be increased.
- G. The power system demonstrated adequate capacity for unrestricted vehicle operation of block one vehicles. However, management of the system while anomalies are present, such as the overheated batteries, was inadequate.
- H. There is a logic error in the A decoder of the Extended Command System (ECS).

1.8 RECOMMENDATIONS

- A. The parachute design and fabrication should be improved to assure aerial retrieval as soon as possible.
- B. Constrain the orbit for Mission 1202 to be compatible with the RV and SBA capability limits demonstrated on Mission 1201, i. e. , nominal design orbit, and solar heating (beta) angle similar to that of Mission 1201.
- C. Institute a program to adequately define the requirements and capabilities of the Reentry Vehicles.
- D. Eliminate the decoder A logic error. Until such time as a permanent fix is effected, procedures should be developed to work around the decoder logic problem. These procedures should have minimum impact on mission operations. In this light, a thorough review of the feasibility of using decoder B as primary should be made.
- E. Develop a power management system which will provide full knowledge of the energy available considering the most probable power system anomalies.
- F. Provide more pyro battery capacity.
- G. The antenna performance should be reviewed to determine possible improvement.
- H. Move the batteries from bay 12 to a colder location, i. e. , bay 3.

PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

TABLE 1-1

ANOMALIES

<u>Rev</u>	<u>Description</u>	<u>Impact</u>
Ascent	HSA output transient	Primary roll and pitch output transients observed during SV/BV separation. Apparently caused by microphonics resulting from separation shock. Operation normal on orbit so no mission impact. Design changes on SV-2 are not indicated although SV-7 and up design will not be as susceptible to microphonics.
Ascent	Acoustic microphone	Microphone sensitivity to static pressure pulses at lift-off caused data degradation. Corrective high pass filters to be installed on SV-2 microphone amplifiers.
2	Hot Aft Section	Over-temperature condition on Bay 12 battery module resulting in degraded main power system capability and early pyro battery depletion. SV-2 to fly with battery module moved to Bay 3, beta angle restricted to one near the one flown on Mission 1201, and contamination experiments will be installed in Bays 11 and 12 to identify problem solution. Appropriate solution planned to be implemented on SV-3.
Throughout	Data drop-outs	Space Ground Links System (SGLS) antenna pattern holes excluded secure work loading at high station elevations. Operational restrictions are not severe and will be continued on future vehicles. No design changes indicated.
82	RV-1 chute damage	Damaged chute sighted by recovery forces. Water impact allowed with successful recovery.
179	RV-2 chute damage	Damaged chute sighted but successful aerial recovery implemented.
314	Emergency shut down	Jam in fine film drive system. Normal ops resumed following constant velocity and engineering tests. No design changes indicated.
402	Emergency shut down	Apparent temporary obstruction in coarse film path. Normal ops resumed following creep and constant velocity tests. No design changes indicated.
405	RV-3 chute failure	RV not sighted, nor recovered. Apparent premature disreef of main chute caused structural failure.
435, 459, 460	RCS Thruster pulse shape distortion	Distortion similar to but not as severe as ground test experience occurred prematurely. Vehicle control entirely adequate and extra propellant usage not indicated. Cause and corrective action under investigation. No design changes indicated.

PERFORMANCE EVALUATION TEAM
REPORT NO. 1201/71

TABLE 1-1 (CONT'D)

ANOMALIES

<u>Rev</u>	<u>Description</u>	<u>Impact</u>
474, 476	RCS Thruster thrust level shift	Thrust level shift similar to ground test experience. Thrust remained within limits and showed a tendency to return toward normal conditions in a subsequent firing. In mono ops, roll rate exceeded fine mode rate limits. To be studied further. No design changes indicated.
445	Emergency shut down	Input drive capstan in fine film drive system stopped rotating. Cause is unknown. Normal ops resumed following mono ops during 5 revs and a recycle operation. No design changes indicated.
484	Pyro battery depletion	Pyro battery number 1 began rapid voltage decay earlier than anticipated. Review of battery duty cycle and temperature environment revealed degradation to be predictable. Reduced loading and cooler environment for SV-2 are planned.
492	Emergency shut down	ECS logic problem caused erroneous commands which caused ESD. SV-2 through SV-4 will restrict use of certain Variable Stored Program Commands (VSPC). SV-5 will incorporate modified ECS.