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11 May 1970

MEMORANDUM FOR DR. McLUCAS

SUBJECT: Analysis of the GAMBIT Project, Flights 1-22

QUESTION

What success has been achieved, from the SAFSP point of view, in the single bucket series of GAMBIT flights?

BACKGROUND

Attached is a letter from General King transmitting a report on the first 22 flights of GAMBIT; that is, those with a single recovery vehicle (SRV).

DISCUSSION

There are one or two serious misstatements in the report, and in general the body and summary of the report tend to mislead. A review of the significant technical discrepancies is at TAB A, and the cost factors are discussed at TAB B.

RECOMMENDATION

That you accept General King's conclusions and expectations regarding GAMBIT, as expressed in the letter, but not those of the report.

RICHARD L. GEER
Major, USAF

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TAB A, Staff Critique
TAB B, Cost Factors
TAB C, BYE 16762-70,
Analysis of G Proj

GAMBIT
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An NRO Staff Critique of the Technical Aspects of "Analysis of GAMBIT (110) Project," an [redacted] Report

(b)(1)
(b)(3)

The statement is made on page one, paragraph 2c, of the report that the goal of [redacted] while at 90 nm altitude, of a target with a two to one contrast ratio. ... was achieved and slightly surpassed with the final mission, Flight 22, which had a best ground resolution of [redacted] by Controlled Range Network (CORN) target determination." This statement is not true. (b)(1) (b)(3) (b)(1) (b)(3)

According to the Performance Evaluation Team Report No. 4322/69 prepared for and by direction of the Director of Special Projects, that particular reading, taken on frame 032 of rev 31, had a ground contrast of 4.85:1 and a system contrast of 3.91:1, not 2:1. It was taken at 77.1 nm altitude, with a 5.3° obliquity, not at 90 nm. Had the conditions been as specified, the resolution would have been close to [redacted] (b)(1) (b)(3)

It should be recognized that the [redacted] read was across the track of the vehicle. The best in-track resolution was [redacted] on frame 030 of rev 31. The associated across-track resolution for that frame was 12 inches. Had the picture been taken at 90 nm slant range, the resolution would have been about [redacted] in-track and 14 inches across-track. (b)(1) (b)(3) (b)(1) (b)(3)

An important point to note is contained in paragraphs 3b and 3c of page 2. "Two systems were injected in orbit with far higher energy than planned", yet "were considered very successful." The reason for this apparent anomaly is that mission success is scored in number of targets photographed, which is aided by high apogee orbits, and best resolution obtained, which is aided by the lower than normal perigees often associated with high apogee orbits. The degradation is in overall quality distribution, which is not comparably scored.

The banding problem mentioned in paragraph 4a(1)(b), page three, also shows up at 10 and 500 Hz. The ten cycle banding is associated with start up transients and is present over the majority of the frame on most of the frames taken on 4326, due to still further reduction in burst time causing photography to be taken during the film start-up transients. The high frequency problem is being investigated, but the low frequency problem can be expected to persist as long as the emphasis is on target quantity rather than quality.

Mission 4322 had the best resolution yet obtained from GAMBIT. It is probable that only on winter missions will we see comparable photography until the introduction of the R-5 lens.

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GAMBIT Cost Factors, Vehicles 1-22

The cost material in BYE-16762-70 is in some cases inconsistent with the official fiscal year NRP summaries, caused partly by varying interpretations of non-recurring costs, partly by differences in allocations between vehicles 1-22 and 23/Subsequent, and partly by inclusion in the BYE of about $70M non-recurring which was funded by SAMSO under Titan III development, rather than by the NRP.

The BYE shows $172.8M non-recurring, for instance. If the SAMSO $70M is deducted, to arrive at NRP funding, this would leave a balance of $102.8M funded by the NRP. Our records otherwise have indicated $146.4M non-recurring for vehicles 1-22 as NRP funded, or a difference of $43.6M. The recurring unit costs are almost the same as used previously, which indicates that more of the non-recurring is now assigned to vehicles 23/Subsequent by SAFSP. This may serve a purpose of making the vehicles 1-22 costs look better for the study, or it may be that post-refinements were made to make better distinctions from vehicles 23/Subsequent (the official financial reports did not make direct distinctions between the lots, but as an illustration of the interpretive difficulties, $16.6M was obligated in FY 1965 for Spacecraft development, ostensibly for vehicles 1-22, as the extended life/2 RV version was not funded until starting in FY 1967, but in the BYE summary, only $11.2M of FY 65 is charged to vehicles 1-22). Another difference is that $7.6M of Aerospace costs charged to development are reflected in the BYE as "recurring." Accordingly, the BYE costs should be considered as rough magnitude for non-recurring, and close for recurring, which would put the total costs for vehicles 1-22 in a range from $586.8M to $622.8M, or a variance of $1.6M each, which is not a significant differential.

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DEPARTMENT OF THE AIR FORCE
OFFICE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

REPLY TO ATTN OF: SP-1

[illegible] 1970

SUBJECT: Analysis of Gambit (110) Project

TO: DNRO (Dr McLucas)

1. As you requested, the subject report is submitted as an analysis of Gambit (110), Flights 1 through 22, covering the same aspects as a previous report of Gambit (206).

2. I think you will consider the success this program has had with obtaining higher resolution photography and in reducing cost per target as quite acceptable. With the further increase in primary film capacity, dual recovery units and projected use of increased battery power and the R-5 lens, you can expect some further improvements in these areas for the follow-on systems.

WILLIAM G KING, JR
BrigGeneral, USAF
Director

1 Atch
[redacted] Letter, subject as above, w/5 Atchs (b)(1) (b)(3)

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69 Pages

Attachment 1

ANALYSIS OF GAMBIT PROJECT

MISSIONS 23 THROUGH 36

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DEPARTMENT OF THE AIR FORCE
OFFICE OF SPECIAL PROJECTS (OSAF)
PO BOX 92960, WORLDWAY POSTAL CENTER
LOS ANGELES, CALIFORNIA 90009

BAFD-2

REPLY TO ATTN OF: SAFSP-1

12 Feb 74

SUBJECT: Analysis of GAMBIT (110) Project

TO: DNRO (Mr. Plummer)

1. Reference report, subject as above, dated 28 April 1970, in which the first 22 flights of the 110 Project were analyzed.

2. The attached analysis covers the second block of Project 110 vehicles, Flights 23 through 36. The analysis clearly reveals that the project has obtained improved resolution and increased on-orbit times while simultaneously reducing the cost per target.

3. Planned modifications scheduled for Vehicle Blocks 42 through 47 and 48 through 54 should result in additional improvements in resolution and vehicle on-orbit life while continuing to reduce the cost per target.

David D. Bradburn
DAVID D. BRADBURN
Brigadier General, USAF
Director

1 Atch: Analysis of GAMBIT Project Missions 23 through 36

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INTRODUCTION

The purpose of this report is to summarize the changes to the GAMBIT (110) project between the recently completed block of vehicles (23 through 36) and the previous series (1 through 22), as well as to analyze the progress achieved. An attempt was made to keep the format generally the same as the previous analysis of Missions 1 through 22 (BYE-16762-70, dated 28 April 1970). Statistics for Missions 1 through 22 and for Missions 23 through 36 are shown to illustrate the growth of this project.

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SECTION I

PROJECT SUMMARY

1. OVERVIEW

a. The series of vehicles covered by this analysis was vastly different from those of the previous series as a major redesign had been effected on GAMBIT Vehicle 23. The primary changes implemented on this vehicle are summarized below:

(1) A second re-entry vehicle was added, doubling the film load (from 5,000 to 10,000 feet).

(2) The Electrical Power Subsystem was redesigned and a ninth Type 1K battery was added to extend mission life from 10 to 14 days. (Mission lifetime was subsequently extended to 27 days in increments.)

(3) The Guidance and Control Subsystem was changed from one high and one low performance system to two high performance systems to increase guidance accuracy, vehicle stability and system reliability.

(4) The Tracking, Telemetry and Command (TT&C) Subsystem was modified to the Space-Ground-Link Subsystem (SGLS) to maintain compatibility with the Air Force Satellite Control Facility (AFSCF)

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Unified S-band capabilities. Also, the MOD IV Command Subsystem was introduced with its associated increased in system reliability and command execution and storage capabilities.

(5) The expansion ratio of the Titan IIIB booster Stage I engine was changed from 8:1 to 12:1. This modification provided an additional 240 pounds of payload capability which was needed to accommodate the added re-entry vehicle.

b. The GAMBIT project was enhanced by the introduction of the second re-entry vehicle in the following ways:

(1) A quick-reaction capability for special coverage without the necessity of sacrificing the remainder of the mission targets was achieved. This quick-reaction capability was utilized on Mission 28 to obtain coverage of the Suez Canal cease-fire zone during the 1970 crisis between Israel and the Arab nations with results which were highly lauded.

(2) The capability of examining the results of the first mission segment allowed identification of any changes to focus, etc., in order to optimize the second mission segment photography. To expedite this process, a "Quick-Look" Team was established to examine the record from the first recovery vehicle in real time at the processing facility. This analysis has proven to be very valuable.

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(3) Assurance was increased that, even if one re-entry vehicle was lost, the results from at least one mission segment would be successfully recovered. This situation arose on Flight 25 with the loss of the second re-entry vehicle due to a parachute system failure. Also, on Flight 27 a command subsystem failure shortly after completion of the first mission segment precluded any further photography.

c. Improvements in tracking accuracy, the accuracy of target location data and the command subsystem allowed more effective use of the film load. Improved ephemeris, target location and diameter data reduced errors and allowed shorter burst (camera on to camera off) times on each frame of film. Additional frame size reductions were achieved with the incorporation of the MOD IV Command Subsystem and its capability to accept time biases, for ephemeris error correction, to previously stored commands in the memory. This ability allowed adjustment of the payload time tags based on later tracking data which reduced errors and the tolerances used in the construction of frames. These reductions in film burst times permitted more efficient film utilization in the high density target areas and a reduction in the average frame length (from a low of 1.08 feet on Mission 22 to a low of 0.85 feet on Mission 31). With the reduction in average

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frame length and the increase in the film load, primary camera operations increased from a peak for Missions 1 through 22 of 4,635 (on Mission 22) to a peak for Missions 23 through 36 of 11,919 (on Mission 31).

d. Total intelligence targets programmed increased from 64,936 for Mission 1 through 22 to 174,693 for Missions 23 through 36. The total intelligence targets readout for Missions 23 through 36 in Categories 1A through 9A, 10, 11, 14 and 16 was 81,845. It should be noted that this figure does not include all targets readout as it was not possible to isolate this data for Categories 20 and 21. The difference between total targets programmed and total targets readout was primarily due to cloud cover, but also due to various hardware problems as well as the inability to obtain all data.

e. The Best Ground Resolution (CORN) reported by the Performance Evaluation Team for Missions 23 through 36 was [redacted] on Missions 33 and 34. In addition, Average Ground Resolution was [redacted] for Missions 23 through 36. The reduction in ground resolution is primarily attributable to optics system improvements which became effective on Vehicle 32.

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2. OPERATIONS

a. Of the 14 missions (28 re-entry vehicles) attempted, one flight (35) failed to achieve orbit due to failure of the Augmented Control System regulator to supply sufficient gas to control the Agena during staging and ascent burn. Also, the second re-entry vehicle from two flights were lost; on Flight 25 due to a parachute failure and on Flight 27 due to a command subsystem and relay failure.

b. One flight (24) was injected into orbit with a far higher apogee altitude than planned due to the failure of the Velocity Control Assembly on the Agena to command main engine shutdown. The orbit was successfully adjusted and mission impact was minimal.

c. Other than the failure of Flight 35, the loss of the second re-entry vehicle from Flight 25 and the attempted termination of the second segment of Flight 27, the missions covered by this report were successful. Although various hardware problems were encountered during each flight, they were successfully circumvented with minimal impact upon the primary photographic mission.

d. Vehicle Atmospheric Survivability Tests (VAST) were conducted on Flights 30, 31, 32 and 34. Radar and telemetry data were obtained, but recovery of actual debris was not achieved.

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f. The most significant operational details are given in Section II.

3. TECHNICAL

a. Photographic Payload Section (PPS)

(1) Camera Optics Module (COM)

(a) The ability to routinely manufacture lens systems exceeding performance specification requirements was achieved through improvements in test techniques and methods of evaluating acceptance test data. Selectro-plating to fill in surface irregularities on the reflective components was eliminated effective with FM-30. Beginning on FM-28, acceptance of the assembled lens system was based upon two-attitude averaging of the interferometrically-obtained system wavefront. Theoretically, if the design is symmetric to the gravity vector, averaging will result in obtaining the zero gravity (orbit condition) wavefront. Evaluation of flight data substantiates the assumptions made in this test technique.

(b) An improved photo-optical lens system, designated as R-5, was employed on Vehicle 32 and subsequent. Significant

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improvements over the previous R-361 system were: Improved general quality both on- and off-axis, increased focal length, improved color correction and reduced field curvature.

(c) The problem with high frequency banding on the primary photographic record mentioned in the analysis report of Vehicle 1 through 22 has been resolved. This banding, which was associated with primary camera drive smoothness, was eliminated by stiffening a shaft between the camera drive motor and the platen. However, since this modification was not effective until Vehicle 37, banding was present on the photography obtained from the missions covered by this report.

(d) Drifts in focus, as a function of Door-open-light (DOL) time, were noted beginning with Vehicle 32. An approximate one mil negative drift per thousand seconds DOL time was confirmed by both focus subsystem and post-flight photographic data. Operational steps have been taken to maintain focus within specification limits while analysis of the cause is underway.

b. Satellite Re-entry Vehicle (SRV)

(1) The GAMBIT configuration change at Vehicle 23 included a dual recovery capability utilizing two SRV's; SRV 1 containing only primary camera film, and SRV 2 containing both primary and astro position-terrain camera film.

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(2) The only major problem encountered with this hardware was associated with the parachute system on SRV 2 from Flight 25. This re-entry vehicle was lost because of the failure of the parachute system to deploy. It was determined that the cause of the failure originated with the parachute thermal cover. This situation has been corrected.

c. Electromechanical Hardware

The only major problem in this area was a relay failure in the Switchover Electronics of SRV 2 on Flight 27. The failure of this relay, however, resulted in an inability to execute the re-entry sequence from the backup command subsystem; and SRV 2 from this flight was not recovered. The Switchover Electronics circuitry was redesigned on Vehicle 35 to eliminate this failure mode.

d. Post-flight Evaluation of System Performance

(1) A "Quick-Look" Team was formed with the initiation of a dual recovery mission to analyze the SRV 1 material in real-time at the processing facility. This type of analysis has proven successful in optimizing the photographic parameters and improving the photographic quality of the second mission segment.

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(2) A Factory-to-Orbit correlation software program was written as a tool for post-flight analysis and used on FM-27 and subsequent vehicles. The program compares factory test performance with orbital CORN target performance data. Allowance is made for measurable smear, defocus, exposure error and contrast. Degradation from these contributors is applied to the factory test Modulation Transfer Function (MTF) curve, and this curve is then crossed with the appropriate film Threshold Modulation (TM) curve. The intersection of the curves is the limiting resolution predicted for the system. Comparison can then be made to the subjectively read CORN tri-bar resolution. Good correlation was evident through Flight 34. However, on Flight 36, results indicated a potential change in astigmatism (both direction and magnitude) and some misalignment. Accounting for degradation from these sources resulted in better correlation. Further refinement in the Factory-to-Orbit correlation program to handle degraders for which allowance is not presently made is expected during the next series of vehicles.

e. Satellite Control Section (SCS)

The SCS was structurally (i.e., the Roll Joint, Spaceframe Subsystem and the Maximum Access Booster Adapter) the same for

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Vehicle 23 as it had been for Vehicle 22. There were, however, many changes to the hardware located within this section. These changes, which included major redesigns and new hardware, are summarized below:

(1) Roll Joint (RJ) - For Vehicles 23 through 36, improvements in servo motor design were incorporated to extend mission life from 14 to 20 days and increase roll capability from 2,250 to 7,000 cycles, minimum. To improve hardware reliability, a second source motor and electronics inverter were incorporated in the redundant servo system. In addition, the RJ flywheel momentum was increased to accommodate the dual recovery module. An inertia changer was also incorporated to compensate for the mid-mission momentum change after ejection of the first recovery vehicle. At Vehicle 27, an RJ "soft stop" protection feature was installed to protect payload and RJ mechanical drive components from damage caused by excessive deceleration rates in the event of loss of servo position control. The last change for this block of vehicles, effective at Vehicle 35, was the increased caster spring stiffness to accommodate increased thrust from the Secondary Propulsion System dual engine operation.

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(2) Tracking, Telemetry and Command Subsystems (TT&C) - At Vehicle 23, the TT&C Subsystems were modified to the Space-Ground-Link Subsystem (SGLS) configuration in order to maintain compatibility with the Air Force Satellite Control Facility (AFSCF). The conversion to the SGLS Unified S-band configuration provided significantly improved tracking and orbit prediction accuracies, increased telemetry sampling and commanding rates and simplified ground support equipment configurations and operational procedures.

The MOD IV Command Subsystem; which consisted of the Extended Command System (ECS), Remote Decoder (RD), and Minimal Command System (MCS); was also introduced on Vehicle 23. The ECS and RD were major design changes with significant increases in reliability obtained through piece part reduction as well as design and packaging improvements. During the production and vehicle test cycles, numerous problems were experienced with early ECS units. Many (57) significant modifications were incorporated into the unit to overcome design deficiencies or improve operating margins. Although several anomalies and four failures occurred during the flights of the 14 vehicles covered by this report, there was no significant impact on any of these missions with the exception of Mission 27. On this vehicle, a failure

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of the ECS clock after SRV 1 recovery resulted in total loss of ECS command capability and, consequently, an attempt to terminate the flight. This failure resulted in three major changes being incorporated into the ECS:

(a) The programmable memory unit (PMU) was divided into "read only" and "read/write" sections. This was done to assure that the executive software program contained in the "read only" portion of the memory would not be destroyed by noise or improper clock pulses, which occurred as a secondary effect of the Vehicle 27 failure.

(b) The PMU was modified to automatically shut down if switched power stayed on an unexpected length of time. This precludes excessive heat, generated by power dissipation, from affecting the system and causing a secondary failure in the redundant side. This type of failure occurred on Vehicle 27 when the PMU hung-up and could not shut itself off.

(c) A second oven limiter was added to the oscillator heater circuit in each of the three oscillator circuits of the clock. This change was made so a single failure on the existing limiter would not cause the oven to turn full on resulting in thermal runaway of the oscillators as was suspected to have happened on Vehicle 27.

(3) Guidance and Control Subsystem - The Guidance and Control Subsystem was changed from one high and one low performance system at Vehicle 22 to a dual high performance system at Vehicle 23. This increased guidance accuracy, reliability and obtained a more stable vehicle. A Back-up Stabilization System (BUSS) latching solenoid valve was added at Vehicle 35 to permit the use of surplus BUSS control gas for the primary mission. This allowed an increase in orbital lifetime.

(4) Propulsion Subsystem - The main Agena engine oxidizer was changed from IRFNA to High Density Acid (HDA) at Vehicle 35. This change increased specific impulse (from 289.8 to 294.7 seconds), allowing an additional 125 to 150 pounds of payload weight or 5 to 6 degrees of increased orbit inclination capability. At Vehicle 35, new Marquardt engines were installed in the Secondary Propulsion System, replacing the ablator-type. The new engines increased performance and reliability and allowed an unlimited number of burns. This resulted in more effective control of orbital parameters for mission optimization.

(5) Electrical Power Subsystem - A major redesign to the Electrical Power Subsystem was effected at Vehicle 23. The subsystem

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was changed from regulated to unregulated D. C. power, one redesigned power distribution box replaced two boxes, a ninth Type 1K battery was added and magnetic current sensors were incorporated to replace the shunt-type current sensors previously used. These changes resulted in a program peculiar power subsystem rather than the Standard Agena power subsystem used on the prior block of vehicles.

At Vehicle 27, an ampere hour meter was added to the pyro bus in order to achieve more exact determinations of pyro bus usage and heater power consumption for power prediction purposes. At Vehicle 31, a diode was removed between the main bus and the Extended Command System bus. The Extended Command System battery was also placed on the main bus, thus increasing its total to six batteries. A tenth Type 1K battery was added at Vehicle 32; and, at Vehicle 33, two each of the Type 1901 and 1902 Magnum batteries replaced four of the Type 1K batteries. Complete changeover to the Type 1903 Magnum battery occurred on Vehicle 35. The above changes were designed and incorporated to enable primary mission lifetime to be extended from 14 to 27 days.

4. Detailed milestones by vehicle with the corresponding impact of/reason for the changes are presented on the following pages.

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VEHICLE MILESTONES

VEHICLE	LAUNCH DATE	CHANGE	IMPACT/REASON (*)
23	23 AUG 69	COMPLETE REDESIGN:	
		1) TWO SRV'S	1) INCREASE FILM CAPACITY TO 10,000 FT.
		2) NINTH TYPE 1K BATTERY	2) INCREASED LIFE FROM 10 TO 14 DAYS
		3) DUAL GUIDANCE SYSTEM	3) TWO HIGH PERFORMANCE SYSTEMS VS ONE HIGH PERFORMANCE AND ONE OLD SYSTEM.
		4) SGLS/PCM	4) IMPROVED TRACKING, TELEMETRY AND COMMAND LINKS
		5) MOD IV ECS	5) HIGHER COMMAND EXECUTION AND STORAGE CAPABILITY
		6) BOOSTER STAGE I 12:1 ENGINE	6) INCREASED PAYLOAD CAPABILITY 240 LBS
24	24 OCT 69	FLANGES ADDED TO TAPE RECORDER	IMPROVE RELIABILITY FOLLOWING TAPE RECORDER FAILURE ON VEHICLE 23
25	14 JAN 70	INTERFERENCE BETWEEN CAMERA AND BULKHEAD ELIMINATED	ELIMINATE LATITUDE DEPENDENT FOCUS SHIFTS OBSERVED ON VEHICLE 24
26	15 APR 70	1) SRV INSULATION IMPROVED	1) IMPROVE PARACHUTE RELIABILITY (25)
		2) CHANGE PARACHUTE DEPLOYMENT TIME	2) IMPROVE PARACHUTE DEPLOYMENT CONDITIONS (25)
		3) IMPROVE BELLOWS ON ROLL JOINT POTENTIOMETERS	3) IMPROVE LIFE OF POTENTIOMETERS (25)
27	25 JUN 70	1) DRAG MEASUREMENT SYSTEM ADDED	1) MEASURE ACTUAL DRAG FORCES ON ORBIT
		2) PAINT PATTERN CHANGE	2) REDUCE TEMPERATURE OF TAPE RECORDER TO INCREASE ITS RELIABILITY (23)

(*) The number in parenthesis at the end of the impact/reason statement refers to a previous mission during which a problem occurred precipitating the change.

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VEHICLE MILESTONES (CONT'D)

VEHICLE	LAUNCH DATE	CHANGE	IMPACT/REASON
28	18 AUG 70	NEW LUBRICANT ON ROLL JOINT POTENTIOMETERS	IMPROVE LIFE OF POTENTIOMETERS (25)
29	23 OCT 70	1) MINUS RED FILTER ADDED TO ROSS CORRECTOR 2) TAPE RECORDER RELOCATED	1) LIMIT BAND PASS AND IMPROVE STATIC OPTICAL PERFORMANCE 2) TO ALLEVIATE TEMPERATURE PROBLEMS OBSERVED ON SEVERAL MISSIONS
30	21 JAN 71	1) TAKE UP RATCHET PIN BEEFED UP 2) ADDITIONAL ECS OVEN CONTROLLER	1) INCREASED MARGIN IN CRITICAL AREA (23) 2) ELIMINATE SINGLE FAILURE MODE IN ECS OSCILLATOR HEATER CIRCUIT (27)
31	22 APR 71	1) PPS SHIPPED FROM FACTORY TO PAD IN ONE PIECE 2) DELETE SEPARATE BUS FOR ECS AND ADD IT TO PYRO BUS (3 PYRO AND 6 MAIN) 3) ONE PIECE DOME NUTS USED ON PPS FILM ENCLOSURE 4) ROLL JOINT FEED BACK POTENTIOMETERS REDESIGNED	1) MOVED CRITICAL ASSEMBLY WORK FROM PAD TO FACTORY 2) INCREASE POWER AVAILABILITY 3) INSURE DOME NUTS DO NOT ENTER FILM HANDLING SYSTEM (24) 4) INCREASE ROLL JOINT OPERATING LIFE (NOT QUALIFIED FOR HIGHER CYCLE LIFE UNTIL 37) (25)

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VEHICLE MILESTONES (CONT'D)

VEHICLE	LAUNCH DATE	CHANGE	IMPACT/REASON
32	12 AUG 71	1) DELETE MINUS RED FILTER ADDED ON VEHICLE 29	1) PERMIT USE OF COLOR FILM. REDUCE SMEAR AND IMPROVE LOW LIGHT PHOTOGRAPHY.
		2) R-5 LENS	2) INCREASE FOCAL LENGTH TO 175 IN. IMPROVE RESOLUTION.
		3) TENTH 1K BATTERY ADDED TO MAIN BUS (3 PYRO AND 7 MAIN)	3) INCREASE ORBITAL LIFE.
		4) DRAG MEASUREMENT SYSTEM DELETED (ADDED ON VEHICLE 27)	4) LOSE CAPABILITY TO MEASURE DRAG DIRECTLY. (ALL PLANNED SYSTEMS HAD BEEN FLOWN.)
		5) STRETCH-TANK BOOSTER	5) INCREASED PAYLOAD CAPABILITY 400 LBS.
33	23 OCT 71	1) HOT DOG SENSOR ADDED.	1) MAKE MEASUREMENTS OF VEHICLE BENDING.
		2) ALIGNMENT SENSOR ADDED.	2) MAKE MEASUREMENTS OF OPTICAL ALIGNMENT ON ORBIT.
		3) TWO 1901 AND TWO 1902 MAGNUM BATTERIES USED IN PLACE OF FOUR TYPE 1K BATTERIES ON MAIN BUS.	3) INCREASE ORBITAL POWER AND LIFETIME CAPABILITIES.
34	17 MAR 72	1) HIGH DENSITY ACID USED AS MAIN AGENA ENGINE OXIDIZER.	1) INCREASED PAYLOAD WEIGHT CAPABILITY OF 125 TO 150 LBS OR INCLINATION CAPABILITY OF 5 TO 6 DEGREES.
		2) IMPROVED SRV PARACHUTE EJECTION PYROS.	2) INCREASE RELIABILITY OF PARACHUTE DEPLOYMENT (25).
		3) FIVE 1902 MAGNUM BATTERIES USED ON MAIN BUS.	3) INCREASE POWER AVAILABILITY.
		4) SWITCHOVER ELECTRONICS CIRCUIT REDESIGN	4) ELIMINATE POTENTIAL FAILURE MODE OBSERVED IN CONNECTION WITH ECS CLOCK FAILURE (27).

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VEHICLE MILESTONES (CONT'D)

VEHICLE	LAUNCH DATE	CHANGE	IMPACT/REASON
35	20 MAY 72	1) TEN MAGNUM BATTERIES.	1) INCREASES PRIMARY MISSION FROM 23 TO 30 DAYS.
		2) BOOSTER STAGE II ENGINE (-11)	2) INCREASED PAYLOAD WEIGHT CAPABILITY OF 200 LBS OR INCLINATION CAPABILITY OF 8 DEGREES.
		3) IMPROVED SECONDARY PROPULSION SYSTEM (NEW MARQUARDT ENGINES).	3) ELIMINATES OPERATING CONSTRAINTS (NO. OF BURNS) AND INCREASES RELIABILITY (29).
		4) BUSS LATCHING SOLENOID VALVE.	4) PERMITS USE OF SURPLUS BUSS CONTROL GAS FOR PRIMARY MISSION.
36	1 SEP 72	1) BAFFLE ADDED TO SLIT 7.	1) MINIMIZE LIGHT FLARE WHEN USING SLIT 6.
		2) REPLACE STERER PNEUMATIC REGULATOR WITH WHITTAKER.	2) IMPROVE RELIABILITY FOLLOWING VEHICLE 35 FAILURE.

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5. PROCUREMENT

a. The form of the contracts written for this series of vehicles did not vary significantly from those written for Vehicles 1 through 22. Of the six major contracts handled by SAFSP for vehicle hardware procurement, three contracts were covert and handled completely within SAFSP. The remaining three major hardware contracts were non-covert and processed through HQ SAMSO and AFSC procurement review and approval channels. HQ SAMSO procured the Titan IIIB booster vehicles with their related support as well as Aerospace Corporation technical support. Funds for these procurements were supplied to HQ SAMSO by SAFSP.

b. The incentive plan developed by Maj Gen John L. Martin, Jr., which was discussed in the previous summary of Missions 1 through 22 and incorporated in the majority of those contracts, was continued for four of the six major contracts for this series of vehicles. This incentive plan, and the necessary modifications thereto, are covered in more detail in Section IV.

c. Further details of the contracts for this series of vehicles are also included in Section IV.

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6. FINANCIAL

a. As of 1 May 1973, the GAMBIT project, Flights 23 through 36, had cost $463.471 million. Final contract settlements over the next few years may cause minor changes in this amount.

b. Of the $463.471 million, $339.414 million was determined as recurring cost for the 14 flights. An estimate of individual flight recurring cost by calendar year was made in an effort to show the trend of decrease in cost per mission day flown and also the decrease in cost per target readout (see Paragraph c below). Because of long-lead funding, the recurring cost attributed to a calendar year of flights may not have actually been funded during the calendar year in which the launches occurred. Recurring cost of the Booster Aerospace allocation, APTC improvement, long-tank booster and R-5 lens, and extended life were not effective until Flights 28, 30, 32 and 35 respectively. Recurring cost by calendar year then followed by adding recurring cost of those flights launched during a calendar year.

c. In order to make a valid comparison of all flights possible, an attempt was made to identify the basis of the target data reported as "Clear Targets Readout" in the analysis of Flights 1 through 22 of the GAMBIT project. As closely as can be reconstructed, these figures refer to Comirex (Category 1A through 9A) targets readout. Tables

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C-1 and C-2 of the previous report were, therefore, reconstructed to reflect "Comirex Targets Readout" instead of "Clear Targets Readout" and are shown as Tables C-3 and C-4 below. Similar data was gathered for Flights 23 through 36, and Tables C-1 and C-2 reflect this data.

d. Since only 14 flights are covered by this analysis, vs 22 flights for the previous report, it is noteworthy that:

(1) The number of primary missions days flown increased 20%,

(2) The number of Comirex targets readout increased 60%,

(3) The average cost per primary mission day flown decreased 37%, and

(4) The average cost per Comirex target readout decreased 63%.

e. It is also noteworthy that this increased performance was achieved at a decrease in total cost of $123.293 million over about the same operational length of time (36 months for Vehicles 1 through 22, and 38 months for Vehicles 23 through 36). This is particularly impressive when the increases in wages and the cost of materials over the lifetime of this program are taken into consideration.

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VEHICLES 23 THROUGH 36

TABLE C-1

Calendar Year	No. of Flights	No. of Primary Mission Days Flown	Comirex Targets Readout	Recurring Cost	Total Cost
1969	2	28	7,027	$ 47.929	
1970	5*	70	26,166	120.342	
1971	4	83	31,643	97.561	
1972	3**	51	14,275	73.582	
TOTAL	14	232	79,111	$339.414	$463.471

All costs are in millions.
* Only 8 of 10 buckets successfully recovered.
** Includes one complete mission failure.

TABLE C-2

Calendar Year	Cost per Flight	Cost per Mission Day	Cost per Comirex Target Readout
1969*	24.0	1.71	.00682
1970*	24.1	1.71	.00460
1971*	24.4	1.18	.00308
1972*	24.5	1.44	.00515
14 Launch Average**	33.1	2.00	.00586

All costs are in millions
*Recurring Cost Only
**Total Cost

NOTE: Operational span - 38 months.

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VEHICLES 1 THROUGH 22

TABLE C-3

Calendar Year	No. of Flights	No. of Primary Mission Days Flown	Comirex Targets Readout	Recurring Cost	Total Cost
1966	3	20	1,856	$ 67.15	
1967	6 + 1*	59	9,664	134.536	
1968	7 + 1*	67	14,082	137.097	
1969	4	40	10,774	69.207	
Total	22	186	36,376	$407.990	$586.764

All costs are in millions

* Mission Failures

TABLE C-4

Calendar Year	Cost per Flight	Cost per Mission Day	Cost per Comirex Target Readout
1966*	22.4	3.36	.0361
1967*	19.2	2.28	.01392
1968*	17.15	2.05	.00974
1969*	17.3	1.73	.00644
22 Launch Average**	26.7	3.16	.0161

All costs are in million dollars

* Recurring cost only
** Total Cost

(b)(1)
(b)(3)

NOTE: Operational span - 36 months.

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6. SUMMARY

The performance of the GAMBIT system over Missions 23 through 36 was highly successful in that:

a. Resolution was improved,

b. The film load was increased and average frame length decreased permitting more optimum coverage in high density target areas,

c. Flexibility was enhanced by the introduction of the dual recovery capability,

d. Coverage (targets) more than doubled, and

e. Cost per Mission Day and Comirex Target Readout was reduced.

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SECTION II

OPERATIONS

1. The following paragraphs summarize the major details of each mission:

a. Mission 4323 - The launch was slipped a total of 11 days to resolve Air Force Satellite Control Facility hardware and software problems, improper door actuation during Phase I of the countdown and a leak in the Agena oxidizer quick disconnect during Phase II of the countdown. On-orbit problems were: (1) The Roll Joint primary separation system failed to operate, but the backup system executed on Rev 2. (2) Crab polarity was improperly defined in two commands between Revs 5 and 30. (3) The quality of tape recorder data varied and, occasionally, the tape recorder jammed but subsequently freed itself. (4) The focus Gain System failed after Rev 154. (5) The Slant Range Compensation System malfunctioned between Revs 42 and 48. (6) The take-up ratchet device in SRV 2 failed after Rev 187. (7) Various AF Satellite Control Facility hardware and software problems were encountered. A successful 14-day photographic mission was completed.

b. Mission 4324 - The launch slipped three days to permit resolution of various AF Satellite Control Facility problems. The launch was

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nominal until the signal from the Velocity Control Assembly on the Agena failed to achieve shutdown of the main engine and the engine burned to depletion. The resulting apogee altitude was 408 n. m. (vs the planned 216 n. m. apogee). On-orbit problems were: (1) The remote tracking stations periodically had problems locking onto the proper carrier frequencies of the vehicle transponders. (2) The Photographic Payload Section focus sensor indicated significant focus shift with target latitude. (3) A 1/4 inch dome nut cover was trapped in the SRV 2 take-up resulting in an eccentric film wrap. (4) Various problems were encountered with AF Satellite Control Facility support. A successful 14-day photographic mission was completed.

c. Mission 4325 - The launch was delayed one day due to excessively high winds. On-orbit problems were: (1) The primary and secondary Roll Joint encoders indicated anomalous positions. (2) SRV 2 was lost on Day 14 due to failure of the parachute system. (3) Some problems were experienced with the ability of the AF Satellite Control Facility to command the vehicle. A successful mission was completed through SRV 1 recovery on Day 7.

d. Mission 4326 - The launch slipped from 17 March to 15 April 1970 to decrease the time between the three "G" switch open and drogue chute

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cover deployment from 34 to 26 seconds on both SRV's 1 and 2. This modification was made to insure against loss of an SRV due to the same problems which resulted in the loss of SRV 2 from Mission 4325. On-orbit problems encountered were: (1) Tape recorder data was noisy after 800 seconds from the beginning of the tape and unusable after 1600 seconds. Data quality gradually improved as the mission progressed. All data was usable during the last half of the mission. (2) The Roll Joint position encoder experienced some anomalous performance. (3) Platen bias was offset -1.0 mil after evaluation of SRV 1 photography. (4) Components of the SRV 1 recovery beacon shorted out due to heat or vibration during re-entry. This condition resulted in anomalous beacon modulation frequency. A successful 14-day photographic mission was completed as well as a solo of 7 days.

e. Mission 4327 - The launch was slipped one week to replace FM-27 with FM-28 due to suspected tension looper encoder contamination, and subsequently was slipped one day to repair the CDC 3100 computer used to analyze satellite vehicle health and test results while on the pad. The only anomaly encountered through recovery of SRV 1 was the fact that the shield remained attached during recovery until the shock of air snatch released it. On Rev 140, the Extended Command

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System clock malfunctioned. Recovery of SRV 2 was attempted on Rev 163, but Select Sequence 2 (the command which enables the reentry sequence to begin) did not execute due to a suspected switch failure. The satellite vehicle orbit would have decayed before another recovery attempt could be made, so the Back-up Stabilization System was reactivated to control vehicle drag, thereby obtaining vehicle decay into a broad ocean area. (The Back-up Stabilization System had been previously turned off in order to conserve control gas for a second recovery attempt.)

f. Mission 4328 - The launch was delayed: three days for further testing of the switchover electronics box, two days to replace a faulty booster guidance can, and one day due to an electrical open in the Stage I/II separation system of the Titan IIIB booster. A successful 16-day mission was completed. On-orbit problems experienced were: (1) The Dual Attitude Control Subsystem encountered malfunctions in the Augmented Control System horizon sensors and unacceptable roll and yaw errors in the Orbital Control System. (2) The Roll Joint had an intermittent relay which caused an inability to achieve four commanded roll positions. (3) Tape recorder data was degraded. (4) The forebody shield remained attached to SRV 2, but separated at air snatch.

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g. Mission 4329 - The launch was delayed two days due to a ground guidance computer failure and an incorrect indication of a transponder anomaly. A successful 18-day mission was flown. On-orbit problems were: (1) Breakstrips on the Roll Joint failed to release and the backup system was used on Rev 2. (2) The Secondary Propulsion System malfunctioned on Rev 210 during its last scheduled burn. There was no impact on the mission due to this failure. (3) The film supply motor malfunctioned on Rev 134, but a work-around method of operation was developed. (4) A gear in the terrain camera shutter mechanism malfunctioned during the second half of the mission, resulting in loss of that photography.

h. Mission 4330 - The launch was delayed one day to evaluate an Extended Command System malfunction. No fix was made due to a low probability of the malfunction recurring. On-orbit problems were: (1) Vehicle attitude deviations were encountered. (2) Leakage of electrolite from the recovery battery was discovered after SRV 2 recovery. A successful 18-day mission was completed. Also, a Vehicle Atmospheric Survivability Test (VAST) was conducted in a broad ocean area. Both radar and telemetry data were acquired by an ARIS tracking ship.

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i. Mission 4331 - The launch was delayed one day to replace the Gyro Reference Assembly in the Orbital Control System. A successful 19-day mission was completed. On-orbit problems were: (1) An interference filter was left out of the focus system. (2) A wrinkling of one edge of the film in SRV 2 caused an eccentric film wrap. A VAST was conducted in a broad ocean area between Midway Island and Hawaii. Visual, radar and telemetry data were acquired by an ARIS ship; telemetry data was acquired by ARIA aircraft; visual sighting was reported by a TRAP aircraft, but not confirmed by sensors; PRESS aircraft acquired no data.

j. Mission 4332 - The launch was slipped one day for removal and replacement of the primary Gyro Reference Assembly. A successful 22-day mission was flown. The only problem encountered was that on-orbit data incorrectly indicated a 2-mil focus shift. A VAST was conducted with an impact prediction in the vicinity of Fort Yukon, Alaska. Searchers were unable to locate any debris, and the search was finally terminated due to bad weather conditions.

k. Mission 4333 - The launch was slipped four days due to Aerospace Ground Equipment problems, and to allow Guam Tracking Station to repair their Univac 1230 computer. The only on-orbit problem encountered was a failure of the power supply for the Attitude

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Control System during solo. The Secondary Propulsion System was used to deboost the satellite vehicle. A successful 24-day mission was completed.

l. Mission 4334 - The launch slipped four days due to weather problems which delayed the shipment of the payload, and to allow redundant engine shutdown and separation commands to be provided on the Titan IIIB booster. A successful 24-day mission was flown with the only on-orbit problem encountered being a failure of the voltage converter on the "B" side of the Extended Command System. This resulted in loss of the "B" side from Rev 22 for the rest of the mission. A VAST was conducted during which the vehicle was deboosted into Eniwetok Atoll. The monitors used did not detect any debris as the impact point was apparently short.

m. Mission 4335 - The launch was delayed three days due to Extended Command System, Power Monitor Control Master Unit and ground guidance computer problems. Vehicle 35 failed to achieve orbit due to the failure of the regulator in the Augmented Control System. This failure resulted in insufficient gas being supplied to the Agena cold gas thrusters for control during staging and ascent burn.

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n. Mission 4336 - The launch was delayed a total of three days due to power disruption to the vehicle and SRV RECAL equipment problems. On-orbit problems were: (1) Power conservation; i.e., the vehicle was colder than expected and this resulted in excessive power consumption by the Photographic Payload Section heaters. (2) Shifts in focus were observed. A successful 27-day mission was flown.

2. The next nine pages summarize the on-orbit problems encountered on each mission, their causes, the operational impact, and any corrective action.

3. Following the summary of on-orbit problems is a table of statistics on each mission. This table includes orbital parameters, resolution, camera operations, and target data as well as launch date and length of mission.

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SUMMARY OF ON-ORBIT PROBLEMS

VEHICLE 23

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION (*)
Roll Joint Breakstrip Failed	Pneumatic System Failure	None (Backup System functioned)	Increased frequency of verifying pneumatic pressure (24). Use pyro for Primary as well as Backup System (37).
Tape Recorder Erratic	Mechanical Problems with Tape Drive	Data loss	Flanges added to reel (24). Humidity controlled (24). Additional tests (25). Thermal environment in vehicle improved (27).
Slant Range Compensation hung up from Rev 42 to 48	Unknown	Some degradation in photography during this span	None
Focus System failed	Unknown	None	None
Ratchet on SRV 2 take up failed causing unstable tension	Shear of pin in ratchet	Loss and degradation of photography	Test to verify ratchet pin (24). Beefed-up pin (30).
Crab polarity improperly defined in two commands between Rev 5 and 30	Error in commands	Loss and degradation	Corrected Data Base

(*) The number in parenthesis after the Corrective Action statement refers to the vehicle effectivity.

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 24

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Velocity Control Assy failed to shutdown main engine during ascent	Relay failure	Reduced available SPS propellants	Use Redundant Velocity Control Assembly (42)
Focus found to be latitude dependent	Interference between camera and adjacent bulkhead	Platen moved to off-set shifts. Degradation in photography.	Interference eliminated (25)
Dome nut trapped in SRV 2 take up caused eccentric film wrap and early fill.	Dome nut fell off film enclosure	None	Push test on all dome nuts (25). Modify test fixture which probably caused problem (26). One piece dome nuts (31).
Remote Tracking Stations had problems locking on proper carrier frequencies of vehicle transponders	Ground/airborne equipment problem	Delays in command loading and loss of some photography	Developed common procedure for all tracking stations for setting modulation index. Adjusted power settings on up-link to minimize probability of locking on spurious up-link signals. Developed a test to check out airborne equipment modulation index.

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 25

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Roll Joint feed back potentiometers out of specification	Wear	Unknown due to loss of SRV 2	Improved bellows and burn-in (26). New lubricating material (28). Major redesign (31).
SRV 2 lost	Parachute failed	Loss of all data in SRV 2 take up (Primary and APTC)	Improved insulation (26). Change chute deployment time (26). Increased ejection pyro force (34). Improved parachute thermal cover (42).

VEHICLE 26

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Noisy tape recorder data	High temperatures	Loss of operational data	Lower environmental temperature: Paint pattern - 27 Relocate - 29
Roll Joint encoder errors	Contaminated encoder tracks	None	Numerous changes including lubricants and wiper materials (27-32)
Recovered film sticky	Condensation in film enclosure	None	Provide vent in film enclosure (39)

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 27

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Ablative shield attached to SRV 1	Cable interference	None	Cable taped down (29). Cable redesign (30).
Extended Command System failed	Clock Oven failure	Neither propulsion system could be used. Little control over debris impact point.	Add'l oven controller (30). Add'l confidence testing (28,29).
Emergency Recovery #2 failed	Switch failure in electronics module	SRV 2 recovery attempt failed. All data lost.	Suspected circuit modified (34). Additional testing (28-33).

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 28

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Horizon Sensor wander	Loose thermal tape in field of view	Increased film usage due to added film pads	Intensified inspection of tape installation (29)
Yaw and Roll errors in OCS	Undesirable filter characteristics (Determined from Msn 30)	Switch to primary Attitude Control System. Increased film usage.	Add'l GRA assembly-level screening tests on remaining units
SRV 2 heat shield failed to separate	Cable interference	None	Cable taped down (29). Cable redesign (30).
Roll Joint pointed vehicle in wrong position four times	Relay intermittent	Four targets off-center in frame	Hot vibration test (29). Improved parts screening (37).
Degraded tape recorder data	Thermal problems	Loss of data	Relocate tape recorder (29).

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 29

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Roll Joint breakstrip failed	Burst tube or blow out	None - Backup separation system (MDF) executed	Dual MDF planned (37)
Continuous power on film supply	Transistor failure	Prohibited simultaneous supply/take up operation. Loss of photography.	None - random part failure
Secondary Propulsion System chamber burn through	Non-uniform chamber ablation	No back up deboost capability	Operational constraints tightened (30)
Erratic Terrain Camera shutter	Incorrect gear face	None	Units 30-32 inspected and corrected

VEHICLE 30

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Non-typical Horizon Sensor	Undesirable filter characteristics	Increased film usage due to increased film pads	Removed/recoated all remaining filters
Recovery Vehicle 2 contamination	Structural failure in sump section of battery	None	Battery redesign (40). External sump added (34). Vehicles 31-33 already assembled.

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 31

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Eccentric film wrap	Crinkling on film edges	None	None
Focus offset	Infra-red filter not installed	Loss of resolution for SRV 1 photography	Improved inspections and procedures (32)

VEHICLE 32

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Focus System indicated 2 mil error	Unknown	None	New Focus System (48)

VEHICLE 33

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Primary Attitude Control System failed	Power supply in GRA	Used redundant system	Instituted additional burn-in and thermal cycling tests.
Tape Recorder malfunction	Motor Drive circuit	Minimized recording and playback. Loss of data.	Improved screening on piece parts for the follow-on contract.

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 34

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Voltage Converter B failed	Short on 15 volt power supply	Nineteen frames of operational photography lost	Redesign suspect filters on power supply (37)

VEHICLE 35

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
Attitude Control System pneumatic system delivered virtually no control gas during ascent resulting in failure to achieve orbit.	Defective pneumatic regulator	Loss of vehicle	Change vendors on pneumatic regulator. Significantly improve ground testing, particularly in area of pneumatic system verification (36).

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SUMMARY OF ON-ORBIT PROBLEMS (Cont'd)

VEHICLE 36

PROBLEM	CAUSE	OPERATIONAL IMPACT	CORRECTIVE ACTION
ECS clock indicated intermittent operation of one of three oscillators	Unknown	None	Redesigned clock (42)
MCS sometimes failed to wake up properly	Unknown	MCS left on between between Revs 282 and 445. Increased power usage.	None
Focus System indicated drifts which were not understood	Unknown	Loss of resolution	New Focus System (48)
Vehicle was colder than predicted resulting in excessive heater power usage	Unknown	None	Review thermal balance

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SUMMARY OF MISSION DATA

MSN	LAUNCH DATE	MISSION PRIMARY	DURATION SOLO	APOGEE	PERIGEE	INCLINATION	PERIOD	RESOLUTION	STEREO PAIRS	STRIPS	LATERAL PAIRS	TARGETS[2] ATTEMPTED	TARGETS[2] READOUT	PERCENT READOUT	1A-9A TARGETS READOUT	1A-9A TARGETS EGF/C[3]
23	23/8/69	14	1	211.30	75.06	107.99	89.35		1,749	2,528	65	11,692	4,475	38.27	4,447	2,337
24	24/10/69	14	1	408.61	76.18	108.04	93.26		1,439	1,758	34	7,078	2,804	39.62	2,580	1,642
25[1]	14/1/70	14 (7rec)	3	216.46	75.64	109.98	89.24		680	1,014	20	3,335	1,632	48.94	1,512	1,001
26	15/4/70	14	7	225.69	74.33	110.99	89.48		2,311	4,200	44	13,972	6,271	44.88	5,937	3,072
27[1]	25/6/70	8	0	228.98	73.03	108.88	89.84		785	3,086	19	8,608	4,752	55.20	4,695	2,864
28	18/8/70	16	0	205.50	80.70	110.96	89.33		2,450	5,830	53	19,169	8,917	46.52	8,749	4,684
29	23/10/70	18	0	224.44	74.90	111.06	89.90		2,261	3,614	33	13,236	5,458	41.24	5,273	3,323
30	21/1/71	18	0	232.54	76.75	110.86	90.10		2,156	2,985	37	11,294	5,556	49.19	5,045	3,503
31	22/4/71	19	2	230.01	75.24	110.95	89.90		3,027	5,629	118	20,947	10,296	49.15	10,047	5,856
32	12/8/71	22	0	237.84	75.23	111.00	90.11		2,829	5,019	82	19,641	10,196	51.91	10,028	6,262
33	23/10/71	24	1	234.57	73.86	110.94	90.00		2,742	4,711	77	15,660	6,816	43.52	6,523	4,669
34	17/3/72	24	0	228.60	72.53	110.97	89.95		3,131	4,038	98	14,960	7,125	47.63	6,915	4,784
35	20/5/72	AGENA FAILED														
36	1/9/72	27	1	215.69	79.50	110.41	89.83		3,432	3,915	190	15,101	7,647	50.64	7,360	5,030

(b)(1)
(b)(3)

(1) ONE SRV LOST

(2) a. TARGETS ATTEMPTED INCLUDE CATEGORIES 1A-9A, 10, 11, 14, 16, 20 AND 21.

b. TARGETS READOUT INCLUDE CATEGORIES 1A-9A, 10, 11, 14, AND 16. IT WAS CONSIDERED IMPRACTICAL TO ATTEMPT TO ISOLATE TARGETS READOUT IN CATEGORIES 20 AND 21.

(3) EG F/C IS A TERM WHICH MEANS THE TARGET DIAMETER WAS COMPLETELY IMAGED AND THE IMAGE WAS OF EXCELLENT, GOOD OR FAIR QUALITY.

SECTION III

CHARTS

(b)(1)
(b)(3)

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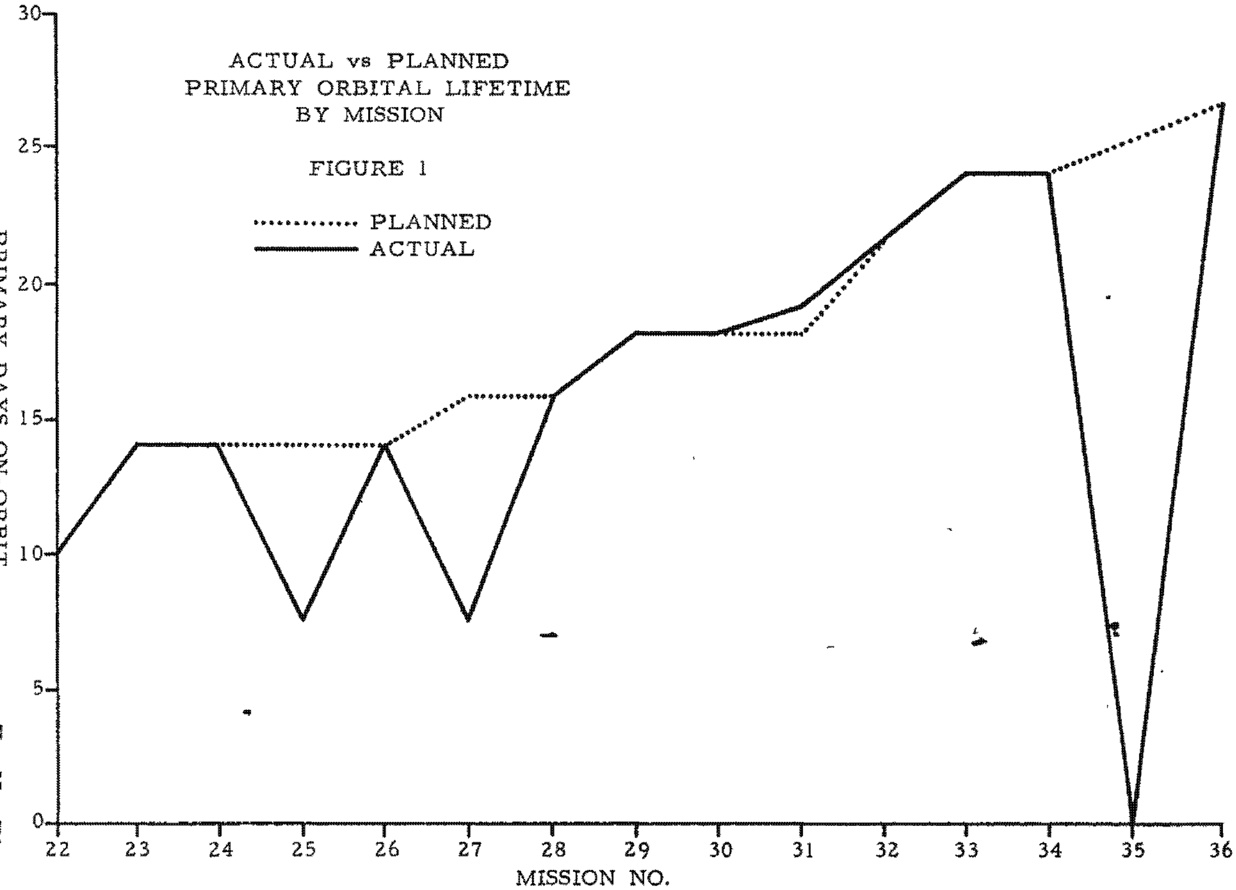

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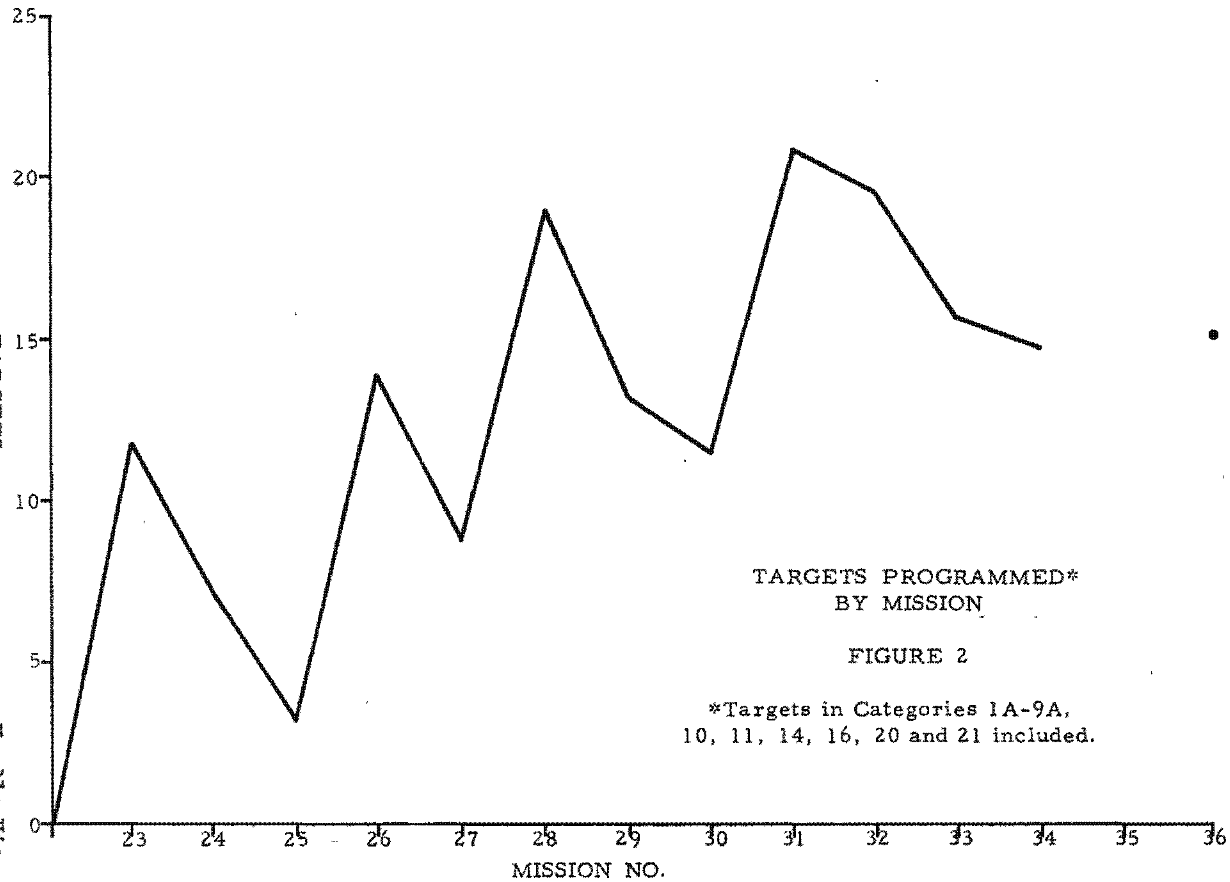

TARGETS PROGRAMMED*
BY MISSION

FIGURE 2

*Targets in Categories 1A-9A, 10, 11, 14, 16, 20 and 21 included.

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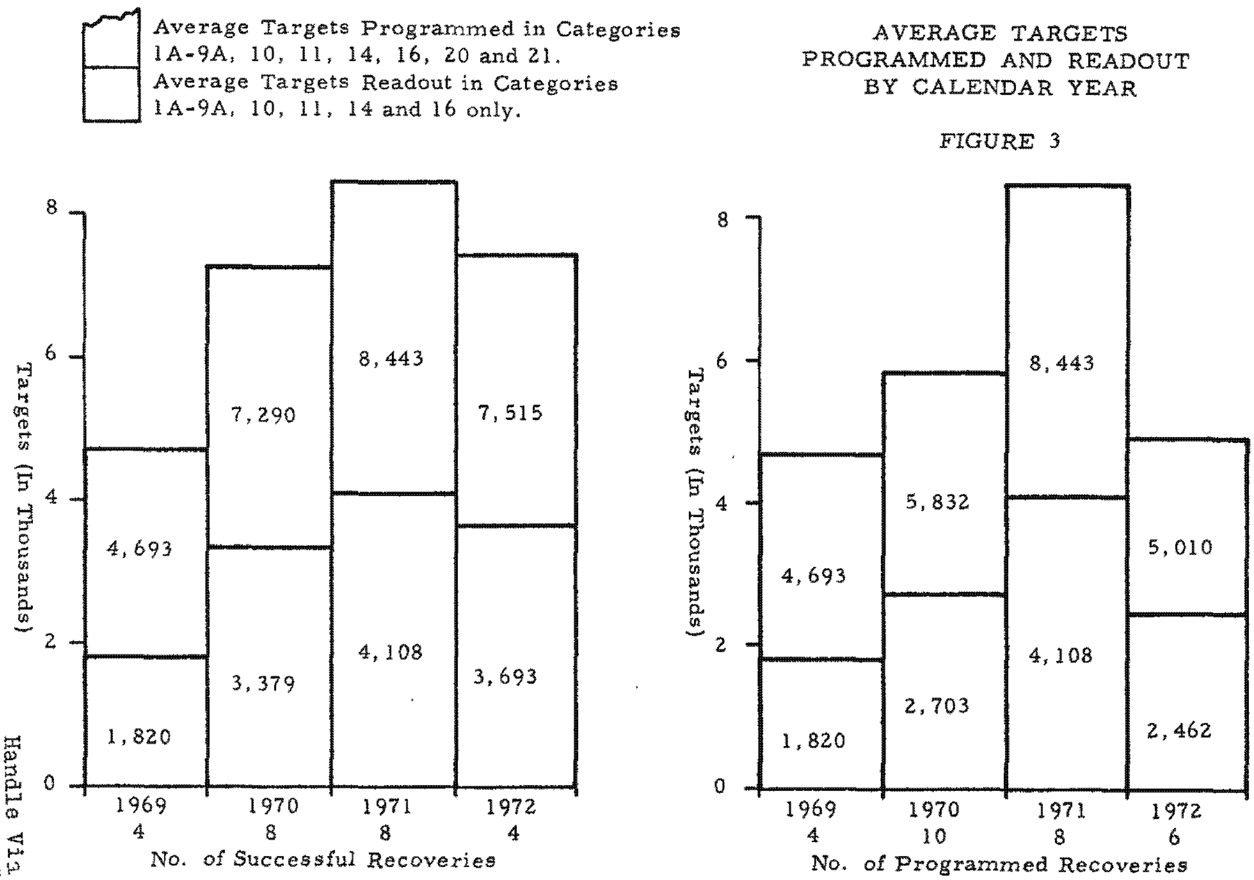
AVERAGE TARGETS
PROGRAMMED AND READOUT
BY CALENDAR YEAR

FIGURE 3



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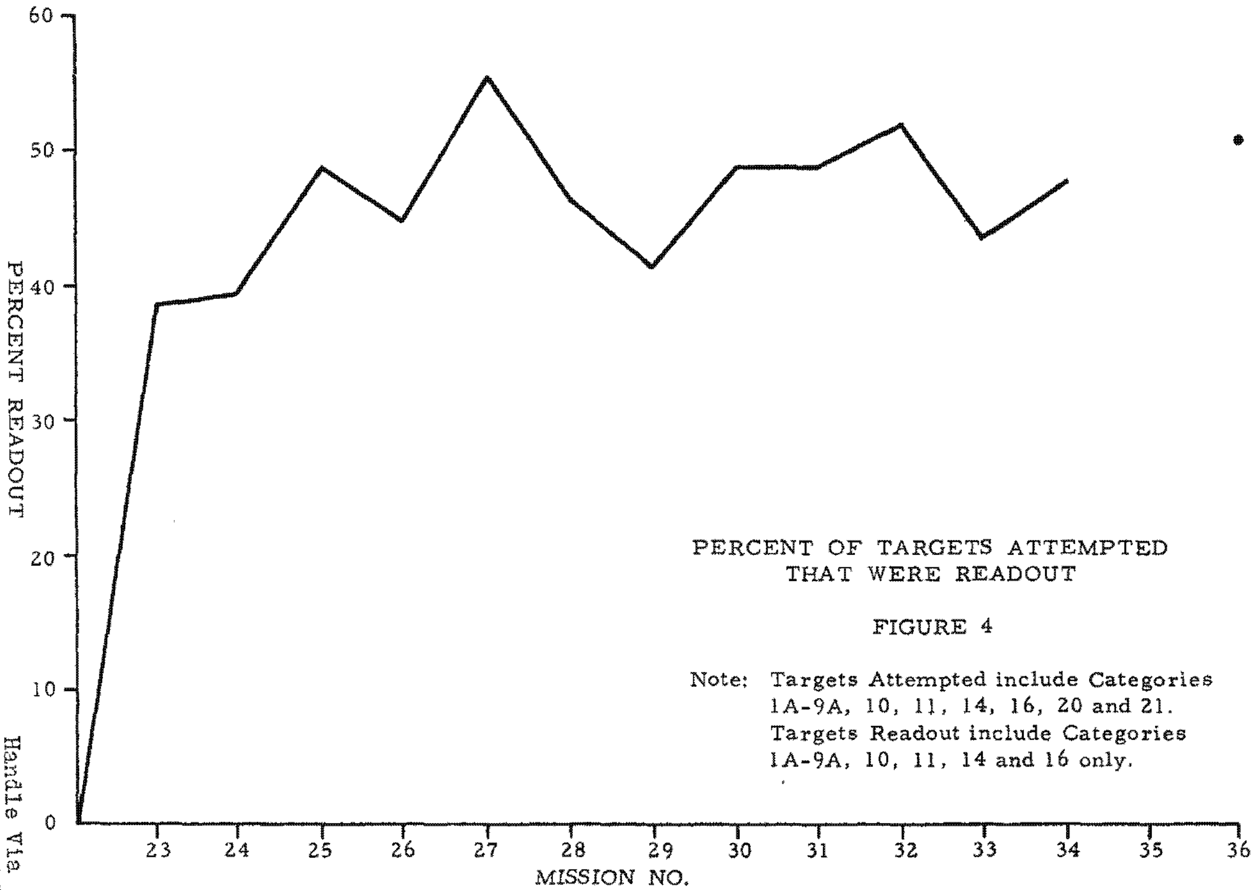

PERCENT OF TARGETS ATTEMPTED THAT WERE READOUT

FIGURE 4

Note: Targets Attempted include Categories 1A-9A, 10, 11, 14, 16, 20 and 21. Targets Readout include Categories 1A-9A, 10, 11, 14 and 16 only.

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(b)(1)
(b)(3)

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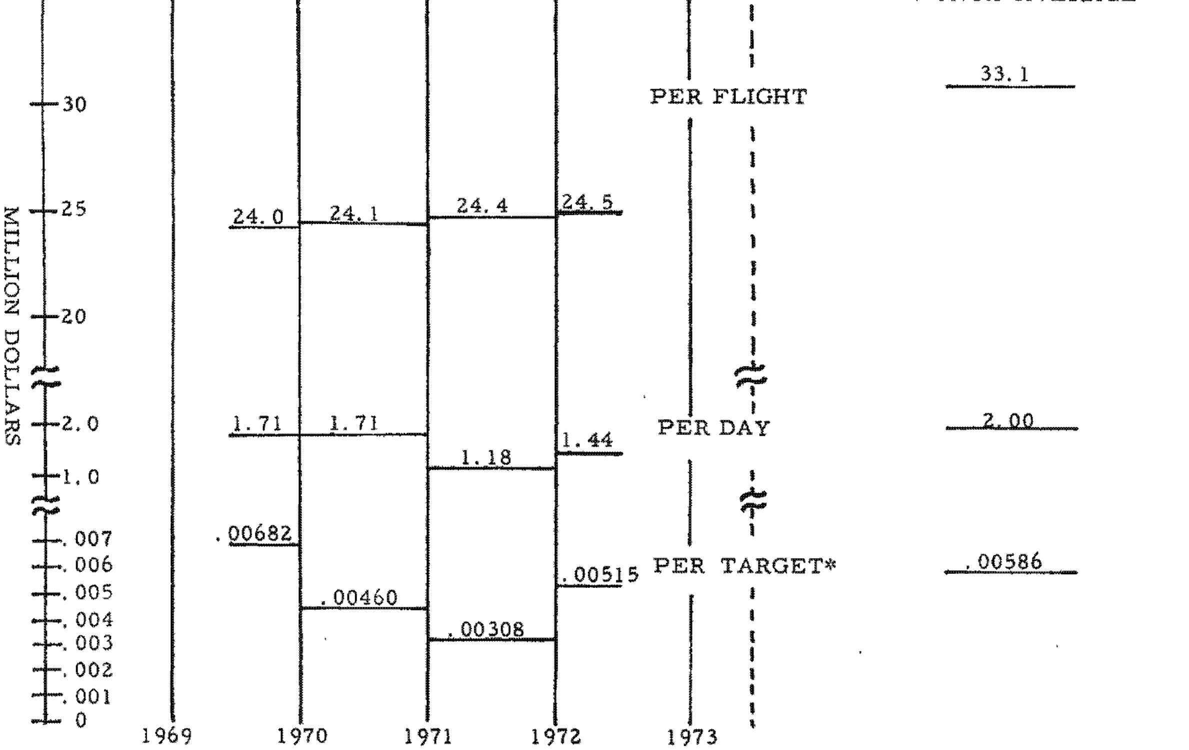
RECURRING COSTS PER FLIGHT, DAY AND TARGET*
BY CALENDAR YEAR
FIGURE 6

TOTAL COSTS
(RECURRING AND NONRECURRING)
14 LAUNCH AVERAGE



*Only targets in Categories 1A through 9A were utilized in computing these amounts.

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SECTION IV

PROCUREMENT

1. GENERAL

a. SAFSP contracted for:

(1) The Photographic Payload Sections (PPS's), including the Astro Position-Terrain Cameras (APTC's), facilities, test equipment and Aerospace Ground Equipment (AGE), with the Eastman Kodak Company;

(2) The Satellite Control Sections (SCS's) and Payload Adapter Sections (PAS's) or Roll Joints with Lockheed Missiles & Space Company, Inc.;

(3) The command subsystems with General Electric Company, Aerospace Electronics Systems Department;

(4) The Satellite Re-entry Vehicles (SRV's) with General Electric Company, Re-entry & Environmental Systems Division; and

(5) Launch support services and mission planning and support software.

b. HQ SAMSO contracted for the Titan IIIB booster vehicles with related launch support services, satellite control services and Aerospace Corporation technical support.

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c. Film was procured by the CIA.

d. The SAFSP contracts were handled by a division of the Directorate of Procurement [redacted]. On the covert contracts, the contracting officer per se was the Director of Special Projects, the Vice Director of Special Projects and the Deputy Director for Procurement. On the non-covert contracts, the contracting officer was one of the buyers in the procurement division. All covert contracts were processed entirely within the SAFSP Directorate of Procurement. The non-covert contracts were processed by the procurement division through HQ SAMSO and AFSC procurement review and approval channels. (b)(1) (b)(3)

2. INCENTIVES

a. During this series of vehicles, GAMBIT continued to use the incentive contracting philosophy developed by the (then) Director of SAFSP, Maj Gen John L. Martin, Jr., on cost-plus-incentive-fee (CPIF) contracts with three of the four hardware contractors. Fixed price incentives (FPI) on cost and schedule only were used to obtain the SRV's, and cost-plus-fixed-fee (CPFF) contracts were written for the mission and operations planning and support software procurements.

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b. The Martin Incentive Plan recognized three key parameters:

(1) Performance - 100% successful on-orbit performance enabled the contractor to earn a full 15% of the target cost allocated to each vehicle.

(2) Cost - The contractor could be penalized up to 9% of the target fee for cost overruns. (The incentive structure used called for the contractor to pay 10¢ of every overrun dollar for the first 15% of the overrun, 20¢ of every overrun dollar between 15 and 30% and 30¢ from 30 to 45%, up to a maximum value of 9% of the target cost.)

(3) Schedule - The maximum penalty for failure to meet hardware delivery schedules was 0.5%.

Thus, the major emphasis continued to be upon performance during this series of vehicles.

c. Starting with Mission 32, a unique incentive arrangement was added to the previous agreements. The original contracts had been negotiated upon the basis of a 20-day operational mission lifetime for performance incentive purposes. As required vehicle mission lifetime was extended beyond 20 days, it became necessary to change the incentives in order to hold the contractor responsible for the total mission performance of the vehicle. Since the contracts

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already had 15% target fee allocated to each vehicle (the maximum permitted for this type of contract), it was not possible to pay the contractor any additional fee as consideration for the added risk that he assumed during the extended mission lifetime. As a result, the contracts were modified to allow the contractor to "earn back" a portion of the performance penalties that he experienced on a vehicle. For this purpose, specified amounts were established for each additional perfect orbital revolution performed by the vehicle. The contractor could thus "earn back" these specified amounts, up to the maximum 15% target fee, from the minor performance penalties assessed against the vehicle. Excluded from this arrangement were those penalties assessed as the result of a catastrophic loss of the mission.

d. Lockheed Missiles & Space Co., Inc., earned 94% of the possible $12,966,334 performance fee through successful on-orbit operation of the SCS and PAS. Eastman Kodak Co. earned 96% of the possible $15,416,884 performance fee on the PPS, and GE/AES earned 96% of the possible $3,255,291 performance fee for successful on-orbit operation of the command subsystem.

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3. NARRATIVE DESCRIPTION OF CONTRACTS

a. Lockheed Missiles & Space Company, Inc.

(1) The SCS and the PAS were provided on separate contracts. The SCS was obtained on a non-covert contract and the PAS or Roll Joint was provided on a covert contract. The contracts for both the SCS and the PAS incorporated all three parameters of the Martin incentives; i.e., performance, cost and schedules. Also, a special factor was included in the performance incentive plans for each contract which resulted in a penalty on both contracts if either the SCS or the PAS experienced a mission catastrophic failure.

(2) The $16 million basic design and development (non-recurring) effort on the SCS was accomplished on the principal contract for the previous series of vehicles; i.e., AF 04(695)-896. The recurring effort for the 14 SCS's used on this series of vehicles was obtained on Contract [redacted] and included the remainder of the design and development, production, testing, launch and orbital support and the related data and Aerospace Ground Equipment (AGE). (b)(1) (b)(3)

(3) The contractor earned 94% or $11,770,085 of the possible performance fee during the SCS contract. An overrun of $4.3 million (5.2%) was incurred and resulted in a cost incentive penalty

of $429,175. The contractor was not penalized under the delivery schedule portion of the incentives.

(4) The PAS was procured on Contract [redacted] (b)(1) (b)(3) The contractor earned $1.2 million or 94% of the possible performance fee during the contract. There was no overrun or schedule penalty applied.

b. Eastman Kodak Company - The basic design and development of the PPS camera system was also done on the principal contract of the preceding series of vehicles; i.e., AF 18600-2108. The remainder of the effort; recurring, production, design, test, launch and orbital support; was provided on Contract [redacted] (b)(1) (b)(3) [redacted] The contractor earned 96% or $14.8 million of the possible (b)(1) (b)(3) performance incentive. There was a 3.8% overrun which resulted in a $424,000 cost penalty and a schedule penalty of $263,000.

c. General Electric Company, Aerospace Electronics Systems Department - This series of command subsystems was procured on the same contract as the previous series; i.e., AF 04(695)-897. The contractor earned 96% or $3.1 million of the possible performance fee. A 30% overrun ($11.1 million) resulted in a $1.5 million cost penalty. It should be noted that most of this overrun was caused by the introduction of the MOD IV Command Subsystem which was used on Vehicles 23 through 36. Several design deficiencies were discovered after the new command subsystems were delivered to the integrating contractor (LMSC). These deficiencies necessitated extensive modifications and resulted in many interruptions during the production cycle of the early units.

d. General Electric Company, Re-entry & Environmental Systems Division - The SRV's were procured on two fixed price incentive contracts; i. e., the components and subassemblies were procured on non-covert Contract [redacted] and fabricated into the final SRV on covert Contract [redacted] Contract [redacted] also served as a security cover contract for the EKC field support effort. These contracts were completed with no cost overruns or underruns and no schedule penalties were assessed.

(b)(1) (b)(3) (b)(1) (b)(3) (b)(1) (b)(3)

4. The following tables present the statistical information on the contracts for this series of vehicles. The first table shows the value and the period of performance of each contract. The second table lists the mission-by-mission results of the operation of the performance incentives.

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LIST OF SAFSP GAMBIT CONTRACTS

Vehicles 23 - 36

NUMBER	TYPE	SECURITY	CONTRACTOR	ITEM	PERFORMANCE PERIOD	ESTIMATED FINAL VALUE
	CPIF	BLACK	EKC	14 PHOTOGRAPHIC PAYLOADS	JAN 68 - NOV 72	$128,677,598
	CPIF	WHITE	LMSC	14 SAT CONTROL SECTIONS	DEC 66 - NOV 72	97,123,078
	CPIF	BLACK	LMSC	14 PAYLOAD ADAPTER SECTIONS	FEB 68 - NOV 72	9,816,845
	FPI	WHITE	GE/RESPD	28 SETS, SRV COMPONENTS	JAN 68 - NOV 72	17,027,404
	FPI	BLACK	GE/RESPD	28 SATELLITE REC VEHICLES	JAN 68 - NOV 72	4,989,044
	CPIF	WHITE	GE/AES	18 COMMAND SUBSYSTEMS for Vehicles 23 - 36 (and 16 C/SS for Vehicles 7 - 22)	NOV 65 - JUL 72	51,056,748
	CPFF	WHITE	GE/C&ISO	SOFTWARE	JUL 68 - JUN 70	8,732,462
	CPFF	WHITE	GE/C&ISO	SOFTWARE	JUL 70 - NOV 72	4,673,469
	CPFF	WHITE	TRW	SOFTWARE	DEC 70 - NOV 71	1,302,450
	CPFF	WHITE	TRW	SOFTWARE	DEC 71 - NOV 72	739,453

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GAMBIT VEHICLES 23 - 36
SAFSP SPECIALIZED PERFORMANCE INCENTIVE ANALYSIS BY FLIGHT

FLIGHT	------ LMSC (AGENA PAS) ------			--------- ONF (PPS) ----------			-------- GE (C/SS) ---------		
NUMBER	POOL	EARNED	%	POOL	EARNED	%	POOL	EARNED	%
23	$ 777,693	$ 756,731	97%	$ 1,040,700	$ 878,351	84%	$ 228,750	$ 228,750	100%
24	771,157	722,682	94%	1,040,700	888,758	85%	228,750	228,750	100%
25	771,157	763,445	99%	1,040,700	1,040,700	100%	228,750	228,750	100%
26	756,912	756,912	100%	1,040,700	1,033,415	99%	228,750	228,750	100%
27	763,503	732,158	96%	686,125	570,138	83%	228,634	114,317	50%
28	764,750	737,381	96%	1,089,345	1,089,345	100%	228,634	228,634	100%
29	900,035	900,035	100%	1,086,125	1,012,269	93%	228,634	228,634	100%
30	899,703	899,703	100%	1,089,348	1,089,348	100%	228,633	228,633	100%
31	902,693	902,693	100%	1,083,920	1,031,892	95%	237,581	237,581	100%
32	967,913	1,017,914	105%**	1,190,028	1,190,028	100%	237,581	237,581	100%
33	957,252	1,097,252	109%**	1,190,029	1,190,029	100%	237,581	237,581	100%
34	1,189,362	1,349,363	113%**	1,230,377	1,230,377	100%	237,581	228,315	96%
35	1,282,629	- 0 -	- 0 -	1,272,400	1,239,972	97%*	237,581	228,260	96%*
36	1,261,575	1,556,949	123%**	1,336,381	1,336,381	100%	237,582	237,582	100%
TOTAL	$12,966,334	$12,143,218	94%	$15,416,884	$14,821,003	96%	$3,255,292	$3,122,118	96%

* Based on average performance scores for all flights because mission lost before equipment could perform.
** Includes Bonus for extended missions.

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SECTION V

FINANCIAL

1. GENERAL - The total $463.471 million program consisted of:

a. Fourteen spacecraft, boosters and payloads launched with two recovery vehicles per flight. Some vehicles were configured with improvements; such as, the long-tank booster, R-5 lens, etc., with effectivities as indicated.

b. Command subsystem costs included 12 prime flight units, two flight units converted from two of the spares on the previous (7-22) block buy, and three spares similarly converted from three of the spares on the previous block buy.

c. Two Higherboy Kits were procured for use on this block buy, but never flown. They were later transferred and reconfigured to permit flight, if required, on Vehicles 37 through 41 of the subsequent (37-47) vehicle block buy.

d. Level-of-effort (Aerospace, launch services, etc.) costs included effort through the final launch of Vehicle 36 (September 1972).

[redacted] (b)(1) (b)(3)

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f. Recurring costs associated with improvements developed under the previous block buy are not broken out separately; but, instead, are included in the appropriate basic line item in this exercise (e. g., RACS is included in the Spacecraft line item).

g. Most non-recurring costs can be identified to specific contractual instruments; however, allocation of these costs by fiscal year is based on Program Office judgment. The recurring costs associated with the major improvements implemented effective Vehicle 23 (e. g., SGLS, DACS, Dual Recovery) were quoted and negotiated as an integral part of the total Vehicle 23 through 36 hardware proposals/procurements. Therefore, allocation of these costs to specific line items is also a matter of Program Office judgment.

h. Efforts to perfect Owens-Illinois Cervit as an optical substrate as well as to establish grinding/polishing capabilities at Itek and Perkin-Elmer were abandoned. Costs associated with these experimental efforts are therefore considered non-recurring.

2. Fiscal year costs by color areas, non-recurring costs by fiscal year, total costs by fiscal year, non-recurring and recurring per unit costs and flight costs by calendar year are shown on the following pages.

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FISCAL YEAR COSTS BY COLOR AREA

	FY-67	FY-68	FY-69	FY-70	FY-71	FY-72	FY-73	TOTAL
WHITE								
Non-Recurring	12.447	28.892	7.736	.100	2.852	1.230	.278	53.535
Recurring	.720	25.433	86.662	62.570	26.907	33.966	4.966	241.224
Subtotal	13.167	54.325	94.398	62.670	29.759	35.196	5.244	294.759
BLACK								
Non-Recurring	22.595	32.959	8.742	1.229	1.134	1.218	.040	67.917
Recurring	17.834	25.194	15.064	19.417	17.916	5.336	.034	100.795
Subtotal	40.429	58.153	23.806	20.646	19.050	6.554	.074	168.712
TOTAL								
Non-Recurring	35.042	61.851	16.478	1.329	3.986	2.448	.318	121.452
Recurring	18.554	50.627	101.726	81.987	44.823	39.302	5.000	342.019
GRAND TOTAL	53.596	112.478	118.204	83.316	48.809	41.750	5.318	463.471

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$ in Millions

GAMBIT (110) NON-RECURRING COST SUMMARY
BY FISCAL YEAR - VEHICLES 23-36

	FY-67	FY-68	FY-69	FY-70	FY-71	FY-72	FY-73	TOTAL
Spacecraft	0	.764	1.347	0	0	0	0	2.111
Command Subsystem	1.947	0	0	0	0	0	0	1.947
Recovery Vehicle	.254	.095	0	0	0	0	0	.349
PAS/Roll Joint	0	.250	0	0	0	0	0	.250
Payload	1.428	0	0	0	0	0	0	1.428
Higherboy Kits (Avail. #34)	0	0	0	0	1.111	1.238	0	2.349
[redacted]								
Extended Life	0	0	0	0	.515	.732	0	1.247
PPS Tests	0	0	0	0	.370	.274	0	.644
12:1 Booster Engine	0	3.637	0	0	0	0	0	3.637
Long Tank Booster (Eff. #32)	0	0	0	.100	1.990	0	0	2.090
SGLS	3.300	9.461	0	0	0	0	0	12.761
Dual Recovery	25.893	43.072	9.870	0	0	0	0	78.835
Glass Polishing	.120	1.574	1.280	.025	0	0	0	2.999
Cervit	1.600	.498	.642	0	0	0	0	2.740
R-5 Lens (Eff. #32)	0	0	2.700	.684	0	0	0	3.384
APTC Improvement (Eff. #30)	0	0	0	.520	0	0	0	.520
DACS	.500	2.500	.639	0	0	0	0	3.639
	[redacted]							

(b)(1)
(b)(3)

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$ in Millions

GAMBIT (110) TOTAL COST SUMMARY BY FISCAL YEAR - VEHICLES 23-36

	FY-67	FY-68	FY-69	FY-70	FY-71	FY-72	FY-73	TOTAL
Spacecraft	0	.764	31.178	22.026	4.546	16.152	.807	75.473
Booster Hardware	.100	10.917	35.853	15.982	0	0	0	62.852
Booster Launch	0	0	.375	2.200	2.500	6.202	2.010	13.287
Booster Aerospace (Eff. #28)	0	0	0	0	1.170	1.020	.252	2.442
BTL Guidance	0	.900	.620	1.820	1.648	1.250	.643	6.881
Command Subsystem	1.947	3.331	5.168	3.460	2.420	.382	0	16.708
Recovery Vehicle	1.000	3.454	6.377	4.538	4.115	1.900	.110	21.494
PAS/Roll Joint	0	1.777	2.710	1.272	1.589	.242	.034	7.624
Payload	15.422	15.389	4.941	10.169	11.470	5.058	0	62.449
Aerospace	0	0	.230	2.310	2.136	2.045	.600	7.321
Software/Mission Planning	0	0	1.723	2.653	2.575	2.289	0	9.240
General Support	0	0	.014	.080	.108	.104	0	.306
Agena Launch	0	0	.252	2.800	2.500	2.500	.544	8.596
[redacted]								
Higherboy Kits (Avail. #34)	0	0	0	0	1.111	1.238	0	2.349
[redacted]								
Extended Life (Eff. #35)	0	0	0	0	.538	.732	0	1.270
PPS Tests	0	0	0	0	.370	.274	0	.644
12:1 Booster Engine	0	5.669	0	0	0	0	0	5.669
Long Tank Booster (Eff. #32)	0	0	0	.100	2.478	.122	0	2.700
SGLS	3.300	10.635	2.770	1.972	.986	0	0	19.663
Dual Recovery	29.607	54.194	17.237	7.401	4.934	0	0	113.373
Glass Polishing	.120	1.574	1.280	.025	0	0	0	2.999
Cervit	1.600	.498	.642	0	0	0	0	2.740
R-5 Lens (Eff. #32)	0	0	2.700	1.232	.135	0	0	4.067
APTC Improvement (Eff. #30)	0	0	0	.729	0	0	0	.729
DACS	.500	3.376	3.565	1.918	.930	0	0	10.289
[redacted]								

(b)(1) (b)(3) (b)(1) (b)(3) (b)(1) (b)(3)

NOTE: All improvements (e.g., SGLS) are effective Vehicle 23 unless otherwise indicated above.

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GAMBIT (110) NON-RECURRING AND RECURRING PER UNIT COST SUMMARY VEHICLES 23-36

	TOTAL NON-RECURRING COST	RECURRING/UNIT COST [1]	TOTAL RECURRING COST	TOTAL PROGRAM COST
Spacecraft	2.111	5.240	73.362	75.473
Booster Hardware	0	4.489	62.852	62.852
Booster Launch	0	.949	13.287	13.287
Booster Aerospace (Eff. #28)	0	.271 (28-36)	2.442	2.442
BTL Guidance	0	.492 [2]	6.881	6.881
Command Subsystem	1.947	.868	14.761	16.708
Recovery Vehicle	.349	1.510	21.145	21.494
PAS/Roll Joint	.250	.527	7.374	7.624
Payload	1.428	4.359	61.021	62.449
Aerospace	0	.523	7.321	7.321
Software/Mission Planning	0	.660	9.240	9.240
General Support	0	.022	.306	.306
Agena Launch	0	.614	8.596	8.596
[redacted] (b)(1) (b)(3)				
Higherboy Kits (Avail. #34)	2.349	0	0	2.349
[redacted] (b)(3)				
Extended Life (Eff. #35)	1.247	.012 (35-36)	.023	1.270
PPS Tests	.644	0	0	.644
12:1 Booster Engine	3.637	.145	2.032	5.669
Long Tank Booster (Eff. #32)	2.090	.122 (32-36)	.610	2.700
SGLS	12.761	.493	6.902	19.663
Dual Recovery	78.835	2.467	34.538	113.373
Glass Polishing	2.999	0	0	2.999
Cervit	2.740	0	0	2.740
R-5 Lens (Eff. #32)	3.384	.137 (32-36)	.683	4.067
APTC Improvement (Eff. #30)	.520	.030 (30-36)	.209	.729
DACS	3.639	.475	6.650	10.289
	[redacted] (b)(1) (b)(3)			

[1] Equivalent Units are 23-36 unless otherwise indicated.

[2] See GAMBIT Cost Data, Attachment 5.

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$ in Millions

GAMBIT (110) FLIGHT COSTS BY CALENDAR YEAR
VEHICLES 23-36

	CY-69 (2)	CY-70 (5)	CY-71 (4)	CY-72 (3)	TOTAL
Spacecraft	10.482	26.200	20.960	15.720	73.362
Booster Hardware	8.984	22.445	17.956	13.467	62.852
Booster Launch	1.898	4.745	3.797	2.847	13.287
Booster Aerospace (Eff. #28)	0	.543	1.085	.814	2.442
BTL Guidance	.982	2.458	1.966	1.475	6.881
Command Subsystem	1.737	4.341	3.473	2.605	12.156
Recovery Vehicles	3.021	7.551	6.041	4.532	21.145
PAS/Roll Joint	1.053	2.634	2.107	1.580	7.374
Payload	8.717	21.794	17.435	13.075	61.021
Aerospace	1.046	2.615	2.092	1.568	7.321
Software/Mission Planning	1.320	3.300	2.640	1.980	9.240
General Support	.044	.110	.086	.066	.306
Agena Launch	1.228	3.070	2.456	1.842	8.596
[redacted]					
Extended Life (Eff. #35)	0	0	0	.023	.023
12:1 Booster Engine	.291	.725	.581	.435	2.032
Long Tank Booster (Eff. #32)	0	0	.244	.366	.610
SGLS	.986	2.465	1.972	1.479	6.902
Dual Recovery	4.934	12.335	9.868	7.401	34.538
R-5 Lens (Eff. #32)	0	0	.273	.410	.683
APTC Improvement (Eff. #30)	0	0	.119	.090	.209
DACS	.950	2.375	1.900	1.425	6.650
	[redacted]				

(b)(1)
(b)(3)

NOTES:

1. The above summary shows the costs in the calendar year of flight and does not consider long-lead funding.
2. The totals by calendar year plus the cost of the three spare Command Subsystems ($2.605 million) plus the non-recurring of $121.452 million reconciles to the total program cost for Vehicles 23-36 of $463.471 million.
3. Numbers in parenthesis reflect the number of flights during the calendar year indicated.

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(b)(1)
(b)(3)
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