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

28 April 1970

REPLY TO
ATTN OF: SP-1

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 [redacted] you can expect some further improvements in these areas for the follow-on systems.

/S/

WILLIAM G KING, JR
BrigGeneral, USAF
Director

1 Atch
[redacted] Letter, subject as above, w/5 Atchs

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28 April 1970

FROM: [redacted]

SUBJ: Analysis of Gambit (110) Project

TO: SP-1

1. Purpose and Scope:

a. This paper analyzes the effectiveness of the recently completed Gambit (110) Project, Flights 1 through 22. The following parameters are addressed: Intelligence, Operations, Technical, Procurement and Costs.

2. Intelligence:

a. As for the missions associated with the 20 successful recoveries, [redacted] intelligence targets were programmed into the flight vehicles. Only 56.5%, [redacted], of the programmed targets were processed and readout into clear usable intelligence photography. The difference between targets programmed and targets readout was a result in some cases of operational problems causing pointing errors or degraded resolution, but most significantly, a result of target cloud cover.

b. As can be seen from Attachment 2 (Figures 1 and 2), the number of programmed and readout targets steadily increased. This was attributed to: (1) an increase in mission lifetime; (2) choosing launch times so as to take advantage of summer high sun angles to permit ascending, as well as descending photography; (3) a more accurate orbit drag prediction, thus decreasing the photography burst time and film used; (4) an increase in film quantity with the use of ultra-thin base film; (5) an increase in desired targets; and (6) improvements in software used for target selection.

c. In addition to the increase in target acquisition, there was also a trend of improvement in best ground resolution as shown in Attachment 2 (Figure 5). The increase in resolution was mostly a result of better optic materials, better optics polishing controls and better optics alignment and focusing procedures at the Eastman Kodak Company factory. A specification goal was set to achieve [redacted] resolution, while at 90 nm altitude, of a target with a two to one contrast ratio. This goal was achieved and slightly surpassed with the final mission, Flight 22, which had a best ground resolution of [redacted] determination.

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3. Operations:

a. Of the 22 missions attempted, 2 flights (Flights 5 and 11) were complete failures. Flight 5 did not reach orbit because the Titan IIIB Second Stage failed 16 seconds after start. The Flight 11 re-entry vehicle parachute deployment system failed during re-entry causing all of its filmed targets to be lost in the water.

b. Two systems were injected into orbit with far higher energy than planned. A ground guidance station problem at Vandenberg AFB resulted in a termination of ground guidance commands and permitted the Flight 18 Titan IIIB Second Stage to burn to depletion even after desired velocity had been reached. The Agena added its planned increase in velocity leaving the injection velocity and the apogee altitude far too high. Flight 18 had a later orbit adjust problem which caused an early mission termination on Day 7. Flight 19 injection velocity meter under-measured the change in velocity produced by the Agena main engine. The Agena burned to depletion. Apogee altitude was 598 nm. The specified maximum apogee altitude of 270 nm was more than doubled.

c. Other than the complete failures of Flights 5 and 11, and the early termination of Flight 18, the other flights were considered very successful. Although most of the 19 successful flights did have some flight hardware problems and operational constraints, operations personnel were able to use redundant systems and change operating procedures to continue the missions until successfully completed.

d. The most significant operational details for each flight are given in Attachment 3. Some important flight data are given in Attachment 1, Table 1.

4. Technical:

a. Photographic Payload Section

(1) Camera-Optics Module

(a) During the conceptual phase of the Gambit (110) system, it was recognized that the large optics which provided the main performance improvement over the previous Gambit (206) program would provide the most serious manufacturing and testing challenge. Initial attempts to introduce unconventional manufacturing techniques and substrates for the large reflectors failed, resulting in dependence on conventionally polished [redacted] fused silica reflectors. Two important developments resulted in the successful employment of the conventional techniques: interferometer testing and selectro-plating. By using the interferometry to draw a map of the surface errors in the reflective pieces, and the selectro-plating to fill in the surface where indicated by the interferometry, the overall surface irregularities could be reduced to specified value. System assembly and testing showed steady improvement from the first unit on. By Flight 18, both the optical components and the assembled camera-optics module were being produced at or very near specification quality.

(b) A persistent problem with primary camera drive smoothness was present on all units in the form of fine corduroy banding at 250 Hz on the primary photography. Performance loss due to this lack of smoothness was calculated to vary from none to 30% loss of resolution. A satisfactory fix has not been determined.

(2) Satellite Re-entry Vehicle (SRV)

(a) The SRV employed on Flight 11 failed to deploy its main parachute and was lost in the recovery zone near Hawaii. Failure investigation did not pinpoint the failure cause, but weaknesses in design were discovered and corrected in the area of the thermal cover bridle and its deployment system. (A similar failure on Flight 25 second SRV in the subsequent double bucket series indicated that the true failure may have been inadequate design of the thermal cover ejection system for the flight environment encountered. It appears that the solution is to deploy the thermal cover earlier.) The SRV was essentially the same as the Gambit (206) model, and except for the catastrophic failure on Flight 11, the SRV operated well.

(3) Electromechanical Hardware

(a) Except for minor random failures, the electro-mechanical (non-optical) portions of the photographic payload section performed reliably. No major problems were encountered in deployment.

(4) Post Flight Evaluation of System Performance

(a) While post flight measures of photographic quality showed a parallel improvement with the improvements in optical quality shown by factory test, a performance, or resolution, gap appeared to exist between the levels of the two. On some flights, this gap was as much as 60% of the factory predicted resolution. Two possible causes of the resolution gap were investigated: hardware malfunction between factory test and flight and inadequate analytical modeling of system performance. These two possibilities were explored in parallel, with no firm conclusions reached at the end of the series.

b. Satellite Control Section (SCS)

There were no major technical problems associated with the SCS in the Gambit (110) program. The hardware was essentially a continued production to that used on the Gambit (206) program. The inadequate design and quality control problems which were corrected on Gambit (206) were successfully carried through on Gambit (110). Most of the technical effort on this program was directed to enhancing the reliability of the hardware and adding a Redundant Attitude Control System (RACS) on

Vehicle 16. This improvement had the capability of providing redundancy to the Primary Attitude Control System (PACS) for on-orbit vehicle attitude control only. The availability of RACS proved extremely fortunate: on Flight 17 PACS failed and RACS was activated on Rev 40 and operated successfully for the remainder of the flight; on Flight 20 PACS failed and RACS was activated on Rev 52 and operated successfully for the remainder of the flight.

c. Roll Joint (RJ)

The original RJ used on Vehicles 1 through 11 used a belt drive with a brushless motor for the primary servo system. Redundancy was provided by a second brush-type motor which could be irreversibly engaged but which would also drive the primary motor and belt if used. Capability of the RJ was 1,250 rolls at a roll rate of [redacted] degrees/second. For Vehicles 12 through 15 the servo systems were changed to two brush-type motors with friction drive. To provide a fully reversible dual system, the friction drive engage mechanism was changed from a spring loaded pyro activated device to spring loaded, electrical linear actuators. Capability was extended to 2,250 total rolls with an average roll rate of [redacted] degrees/second. For Vehicles 16 through 22 the redundant drive motor was replaced with a new design "long-life" motor. With a new Servo Electronics Assembly, including an inverter, the redundant system could now operate on unregulated power. The primary purpose for these changes to the redundant system on Vehicle 16 was to gain flight experience on one of the two "long-life" (7,000 roll capability) servo systems which would be effective on Vehicle 23.

5. Procurement:

a. Of the approximate total of [redacted] cost for Gambit (110) [redacted], was contracted directly by Special Projects for the satellite system and related support. Procurement of the remainder was handled by Space and Missile Systems Organization (SAMSO) for the booster system and related support. Funds were provided to SAMSO by SAFSP.

b. Five of the program's major contracts implemented a novel incentive fee arrangement personally developed by Major General John Martin, Jr for use on satellite systems. His paper entitled, "A Specialized Incentive Contract Structure for Satellite Projects" has become the established incentive guide for satellite programs. His approach emphasizes vehicle system performance, with cost and schedule trade-offs.

c. Details of the program contractual arrangements are contained in Attachment 4.

6. Cost:

a. As of 1 April 1970, the Gambit (110) project, Flights 1 through 22, had cost [redacted]. Final contract settlements over the next few years may cause minor changes in this amount.

b. Of the [redacted] was determined as recurring cost for the 22 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 cost per clear target readout. Because of long lead funding, the recurring cost attributed to a calendar year of flights may not have been funded during the calendar year in which the launches occurred. Because of overlapping contract periods, recurring costs were divided between those associated with the first six flights and those associated with the last sixteen flights. Recurring cost of the [redacted], Redundant Roll Joint System and Redundant Attitude Control System were not effective until Flights 10, 12 and 16 respectively. Recurring cost by calendar year then followed by adding recurring cost of those flights launched during a calendar year.

c. From the supporting attachments the following data of Table C-1 was gathered so as to determine the succeeding data of Table C-2.

TABLE C-1

Calendar Year	No. of Flights	No. of Primary Mission Days Flown	Clear Targets Readout	Recurring Cost	Total Cost
1966	3	20	[redacted]	[redacted]	
1967	6 + 1*	59			
1968	7 + 1*	67			
1969	4	40			
Total	22	186			[redacted]

All costs are in [redacted]
* Mission Failures

TABLE C-2

Calendar Year	Cost per Flight	Cost per Mission Day	Cost per Clear Target Readout
1966*	[redacted]	[redacted]	[redacted]
1967*	[redacted]	[redacted]	[redacted]
1968*	[redacted]	[redacted]	[redacted]
1969*	[redacted]	[redacted]	[redacted]
22 Launch Average**	[redacted]	[redacted]	[redacted]

All costs are in [redacted] dollars

* Recurring cost only
**Total Cost

Most significant from the above data is that the cost per target was constantly going down to an average in calendar year 1969 of about [redacted] per clear target readout. Fortunately, costs per target of Gambit (110) were far more favorable than for Gambit (206) which considered for the majority of cases, targets recovered rather than cloud free targets. (Reference report to SP-1, "Analysis of Gambit Project" dated 24 August 1967.)

d. More detailed recurring and non-recurring cost data are included in Attachment 5. Costs per flight, per mission day and per clear target readout by calendar year are charted on Attachment 2, Figure 6.

7. Summary:

The Gambit (110) project, Flights 1 through 22, was highly successful in that:

a. Its capability of obtaining high resolution photography was good from its beginning and was continually bettered until its conclusion to the point only considered possible at its onset.

b. With the cost inflation of wages and materials, its cost per mission day and cost per filmed target continued to decrease.

c. The record of successful missions completed even if not perfect, was outstanding.

d. Action was taken to add features to increase reliability such as the Redundant Attitude Control System which proved to be required on Flights 17, 18 and 20. Action was taken to increase capability as in the case of technical improvements with the optics system.

[redacted]

5 Atchs
1. Project History
2. Graphs
3. Flight Brief
4. Procurement Data
5. Cost Data

Following is a narrative description of each contract and the results thereof:

Lockheed Missiles and Space Company

a. AF-619 (White) Covered the design, development test and production of the peculiarization of the first six SS-01B Standard Agena vehicles into GAMBIT Satellite Control Section (SCS) vehicles. Originally negotiated as a conventional cost-plus-incentive-fee contract, it was changed to incorporate the above "Specialized Incentive" structure prior to the first launch. Target fee was [redacted] equal to 13.8 percent of target cost. (The target fee was reduced from 15 percent due to non-vehicle related changes I.E. AGE and STE) No schedule incentive was used. Cost incentive was negative only, shared at a ratio of 85/15 up to 9 percent of target cost. All six of the vehicles were scored at 100 percent success. The contract experienced a cost penalty of [redacted] due to an overrun of [redacted] (equal to 6.8 percent of target cost). As a result the contract final fee is [redacted] equal to 13.0 percent of target cost.

b. [redacted] covered design development test and production of the first six roll joints (PAS) and was also originally negotiated as a conventional cost-plus-incentive-fee contract with conventional cost, schedule and performance arrangements. However, concurrent with the change in AF-619 the "Specialized Incentive Contract Structure" was implemented. The same performance and cost parameters as those on AF-619 were used. Vehicle performance was identical to AF-619. The contract experienced an overrun of 17.6%. As a result the final adjusted fee rate was 10.44 percent. Final fee is as follows:

Target fee [redacted]
Actual fee

c. Contracts AF-896 (white) and [redacted] (black) were originally negotiated as sustaining follow-on effort for peculiarization of sixteen additional SS01B Standard Agena vehicles into GAMBIT SCS vehicles and roll joints (PAS's), respectively. However, the contracts were amended to include the development (non-recurring) effort associated with longer life, redundant capability vehicles to be flown on subsequent contracts.

(1) AF-896 originally covered engineering, manufacturing, test and launch support of sixteen SCS vehicles. Later the changes were added for long life development, SGLS, RACS & DACS. The same incentive structure as AF-619 was used, with the addition of a schedule incentive penalty of one-half percent of target cost up to a maximum [redacted] applied at [redacted] per day. Cost incentive penalties applied over a range up to 9% of target cost. Cost sharing ratios of 90/10 from 9%-15% over target cost, 80/20 from 16%-30% and 70/30 from 31 to 45% were applied. Actual results were 100% vehicle performance, schedule penalties of [redacted] and a cost penalty of [redacted] actual results were:

Target fee [redacted]
Final fee

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(2) [redacted] produced sixteen PAS's (roll joints) and all development and non-recurring effort for the long life redundant capability. The identical incentive fee parameters as AF-896 were employed. An overrun of 1% was incurred. All vehicles were on schedule and 100% successful performance was scored. Actuals were:

Target fee
Final fee
[redacted]

General Electric Light Military Electronics Department, Later: Aerospace Electronics Department

a. Contracts AF-594 and AF-897 (both white) covered the development and production efforts of the vehicle Command Subsystems including STE, AGE and facilities.

(1) AF-594 was negotiated as a CPIF with cost and schedule parameters. Under this incentive arrangement the contractor shared cost variances from target cost up to plus or minus 5% at the ratios of 85/15. Target fee was 8.0%. The contractor could earn as much as 13% or lose down to 3%, respectively, for underruns or overruns to a maximum gain/loss of [redacted]. Schedule incentive was a penalty of [redacted] for the first unit and [redacted] for each subsequent flight unit up to a maximum of [redacted]. All six flights were flown at 100% success. Pending completion of determination of final costs the following are the estimated fee results:

Target fee
Cost Penalty
Schedule Penalty
Net loss
Net fee
[redacted]

(2) AF-897 was negotiated as a CPIF-P contract utilizing the "Specialized Incentive Contract Structure" of 15% for performance and covered flight units 10 through 25. Of the sixteen flights flown, fourteen were scored at 100% success. Of the two units flown with anomalies, Flight 7 was scored at [redacted] penalty points and Flight 16 at [redacted] penalty points resulting in a total fee loss of [redacted]. Cost incentives were negative only and had sharing ratios of 90/10 up to 15% over target cost, 80/20 from 16 to 30% and in excess of 30% to a maximum of [redacted]. Schedule and combined system test penalties of minus 1% respectively were applied to each unit to a maximum of [redacted] for each parameter. Flight unit 13 experienced a system test failure of [redacted]. No schedule penalties were experienced. Pending completion of final cost, the following are the final results: ($ earned)

Target fee
Par Performance
Adjusted Performance
C/ST Failure (loss)
Cost (loss)
Net fee
[redacted]

General Electric - Re-Entry Systems Department

a. Black contract [redacted] covered the production of SRV's 6 thru 22. (All development work and flight models 1 through 5 was accomplished on a subcontract basis under prime contract AF-2108 with Eastman Kodak.) The contract was a FPIF contract with cost and delivery incentives. Cost ceiling was 11.7% with sharing of 70/30. Schedule incentive was 1% of target cost over 4 weeks, shared at the rate of 10% for the week 1, 25% for week 2, 30% for week 3 and 35% for week 4. The contractor experienced an overrun of [redacted] and all deliveries were on time. Final results are:

Cost
Fee
Price [redacted] (fee loss of [redacted])

General Electric - Spacecraft Department

a. White contract AF-693 was a CPIF contract for mission planning software. Cost share ratio was 85/15. The contract target fee was [redacted] 8.5% of target cost. Final fee was increased to [redacted] due to an underrun.

b. White contract [redacted] was a CPFF contract for mission planning software with a fixed fee of [redacted] equivalent to 8.3% of final estimated cost.

c. White contract [redacted] is a CPFF follow-on contract to [redacted] to provide continuing software support. The contract is still active. The fixed fee is [redacted] 8.6% of estimated cost.

d. White contract AF-636 was a CPIF contract with target cost of [redacted] and cost incentives only at a sharing ratio of 86/14. The effort was for a SCS parallel study. The target fee was increased by an underrun and the final fee amount was [redacted] to 8.2%.

TRW, Inc.

a. White contract [redacted] was a CPIF contract, with cost incentives only and a sharing ratio of 75/25, to provide mission planning software for earlier versions of GAMBIT vehicles. The contract remained active over the transition from the earlier versions. Target fee was [redacted]. The final adjusted fee is expected to be [redacted] as a result of reduction due to an overrun.

b. White contract [redacted] was a CPIF follow on to [redacted]. Cost incentives only were applied at the ratio of 75/25. Target fee was [redacted]. Actual fee is expected to be [redacted] when final rates are established and the contractors underrun computed.

Eastman Kodak

Contract [redacted] covered development, test production and launch support for Photographic Payload Section vehicles number one through twenty-two including facilities, STE, AGE and launch support. The first five SRVs were included in this contract on a subcontract basis with GE-RSD. The contract effort also included design, development and test of the follow-on Dual-Recovery version PPS. A CPFF contract was negotiated at a fixed-fee rate of 7.7%. Final fee is expected to be [redacted], equivalent to 6.18% of final estimated cost.

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LIST OF SAFSP GAMBIT CONTRACTS

NUMBER	TYPE	SECURITY	WITH	FOR	LIFE	FINAL PRICE	FEE EARNED (% OF ACTUALS)
AF-619	CPIF-P	(White)	LMSC	Des. Dev. & Prod 6 SCS	Jul 64-Aug 67	[redacted]	13.0
[redacted]	CPIF-P	(Black)	LMSC	Des. Dev. & Prod 6 PAS	Jul 64-Aug 67	[redacted]	10.4
AF-896	CPIF-P	(White)	LMSC	Des. Dev. & Prod 16 SCS (includes: SGLS, DRM, PACS, RACS.)	Jan 66-Dec 69	[redacted]	13.9
[redacted]	CPIF-P	(Black)	LMSC	Des. Dev. & Prod 16 PAS	Jan 66-Jul 69	[redacted]	14.5
AF-594	CPIF-PV	(White)	GE-LMED	Des. Dev. & Prod 9 C/SS	May 64-Aug 67	[redacted]	4.4
AF-897	CPIF-P	(White)	GE-AED	Des. Dev. & Prod 22 C/SS	Nov 65-Aug 68	[redacted]	13.3
[redacted]	FPIF	(Black)	GE-RSD	Recurring 17 RSVs	Dec 65-Jul 69	[redacted]	10.4
	CPFF	(Black)	EKC	Des. Dev. & Prod 22 PPS	Mar 64-Dec 69	[redacted]	6.2
[redacted]	CPIF	(White)	TRW	Software	Apr 66-Dec 67	[redacted]	10.8
	CPIF-V	(White)	TRW	Software	Jan 68-Nov 69	[redacted]	10.9
AF-693	CPIF-V	(White)	GE-Spacecraft	Software	Sep 64-Feb 67	[redacted]	9.2
[redacted]	CPFF	(White)	GE-Spacecraft	Software	Jul 68-Current	[redacted]	8.6
AF-0014	CPFF	(White)	GE-Spacecraft	Software	Dec 66-Jul 68	[redacted]	

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LIST OF SAFSP GAMBIT CONTRACTS (Con't)

NUMBER	TYPE	SECURITY	WITH	FOR	LIFE	FINAL PRICE	FEE EARNED (% of ACTUALS)
MISCELLANEOUS							
AF-636	CPIF	(White)	GE-ASPD	SCS Parallel Study	Jul 64-May 65	[redacted]	8.2
[redacted]	CPFF	(Black)	Perkin-Elmer	Glass Polishing	Oct 66-Sep 68	[redacted]	7.8
Related Work:							
[redacted]	CR	(Black)	[redacted]		Jul 66-Current	[redacted]	0
[redacted]	CPFF	(Black)	LMSC	[redacted]	Aug 66-May 69	[redacted]	8.2
[redacted]	FFP	(Black)	Sylvania Corp	[redacted]	Apr 67-Sep 69	[redacted]	N/A
[redacted]	FFP	(Black)	Sylvania Corp	[redacted]	Aug 66-Current	[redacted]	N/A

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OVERALL FEE EARNING

PRINCIPAL SAFSP CONTRACTORS ON TOTAL GAMBIT WORK

CONTRACTOR	NO. OF CONTRACTS	ACTUAL COST [redacted]	[redacted]	ACTUAL FEE (% OF ACTUAL COST)
LMSC	5	[redacted]	[redacted]	12.3
GE	7			8.3
EKC	1			6.2
TRW	2			9.8
OTHERS	4			.02
	19			8.84 (average)

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RESULTS OF INCENTIVE FEATURES ON GAMBIT CONTRACTS

CONTRACT	FEE GAIN (LOSS) FOR:			NET FEE GAIN (LOSS)	RESULTANT FEE EARNED	% OF ACTUAL COST
	PERFORMANCE	SCHEDULE	COST			
LMSC - 619	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	13.0
LMSC - [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	10.4
LMSC - 896	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	13.9
LMSC - [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	14.5
GE - 594	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4.4
GE - 897	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	13.3
GE - [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	10.4
GE - 693	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	9.2
GE - 636	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	8.2
TRW - [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	10.8
TRW - [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	10.9

* Estimated
** Reduction due to combined system test failure.

ATTACHMENT 1

PROJECT HISTORY

1. As was the Gambit (206) project, Gambit (110) was managed entirely by SAFSP, which had responsibility for development, production and operation of all system components. With this span of responsibility, SAFSP was able to coordinate efforts towards obtaining increasingly better resolution photography. The final Gambit (110) mission obtained a best ground resolution by [redacted] target determination of [redacted]. Gambit (110) initial development began in March 1964, approximately 28 months before the first Gambit (110) flight of July 1966. The success of Gambit (110) project brought about the termination of Gambit (206) project which had its thirty-eighth and last flight in June 1967.

2. The launch system configuration of the Gambit (110) project differed considerably from that of the Gambit (206) project. Major launch system changes incorporated at the onset of Gambit (110) were:

a. The two-stage Titan IIIB was the booster for ascent from the pad.

b. A roll joint was used between the payload and the Agena stage. In this configuration, the payload and Agena orbited together throughout the mission with roll joint movements as required for photographs in track or either side of track. The Agena was the orbit control vehicle or Satellite Control Section, as well as the orbit injection booster.

c. The Gambit (110) Photographic Payload became a separate section which adapted to the Agena (Satellite Control Section). This configuration differed very much from the earlier Gambit arrangement in which the payload fit within the orbital control vehicle. The Gambit (110) optics were arranged to achieve a focal length of 160 inches, a change from 77 inches for the Gambit (206) system.

d. The "factory-to-pad" concept became a reality with Gambit (110). The Titan IIIB booster, Agena with roll joint, and photographic payload section were shipped separately to Vandenberg AFB and assembled on the launch pad. This required more thorough testing at the "factory" before shipment and reduced the testing and hardware changes required at Vandenberg AFB.

3. Two important changes made during the deployment of Gambit (110) were:

a. The primary film was changed from a thin base to an ultra-thin base which increased the film capacity from about 3,000 feet to about 5,000 feet. Ultra-thin base film was used on Flights 3 through 22.

b. A Redundant Attitude Control System (RACS) was first flown and tested during solo flight or Flight 16. Fortunately, the RACS was included on all subsequent Agena vehicles and was necessarily used during the primary portion of Flights 17, 18 and 20.

4. Principal components and their manufacturers were:

Payload	EKC
Re-entry Vehicle	GE/RESD
Agena Stage	LMSC
Command Subsystem	GE/AE
Titan IIIB	Martin Marietta

5. During the life of the project, these were the key personnel:

a. DNRO:

Mar 64 - Sep 65	Dr B. McMillan	Initial Development
Sep 65 - Mar 69	Dr A. H. Flax	Development, Flights 1 through 20
Mar 69 - Conclusion	Dr J. McLucas	Flights 21 and 22

b. Director of Special Projects

Mar 64 - Jul 65	MajGen R. Greer	Initial Development
Jul 65 - Conclusion	MajGen J. Martin, Jr	Development, All Flights

c. Program Director

Mar 64 - Sep 66	Col W. King, Jr	Initial Development, Flight 1
Sep 66 - Jun 68	Col [redacted]	Flights 2 through 14
Jun 68 - Conclusion	Col [redacted]	Flights 15 through 22

6. The following Table 1 contains some important data about each of the 22 Gambit (110) flights.

ATTACHMENT 2

GRAPHS

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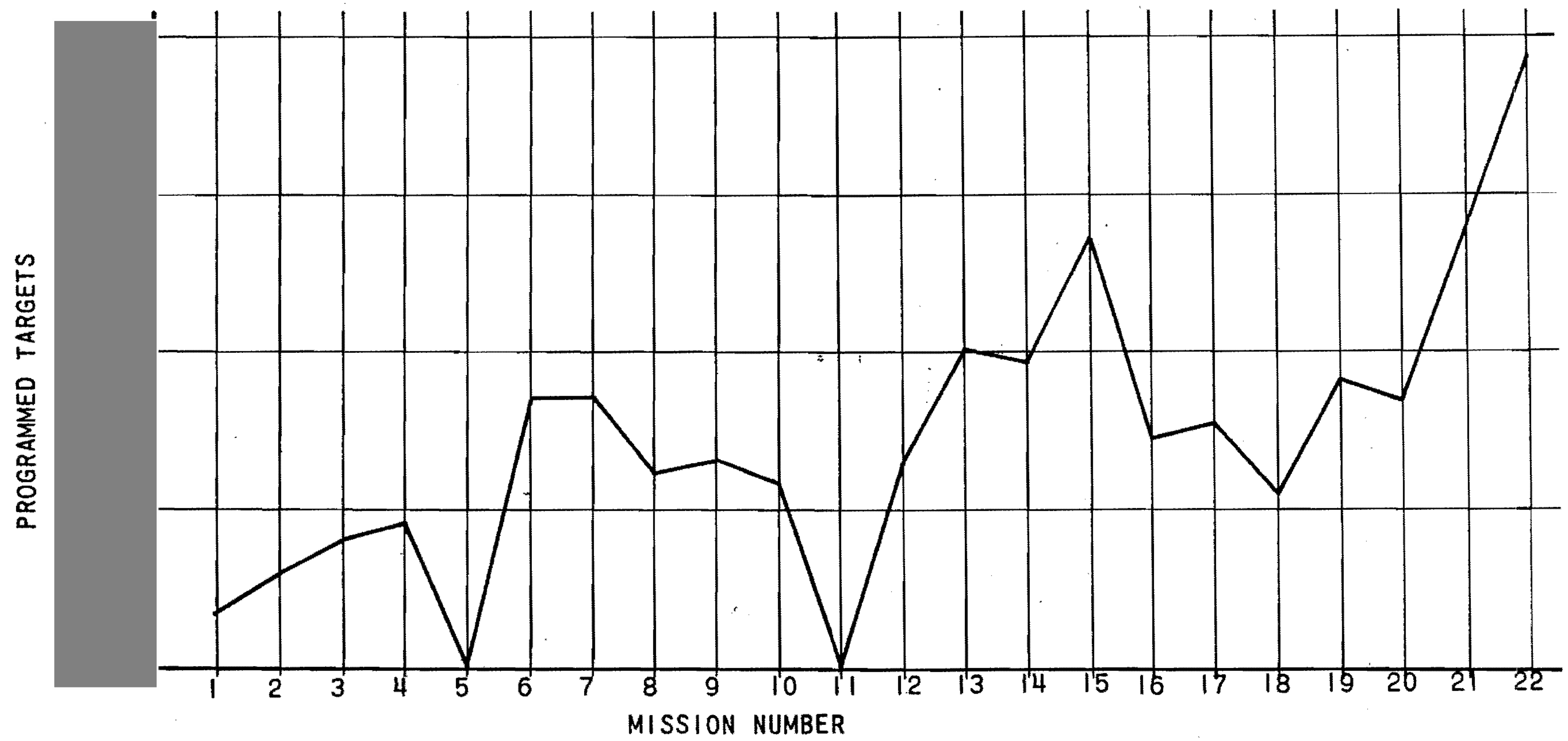

Figure 1 TOTAL PROGRAMMED TARGETS BY MISSION

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ATTACHMENT 5

GAMBIT (110) COST DATA - VEHICLES 1-22

1. The total program of [redacted] includes the following:

a. Twenty-two satellite vehicles, boosters, Agenas, payloads, and recovery vehicles launched. Some vehicles are configured with RACS [redacted] and Redundant Roll Joints with effectivities as indicated.

b. Titan IIIB costs include the [redacted] allocated directly to the Titan SPO for development of the booster, required pad modifications, and payment for the first booster/Agena and their associated launch costs.

c. Command Subsystem costs include twenty-two flight systems and nine spares.

d. Aerospace, Mission Planning and General Support costs include effort through the final launch of Vehicle 22 (June 1969).

e. Although non-recurring investment costs are segregated in total on the contracts, they are not segregated by fiscal year. The allocation shown is based on the best judgment of the Program Office.

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[redacted]

GAMBIT NON-RECURRING INVESTMENT
BY FISCAL YEAR - VEHICLES 1-22

	FY-64	FY-65	FY-66	FY-67	FY-68	FY-69	TOTAL
WHITE	[redacted]						
Spacecraft							
Booster Hardware							
Booster Pad Mod							
Command Subsystem							
Agena Hardware							
RACS (eff #16)							
Agena Improvement							
Pad Disaster Pool							
GE Parallel Study							
Industrial Facilities							
Sub-Total							
BLACK	[redacted]						
PAS/Roll Joint							
Payload							
Recovery Vehicle							
Redundant R/J (eff #12)							
[redacted] (eff #10)							
Equipment Move							
Industrial Facilities							
Sub-Total							
GRAND TOTAL							

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GAMBIT (110) COST SUMMARY - VEHICLES 1-22

	FY-64	FY-65	FY-66	FY-67	FY-68	FY-69	TOTAL
WHITE	[redacted]						
Spacecraft							
Booster Hardware							
Booster Launch							
Booster Pad Mod							
Command Subsystem							
Agena Hardware							
Agena Launch							
RACS (eff #16)							
OTEX (eff #10)							
Agena Improvement							
Pad Disaster Pool							
GE Parallel Study							
Aerospace							
Mission Planning							
Industrial Facilities							
General Support							
Sub-Total							
BLACK	[redacted]						
PAS/Roll Joint							
Payload							
Recovery Vehicle							
Redundant R/J (eff #12)							
[redacted] (eff #10)							
Equipment Move							
Industrial Facilities							
Sub-Total							
GRAND TOTAL							

[redacted]

GAMBIT (110) NON-RECURRING AND RECURRING PER UNIT COST SUMMARY VEHICLES 1-22

	Non-Recurring	Recurring/Unit Systems 1-6 ①	Recurring/Unit Systems 7-22 ①	TOTAL
WHITE	[redacted]			
Spacecraft				
Booster Hardware				
Booster Launch				
Booster Pad Mod				
Command Subsystem				
Agena Hardware				
Agena Launch				
RACS (eff #16)				
[redacted] (eff #10)				
Agena Improvement				
Pad Disaster Pool				
GE Parallel Study				
Aerospace				
Mission Planning				
Industrial Facilities				
General Support				
Sub-Total				
BLACK	[redacted]			
PAS/Roll Joint				
Payload				
Recovery Vehicle				
Redundant R/J (eff #12)				
[redacted] (eff #10)				
Equipment Move				
Industrial Facilities				
Sub-Total				
GRAND TOTAL				

① Numbers in parenthesis show the inclusive number of equivalent systems.

② 6 flight units plus 3 spares

③ 16 flight units plus 6 spares

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[redacted]

GAMBIT (110) FLIGHT COST BY CALENDAR YEAR
VEHICLES 1-22

	CY-66 (3)	CY-67 (7)	CY-68 (8)	CY-69 (4)	TOTAL
WHITE					
Spacecraft	[redacted]				
Booster Hardware					
Booster Launch					
Command Subsystem					
Agena Hardware					
Agena Launch					
RACS (eff #16)					
[redacted] (eff #10)					
Aerospace					
Mission Planning					
General Support					
Sub-Total					
BLACK					
PAS/Roll Joint	[redacted]				
Payload					
Recovery Vehicle					
Redundant R/J (eff #12)					
[redacted] (eff #10)					
Sub-Total					
GRAND TOTAL					

The above summary shows the costs in the calendar year of flight and does not consider long lead funding.

The totals by Calendar Year plus the cost of nine spare Command Subsystems [redacted] plus the non-recurring of [redacted] reconciles to the total program cost for Vehicles 1-22 of [redacted].

Numbers in parenthesis reflect the number of flights during the calendar year indicated.

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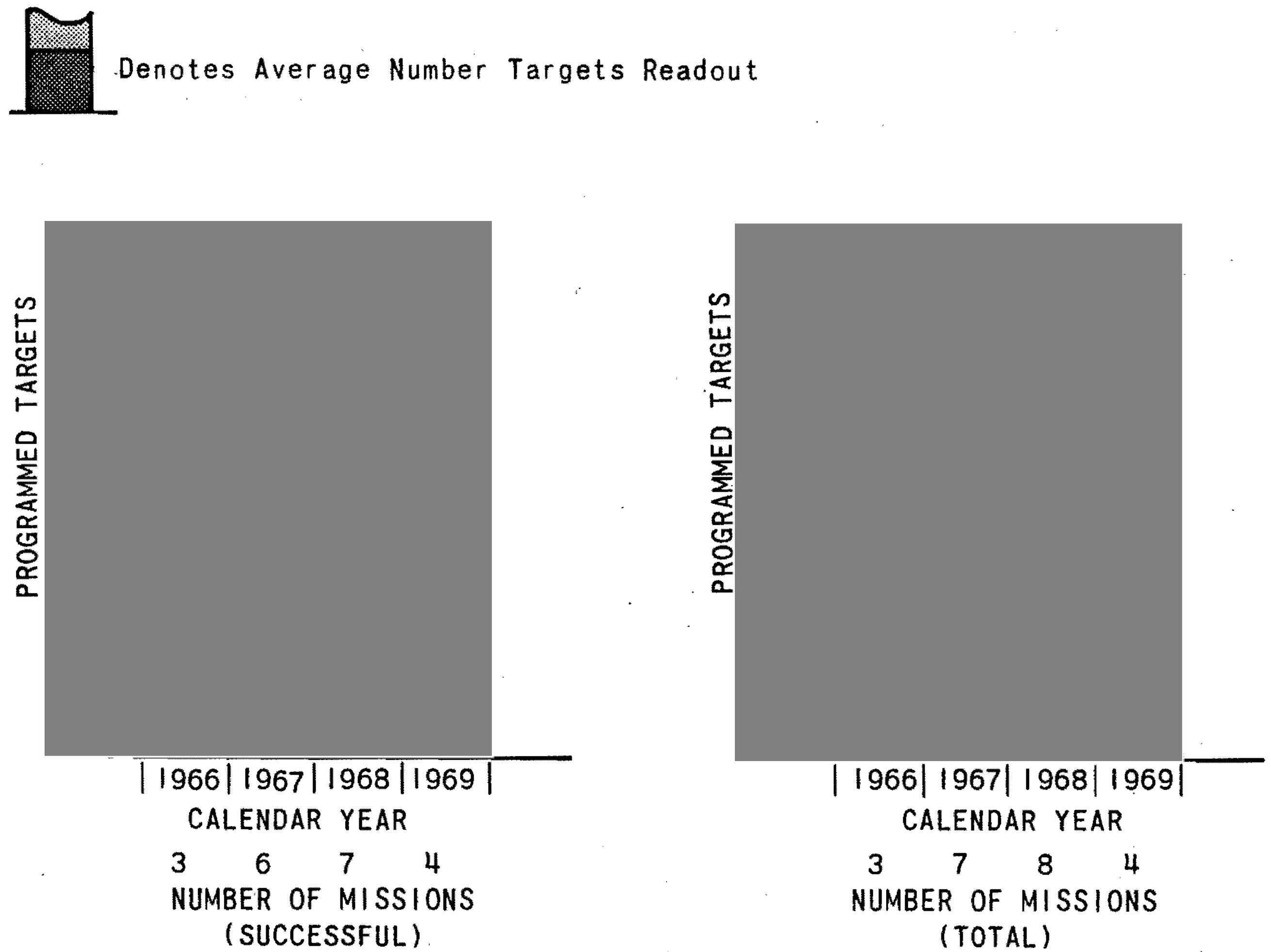

Figure 2 AVERAGE TARGETS PER MISSION BY CALENDAR YEAR

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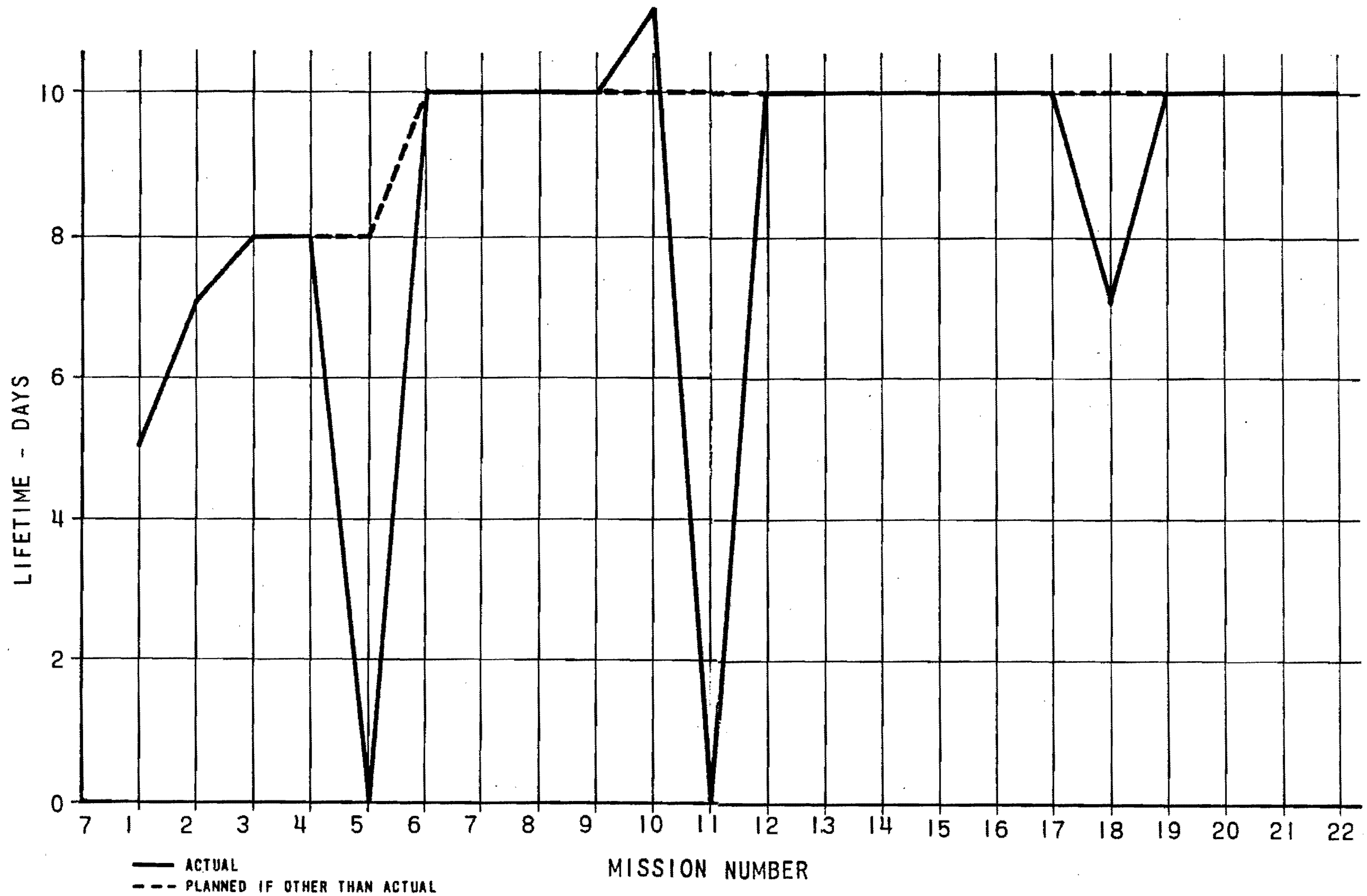

Figure 3 ACTUAL vs PLANNED ORBITAL LIFETIME BY MISSION
(SOLO MISSION NOT INCLUDED)

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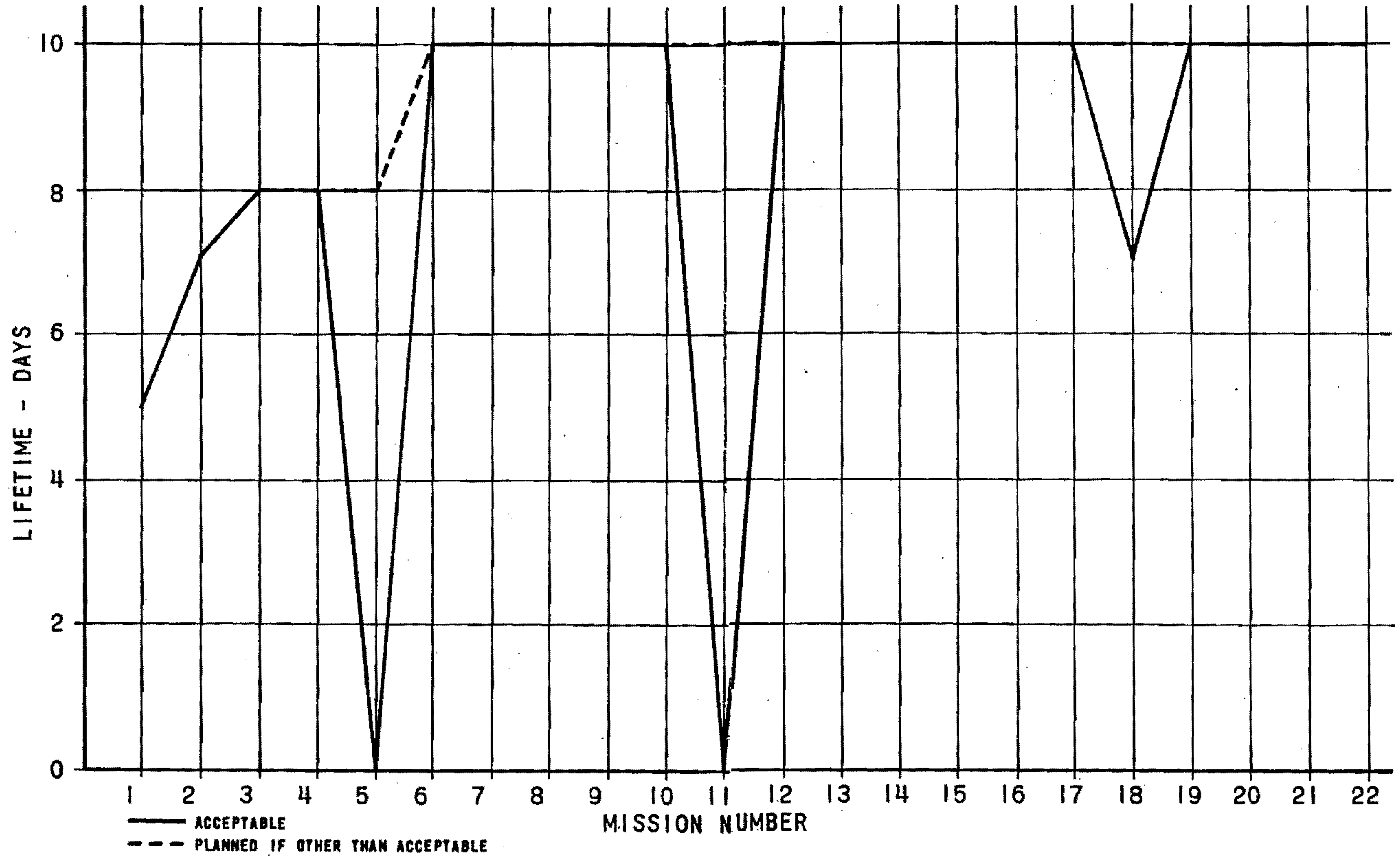

Figure 4 ACCEPTABLE vs PLANNED ORBITAL LIFETIME BY MISSION
(SOLO MISSION NOT INCLUDED)

[redacted]

1 2 3 4 6 7 8 9 10 12 13 14 15 16 17 18 19 20 21 22

MISSION NUMBER

(SUCCESSFUL MISSIONS)

Figure 5 BEST GROUND RESOLUTION [redacted] BY MISSION

TABLE 1

GAMBIT (110) FLIGHT DATA

FLIGHT NO.	LAUNCH DATE	LAUNCH TIME (GMT)	INCLINATION (DEGREES)	APOGEE/PERIGEE AFTER INJECTION (NM)	RECOVERY REV	RECOVERED	DEBOOST REV	TARGETS PROGRAMMED	TARGETS READOUT	BEST RESOLUTION (INCHES)	PRINCIPAL PROBLEMS DURING OPERATION
1	29 Jul 66	1830	94.15	150.33/84.43	83	Yes	130	[redacted]	[redacted]	[redacted]	APTC shutter malfunction (APC intermittent); Slit position fixed (No. 4); RJ constrained, ± 35°
2	28 Sep 66	1907	94.0	176.07/83.93	115	Yes	147	[redacted]	[redacted]	36	APTC disable prior to flight (erratic behavior of advance mechanism)
3	14 Dec 66	1814	109.5	221.95/82.64	131	Yes	162	[redacted]	[redacted]	[redacted]	ECS command system problem, memory channel 22, Revs 28-31; APTC (APC shutter, intermittently stuck open)
4	24 Feb 67	1959	107.0	231.2/76.90	131	Yes	163	[redacted]	[redacted]	27	APTC (APC shutter failed in open position, Rev 46)
5	26 Apr 67	1800	-	-	-	No	-	[redacted]	[redacted]	-	Titan IIIB Second Stage failure (ΔV 8,000 fps low); Failed to obtain orbit
6	20 Jun 67	1615	111.42	196.15/75.21	164	Yes	165	[redacted]	[redacted]	[redacted]	Titan IIIB Second Stage skirt failure (ΔV of 88 fps low); RJ positioning error, Rev 64, certain angles were unattainable to end of flight
7	16 Aug 67	1707	111.58	252.91/79.95	163	Yes	195	[redacted]	[redacted]	[redacted]	Primary RJ release failed (B/U system functioned properly); ECS failure (delay line 12, Rev 39; delay line 11 intermittent, Revs 62-65)
8	19 Sep 67	1837	106.12	241.97/70.93	163	Yes	164	[redacted]	[redacted]	[redacted]	None
9	25 Oct 67	1915	111.56	243.70/74.21	163	Yes	164	[redacted]	[redacted]	[redacted]	Film handling system stalled (primary, Rev 155, Loss 200')
10	5 Dec 67	1845	109.57	248.90/77.09	178	Yes	179	[redacted]	[redacted]	[redacted]	SCS pitch valve intermittent failure to fire, Rev 103; ECS Decoder 2 failure, Rev 163; TC failure, Rev 37

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GAMBIT (110) FLIGHT DATA (Con't)

TABLE 1
Page 2

FLIGHT NO.	LAUNCH DATE	TIME (GMT)	INCLINATION (DEGREES)	APOGEE/PERIGEE AFTER INJECTION (NM)	RECOVERY REV	RECOVERED	DEBOOST REV	TARGETS PROGRAMMED	TARGETS READOUT	BEST RESOLUTION (INCHES)	PRINCIPAL PROBLEMS DURING OPERATION
11	18 Jan 68	1904	111.54	241.12/70.90	163	No	274	[redacted]	[redacted]	-	SRV parachute deployment system failed
12	13 Mar 68	1951	99.87	235.94/73.26	163	Yes	164	[redacted]	[redacted]	[redacted]	TC failed, Rev 4
13	17 Apr 68	1700	111.50	246.25/73.84	163	Yes	196	[redacted]	[redacted]	[redacted]	None
14	5 Jun 68	1733	110.55	251.11/69.89	163	Yes	196	[redacted]	[redacted]	[redacted]	Tape recorder failed, Rev 66
15	6 Aug 68	1630	110.0	250.60/69.36	162	Yes	163	[redacted]	[redacted]	[redacted]	TLM Ch 10 and 11 failed, Rev 9; [redacted] Rev 76; TC shutter failure
16	10 Sep 68	1830	106.0	235.81/70.77	163	Yes	238	[redacted]	[redacted]	[redacted]	Extended Command System failed on Rev 124
17	6 Nov 68	1910	106.0	224.32/72.71	163	Yes	212	[redacted]	[redacted]	[redacted]	PACS right head horizon sensor failed, Rev 38; RACS took over on Rev 41
18	4 Dec 68	1923	106.20	405.97/75.47	111	Yes	127	[redacted]	[redacted]	[redacted]	Ground guidance problem, Titan IIIB Second Stage burn to depletion; SPS single engine burn, Rev 93
19	22 Jan 69	1910	106.153	597.08/74.76	161	Yes	181	[redacted]	[redacted]	[redacted]	V/M failed, Agena burned to depletion; ECS Decoder 2 failed to execute PSPC's
20	4 Mar 69	1930	92.027	253.68/73.62	161	Yes	224	[redacted]	[redacted]	[redacted]	PACS failure, Rev 52 (Thrust valve); APC failure, Rev 24
21	15 Apr 69	1730	108.78	261.55/74.76	163	Yes	244	[redacted]	[redacted]	[redacted]	Ground guidance problem, slight inclination error; ECS Decoder 2 relay driver failed open; RACS failure, Rev 217
22	3 Jun 69	1649	110.03	239.07/75.36	163	Yes	179	[redacted]	[redacted]	[redacted]	None

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