CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1009-1 and 1009-2

FTV 1605; J-12

30 April 1965

Approved: [redacted]
Mgr.
Advanced Projects

Approved: [redacted]
Mgr.
Program [redacted]

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1605.

Lockheed Missiles and Space Company has the responsibility for evaluating payload performance under the Systems Integration and "J" System contracts.

This document is the final payload test and performance evaluation report for Missions 1009-1 and 1009-2 which was launched on 5 August 19[illegible]4.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1009-1 and 1009-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the J-12 payload system, to identify the source of in-flight anomalies and recommend the appropriate corrective action.

The performance evaluation was jointly conducted by representatives of Lockheed Missiles and Space Company (LMSC) and ITEK at the facilities of NPIC and AFSPPL. The off-line evaluation using Corona engineering photography acquired over the United States was performed at the individual contractors plants.

The quantitative data used for this report is obtained from government organizations. The diffuse density data, visual RES values and MTF/AIM resolution are produced by AFSPPL. The vehicle attitude error values, frame correlation times are made at NPIC who also supply the Processing Summary and MTF/AIM resolution reports published by [redacted]

Computer programs developed by A/P are utilized to calculate and plot the frequency distribution of the various contributors to image smear to permit analysis and correlation of the conditions of photography to the information content and quality of the acquired pictures. Computer analysis of the exposure, processing and illumination data provides the necessary data to analyze the exposure criteria selected for the mission.

SECTION 1
SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The payload section of Mission 1009, placed into orbit by Flight Test Vehicle #1605 and SLV-2A booster #413, consisted of two panoramic cameras, two Stellar-Index cameras, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipments. Figure 1-1 presents an inboard profile of the J-12 payload system. This Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. The planned mission was two, four day photographic periods separated by a seven day inactive period.

B. MISSION DESCRIPTION

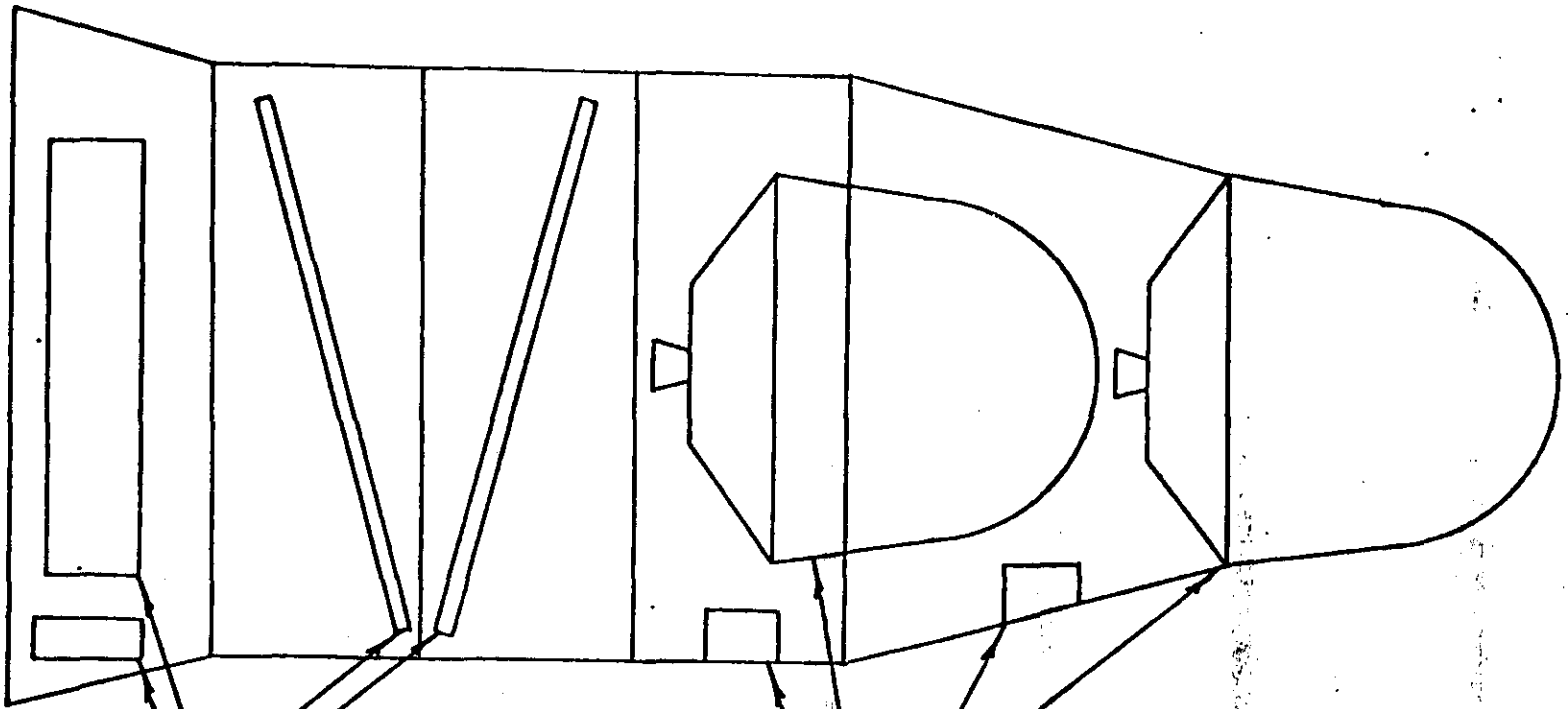
The payload was launched from Vandenberg Air Force Base (VAFB) at 2315:04 Z (4:15:35 PDT) on 5 August 1964. Ascent and injection were normal and the achieved orbit within nominal tolerances. Tracking and command support was effected by the Air Force Satellite Control Facility consisting of tracking and command stations at [redacted] under central control of the Satellite Test Center at Sunnyvale, California. Mission 1009-1 consisted of three days operation and was completed by air recovery on 8 August 1964. The mission was one day shorter than originally planned as a problem was encountered with the S-Band transponder. Mission 1009-2 was completed with an air recovery on 13 August 1964 following five days of photographic operations.

The comparison of the planned and actual orbit parameters is tabulated as follows:

[redacted]

SCHEMATIC INBOARD PROFILE - CORONA J SYSTEM

MISSION 1009



Master Camera No: 154

Slave Camera No: 155

Supply Cassette No: SC-15

Clock No: 517

Yaw Programmer No: 258

"A" Recovery Subsystem No: 646

"A" Stellar-Index Camera No: D56/54/56

"B" Recovery Subsystem No: 647

"B" Stellar-Index Camera No: D38/38/34

Pressure Make-up Unit No: 111

FIGURE 1

[redacted]

ORBITAL PARAMETERS

Parameter	Predicted	Orbit 1 Actuals
Period (Min.)	90.87	90.7
Perigee (N. M.)	100.00	99.6
Apogee (N. M.)	251.00	243.0
Inclination (Deg.)	80.00	80.1
Perigee Latitude (Deg. N.)	40.00	39.5
Eccentricity	0.02098	0.0198

A total of 770 feet of film remained on the Master camera supply spool after the completion of Mission 1009-2 while 885 feet remained on the Slave camera supply spool as a result of the early recovery of Mission 1009-1.

The Agena vehicle was deactivated and reactivated after the completion of Mission 1009-2. No problems were encountered.

C. PANORAMIC CAMERAS

The Master and Slave panoramic cameras operated throughout both missions with no significant problems and produced excellent photographic coverage. The cloud cover and atmospheric haze observed in the photography was high. A small area on the Master camera formats during the majority of Mission 1009-1 contained a small soft focus area which was not present during Mission 1009-2.

D. STELLAR-INDEX CAMERAS

The Stellar-Index cameras operated properly through both missions. The Index camera for Mission 1009-2 had a small light leak which was degrading only at camera sit times.

E. OTHER SUB-SYSTEMS

The clock, instrumentation, command and thermal control sub-systems performed satisfactorily through both missions.

F. CONCLUSIONS

Mission 1009-1 and 1009-2 achieved the objective of acquiring high quality search and reconnaissance photography from orbital altitudes.

G. RECOMMENDATIONS

The evaluation and analysis of the data produced by both missions has resulted in the following recommendations:

1. Incorporate the yaw programmer on all future Corona "J missions.

2. Continue the use of the Pressure Make-Up device on future missions but do not modify the present system test philosophy.

3. Continue the analysis of the cause of soft focus areas in the panoramic photography.

SECTION 2

PRE-FLIGHT SYSTEMS TESTS

A. ENVIRONMENTAL TESTING

1. Test Objective

As a standard procedure, the J payload systems are subjected to thermal/altitude environmental testing which simulates orbital environment. One of the purposes of this test is to demonstrate the system susceptability to corona discharge. Such discharge fogs the film thus degrading the operational photography.

2. Test Summary

The J-12 payload system completed a 5 1/2 day orbit simulation test at the Sunnyvale TASC Chamber. a seven (7) day test was initiated 4 June 1964 but was shortened by skipping orbits 6-14 of the SRV-B, second day.

The electrical and mechanical operation of the system was generally acceptable, except for the following: (1) There was no Stellar/Index installed during the SRV-"A" test. (2) Cycle rate predictability exceeded limits. (3) Clock interrogated randomly at Master camera "ON". (4) The yaw programmer failed after orbit 14 day 2. Several noise disturbances during operation scan periods. Two self-heating tests were conducted and showed good repeatability.

A pressure make-up system was tested on selected operations throughout the TASC test. Pressure data as recorded by an alphatron gage correlated with test payload indicated that start up corona did not appear when pressure make-up gas was turned on simultaneous with the instrument.

However, the master instrument showed excessive amounts of corona without the pressure make-up gas on, and the system returned to the HIVOS chamber for correctional tests.

The J-12 payload system completed a one day orbit simulation test in the Sunnyvale HIVOS chamber on 18 June 1964. The chamber was set for on-orbit temperature and pressure environ-

ment. This test was run in the "B" mission configuration to retest for corona markings as observed on the Master camera in the "B" mission of the TASC chamber test. The retest proved acceptable corona levels. The electrical and mechanical operation of the system was good. The following problems were noted: (1) Cycle rates exceeded the 1% predictability but were all within 0.5% fast to 2.1% slow. (2) Clock interrogated by the Master camera "ON" at random times. (3) The continuity loop/water seal monitor indicated that the S/I water seal did not close. (4) The clock indicated 49.1 seconds fast at the end of the test. Instrument temperatures were 70° at the start of the test and 82° at the end of the test. Self-heating corrections are applied.

The pressure make-up system was installed and operated on selected orbits throughout the test.

3. Panoramic Camera Performance

Cycle rate errors during Panoramic instrument operation exceeded the 1% predictability approximately 50% of all operations. Maximum deviation was 2.1% slow and 0.5% fast. The mean deviation was 1.3% slow for both instruments.

Evaluation of the test film showed that the Master camera produced minor start-up corona marking which was well within the acceptance criteria. The J-12 system was recommended for flight.

4. Stellar-Index Camera Performance

The Stellar-Index performance was nominal. A system was installed such that the S/I programmer input and/or output could be disabled. The S/I Programmer would get out of sync with the S/I when the programmer output was disabled. S/I performance resumed normal sequence within 14 frames of programmer output enable.

5. Instrumentation Performance

The continuity loop and water seal monitor (11-1-54) indicated that the S/I water seal did not close at transfer.

The skin temperature sensor #1 was out of band high (13-1-2).

The film footage pot consumption indication was in agreement with cycle counter.

Channel 18-1-00 exhibited 0.25 to 0.5V spikes when RTC 14 was executed.

Serious ground loop problems existed during instrument operate. T/M monitors referenced to 28V regulated return shift as much as 0.6 volts at instrument on to 2.5 volts when the two instruments center format occurs together.

6. Temperature Environment

Typical instrument temperatures recorded through the test are as follows:

Orbit	Master Camera	Slave Camera
1	70°	70°
5	69°	65°
10	68°	64°
16	66°	62°

7. Clock Performance

Clock performance, when compared to IRIG C, showed the following errors:

Orbit	Error (Accum. from Ø 1)
5	+ 16.398 seconds
10	+ 16.386 seconds
12	+ 16.404 seconds
15	+ 32.775 seconds
16	+ 49.141 seconds

8. Yaw Programmer

The yaw programmer operated satisfactory through the test. The period was a nominal 5300 seconds. The period duration during

one-orbit was 5281 seconds and the next orbit 5332 seconds. Phase relationship was proper and amplitude was 50 mv peak to peak.

9. Pressure Environment

The pressure environment of the instruments was less than 0.5 micron in a non-operating condition. The pressure would increase to a nominal 1 micron during operation when the pressure make-up system was not used. The pressure make-up system would cause the pressure to increase to a nominal 40 microns during an operate.

Typical pressures in microns of Hg as recorded are as follows:

Orbit	ALPHATRON Master Camera		ALPHATRON Slave Camera		Pressure Make-up System
	On	Off	On	Off	
1	0.8	10+	0.4	10+	ON
3	0.4	2.4	0.6	2.0	OFF
8	0.4	42	0.4	41	ON
10	0.4	0.9	0.4	0.9	OFF
13	0.55	39	0.5	44	ON
16	0.44	0.88	0.38	0.87	OFF

B. RESOLUTION TEST

The dynamic resolution test of the J-12 payload system was performed at the A/P facility on 19 June 1964. Each panoramic camera photographed high and low contrast resolution targets. The resulting through focus resolution data is shown in Figure 2-1 for the Master camera and in Figure 2-2 for the Slave camera.

C. LIGHT LEAK TEST

The examination of the film threaded in the J-12 system during the light leak test determined that no film fogging was present. The light tight integrity of the system was considered acceptable for flight.

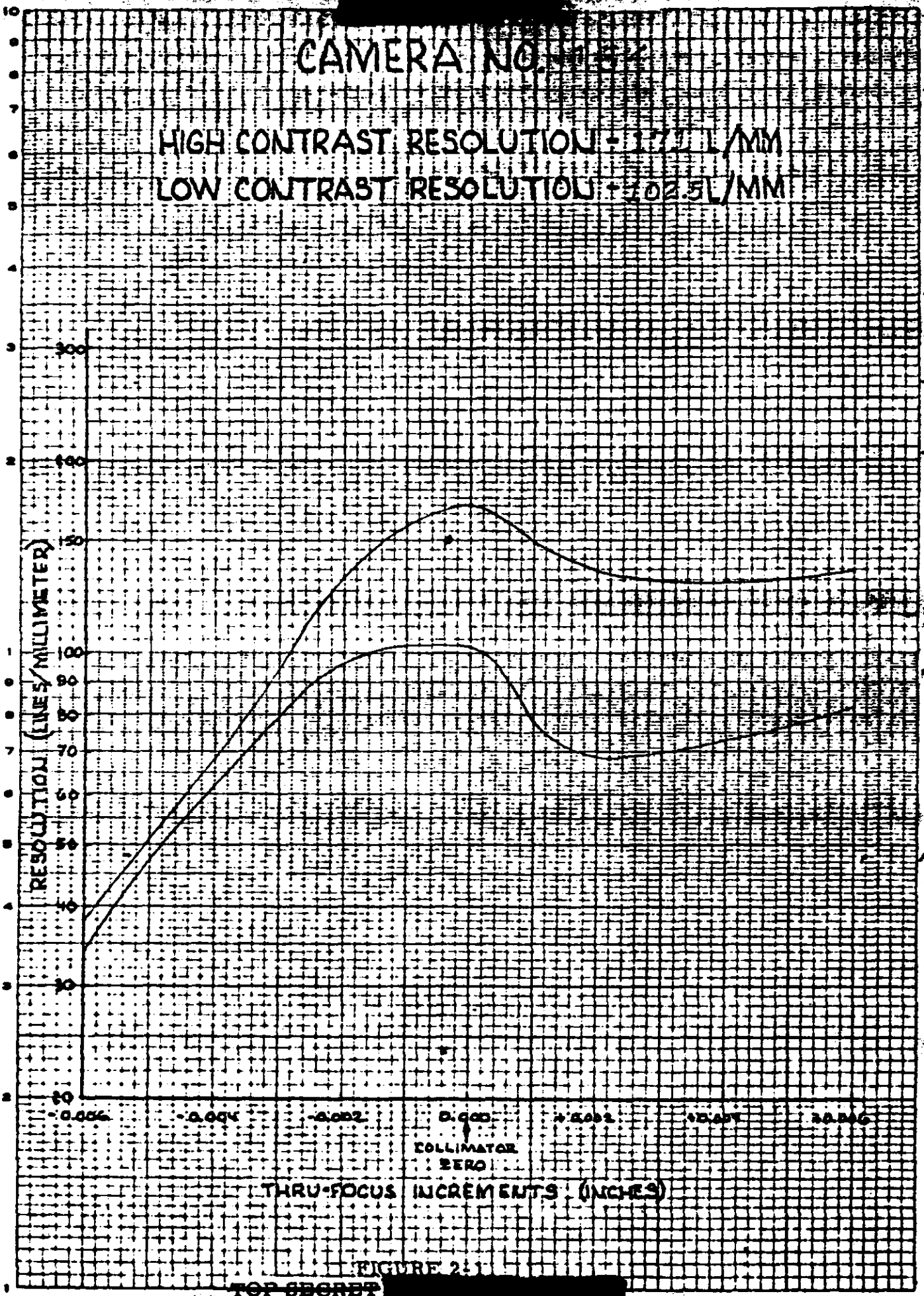


FIGURE 21

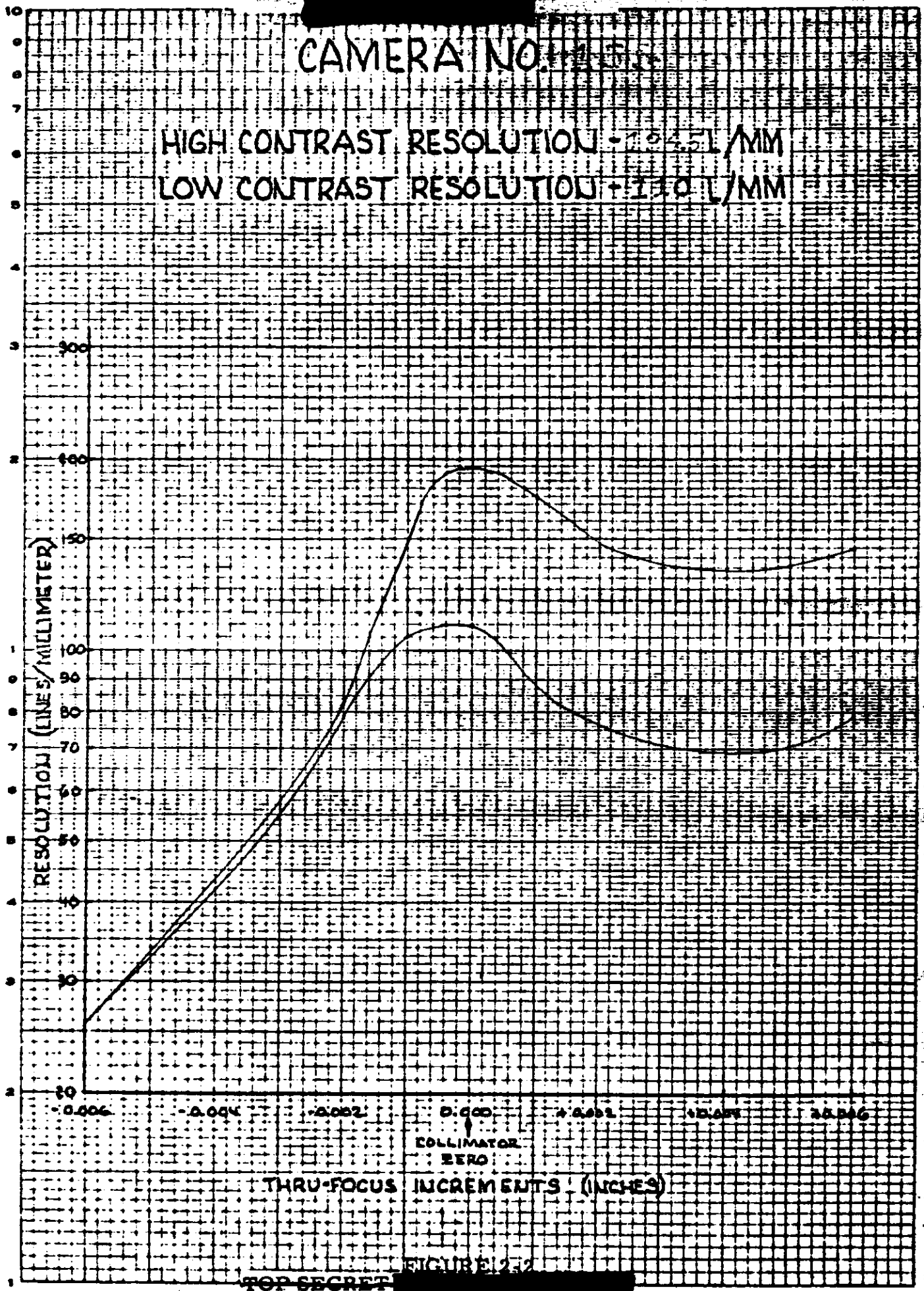


FIGURE 2-2

SECTION 3

FLIGHT OPERATIONS

A. INSTRUMENTATION AND COMMAND PERFORMANCE

All Instrumentation System functions operated properly throughout both missions. All monitors operated properly, except Fairing Temperature Sensor #6 (13-1-14) and Orbital Sine Function Generator Position (11.1-7).

The Fairing Temperature Sensor #6 (13-1-14) was open at injection into orbit. The sensor opened during ascent.

The orbital sine function generator position monitor failed on orbit 111 ascending, approximately 1000 seconds from the start point. The generator was enabled for 240 seconds on orbit 88 ascending, 132 ascending, 189 descending, and 205 descending. Vehicle phase response was proper in each case for the particular ascending/descending conditions. Post flight payload analysis also indicated that the function generator was operating properly through orbit 116.

The vehicle S-band transponder became intermittent on orbit 21. This condition presented some problems in tracking and commanding. This intermittent condition encouraged early recovery of Mission 1009-1. On orbit 56 the transponder transmitter failed. After this transmitter failure, commanding was accomplished with very few problems using alternate tracking and verification techniques.

B. PANORAMIC CAMERA PERFORMANCE

Both panoramic instruments operated properly throughout the mission. Camera operation was monitored on 9 operations during the active mission and 3 operations after completion of Mission 1009-2. Significant items of operation observed were as follows:

1. Maximum cycle rate deviations were +1.5% to -1.4% for the master instrument and +0.7% to -2.1% for the slave instrument.

2. The cut and wrap operation for Mission 1009-1 was normal.

3. A total of 4757 frames were taken on both instruments during Mission 1009-1 and 6236 frames during Mission 1009-2 as indicated by the cycle counters.

4. A total 770 feet of payload on the master supply spool and a total of 885 feet was left on orbit as a result of early recovery of Mission 1009-1.

5. The two instruments were operated in mono mode after re-activation.

Below is a tabulation of cycle rate history of actual vs. predicted of all operations observed during the active missions.

CYCLE PERIOD DATA

		Master			Slave		
Orbit	Time Up Ramp	Nominal	Actual	%Error	Nominal	Actual	% Error
1	2150	2.293	2.292	0	2.300	2.312	0.5 S
9	910	4.645	4.566	1.5 F	4.602	4.570	0.7 F
25	956	4.499	4.457	0.93 F	4.461	4.490	0.65 S
40	1005	4.344	4.328	0.40 F	4.310	4.336	0.6 S
47	2600	2.270	2.287	0.80 S	2.277	2.305	1.2 S
56	1050	4.210	4.270	1.4 S	4.180	4.270	2.1 S
72	1115	4.026	4.080	1.3 S	4.000	4.072	1.8 S
88	1168	3.678	3.740	1.2 S	3.676	3.728	1.4 S

F - Fast

S - Slow

The cut and wrap operation performed properly. The instruments operated for 4 cycles and stopped in the stow position.

The film payload consumption summary of the mission was:

	Master	Slave
Off Spool	200 Ft.	200 Ft.
Control Sample	109	109
Recovered - 1 Mission	6,628	6,558
Recovered - 2 Mission	8,293	8,248
Left on Orbit	770	885
TOTAL	16,000 Ft.	16,000 Ft.

Both cameras were operated after the completion of Mission 1009-2. The Slave camera was operated on orbit 139 (prior to deactivate) and the no-takeup failure mode was observed. The input metering was normal for 8 frames where it became erratic. After 11 frames, both the input and output idlers had stopped. The center format and lens rotation monitors continued to operate properly.

The Slave camera was operated after reactivation on orbit 189. The Master was operated after reactivation on orbit 190. No payload metering was observed on these two operations.

C. STELLAR-INDEX PERFORMANCE

The Stellar-Index units operated properly throughout both missions.

D. CLOCK PERFORMANCE

The clock gained the 15th bit 6 times through the mission. This problem occurred between orbits 8 and 9, between orbits 40 and 41, during acquisition of orbit 56, between orbits 95 and 103, and twice between orbits 110 and 119. When corrections were made for the added bits, correlation with system time was good.

E. ORBITAL SINE FUNCTION GENERATOR PERFORMANCE

Operation of the Orbital Sine Function Generator was normal throughout the mission. The output remained disabled until orbit 88 ascending. On this orbit the output was enabled for 240 seconds to test response from the guidance system. Analysis of the Guidance TM showed proper response to the generator output. The generator then was enabled on orbit 112 and remained enabled until orbit 119 where it was disabled. The T/M position monitor failed on orbit 111 ascending. Tests were made on orbit 135 ascending, 189 descending and 205 descending to determine that the generator output was still functioning. The output was enabled for 240 seconds in each case and vehicle guidance system response was proper for the orbital conditions. Post flight payload analysis also showed that the generator output was producing proper yaw error correction.

F. PRESSURE MAKE-UP SYSTEM PERFORMANCE

The pressure make-up system operated properly throughout the mission. The supply was adequate for the mission flown. The conic pressure increased from 1 micron to 60 microns during operates toward the end of the mission.

At launch the supply pressure was 2500 PSIA. At acquisition of orbit 1 [redacted]he pressure had increased to 2700 PSIA from ascent thermal environment. At the last operation of Mission 1009-2, the supply pressure was at 1075 PSIA. Figure 3-1 is a plot of Supply Pressure vs. Orbit Number of the Mission.

The Conic Chamber Pressure increased to above 10 microns in 5 seconds or less in all operations observed. The pressure regulator kept the chamber pressurized from 20 to 40 seconds after the instrument had shut off. This is a result of the regulator being located between the shutoff valve and the metering orifice. The time decreased as mission life increased. Figure 3-2 is a plot of conic pressure prior to instrument operate and the maximum pressure obtained during the operate. Figures 3-3 through 3-8 are conic chamber pressure profiles of orbits 9, 25, 40 72, 88 and 103 respectively.

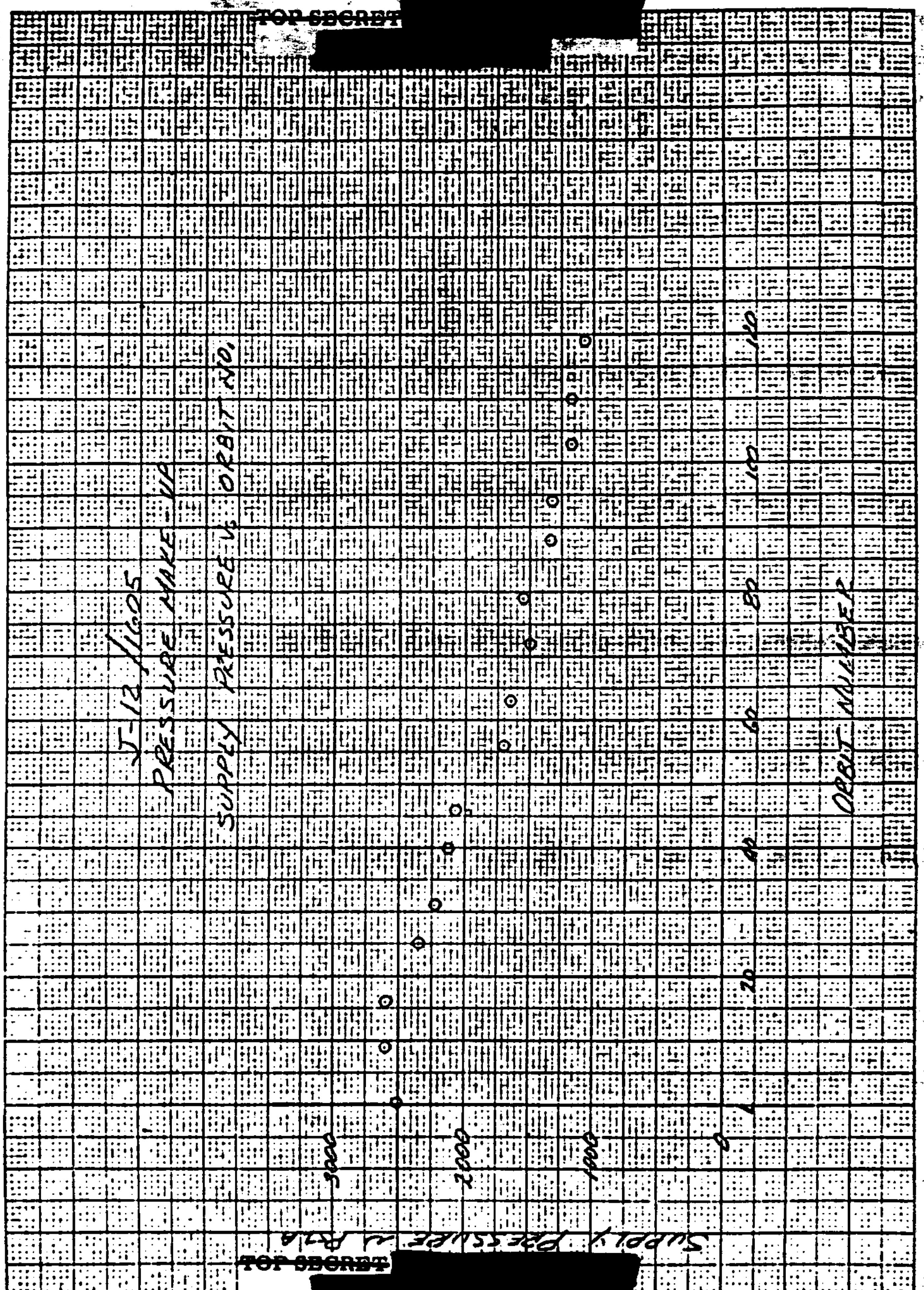

PRESSURE MAKE-UP
SUPPLY PRESSURE VS. ORBIT NO.
ORBIT NUMBER
SUPPLY PRESSURE IN PSIA
3000
2000
1000
0
20
40
60
80
100
120

FIGURE 3-1

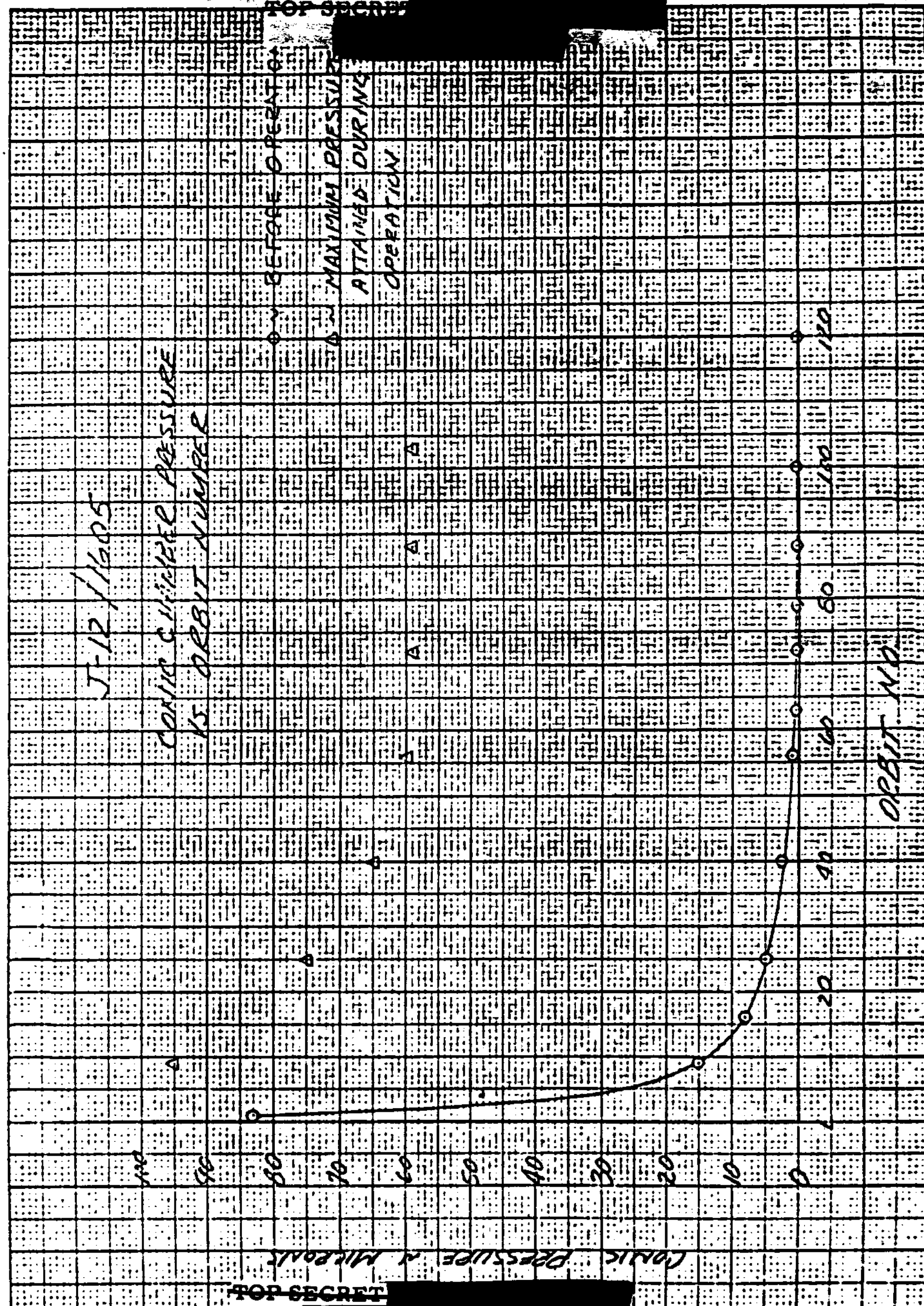

CONIC CHAMBER PRESSURE
VS ORBIT NUMBER
MAXIMUM PRESSU
ATTAINED DURING
OPERATION
CONIC PRESSURE - MICRONS
ORBIT NO.
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
100

FIGURE 3-2